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THE

CHRONIC DISEASES:

THEIR

SPECIFIC NATURE

AND

HOMŒOPATHIC TREATMENT.

BY

Dr. SAMUEL HAHNEMANN.

TRANSLATED AND EDITED

BY

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WITH A PREFACE

BY CONSTANTINE HERING, M.D.

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TO THE

HOMŒOPATHIC PHYSICIANS

OF

THESE UNITED STATES,

THIS PUBLICATION IS RESPECTFULLY INSCRIBED.

This is the first English translation which has ever appeared of Hahnemann's Chronic Diseases. It is needless to inquire why this admirable volume which incloses so many important truths, the proper knowledge and appreciation of which is indispensable to the homœopathic practitioner, should never have before appeared in an English dress. As this omission cannot have originated in indifference on the part of Hahnemann's disciples, the presumption is either that those few homœopathic physicians who are really imbued with the spirit of Hahnemann's doctrine, have been prevented by the pressure of business from undertaking the translation of this work, or else, that they were not sufficiently conversant with both the German and the English languages, to accomplish such a translation to their perfect satisfaction.

But for the admirable truths which Hahnemann points out in this volume, it probably would never be read in German. Hahnemann's phraseology is so involved, and bears so little resemblance to the usual modes of constructing periods, either in German or

any other language, that it is utterly impossible to furnish a bare translation of Hahnemann's writings. There is but one way of turning them into another language; this is, first, to master the sense of a period, and afterwards to embody it in the foreign tongue in a free manner. This is the course which I have pursued in translating this volume. I have not translated *words* but *ideas*. And the ideas I have rendered fully and faithfully: on this head I challenge criticism.

Of the merits of Hahnemann's theory of chronic diseases, I have nothing to say. It is not received with the same unbounded confidence by all homœopathic practitioners; but I venture to say that its general principles are fully admitted by all those who have a true perception of the spirit of the homœopathic doctrine.

It cannot be expected that the homœopathic doctrine should be fully understood as long as our knowledge of the nature and operations of the vital principle is deficient. Hahnemann's conception of the action of the homœopathic drug was altogether vague, incomplete, and even erroneous. My own conception of the homœopathic doctrine I have brought before the profession in my inaugural thesis. It is substantially as follows; and I wish it to be understood that I give it not as a mere speculation, but as a *demonstration*, so far, that is to say, as any physical truth can be demonstrated in the present state of our knowledge.

Inductive reasoning leads us necessarily to the admission of two orders of creative forces, one of which may be designated by the term *harmonic*, the other by the term *subversive*. The harmonic forces, by their action upon matter, produce those substances, animals, plants, and minerals, which are necessary to the development of the harmonious or healthy organism; the subversive forces, on the contrary, are those forces which produce the substances adapted to the organism in disturbance, and destined to restore it to its original conditions of health. Both those forces, by their action upon matter, embody themselves in

visible forms, each form representing or typifying a peculiar variety of those forces. The types or results which those forces create by their action upon matter, are united to those forces by that same indivisible bond which unites the effect to its cause.

The idea of a machine, and the machine itself, though they seem to be two distinct things, are nevertheless united to each other in such an indivisible manner as to make it utterly impossible to think of one separately from the other. The idea will at once call up the machine, and on viewing the machine, you are involuntarily reminded of the idea. The existence of a bond uniting effects to their causes, cannot be denied, although the nature of that bond may be totally unknown.

So far I have shown the existence of subversive creative forces and their subversive results, these latter being indivisibly united to the former. These results are the natural bases, or forms, or orders of existence of those forces. The embodying of those forces in their natural physical forms is effected according to order. But it often happens that those forces, instead of acting upon or embodying themselves in matter, act upon, and try to embody themselves in the animal organism. They then endeavour to adapt the animal organism to their own nature. This adaptation can only be completed by first destroying the organism, converting it to formless matter, and then impressing upon this formless matter their own creative energy.

It is evident that the animal organism is not the type or natural order of existence of those subversive forces. Hence there is no bond of union between these forces and the organism, and it must be possible to separate them. As the invasion of the organism by those forces and their attempts at adapting the organism to themselves constitute disease, so does the separation of those forces from the organism constitute the cure of that disease. The question then is, how are those forces to be separated from the organism?

The answer to this question is perfectly simple and self-evident. We introduce into the organism the natural types or forms of existence of that variety of subversive forces which has invaded the organism. These types being united to the forces by that indivisible bond which I have shown to exist between effects and their causes, the disease will, of its own accord, and with readiness, leave the organism which is not its natural product or type, and embody itself in its natural type which is the medicinal substance. How this embodying takes place is to be shown by the farther progress of science. It is probable that the typical substance acts upon the subversive force with a power of attraction. The subversive force flows into or converges in the medicinal substance which is its type. In the same way do the sun's rays converge in the focus of a burning-glass, does the magnetic sphere of this globe converge in the point of a needle and its attractive force act upon the smallest molecule. In order to find out what medicinal substance is typical of any given variety of the subversive forces, we must, in the first place try to discover the symptoms of the diseases which are embodied in the various medicinal substances. For this purpose we try them upon the healthy organism. The symptoms which are thus evoked in the organism are *indications* of the effects which a certain order of subversive forces is capable of producing in the organism. To the medicinal substances producing those symptoms, this certain order of subversive forces is therefore related as causes are to their effects, and as soon as they are brought in contact with each other, they become indissolubly united, the disease becomes a mere material point, and is separated from the organism in perfect freedom, and what is essential, *in perfect order*.

So far my conception of the homœopathic doctrine, in its general nature at least, amounts to a demonstration. But now the question occurs: by what process, in what manner does the invasion of the organism by the subversive forces take place and

is disease constituted? Here, I confess, science leaves us altogether, and any attempt at solving this problem, must necessarily be speculative reasoning.

One thing however is yet sufficiently clear; it is this, that the human organism cannot be invaded by disease unless it has first undergone a process of adaptation to the nature of a certain order of the subversive forces. An indigestion, for instance, can only take place, when the original harmony or equilibrium of the organism has been interfered with by substances having been introduced which are not adapted to the organism, or by those substances having been introduced in too large a quantity or at improper hours. What is termed indigestion, is therefore the effects of a peculiar order of subversive forces acting upon the organism existing in a peculiar state of preparatory adaptation. It is so with every other disease. *Disease is the totality of the effects by which we recognise or perceive the action of a peculiar order of subversive forces upon an organism which has been exceptionally or specially adapted to, or prepared for their reception.*

Hahnemann's theory of Chronic diseases corresponds exactly with my conception of the homœopathic doctrine. The itch-vesicle, the chancre, and the cauliflower excrescence, are vicarious embodiments of some internal disease, in a similar way as the homœopathic medicinal substance is the external visible type or embodiment of the internally acting subversive forces. There is this difference between that vicarious embodiment of the internal disease and the homœopathic type, that the latter may be introduced into the organism and be again, by its own choice, separated from it together with the disease, whereas the vicarious embodiment of the internal disease is the measure of the degree and mode of adaptation which the subversive forces have accomplished in the organism. Hence the vicarious embodiment or symptom is a mere palliative, whereas the homœopathic type has a curative effect.

Hahnemann's theory of Chronic diseases strikes a death-blow at those violent modes of invading the living organism, which are practised by the allœopathic physicians. The contents or the secretions of an organ are exactly proportionate to, or are the exact measure of the peculiar state of vitality of the organ. If the organ be invaded by subversive forces, those contents or secretions indicate the degree of adaptation existing between the subversive forces and the organ. Those contents act as palliatives inasmuch as they appease to a certain extent the fury of the invading forces. To deprive those forces of results which they claim as their legitimate property, would be to excite them into a more violent action and to cause them to attack the more delicate parts of the organism. I have explained this view more fully in my inaugural thesis and in my note on blood-letting. Allœopathic physicians and people generally are inclined to believe that retching indicating a desire of vomiting, or that tenesmus indicating a desire of going to stool, the system, in both these instances, may be and ought to be relieved by an emetic or a cathartic. To administer these violent remedial agents, is a foolish mode of relieving the system. Spontaneous vomiting or a spontaneous evacuation of the intestines may afford relief, because they are the natural terminations of a morbid development; but those artificial evacuations, though they may, for obvious reasons, by establishing a momentary counter-irritation for example, be momentarily followed by a semblance of relief, are not natural terminations of a morbid process, but they are concussions of the system taking place independently of the existing invasion of the organism by the subversive forces. Retching and tenesmus simply show that the subversive forces have not yet succeeded in adapting the organism to their own action, and that, so far from favouring this action by artificial means, the organism may be the more easily disembarressed from it by the homœopathic type.

The conception which I have offered of the homœopathic doctrine explains to a certain extent the rationale of the peculiar mode prescribed by Hahnemann for the preparation of homœopathic remedial agents. The medicinal substances are material forms in which the subversive forces have *embodied* their essence or spirit. That essence exists therefore in its fulness, though in a latent condition, in the medicinal substances. Now, in order that points of contact, of attractive affinity, may be established between the homœopathic type and the subversive forces which have invaded the organism, it becomes first necessary that the medicinal substance should, from its material nature, be raised to what Hahnemann terms a semi-vital or spiritualized condition. We know of no better mode to obtain this result than the mode of trituration proposed by Hahnemann. To excite the latent life or heat-principle of any known substance we resort to friction. We draw fire from wood by rubbing one piece against another. By friction we excite sparks from pebbles. By friction we excite the electric fluid. If any one knows a better mode than Hahnemann's of spiritualizing the typical forms of the forces productive of disease, let him propose it. The subsequent process of shaking is evidently analogous to the process of trituration. I believe, although I can only give this as a mere speculation, that the homœopathic preparation, be it administered in the form of a globule, powder, or drop, introduces into the organism an intermediate sphere of a semi-spiritual and semi-material nature, that the subversive forces flow into or converge in that sphere by virtue of its attractive spiritual power, and become gradually materialized by uniting themselves with the material nature of the sphere; after this process of materialisation is completed, the subversive forces leave the organism, together with their type, in perfect freedom, and, as I said above, *in perfect order*.

It is evident from what I have here advanced that the attractive

spiritual force of the homœopathic preparation increases in proportion as the process of trituration is carried up to a higher degree. Nevertheless there must be a limit beyond which the attractive spiritual force of the intermediate sphere may cease to act, on account of being *raised above the spheres* from which the subversive forces themselves emanate. The great difficulty, it seems to me, is, to discover the point, where the attractive force of the homœopathic type will exercise its due influence over the subversive forces in the organism. Can this focus of attraction be determined by experiment? Does it depend upon the nature of the medicinal substance? Does it depend upon the order in which the subversive forces creative of disease, are related to or super-imposed upon each other? Until questions like these shall have been solved, we shall have to depend greatly upon experience and careful observation for the determination of the most adequate degree of potency, in which homœopathic preparations should be exhibited in any given form of disease.

And we shall have especially to depend upon the word of the master.

The recklessness with which many homœopathic practitioners use either low or high potencies, and administer large or small doses, one, two, or three drops, just as it comes, or twelve, eighteen, or twenty globules just as they happen to drop out of the vial, is altogether unpardonable, and a species of quackery *sui generis*.

There are even homœopathic physicians who practise upon the principle that, if they do not know what remedy is homœopathic to a disease, they give the remedy which they suppose to be homœopathic, in a quantity sufficient *to make an impression upon the system*. Such horrible delusions can never blind the minds of those who *feel* the homœopathic doctrine in their souls.

I intended to have here instituted a sort of inquiry into the

scientific character of Hahneman's theory of the chronic miasm The results of my inquiry I shall communicate on some other occasion. Such an inquiry is necessarily connected with an inquiry into the whole physiological and psychological nature of man, and this preface is already too long to admit of any more space being devoted to farther considerations. I therefore take leave of the reader, and trust, that this little volume may prove acceptable to the veneration which he doubtless feels for the great author of homœopathy.

CHARLES J. HEMPEL, M.D.

NEW-YORK, April, 1845.

Mr. RADDE takes this opportunity of informing the Profession, and those persons generally who are friendly to Homœopathy, that the publication of the present volume will be immediately succeeded by that of the anti-psoric remedies, the first series of which, comprising "agaricus muscarius, ammonium carbonicum, ammonium muriaticum, anacardium, baryta, borax, calcarea carbonica," is now in the press, and will be for sale at Mr. Radde's book-store on the 15th of June next.

The anti-psoric remedies acquire an additional interest from the fact that Hahnemann himself has pointed out the diseases in which every anti-psoric remedy has been found most eminently useful.

On the first of August next will appear the first series of the remedies constituting Hahnemann's Materia Medica Pura. This series will comprise belladonna, pulsatilla, and arnica. If it is at all probable that the expenses of the publication of this great work will be covered, no efforts will be spared to secure it as speedy a termination as is consistent with the great care which the translation of Hahnemann's writings demands. Every admirer of Homœopathy should possess himself of Hahnemann's materia medica, as the greatest monument of his genius and perseverance.

The translation of this work will be achieved by Dr. Hempel, who is intimately acquainted with all the idioms and peculiarities of the German language, and will give a correct translation of every symptom contained in Hahnemann's Materia Medica. No one but a German scholar is competent to translate homœopathic works from the German.

All those who feel disposed to procure Hahnemann's great work, are respectfully requested to signify their intentions to Mr. Radde, so that he may be able to calculate the probable chances of his enterprise, and carry it out with proportionate energy.

Every series, of about 200 pages each, will be paid for in proportion as it leaves the press.

W. RADDE takes also this opportunity to inform the Physicians and the Friends of Hahnemann's System, that he is the sole Agent for the Central Homœopathic Pharmacy at Leipzig in the United States, and that he has always on hand a good Assortment of

HOMŒOPATHIC MEDICINES

in their different preparations, as Essences (Tinctures) Triturations and Dilutions, put up in cases containing 415 vials, with tinctures and triturations; ditto with 175; ditto cases containing 144 vials, with low Dilutions and medicated pellets. Cases containing from 27 to 400 vials, with pellets medicated with different (low and high) dilutions. Boxes with 60-80 vials containing medicated pellets. Double and single leather pocket-cases of Medicines for Physicians. Boxes for family use from three to six dollars. Also all Isopathic Remedies. Refined Sugar of Milk, pure globules, vials, corks, diet papers, labels, homœopathic chocolate, &c., &c.

DR. HERING'S PREFACE.

(*The following article has been kindly furnished by* Dr. Hering *of Philadelphia, in German. The Editor is responsible for the translation.*)

Hahnemann's work on chronic diseases may be considered a continuation of his organon; the medicines which will follow the present volume may therefore be considered a continuation of his materia medica pura. As the principles and rules of general therapeutics have been developed in the organon, so does Hahnemann develop, in the present treatise, the principles and rules which ought to prevail in the treatment of chronic diseases, whose name is "legion." In the materia medica pura Hahnemann describes to us the symptoms which the general remedies that he tried upon healthy persons, are capable of producing; the present treatise, on the contrary, will be succeeded by an account of those remedies, which Hahnemann especially employed in the treatment of chronic diseases, and which he therefore called "anti-psorics." In the organon Hahnemann tries to establish the fact that the principle "similia similibus curantur" is the supreme rule in every true method of cure, and he shows how this rule is to be followed in the treatment of disease; whereas in his treatise on the chronic diseases, which is based upon the organon and does not, in the least, modify or alter its teachings, Hahnemann shows that most chronic diseases, originating in a common source and being related amongst each other, a special class of remedies designated by Hahnemann "anti-psorics," should be used in the treatment of those diseases. This common source of most chronic diseases, according to Hahnemann, is *Psora*.

The shallow opponents of Homœopathy—and we never had any other!—pounced upon the theory of the psoric miasm with a view of attacking it with their hollow and unmeaning sarcasms. Making *Psora* to be identical with itch, they sneeringly pretended that according to Hahnemann's doctrine the itch was the

primitive evil, and that this doctrine was akin to the doctrine of the original sin recognised by the Christian Faith.*

* NOTE OF THE EDITOR: I beg pardon of my distinguished and learned friend for annexing a few remarks to this passage. In doing so I merely anticipate what I intend to express more fully on this subject some other occasion.

As it would be absurd for a philosophical Christian to reject the doctrine of original sin, so it is absurd for any one who professes to have a clear perception of Homœopathy, to reject the doctrine of an hereditary morbific miasm. Both these doctrines must stand and fall together; and, as truth is one and indivisible, they both hold and illustrate each other. If we admit with Rousseau that every thing which leaves the hand of God, is perfectly holy, then the first created man must have been perfectly pure, and must have appeared in the image and likeness of his maker. It seems to me absurd to suppose that something perfectly pure can, of itself, by its own free and orderly development, produce things impure and evil. We do not know how far God permitted an *adaptation to evil* to co-exist in the first man together with an adaptation to goodness. But this we certainly know that evil fruits must be the result of evil forces. In a certain moment man, or God through man, permitted the adaptation to evil to prevail in his nature; and instantaneously the forces of evil, be they called serpent, devil, or otherwise, invaded man's nature, engrafted themselves upon it, and have, up to this moment, perpetuated their existence in it. This is relatively speaking, a fall, although, this fall, having been the first necessary phasis of human development, it may, in reality, be considered a progress. Man's destiny consists in reuniting himself again with the Divine Life through the universal expansion of all the faculties of his soul, and the realization of all the celestial harmonies the germs of which God had deposited in his nature, and towards the construction of which science and art will furnish him the means. The principle of division or dissolution which man had suffered to be introduced into his spiritual nature, must necessarily have embodied itself in a corresponding principle in the material organism. It is this principle which Hahnemann calls *Psora*. In proportion as man's spiritual nature becomes developed and purified, this psoric miasm will be diminished, and will finally be completely removed from the life of humanity. This complete physical regeneration of human nature will necessarily be attended with great changes in all the external relations of man, education, mode of labouring, living, etc., etc.

The principle of division or dissolution existing in the human organ-

With the same impudence with which they had, on former occasions, asserted, that Hahnemann rejects all pathology in his organon, they now asserted that he himself advanced a pathological hypothesis, and "that the true which it contained was not new, nor the new true."

Equitable judges will not fail to recognise in this treatise on chronic diseases the same carefulness of study and observation which the great author of Homœopathy has shown in all his other writings. Hahnemann had no other object in view except to cure. All the energies of his great soul were directed to this one end. His object was not to overthrow pathology, although the pathology of his time has been set aside as a heap of foolish speculations, and has been replaced by other systems, that may perhaps suffer the same fate in fifty years; he merely contended against the foolish and presumptuous application of pathological hypotheses to the treatment of disease. He rejected and overthrew the foolish belief which had been driven like a rusty nail, into the minds of the Profession and, by their instrumentality, into the minds of the people, that the remedies should be given against a name, against an imaginary disease, and that the name of this imaginary disease indicated the remedy. Up to this day physicians have been engaged in accrediting that superstition. Whence should otherwise spring the desire which so many patients manifest, of inquiring into the name of the disease, as if a knowledge of that name were sufficient to discover the true remedy against the disease. Many patients are disconsolate when the doctor cannot tell them what is the matter with them. Do we gain anything by being able to say that the disease is rheumatism, dyspepsia, liver-complaint? Does it avail the patient any to be able to repeat his doctor's ipse dixit "that

ism as an established and constituted fact, does not preclude the possibility of this organism being invaded by acute miasms. The psoric principle marks the general adaptation to evil, recognised and inherently received by the human organism; acute diseases are violent and sudden invasions of the organism by the forces of evil—which I have named subversive forces in my preface. Those sudden invasions could never have taken place without man having first admitted the psoric principle to be constitutional in his organism.

he is bilious, nervous, etc. ?" Do these words mean any thing definite ? Are there yet physicians foolish enough to believe that their speculative explanations mean any thing ? Does not every body acknowledge that they are mere ignes fatui flitting to and fro upon the quagmire of the old decayed systems of pathology ?

Assuredly, a physician of modern date, who has not remained altogether ignorant, would be ashamed of assuring his patients with the air of a deep thinker, that one has a disease of the spine, another consumption, a third a uterine affection, etc. Every tyro in pathology knows that all this means nothing definite, and that it is only to very ignorant persons that such assertions can be given as science. Every tyro knows that the question is, to find out what are the symptoms and the nature of that disease of the spine or the uterus. It is moreover known that this more precise knowledge is necessary as respects prognosis, and for the purpose of regulating the mode of life of the patient; but it is also settled that to know merely the variety, to which the disease belongs, is not sufficient to cure it. All the successful and celebrated practitioners of the old school have been such as have constantly modified and individualized the treatment of disease. This is all that Hahnemann has tried to accomplish; with this difference that he has individualized every case of disease with much more precision than any of the older physicians had done. Hahnemann had courage enough, at once to face the contradictions which constantly existed between practice and theory; he declared that the speculative knowledge of physicians was merely learned dust which they were in the habit of throwing into people's eyes for the purpose of blinding them and inducing them to consider the ignorance of the doctors and the insufficiency of their knowledge as something respectable. Hahnemann dared to lay down this maxim: that, in treating disease, he had nothing to do with its name.

Hahnemann teaches that the remedies should be chosen according to the symptoms of the patient. The physician should be governed by what is certain and safe, not by that which is more or less uncertain and unsafe, and which is changed according to fashion. Both in the organon and in his treatise on the chronic diseases, Hahnemann insists upon the remedies being chosen in accordance with the symptoms.

It is not an easy matter to choose a remedy according to symptoms. This may be inferred from the manner in which tyros in homœopathy and physicians of the old school who come over to us, go to work. They constantly rely upon names, giving a certain remedy in scarlet fever, because some one else had found it useful; or a certain remedy in pulmonary inflammation, because it had been successfully exhibited upon a former occasion; whereas Hahnemann teaches that, because a remedy has helped before, this is no reason why it should help again in a similar disease. The symptoms and not the name are to point out the remedy. This is also the case in chronic diseases. In the treatment of chronic diseases Hahnemann has been taught by experience to give preference to the anti-psoric remedies. This preference is not theoretical, and is constantly subordinate to the general principle.

Hahnemann has never said that the principal constituents of mountains, which are the most important materials in nature—the metals, for instance—are the most important remedies for the cure of the most universal diseases. However, he has pointed out the oxydes or salts of ammonium, potassium, sodium, calcium, aluminium, magnesium, as the most important anti-psoric remedies. Hahnemann has said nowhere that the most important metalloids constitute the most important remedial agents, although he has introduced sulphur, phosphorus, silicea, chlorine, and iodine, in one form or another, as anti-psoric remedies. In selecting a remedy Hahnemann has never been guided by theories, but always by experience. He chose his remedies agreeably to the symptoms which they had produced upon healthy persons, looking at the same time to their remedial virtues having been tested by practice. This is the reason why the general views which have been expressed just now did not prevent him from admitting as chief anti-psorics *borax* and *ammonium carbonicum*, *anacardium* and *clematis*.

Why, it may be asked, has a great number of homœopathic physicians, neither recognised Hahnemann's theory of psora, nor the specific character of the anti-psoric remedies? Why have some even gone so far as to set the theory sneeringly aside, and to decry the anti-psorics as less trustworthy than the other remedies?

For the same reason that the astronomical discoveries of our

Herschel are doubted by people who have no faith in the discoverer, and are not able to verify his discoveries. To do this, knowledge, instruments, talent, care, perseverance, opportunities, and many other things are required. Not one of all these requisites can be found with those who are mere dabblers in practice, scribbling authors opposing their own opinions and imaginations to facts and observation.

Or, for the same reason that Ehrenberg's discoveries cannot be appreciated by those who have either no microscope, or who have one which is not good, or who have a microscope without understanding the difficult art of using it; or else who know how to use it, but do not use it with the same exactness and carefulness as Ehrenberg, who discovered in the chalk-dust of visiting cards the shells of new species of animals, by simply making the cards transparent by means of the oil of turpentine.

Or lastly, for the simple reason that physicians find it more easy to write something for print, than to observe nature; that it is more easy to impose upon people than to cure the sick, and because the greater number of physicians is affected with the delusion that things which they do not see, do not exist.

If such physicians succeed in effecting a cure, they are at once ready to boast of their exploits, whereas the cure was due to Hahnemann's doctrine, to the remedies which he has discovered, to the researches of other physicians, to their instructions or example, or to so-called chance. But if they do not succeed, they impute their failure to anything but themselves: it is homœopathy that is deficient; this or that rule is not correct; the materia medica is at fault; or, if something in Hahnemann's system does not suit them, they are prone to say that they have never seen this or that, that they cannot agree with it. And in talking in this way, they really imagine to have said something against the matter itself.

Upon the same ground that Hahnemann carefully distinguished from the disease the symptoms which owed their existence to dietetic transgressions, or to medicinal aggravations; upon the same grounds that he acknowledged as standing and independent diseases the acute miasms, known as purpura, measles, scarlatina, small pox, hooping cough, etc., or that he distinguished the venereal miasm into *syphilis* and *sycosis*, we may afterwards, if ex-

perience should demand it, subdivide *psora* into several species and varieties. This is no objection to Hahnemann's theory. Hahnemann has taken the first great step without denying the faculty of progressive development inherent in his system. But let improvements be made in such a way as to become useful, not prejudicial, to the patients. We ought to raise our superstructure upon Hahnemann's own ground, in the direction which he has first imparted to his doctrine.

Although it matters little what opinions the respective disciples of Hahnemann hold relatively to the theory of *psora*, I will nevertheless, communicate a short extract from my essay, "Guide to the Progressive Development of Homœopathy."

"As acute diseases terminate in an eruption upon the skin, which divides, dries up, and then passes off, so it is with many chronic diseases. All diseases diminish in intensity, improve, and are cured by the internal organism freeing itself from them little by little; the internal disease approaches more and more to the external tissues, until it finally arrives at the skin.

"Every homœopathic physician must have observed that the improvement in pain takes place from above downward; and in diseases, from within outward. This is the reason why chronic diseases, if they are thoroughly cured, always terminate in some cutaneous eruption, which differs according to the different constitutions of the patients. This cutaneous eruption may be even perceived when a cure is impossible, and even when the remedies have been improperly chosen. The skin being the outermost surface of the body, it receives upon itself the extreme termination of the disease. This cutaneous eruption is not a mere morbid secretion having been chemically separated from the internal organism in the form of a gas, a liquid, or a solid; it is the whole of the morbid action which is pressed from within outward, and it is characteristic of a thorough and really curative treatment. The morbid action of the internal organism may continue either entirely, or more or less in spite of this cutaneous eruption. Nevertheless, this eruption always is a favourable symptom; it alleviates the sufferings of the patient, and generally prevents a more dangerous affection.

"The thorough cure of a widely ramified chronic disease in the organism is indicated by the most important organs being

first relieved; the affection passes off in the order in which the organs had been affected, the more important being relieved first, the less important next, and the skin last.

"Even the superficial observer will not fail in recognising this law of order. An improvement which takes place in a different order can never be relied upon. A fit of hysteria may terminate in a flow of urine; other fits may either terminate in the same way, or in hemorrhage; the next succeeding fit shows how little the affection had been cured. The disease may take a different turn, it may change its form, and, in this new form, it may be less troublesome; but the general state of the organism will suffer in consequence of this transformation.

"Hence it is that Hahnemann inculcates with so much care the important rule to attend to the moral symptoms, and to judge of the degree of homœopathic adaptation, existing between the remedy and the disease, by the improvement which takes place in the moral condition, and the general well-being of the patient.

"The law of order which we have pointed out above, accounts for the numerous cutaneous eruptions consequent upon homœopathic treatment, even where they never had been seen before; it accounts for the obstinacy with which many kinds of herpes and ulcers remain upon the skin, whereas others are dissipated like snow. Those which remain, do remain because the internal disease is yet existing. This law of order also accounts for the insufficiency of violent sweats, when the internal disease is not yet disposed to leave its hiding-place. It lastly accounts for one cutaneous affection being substituted for another."

"This transformation of the internal affection of such parts of the organism as are essential to important functions, to a cutaneous affection—a transformation which is entirely different from the violent change effected by means of Autenrieth's ointment, ammonium, croton-oil, cantharides, mustard, etc.—is chiefly effected by the anti-psoric remedies.

"Other remedies may sometimes effect that transformation, even the use of water, change of climate, of occupation, etc; but it is more safely, more mildly and more thoroughly effected by the anti-psoric remedies."

This latter is altogether an individual opinion; others may have different opinions relative to the same subject; this needs

not to prevent us from aiming all of us at the same end, side by side, in perfect harmony.

But alas! the rules which the experienced founder of Homœopathy lays down in the subsequent work with so much emphasis, are not always practised, and therefore, cannot be appreciated. Many oppose them; cures which otherwise might be speedy and certain, are delayed; much injury is being done by the wiseacres who intrude themselves into our literature and mix with it as chaff with the wheat. On all this we may console ourselves with the expectation that also in the history of Science there will be those great days of harvest, when the tares shall be gathered in bundles and thrown into the fire.

It is the duty of all of us to go farther in the theory and practice of Homœopathy than Hahnemann has done. We ought to seek the truth which is before us and forsake the errors of the past. But wo unto him who, on that account, should personally attack the author of our doctrine; he would burthen himself with infamy. Hahnemann was a great savant, inquirer, and discoverer; he was as true a man, without falsity, candid and open as a child, and inspired with pure benevolence and with a holy zeal for science.

When at last the fatal hour had struck for the sublime old man who had preserved his vigour almost to his last moments, then it was that the heart of his consort who had made his last years the brightest of his life, was on the point of breaking. Many of us, seeing those who are dearest to us engaged in the death-struggle, would exclaim: why should'st thou suffer so much! So too exclaimed Hahnemann's consort: "Why should'st thou who hast alleviated so much suffering, suffer in thy last hour? This is unjust. Providence should have allotted to thee a painless death."

Then he raised his voice as he had often done when he exhorted his disciples to hold fast to the great principles of Homœopathy. "Why should I have been thus distinguished? Each of us should here attend to the duties which God has imposed upon him. Although men may distinguish a more or less, yet no one has any merit. God owes nothing to me, I to him all."

With these words he took leave of the world, of his friends,

and his foes. And here we take leave of you, reader, whether our friend or our opponent.

To him who believes that there may yet be truths which he does not know and which he desires to know, will be pointed out such paths as will lead him to the light he needs. If he who has sincere benevolence and wishes to work for the benefit of all, be considered by Providence a fit instrument for the accomplishment of the divine will, he will be called upon to fulfil his mission and will be led to truth evermore.

It is the spirit of Truth that tries to unite us all; but the father of Lies keeps us separate and divided.

C. Hg.

Philadelphia, April 22, 1845.

PREFACE

TO THE FIRST EDITION, 1828.

If I did not know, for what object I exist upon earth—"to make myself as good as possible, and to improve things and men around me to the best of my ability,"—I should have to consider myself deficient in worldly wisdom for promulgating, before my death, an art whose sole possessor I was, and which, being kept secret, might have become a source of permanently increasing profit to me.

In communicating these great discoveries to the public, I cannot help entertaining doubts as to the good will of my cotemporaries to appreciate the justness of my doctrines. Will they be practised with care, and yield to suffering humanity the benefit which must necessarily be derived from their conscientious application; or will my cotemporaries, intimidated by the unheard-of newness of my discoveries, prefer leaving them unexamined, unimitated, and therefore suffer them to remain useless?

I have no reason to expect that these communications will fare better than my previous publications on general Homœopathy. The power of small and highly diluted doses was doubted; their greater fitness for effecting a homœopathic cure and the higher development of their dynamic action were overlooked; and despite of the warning trials which enabled me to recommend small doses as the most appropriate for the

cure of disease, my faithful assurances and reasonings were disdained, and medical men continued for years to jeopardize the lives of their patients by large doses, and were therefore deprived of an opportunity of witnessing the happy results of the homœopathic treatment, as was indeed my own case before I had adopted the rule of administering small doses.

What would they have risked, if they had first followed my indications and had employed small doses? The worst which could have befallen them, was, that these doses would be of no avail. It was impossible that they should do any harm. But instead of exhibiting small doses, they employed, from a want of sense, and of their own accord, large doses for homœopathic use, thus exposing the lives of their patients and arriving at truth by that circuitous rout which I had travelled upon before them with trembling hesitation, but the end of which I had just reached with success. Nevertheless, after having done much mischief, and having squandered the best period of their lives, they were obliged, when they were really desirous of curing disease, to resort to the only true method which I had demonstrated to them a long while ago.

Would that they acted more discreetly in regard to the discovery which I promulgate in this volume!

And suppose they do not act so,—in that case, a more conscientious and more intelligent posterity will have the advantage, by faithfully and correctly applying the principles developed in these pages, freeing humanity from the innumerable sufferings which nameless chronic diseases have heaped upon the poor patients from time immemorial, and thus conferring upon them a blessing which the previously taught doctrines of homœopathy had not been able to realize.

OF THE NATURE OF CHRONIC DISEASES.

The faithfully practised precepts of the homœopathic method of cure, as it is taught in my own writings and those of my disciples, have hitherto manifested to all men, and in a very striking and decisive manner, their natural advantage over the allœopathic method, both in regard to acute diseases as well as epidemics and sporadic fevers.

Venereal diseases have been likewise cured more safely, more convenently, more thoroughly and without any secondary ailments, by the homœopathic practice; for it eradicates the internal disease and cures it from within, by the best specific remedy, without either disturbing or destroying the local affection.

But there remained the chronic diseases which afflict humanity, and the number of which continued to be immensely large.

The manner in which those diseases had been treated by allœopathic physicians, has only served to increase the sufferings of such patients. By employing a quantity of disgusting mixtures, compounded by the apothecary out of large doses of violent medicinal substances, whose separate effects were unknown, or by using all sorts of baths, violent diaphoretics or expectorants, pretended anodynes and sedatives, clysters, ointments, fomentations, fumigations, vesicatories, cauteries, fontanelles, and especially those everlasting purgatives, leeches, bloodlettings, and methods of starvation, and the various other fashionable medicinal torments, the disease was either made worse, and the vital energies, despite of the intermediate use of pretended tonics, were more and more diminished; or else, in case a striking change had been obtained, another nameless medicinal disease, being

much worse and much more incurable than the original natural disease, was substituted in the place of the previous disturbance; whilst the physician consoled the patient by saying, that "the old disease had been happily removed; that unfortunately a new disease had indeed made its appearance, but that he was confident he would conquer this new disease as successfully as the former." And in this way nothing was done except to modify the forms of the same disease, to increase it by the additional sufferings consequent upon the use of improper and noxious medicines, until the complaints of the poor patient ceased with his last breath, and the relatives were consoled by the delusive excuse, "that every known remedy had been employed in the case of the deceased."

How different is God's great gift, homœopathy! In these cases of chronic disease to which I have just alluded, and provided the patients had not been too much ruined by the allœopathic practice, (as was unfortunately too often the case where some money was to be made out of the patient,) the homœopathic practitioners, by practising the precepts contained in the writings which I had then published, and by following the advice which I had given on former occasions, both in lectures and conversations, did infinitely more good by their treatment than all the previously known so-called methods of cure had been able to accomplish.

By following the method which I had recommended, and which is much more conformable to nature, the homœopathic practitioners, having in the first place inquired into and noted down all the perceptible symptoms of the disease, were able to remove it by means of the smallest dose of a remedy which had been carefully selected among the most appropriate homœopathic drugs, whose genuine and true action had been ascertained up to that moment. The improvement which was obtained by the homœopathic practitioner, exceeded all that allœopathic doctors had ever been able to accomplish by some luckily successful inroad upon their medicine-chests; for the cure was often accomplished

in a very short time, the patient never was deprived of his strength, as is always the case by the allœopathic method of cure, and he was again enabled to enjoy his life.

The disease yielded in a great measure to a very small dose of that remedy which had been found capable of producing upon a healthy person the existing series of morbid symptoms; and if the disease was not too old, and had not been too extensively mismanaged by allœopathic practice, the improvement often lasted for a good while; so that mankind might already deem themselves fortunate on account of this aid, and very often did so. The patient who had been thus treated, might have considered himself almost cured, and very often did consider himself so, when he made just allowances for the difficulties of his condition previous to the homœopathic treatment, and compared it with the improved state of health which he now enjoyed.*

But, in case the apparently cured disease resulted from a more extensively developed psora, then a few excesses at table, a cold, the approach of unusually rough, damp or stormy weather, sometimes even the fall season, though mild, but especially winter and a winterly spring, a violent bodily or mental effort, a concussion of the system consequent upon great external

* The cures here referred to concern diseases from an imperfectly developed *psora*. In the treatment of those diseases my followers did not employ the remedies which were afterwards found to be the principal antipsories—they were not known then;—the treatment was carried on by means of those drugs the pathogenetic effects of which upon the healthy system corresponded most accurately to the existing symptoms, and had power to remove them for a time. By means of these remedies the outbreaking *psora* was reduced back again to its latent condition; and, in this way, a sort of cure was effected, which gave often, for many years, great bodily comfort to young vigorous persons, who must, on that account, have appeared really cured to a superficial observer. But the remedies which were known at that time, were then and are now insufficient for the complete cure of those chronic diseases where the psoric poison has established its full action.

injuries, or some melancholy, heart-breaking event, frequent fright, deep sorrow and grief, or continual chagrin, were often sufficient in an enfeebled system, to cause one or more of the former ailments to reappear after they had been conquered for a time; and then they were often accompanied with a series of new symptoms, which may not have denoted any more danger than the former symptoms did that had yielded to the homœopathic treatment, but which were just as difficult to cure, and therefore so much more inveterate. Against these new symptoms the homœopathic physician employed again, with tolerable success, the remedy which acted most homœopathically among the then known drugs, and the condition of the patient was again improved for a time. In case the primitive symptoms which had been cured once already homœopathically, reappeared in consequence of one of the above mentioned causes, the remedy which had been first employed, helped again, though less perfectly; and still less so, on being given a third time. Under these circumstances, the remedy which had appeared most homœopathic often produced new symptoms, and, despite of a correct mode of life on the part of the patient, they yielded but scantily and imperfectly to the best adapted remedies, and often even remained when the cure was checked by the above mentioned external influences.

Sometimes the chronic malady was arrested in a remarkable manner, for a shorter or longer period, by the occurrence of agreeable circumstances, by some fortunate improvement in the affairs of the patient—a pleasant journey, a favourable season, and dry uniform weather; in this case the homœopathic physician had a right to consider the patient almost cured, and the patient did consider himself so, provided he was willing to overlook moderate ailments. However, this favourable cessation of the disease never lasted long, and the return, especially the frequent return of the disease, which induced a repeated exhibition of the same remedial agents, weakened their power in a proportionate degree, notwithstanding they had been selected with the greatest care according to

their homœopathic nature, and exhibited in the smallest and most appropriate doses. They finally acted only as mere palliatives. Generally, however, after the physician had repeatedly tried to conquer the disease, which reappeared again and again in a modified form, and in spite of a correct mode of life and perfect obedience on the part of the patient, there remained morbid symptoms which the then known numerous homœopathic remedies were unable to extirpate, and often even to diminish. These symptoms increasing in intensity, and becoming more and more dangerous by their progressive development, the homœopathic physician lost all power of checking the onward course of the disease.

This result occurred in the treatment of all great, chronic, non-venereal maladies, even when it appeared to be conducted according to the precepts of homœopathy, as far as it was then known. First, the treatment was satisfactory, then it became less favourable, and finally hopeless.

Despite of these failures, the doctrine itself has then been, and will ever be founded upon the unshakeable pillars of truth. Facts have confirmed its excellence, yea, if this may be said of human things, its infallibility.

The homœopathic doctrine was the only and first doctrine which made us acquainted with the proper treatment of the great, standing, idiopathic diseases, the old scarlatina of Sydenham, the modern purple-rash, hooping-cough, croup, sycosis, dysentery; even acute pleuritis and epidemic typhus are promptly cured by a few small doses of carefully selected homœopathic remedies.

What then was the reason why the continued homœopathic treatment of the non-venereal chronic diseases should have been so unsuccessful? Why should homœopathy have failed in thousands of cases to cure such chronic ailments thoroughly and forever?

These failures were perhaps owing to the small number of the homœopathic medicines whose pure action had been ascertained.

The followers of homœopathy were satisfied with this excuse. But the founder of homœopathy rejected

it as a mere subterfuge. For, the yearly increase of powerful homœopathic remedies left the treatment of chronic non-venereal diseases in the dark, whereas acute diseases, provided they were not fatal from their beginning, were not only considerably alleviated by correctly chosen homœopathic remedies, but even promptly and thoroughly cured by means of the vis medicatrix of the organism.

Why should this vis medicatrix of the organism, whose object is to restore the integrity of the organism, and to be indefatigably active in completing the recovery from virulent acute diseases, have been insufficient to effect a durable cure of those chronic maladies, even when it was aided by those homœopathic remedies, the symptoms of which corresponded most accurately to those of the disease ?

In trying to answer this question, I was led to the discovery of the nature of chronic diseases.

Ever since the years 1816 and 1817, I had been employed day and night, to discover the reason why the homœopathic remedies which were then known, did not effect a true cure of the above named chronic diseases. I tried to obtain a more correct, and, if possible, a completely correct idea of the true nature of those thousands of chronic ailments which remained uncured in spite of the incontrovertible truth of the homœopathic doctrine; when, behold! the Giver of all good permitted me, about that time, to solve the sublime problem for the benefit of mankind, after unceasing meditation, indefatigable research, careful observations and the most accurate experiments.*

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* I kept my great efforts secret both from the public, and from my disciples, not on account of the ingratitude which I have frequently experienced—for I heed neither the ingratitude nor the persecutions that I meet upon my path, which, wearisome as it is, is nevertheless not without pleasure on account of the great end to be attained. I never spoke of my exertions, because it is improper, and even dangerous, to speak of things that are but half accomplished. Not till the year 1827 did I communicate the most important part of my discoveries relative

yearly increase of disagreeable symptoms. This proved to me the fact that the phenomena which appeared to constitute the ostensible disease, ought not to be regarded as the whole boundaries of the disease—otherwise the disease would have been completely and permanently cured by homœopathic drugs, which was not the case,—but that this ostensible disease was a mere fragment of a much more deep-seated, primitive evil, the great extent of which might be inferred from the new symptoms which continued to appear from time to time. This showed me that the homœopathic practitioner ought not to treat diseases of this kind as separate and completely developed maladies, nor that he ought to expect such a permanent cure of these diseases as would prevent them from appearing again in the system, either in their original or in a modified and often more disagreeable form. I became convinced that the first condition of finding out one or more homœopathic medicines which should cover all the symptoms characterising the whole disturbance, was, *to discover all the ailments and symptoms inherent in the unknown primitive malady.* The medicines being found out, the physician would then be able to conquer and completely to extinguish the whole disease, together with its successively appearing groups of symptoms.

This primitive disease evidently owed its existence *to some chronic miasm.* For as soon as it had reached a certain height, it never yielded to the simple action of a robust constitution, or to the best regulated diet or

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to the treatment of chronic diseases to two of my most deserving disciples, both for their own benefit and that of their patients. I did so in order to avoid the danger of seeing my discoveries lost for mankind. Having reached my 73rd year, it was not improbable, that I should have been called into eternity before having completed my work.

mode of life; on the contrary, it grew worse from year to year, to the end of life, gradually assuming different and more dangerous symptoms.* This is the case with every chronic, miasmatic disease,—for instance, the venereal bubo, when it has become a syphilitic disease on account of its not having been cured from within by mercury, its specific. Syphilis never becomes extinct of itself; in spite of the best mode of life and the robustest constitution, it increases from year to year, and assumes new and more dangerous symptoms to the end of life.

I had reached this point, when my investigations and observations upon non-venereal chronic patients led me at once to perceive that a previously existing itch, which they often confessed to have had, was the cause why many diseases that appeared to be separate and coherent maladies, should not be cured by homœopathic treatment. All the subsequent sufferings were dated from the time when the psoric eruption had manifested itself. In many of these chronic patients, who were unwilling to confess having had the itch, or who had been too careless to heed it, or had no recollection of it, I often discovered, by careful inquiries, that vestiges of the itch had shown themselves upon their bodies from time to time, in the shape of small pustules or herpes, etc., as so many infallible symptoms of the chronic contagion.

These circumstances, coupled with the fact, that psoric eruptions which had been removed by evil practices or by some other cause, were evidently followed in otherwise healthy persons by chronic ailments having the like or similar symptoms—as had been observed

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* Phthisis often passed into frenzy, drying-up ulcers into dropsy or apoplexy, intermittent fever into asthma, affections of the abdomen into pains in the joints or paralysis, influenza into hemorrhage, etc. It was not difficult to perceive that the new symptoms were founded in the existing primitive malady, and could only be parts of a much more extensive disease.

both by other physicians,* and myself, in an infinite number of cases—left me no doubt about the internal enemy which I had to combat in my medical treatment.

This internal enemy I shall designate by the general term *psora*. It is an internal disease,—a sort of internal itch,—and may exist either with or without an eruption upon the skin. Little by little I discovered more adequate remedies against this internal disease, from which sprang so many sufferings. From the relief which I obtained by their employment in cases where the patient had no recollection of the itch, I inferred that they resulted from a *psora* which had been communicated to the patient in the cradle, or in some other way, of which he had no recollection. By carefully inquiring of the parents or old relatives, I discovered that my suspicion was well founded.

Investigating with the utmost care the curative power of the antipsoric remedies which had been discovered for the last eleven years, I became more and more convinced that the milder as well as the more extensive, and even the most inveterate chronic diseases, owe their existence to the psoric miasm.

I found that thousands of tedious ailments, which we find enumerated in our pathological works under distinct names, originate, with a few exceptions, in this widely ramified *psora*. Such diseases are most of those eruptions upon the skin which have been distinguished with so much care, and separately denominated by *Willan;* almost all adventitious formations, from the common even up to the largest sarcomatous tumours, from the deformities of the finger-nails up to ramollissement of the bones and curvatures of the spine, and several other diseases of this kind, in early as well as a more advanced age; frequent epistaxis, varices of the veins of the rectum and the anus, blind or flowing hemorrhoids, hemoptysis, hematemesis, hematuria, amenor-

* More recently, especially, by *von Autenrieth*, (see Tübinger Blätter für Naturwissenschaft und Arzneikunde, sec. vol., sec. part.)

rhœa; menorrhagia; night-sweats and diarrhœa of several years standing; parchment-like dryness of the skin, permanent constipation and difficult evacuation of the bowels; long-continued local pains; convulsions having occurred again and again for a number of years; chronic ulcers and inflammations; sarcomatous enlargement of the adipose tissue as well as emaciation; sur-excitation as well as weakness of the different senses; excessive as well as extinguished sexual desire; diseases of both the mind and the soul from imbecility up to ecstasy, from melancholy up to frenzy; swoons, vertigo, the so-called diseases of the heart, abdominal complaints, and the different forms of hysteria and hypochondria. Careful observations, comparisons and experiments in latter years have revealed to me the fact, that the tedious ailments of both the body and the soul, (provided they do not belong to the class of syphilis or sycosis,) which differ so much from each other in their principal symptoms, as well as in the different patients, are all of them nothing but partial manifestations of one primitive chronic psoric miasm, in which they all originate, and whose innumerable symptoms form but one integral disease, and ought, therefore, to be regarded and treated as parts of one and the same disturbance. Of this nature are the great epidemic typhus fevers, like that of 1813. One patient exhibits but a few symptoms of the epidemic, a second patient a few others, a third and a fourth again other symptoms inherent in that disease, all of these different symptoms constituting the same pestilential fever, and in their integrality, exhibiting the complete image of the disease. A few homœopathic remedies* will cure such a typhus in every patient infected with the disease, though each patient may exhibit different symptoms, and may seem to be afflicted with a different malady.†

This is, *upon a larger scale*, the case with *psora*, this

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* In the typhus fever of 1813, bryonia and rhus toxicodendron were the specific remedies for all patients.

† See Organon of the healing art, fifth edition, 1834, § 100, etc.

fountain-head of so many chronic ailments, each of which appears to be essentially different from the other. But this difference does not exist, as may be inferred from the fact, that the various successively appearing symptoms constituting those ailments belong to many of them in common, and may be cured by the same remedies.

I have already mentioned that all chronic diseases of mankind—even those which are left to themselves without having been made worse by wrong treatment—are so inveterate immediately after they have become developed in the system, that, unless they are thoroughly cured by art, they continue to increase in intensity until the moment of death. They never disappear of themselves, nor can they be diminished, much less conquered or extinguished, by the most vigorous constitution, or the most regular mode of life and strictest diet. All chronic diseases, therefore, originate and are based upon fixed chronic miasms, which enable their parasitical ramifications to spread through the human organism and to grow without end.

In Europe, as well as in the other continents, we have been able to discover but three psoric miasms which cause diseases manifesting themselves by local symptoms, and in which most chronic ailments originate. These miasms are *syphilis*, (which I have also termed the venereal chancre,) *sycosis*, and then *psora*, which forms the basis of the itch. The last being the most important, I shall speak of it first.

Though this *psora* is the *oldest*, *most universal* and *most pernicious* chronic miasmatic disease, yet it has been misapprehended more than any other. For thousands of years it has disfigured and tortured mankind; and, during the last centuries, it has become the cause of those thousands of incredibly different, acute as well as chronic, non-venereal diseases, with which the civilized portion of mankind becomes more and more infected upon the whole inhabited globe.*

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* Note of the translator.—This statement about the progressive increase of disease is erroneous, though it does by no means invalidate the general truth of the principle. Professor

Psora is *the oldest* miasmatic chronic disease known. The oldest history of the oldest nations does not reach its origin.

Psora is just as tedious as *syphilis* and *sycosis*, and is, moreover, *hydra-headed.* Unless it is thoroughly cured, it lasts until the last breath of the longest life; not even the robustest constitution, by its own unaided efforts, is able to annihilate and to extinguish *psora.*

In the many thousands of years since it has visited mankind, the multitude of its morbid symptoms has increased to such an extent,* that its secondary symptoms have become innumerable. All natural chronic ailments now existing, which have not been produced by bad medical treatment, or by the fumes of quicksilver, lead, arsenic, etc., in the workshops, and which we find arrayed in the usual treatises on pathology as distinctly bounded and separately named diseases, originate in *psora* as their fountain-head. The diseases originating in syphilis, and those rare ones resulting from sycosis, do not come under this remark.

Marx, of Gœttingen, in his treatise of the statistics of disease, which has been translated into English by Doctor W. R. Willis, has conclusively shown, that disease has been decreasing from age to age, and that there is much less of it now than there ever was before. The reason why even such men as Hahnemann believe in a progressing increase of disease, may perhaps be this, that there is yet an immeasurable quantity of disease existing around us, and that we imagine the existence of so much disease impossible, unless it be the result of a constantly increasing accumulation.

* NOTE OF THE TRANSLATOR.—Hahnemann thinks that this extension of the manifestations of *psora* may be explained by this miasm spreading through so many organisms. Hahnemann's statement may lead us to infer that the psoric miasm has increased *in intensity.* This is not so. By spreading through millions of organisms, the psoric miasm has become divided, and its intensity is, therefore, less. Division implies diminution—increase in extent, but decrease in quality or degree. It is assuredly true that the psoric miasm must have infected all the progressive manifestations of man's inherent vital energies, and even of the soul's vitality, but making allowance for this loss, there must yet be left a balance in favour of the opposing orces, otherwise life would gradually become extinct.

According to the most ancient historical writings which we possess, *psora* existed already almost fully developed in the earliest ages of mankind. Several varieties of *psora* have already been delineated by Moses* 3400 years ago. At that time, however, and always afterwards, among the Israelites, *psora* appears to have especially infected the external parts of the body. This was also the case among the Greek barbarians, then among the Arabs, and finally in the uncivilized Europe of the middle ages. It is not my object to relate here the different names by which the various nations have designated the more or less malignant varieties of leprosy, (external symptoms of *psora*,) by which the external parts of the body become variously disfigured. Names are of no consequence here, since the essence of this miasmatic itch is every where the same.

In the middle ages Europe was visited for several centuries by the frightful *psora* of the occidental countries, in the shape of a malignant erysipelas, called *St. Anthony's Fire.* In the thirteenth century it assumed again the form of leprosy; the crusaders brought this latter disease along with them. By this means leprosy spread in Europe more than it ever had done before, for in the year 1226 there were in France about 2000 houses for the reception of leprous patients. Neverthe-

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* In the 13th chapter of the third book, and also in the 21st chapter, 20th verse of the same book, where Moses speaks of the defects which priests destined to do the offering ought not to have, the malignant itch is designated by the term גָּרָב; the Alexandrian translators render this by ψώρα ἀγρία, the Vulgate by scabies jugis. The interpreter of the Talmud, Jonathan, defines it *a dry itch spread over the body;* and, according to him, the expression used by Moses רַפַּת represents *lichen*, herpes. (See Rosenmüller; scholia in Levit. P. II., edit. sec., page 124.) The interpreters of the so-called English bible-work agree with this definition. Calmet says that "leprosy is like an inveterate itch, with vehement itching."

The ancients also mention the *voluptuous* itching, which has constantly been peculiar to and characteristic of the eruption of the itch. The scratching is followed by the painful burning. Plato calls the itch γλυκυπικρον. Cicero speaks of the *dulcedo* of *scabies.*

less, *psora*, spreading farther and farther in the form of a horrible eruption upon the skin, found at least some external alleviation in those means of cleanliness which the crusaders had brought along with them from the East, such as (cotton? linen?) shirts which had been unknown in Europe heretofore, and the frequent use of warm baths. These means, together with an increasing refinement and more select nourishment, succeeded, in a couple of centuries, in diminishing the disgusting appearance of *psora* so as to reduce the disease, towards the end of the fifteenth century, to the ordinary eruption of the itch. But alas! about this time, in the year 1493, *syphilis*, the second miasmatic chronic disease, began to raise its fearful head.

The psoric eruption which appeared after infection had taken place, and which, in civilized countries, had been reduced to a simple manifestation of the common itch, was easily driven from the skin by all sorts of contrivances. By means of baths, lotions, sulphur ointments, preparations of lead, copper, zinc, and mercury, of which the middle and higher classes availed themselves, the psoric eruption was often, and is now so quickly suppressed, that it remained often unknown whether a child or a full-grown person, in those classes, had been infected with the itch.

But the cause of humanity was not improved by these proceedings; on the contrary, in many respects it grew worse. During the centuries when the psoric eruption was first known in the form of leprosy, the patients, though they suffered much in consequence of lancinating pains in the tumours and scabs, and the vehement itching all around, enjoyed nevertheless a fair share of general health. For, the obstinately lasting eruption upon the skin served as a substitute for the internal psora; and, what is more, the horrible and disgusting appearance of leprous patients made such an impression upon all healthy persons that they were frightened away already at a distance; in this way the leprous patients being kept apart from human society in separate houses, the contagion remained limited and was, comparatively speaking, rare.

The milder forms of *psora*, which appeared again, as has been mentioned before, during the 14th and 15th centuries, in the shape of the itch, infected a far greater number than the leprous patients were able to do, whose frightful appearance caused them to be carefully avoided by every body. The itch vesicles do scarcely appear, and may be easily kept concealed; but being constantly scratched open in consequence of the intolerable itching, and the fluid being spread over the skin and those things which had been touched by such patients, the infection, being concealed, takes place the more easily, and certainly, and affects a greater number.

In this way *psora* has become the most *contagious* and the most *universal* of the chronic miasms.

This miasm has generally already been communicated before the patient uses some external remedy (lead-water, mercurial ointment) against the eruption. Often he does not even admit having had the itch; perhaps he did not know it; and it even happens that the physician or the surgeon are ignorant of the nature of the eruption which is repelled by lead-water, &c.

It may be easily conceived that, among persons of the inferior classes, who suffer the eruption to grow upon the skin until they become objects of horror to their fellow beings, the infection must have been widely spread by such patients before they do something towards removing the eruption.

The more concealed and proportionately easier and more frequent infection of the itch is not the only disadvantage which has resulted for mankind from the psoric miasm having been reduced from leprosy to the common itch. There is another disadvantage, which is this, that the essence of this reduced psora is unchanged, that it is equally formidable as before, and that, being more easily repelled from the skin, it appears so much more imperceptibly upon the inner surfaces; the chief symptom, which is the external eruption, having been suppressed,* it produces an innumerable quantity

* The itch may not only be removed by the evil practice of physicians and quacks; it often leaves the skin o

of secondary chronic ailments. Physicians lose sight of the origin of that host of secondary morbid symp-

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itself, as may be seen below from the observations of older physicians, in Nos. 9, 17, 26, 36, 50, 58, 61, 64, 65. In this respect *syphilis* and *sycosis* have an advantage over *psora*. In *syphilis* we have the chancre or bubo, and in *sycosis* the cauliflower excrescence, which never leave the external parts, until they have either been destroyed by external applications or else have been removed by a rational cure, together with the whole of the internal disease. Hence *syphilis*, and the secondary symptoms of *sycosis*, are impossible as long as the chancre or the cauliflower excrescence are not violently removed from the external parts. Both chancre and cauliflower excrescence are external, unchangeable local substitutes for the internal disease, leaving it latent to the end of life, and enabling the practitioner to cure the internal disease by the appropriate internal remedies, which ought to be continued until the local substitutes have disappeared without any external applications. As soon as this shall have taken place, both *syphilis* and *sycosis* are thoroughly cured.

In the last three centuries, the psoric miasm, which now manifests itself in the shape of the common itch, has been losing this benign character. The itch does not remain upon the skin as constantly and invariably as either chancre or cauliflower excrescence. Although the eruption is often removed by the evil practice of physicians and quacks, by desiccating washes, by salves of sulphur, drastic purgatives or cupping, yet it often disappears *of itself*, as it is called, without any known cause. It often disappears in consequence of an untoward physical or moral impression, violent fright, permanent chagrin, deep grief, violent catarrh, cold air, (as may be seen below, No. 67,) cold, tepid and warm mineral and river baths, a fever which may have resulted from any cause, or some other acute disease, (small-pox, see No. 39,) continuous diarrhœa, or perhaps a peculiar want of action in the skin; in all these cases the consequences are just as bad as if the eruption had been removed by irrational medical treatment. The secondary symptoms of the internal *psora*, and some one of the innumerable chronic diseases which owe their existence to this cause, break out sooner or later after the external eruption has disappeared by any of the above named causes.

Nevertheless it ought not to be supposed that the psoric miasm, as manifested by the milder eruption, is essentially different from the ancient leprosy. Recent leprosy was, in old times, often removed from the skin by cold bathing, frequent ablutions in rivers, warm mineral baths, (see No. 35;) but the old physicians heeded the evil consequences of such a treatment no more than the modern do the acute affections and the lingering maladies which constantly appear as results of the internal psora, after the voluntary or violent removal of the external eruption.

toms; they are unable to discover it, and the secondary disease is just as incurable as had been the original malady with its eruption existing upon the skin. This had, in fact, never been thoroughly cured, as experience showed, but had constantly been made worse by a quantity of false remedies.

At the time when the psoric poison was yet reduced to its formidable external substitute, leprosy, there were much less nervous affections, painful ailments, spasms, cancerous ulcers, adventitious formations, weaknesses, paralyses, consumptions, and degenerations of either body or soul, than there are now. These have especially appeared in the last three centuries from the above named causes.*

Psora became therefore the *common* mother of most chronic diseases.

It may be said that at least *seven eighths* of the presently existing chronic maladies originate in the reckless suppression of the chief external symptom of *psora*, which acts as a substitute for the internal disease. The remaining eighth originates in *syphilis* or *sycosis*, or in a complication of both miasms, or, what is very rare, in all three combined. *Syphilis* may be easily cured by the smallest dose of the best mercurial preparation, and *sycosis* by a few doses of thuya employed in alternation with nitric acid. The cure of these mias-

* The increased irritability of the muscular fibre and the nervous excitability consequent upon the use of coffee and Chinese tea, which has become so universal for the last two hundred years, have given the past generation an additional impulse towards a multitude of chronic sufferings, and have helped the *psora* to spread itself more and more. I, least of all, have a right to deny this, as I have shown, perhaps too strongly, in my little work on the *effects of coffee*, (Leipsic, 1803,) what a large share this beverage has in the bodily and spiritual ailments of mankind. At that time I had not yet discovered the principal source of most chronic diseases, which is *psora*. Coffee and tea are palliatives for several psoric symptoms. *Psora* could not have produced such inveterate chronic ailments, if it had been aided by the immoderate use of coffee and

matic diseases is only then difficult and tedious when they are complicated with *psora*. *Psora* is most easily overlooked and misapprehended, and is, for this reason, treated in the worst and most pernicious manner.

Modern physicians, even the most distinguished, without excepting almost any, either teacher or author, have established the rule, and have given it almost as an infallible proposition, "that every psoric eruption is a mere local affection of the skin, with which the organism has nothing to do; that the eruption may be unhesitatingly removed by sulphur ointments, by the more active ointment of Jasser, by sulphur fumigations, by solutions of lead or zinc, but most speedily by mercurial preparations; that health is restored as soon as the external eruption has been removed; that it is indeed true that, by neglecting the eruption and leaving it upon the skin, the morbid matter may be finally absorbed into the humours; that it may deteriorate the blood, and ruin the general health; that these perverted humours may however be easily removed out of the system by purgatives and bloodlettings; but that all these secondary diseases may be entirely avoided by speedily removing the eruption from the skin." There never was taught a doctrine which has been more fraught with evil consequences for mankind.

Such horrible untruths were not only taught formerly, but they are taught and even practised in our days. In the most celebrated civil and military hospitals of the most enlightened countries and cities, and also among private patients of all classes, in prisons and orphan asylums, in short, all those who are affected with the itch, are ordered, by common as well as distinguished physicians, to use external applications for the purpose of removing the eruption the sooner the better,* (as they

* These gentlemen, agreeably to the fanciful notion which they have fashioned of the nature of this important disease, assert that, in this case, the psoric miasm has not had time to be absorbed into the humours and to deteriorate them. But suppose the first little itch vesicle, the voluptuous itching of which excites a continual desire for scratching, which is followed by

imagine;) they may use perhaps large quantities of flowers of sulphur internally, and some strong purgatives, with a view, as they suppose, of cleansing the system. This being done, they impudently assert that the disease is cured, and the patients are dismissed * without the least regard for the secondary ailments which will certainly sooner or later manifest themselves as results of the psoric reaction. †

The deceived and unfortunate patients sooner or later return to the hospital, affected with the unavoidable consequences of the former treatment, such as swellings, obstinate pain in various parts of the body, hypochondria, hysteria, gout, consumption, tubercular phthisis, spasmodic asthma, blindness, deafness, paralysis, carcinoma of the bones, cancerous ulcers, spasms, hemorrhage, diseases of the mind and the soul, etc. These are

the burning pain, should prove, as we shall see below, that the psoric disease was already formed and completely developed in the inmost depths of the organism? What is to be done, if every removal of the eruption by external applications, so far from diminishing the violence of the internal malady, forces it, as is shown by thousands of facts, to break forth either in a vast number of acute affections, or else gradually to ramify into a host of chronic ailments, that torture mankind and paralyse their strength? Can these be cured by the ordinary methods? Experience shows that they cannot.

* It sometimes happens that in vigorous patients affected with the itch, the eruption which had been removed by salves and purgatives, is brought out again by the vital power, (whose instinctive wisdom, being based upon a natural law, is superior to the understanding of its destroyers.) The patient then returns to the hospital, and the treatment by ointments and washes of zinc or lead in solution is renewed. To my knowledge, this pernicious removal of the eruption by external applications has been repeated three times in succession in military hospitals by senseless and homicidal quacks, their excuse being that the patient had caught the itch at three different periods, which is impossible.

† I wrote this six years ago; but even at this moment the same criminal doctrines are taught by physicians of the old school. In this most important of all medical interests, they have neither become wiser nor more charitable by one hair's breadth.

considered new diseases, and, without suspecting their origin, treated according to the usual routine of therapeutics. But the remedies are directed against phantoms, *imaginary* causes. until, after many years of increasing suffering, death ensues, and frees the patients from the hands of the doctor.*

In the treatment of *psora* the older physicians were much more conscientious than modern doctors are, and they were much more enlightened observers. Their practice was based upon experience, which showed them that the removal of the psoric eruption from the skin by external applications was followed by innumerable ailments, and the most grievous chronic maladies. Hence they concluded that every case of itch originated in some internal disease, which they endeavoured to cure, as well as possible, by an innumerable quantity of their therapeutic agents. Of course, their endeavours were fruitless, for they were ignorant of the only true method of curing psoric diseases, which it was reserved for homœopathy to reveal to the world. Nevertheless, their efforts being aimed at removing the internal disease, which had given origin to the eruption upon the skin, they deserve much praise. In this respect the older physicians differ from the modern, whose chief object is to remove the itch from the skin as though it were a mere cutaneous disease, without dreaming of the subsequent injuries which the older physicians have, in a thousand instances, exhibited in their works as warning examples.

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* By a kind of accident the patients were sometimes directed to use sulphur baths. But this direction was given without the doctor knowing why he gave it; it was mere empiricism, for he gave this direction because he had exhausted his whole stock of remedies, and did not know what else to prescribe. By these baths the chronic disease often disappeared for a time, but afterwards returned either with the same or analogous symptoms; in this case it was useless to resort again to the bath, because the cure of *psora* which has ceased to be latent, requires a much more adequate treatment than the brutal use of sulphur baths can afford.

But the remarks of these honest practitioners are too striking to be left unnoticed, or to be treated with contempt.

I shall subjoin here some of the innumerable cases of malpractice in the treatment of the itch, which the older physicians have left us, and which will be found sufficient, though I might double the number by quoting the cases which I have witnessed myself, to prove that the internal *psora* breaks forth with a perfect rage whenever it has been deprived of its external substitute, the cutaneous eruption. Would that the physician might learn from these cases that all his efforts should be directed against the internal disease, and that an adequate cure of this disease will not only cause the cutaneous eruption completely to disappear, but will prevent, and, in case they should already exist, will cure all the secondary chronic ailments consequent upon psoric reaction, and undermining the patient's life to his last moment.

These ailments, either acute or chronic,—the latter being the more important,—by which a suppression of the cutaneous eruption acting as a substitute for the internal disease, is unavoidably followed—this mode of suppressing the eruption being falsely called, "*repelling the itch into the system*"—are as various as the peculiarities of the different constitutions, and the different modes in which they are affected by external influences.

A short review of the evil consequences resulting from the suppression of the cutaneous eruption of the itch, may be found in a dissertation "De Damno ex Scabie Repulsa, Hal. 1750," p. 15—18, by the experienced and honest Lewis Christian Juncker. He observed that in young people of a sanguine temperament, this suppression was followed by tubercular phthisis; and that generally, in persons of a sanguine temperament, it was followed by hemorrhoids, colic, with bloody stools, and gravel; in persons of a sanguine-choleric temperament, by swelling of the inguinal glands, stiffening of the joints, and malignant ulcers, (called in German, *Todtenbrueche*;) in fat persons, by a suffocating ca-

tarrh and tabes mucosa, inflammatory fever, acute pleurisy and inflammation of the lungs. He says that in opening the bodies of such patients, the lungs have been found indurated and interspersed with sacculated cavities full of pus; that other indurations have likewise been discovered, together with swelling of the bones, and ulcers; that in persons of a phlegmatic temperament, this suppression of the cutaneous eruption produced in most cases dropsy; that the menses were delayed, and that they were changed to hemoptysis in case the eruption had been suppressed during their flow; that persons of a melancholy temperament became sometimes deranged, and that in pregnant women, having this temperament, the fœtus was killed; that the suppression of the eruption sometimes caused sterility;* that the secretion of milk in nursing women was arrested; that the menses ceased to flow before women had attained the proper age; and that in older women the uterus became affected with carcinoma, accompanied with deep-seated, burning pains, and general emaciation.

His experience has been frequently confirmed by the observations of others.† From this suppression of the cutaneous eruption of the itch have resulted:

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* A pregnant Jewess had the itch upon her hands; she removed it in the eighth month of her pregnancy, in order not to show it during the period of her delivery. She was delivered three days after the suppression of the eruption. The lochial discharge was arrested, and she had an acute fever. It was now seven years since she had been sterile and afflicted with leucorrhœa. Having become poor, she was obliged to go a great distance barefooted; this brought the itch out again; leucorrhœa and the hysteric affection disappeared, she became again pregnant, and was delivered of a healthy child.—(Juncker, ibidem.)

† In preparing the first edition of my Chronic Diseases, I was yet unacquainted with *Autenrieth's* Essays for the Practice of Medicine, based upon observations made in the clinical hospitals of Tübingen, 1808. His remarks on the diseases consequent upon the suppression of the itch by external applications, confirm perfectly all that I had already found in hundred other authors. He too has observed that this suppression is succeeded by ulcers on the feet, pulmonary consumption, chlorosis, menstrual irregularities, white-swelling in the knee, dropsy of the

*Asthma.**—F. H. L. Muzell, Wahrnehmungen, second collection, 8th case;[1] J. Fr. Gmelin in Gessner's Collection of Beobachtungen, v., p. 21;[2] Zieger, Diss. de Scabie Artificiali, Lips. 1758, p. 32;[3] Stanmen, Diss. de Causis Cur Imprimis Plebs Scabie Laboret. Helmst. 1792, p. 26;[4] Pelargus (Storch) Obs. Clin.

joints, epilepsy, amaurosis with obscured cornea, glaucoma, (opacity of the crystaline lens,) with complete amaurosis, mental derangement, paralysis, apoplexy, torticollis, etc. He attributes all these diseases (though incorrectly) to the use of ointments. But the slow removal of the itch, which he proposes to effect with hepar sulphuris and salves, is not a whit better; it is likewise a mere local suppression of the disease. He says that "it is ridiculous to undertake to cure the itch internally." This shows that he knows nothing about the proper treatment of the itch. It is indeed absurd to undertake to cure the internal psoric disease completely and thoroughly, by any other but internal remedies.

* Note of the translator.—Hahnemann quotes a vast number of authors who have furnished cases of the evil consequences of the suppression of itch. For the sake of brevity, I have omitted the names of these authors, together with the indication of their works and the cases quoted, leaving only those authors whose cases have been extracted by Hahnemann in full.

(1) A man, 30 or 40 years old, had been affected with the itch a long time ago, which had been removed by ointments. Ever since then he became more and more asthmatic. Breathing became finally very short and painful, even when he was perfectly quiet. In breathing there was a sibilant sound, but little cough. He was directed to take an injection of squills, 16 grains, and the same drug internally in the form of a powder, 3 grains. But, by a mistake, he swallowed the 16 grains. He was in danger of losing his life. He had immense nausea and retching. But the itch coming out again in abundance on his hands, feet, and on the whole body, the asthma disappeared at once.

(2) The vehement asthma was combined with general swelling and fever.

(3) A man of 32 years had the itch removed by sulphur ointment, in consequence of which he suffered the most violent asthma for eleven months. The eruption was at last restored on the 23rd day.

(4) A student caught the itch when he was about going to a dance. To be able to do this, he had the itch removed as soon as possible by a sulphur ointment. Soon after he was attacked

year 1722, page 435 to 438;[5] Breslauer Sammlungen, of the year 1727, p. 293;[6] Riedlin, father, Obs. Cent. II., obs. 90. Augsburg, 1691.[7]

Catarrh with suffocation.—Ehrenf. Hagendorn, Hist. Med. Phys. Cent. I., Hist. 8, 9;[8] Pelargus, Al. Loc. Jahrgang, 1723, p. 15.[9]

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with such a vehement asthma that it was impossible for him to take breath except with his head raised; during the attack he was almost suffocating. After having thus wrestled with death for an hour, he threw up little pieces of a cartilaginous substance; this gave him some ease for a time. Having returned to Osterode, his home, he suffered for two years of this disease. The attack came on at least ten times each day. His physician, Beireis, was not even able to give him the slightest relief.

(5) A boy of 13 years had been affected with tenia ever since his childhood. His mother having removed it by an ointment, he had 8 or 10 days afterwards a violent attack of asthma and of acute pain in the limbs, back and knee, which only disappeared a month after, when the itch broke out all over his body.

(6) Tenia capitis was cured in a little girl by purgatives and other internal remedies. The child was then attacked with dyspnœa, cough and great lassitude. The child speedily recovered his health as soon as the remedies were discontinued, and the tenia disappeared.

(7) A boy of five years had the itch. It was removed by an ointment, whereupon he was seized with great melancholy and cough.

(8) Tenia capitis having been removed by the application of almond oil, there came on great weariness in all the limbs, headache on one side, want of appetite, asthma, waking up in the night from an attack of catarrhal suffocation, violent rhonchus and sibilus in the chest, convulsive torsions of the limbs, as though he were in articulo mortis, and hematuria. Upon the tenia reappearing, he recovered from all these ailments.

A girl of three years old had been affected with the itch for some weeks, which was removed by an ointment. The next day the child was attacked with a suffocating catarrh, rhonchus, dumbness, coldness of the whole body; she recovered as soon as the itch came out again.

(9) A girl of 12 years old had her itch removed by an ointment, whereupon she was attacked with an acute fever, hooping-cough, asthma and swelling, and afterwards pleurisy. Six days later she took some internal medicine containing sulphur. This brought the itch out again, and, with the exception of her swelling, all her ailments disappeared. However, after the lapse of 24 days the itch dried up again, which was followed by inflammation of the chest, pleurisy and vomiting.

Asthmatic Suffocations.—Wilh. Fabr. v. Hilden, Obs. Cent. III. obs. 39;[10] Ph. R. Vicat, Obs. pract. obs. 35. Vitoduri, 1780;[11] J. J. Waldschmid, Opera,

Asthma, with swelling all over the body.—Pelargus, Aliis Loc. Jahrgang, 1723, p. 504;[13] Riedlin, father, Aliis Loc. Obs. 91.[14]

Asthma, with dropsy of the chest.—Morgagni, de sed. et Caus. Morb. XVI. art. 34;[15] Hagendorn, Al. Loc. Cent. II. Hist. 15.[16]

Pleurisy and inflammation of the chest.—Pelargus, Al. Loc. p. 10;[17] the same, Jahrgang, 1721, p. 23 and

(10) In a man of 20 years, dyspnœa came on after the removal of the itch; it was so violent that it was impossible for him to breathe, in consequence of which he died of suffocation.

(11) A young man of 19 years had a moist herpes on the left upper arm, which was removed by a great many external applications. Soon after he was attacked with a periodically returning asthma, which became almost suffocating in consequence of a long journey in the heat of the summer; the face was tumefied, blue-red, and the pulse feeble and unequal.

(12) Immediately after the removal of the itch, the patient was attacked with dyspnœa, and died of suffocation.

(13) A girl of 5 years had had, for some time, large itch vesicles on her hands, which had dried of themselves. Shortly after she was seized with short breathing, and became sleepy and exhausted; on the following day the asthma continued and her abdomen became distended.

(14) A countryman of 50 years had been affected with the itch for a long time. He had it removed by some external application, whereupon there was difficult breathing, want of appetite and swelling of the whole body.

(15) A girl of Bologna, on removing the itch by an ointment, had a most violent attack of asthma without fever. After two bloodlettings she became so exhausted and the asthma increased to such an extent, that she died the day after. The whole chest, as well as the cavity of the pericardium, were full of bluish water.

(16) A girl of 9 years, whose tenia had been removed, was attacked with a lingering fever, swelling all over the body and difficult breathing; she recovered after the tenia had reappeared.

(17) A man of 46 years removed his itch by sulphur ointment. Thereupon he was seized with inflammation of the chest, bloody expectoration and great anguish. The day after, heat and anguish became almost intolerable; the pain in the chest increased on the third day. Then sweat broke out. After the lapse of a

114,[18] and Jahrgang, 1723, p. 29,[19] and Jahrgang, 1722, p. 459;[20] Jerzembsky, Diss. Scabies Salubris in Hydrope, Halae, 1777;[21] Karl Wenzel, die Nachkrankheiten von Zurückgetretener Krätze, Bamb. 1826, p. 49.[22]

Pleurisy and cough.—Pelargus, Jahrg. 1722, p. 79.[23]

Violent cough.—Hundertmark, p. 23.[23*]

Hemoptysis.

Hemoptysis and consumption.—Chn. Max. Spener, Diss. de Ægro Febri Maligna, Phthisi Complicata Laborante, Giess., 1699;[24] Sicelius, Praxis Casual. Exerc. III. cas. I. Francf. and Lips., 1743;[25] Morgagni, XXI. art. 32;[26] Unzers, Arzt, CCC. p. 508.[27]

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fortnight the itch had broken out again, and he felt relieved. He had a relapse, the itch dried in again, and he died 13 days after.

(18) A thin man died of inflammation of the chest and other ailments, 20 days after the itch had been removed.

(19) A boy of 7 years, whose tenia and itch dried away from the skin, died, after the lapse of 4 days, of an acute fever accompanied with asthma and expectoration.

(20) A young man who removed his itch by means of a lead-ointment, died in 4 days of a disease of the chest.

(21) Anasarca was quickly relieved by the itch breaking out again. Being suppressed again in consequence of a violent cold, pleurisy came on and death ensued in 3 days.

(22) A country lad was attacked with an acute fever, pleurisy, dyspnœa, etc., in consequence of having had the itch suppressed by sulphur ointment 6 weeks before those diseases.

(23) A boy of 13 years, in whom the itch dried in, had cough and stitches in the chest. These symptoms disappeared after the itch had come out again.

(23*) A man of 36 years had the itch removed 16 months ago by an ointment of lead and mercury; ever since then he suffered of a convulsive cough, combined with great anguish.

(24) A young man of 18 years had the itch removed by a black cooking wash. A few days after, he was seized with chills and heat, weariness, anguish, headache, nausea, violent thirst, cough, difficult breathing; he spit blood in coughing, he began to talk delirious, his face became dead-coloured and emaciated, the urine looked blood-red, without sediment.

(25) In a young man of 18 years, whose itch had been removed by a mercurial ointment.

(26) The itch disappeared of itself, and was succeeded by a lingering fever and fatal expectoration of pus; the left lung was found full of pus.

(27) A robust-looking candidate for the ministry, wishing to

Collection of pus in the chest.—F. A. Waitz, Med. Chir. Aufsätze, Th. I., p. 114, 115.[28]

Sacculated bags full of pus in the intestines.—Schubert, Diss. de Scab. Hum. Lips., 1779, p. 23.[29]

Great degeneration of a large portion of the intestines.—J. H. Schulze, in Act. Nat. Cur., Tom. I., obs. 231.[30]

Degeneration of the brain.—Bonet, Sepulchretum Anat., sect. IV., obs. I., § 1,[31] and § 2.[32]

Hydrocephalus.

Ulcers upon the stomach.—L. Chn. Juncker, Diss. de Scabie Repulsa, Hal. 1750, p. 16.[33]

Sphacelus of the stomach and duodenum.—Hundertmark, p. 29.[34]

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free himself from his old itch on account of being obliged to preach in a few days, covered himself with an itch-ointment in the morning. In a few hours he was attacked with anxiety, short breathing, and tenesmus, and died immediately after noon; on opening the body the whole lungs were seen filled with liquid pus.

(28) Empyema consequent upon repelled itch, which had come out a few years ago, especially in the months of March and April.

(29) A young man, heedless of the warning of the excellent physician and professor, Krause, died of constipation in consequence of having used a sulphur ointment against the itch which had broke out again upon his skin. Collections of pus were found in his intestines.

(30) The diaphragm and liver were also diseased.

(31) A little prince of two years had tenia removed by ointments. After his death much bloody water was found under the skull.

(32) In a woman who died on account of having used a wash for the removal of tenia, one half of the brain was found putrefied and filled with yellow pus.

(33) A rich man of a cholerico-sanguine temperament, had a gouty affection of the abdomen, and pain like that consequent upon stone. He removed the gout by all sorts of remedies. After this the itch broke out. The eruption having been removed, an ulcer formed on the stomach, which caused his death, as was made evident by a post-mortem examination.

(34) A boy of seven weeks, and a young man of 18 years, died all on a sudden in consequence of the itch having been removed by sulphur ointment. In the body of the former the upper portion of the stomach immediately below the orifice, and in the latter

General dropsy.[35] *Dropsy of the chest. Swelling of the scrotum,* (in boys.) *Red swelling of the whole body.*

Jaundice. Swelling of the parotid glands. Swelling of the cervical glands.—Pelargus, Jahrg. 1723, p. 593;[36] Unzer, Arzt, Th. VI., St. 301.[37]

Obscuration of the eyes and presbyopia.—Fr. Hoffmann, Consult. Med. I., cas. 50.[38]

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that portion of the duodenum into which the ductus choledochus communis and the pancreatic duct open, were found destroyed by sphacelus. A similarly fatal mortification of the stomach occurred in a journeyman. See Morgagni, LV., art. 11.

(35) Innumerable cases of such dropsy may be found in a vast number of authors, among whom I shall simply refer to J. D. Fick, Exercit. Med. de Scabie Retropulsa, Hal. 1710, § 6. He mentions a case of itch that, having been suppressed by mercurial ointment, produced dropsy. This was only alleviated by the reappearance of the dropsy.

The author of *Epidemion*, which is attributed to Hippocrates, has been the first to mention, in No. 4, of the fifth book, the sad result which has been alluded to in the preceding paragraph. An Athenian was seized with a violently itching eruption, which was not unlike the eruption of lepra, and which extended over the whole body, and especially the genital organs. The eruption having been suppressed by warm baths upon the island of Melos, the patient died of subsequent dropsy.

(36) A boy of 8 or 9 years had tenia, which was suppressed by ointment. There was much swelling of the cervical glands, which made the neck crooked and stiff.

(37) A youth of 14 years had the itch in June, 1761. It was suppressed by means of a gray ointment. In consequence of this suppression, his parotid glands swelled considerably. The swelling of the left disappeared of itself, but the right became enormously enlarged, and, towards August, painful. All the cervical glands were swollen. The large ones on the outside felt hard and knotty; but on the inside there was an obtuse pain, especially during night; moreover, he suffered of difficult breathing and swallowing. All attempts at causing the glands to suppurate, remained fruitless; they grew so large that the patient finally died of suffocation in the year 1762.

(38) A girl of 13 years was attacked with the itch, especially in the joints, upon the face and the pudenda. The itch having been suppressed by means of zinc and sulphur ointments, the girl's sight became affected. She saw dark bodies floating before her face, which might also have been seen floating in the aque-

Inflammation of the eyes.—Hallmann, in Königl. Vetenskaps Handl. f. A. X. S. 210.[39]

Lenticular cataract.—Chr. Gottlieb Ludwig, Advers. Med., Tom. II. S. 157.[40]

Complete amaurosis.—Northof, Diss. de Scabie, Gotting. 1792, S. 10;[41] Chr. G. Ludwig;[42] Fabricius ab Hilden, Cent. II., obs. 39.[43]

Deafness. Inflammation of the bowels. Hemorrhoids. —Acta Helvet. V. S. 192;[44] Daniel, Syst. Ægrit. II., S. 245.[45]

Abdominal complaints.—Fr. Hoffmann, Med. Rat. Syst. III., S. 177.[46]

Diabetes, (suppression of urine.)—Morgagni, XLI., art. 2.[47]

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ous humour of the anterior chamber. She was unable to perceive little objects unless she used spectacles. The pupils were dilated.

(39) A girl had a violent eruption of the itch on her legs, together with large ulcers in the bent of the knee. Being attacked with the small-pox, the itch was suppressed. This suppression induced a moist inflammation of the white of the eye and the eyelids, which lasted for two years, and was accompanied with itching and suppuration of the lids, and a sensation of dark bodies floating before the eyes. After this she put on for three days woollen stockings having been worn by a child affected with the itch. On the third day a fever broke out, with dry cough, dyspnœa, and an inclination to vomit. Next day the fever and the symptoms in the chest abated. Sweat broke out, which increased until erysipelas appeared on both legs, which became true itch on the day following. The eyes improved.

(40) A man of robust constitution, whose itch had been suppressed by ointment, was seized with cataract.

(41) Suppression of the itch caused amaurosis, which disappeared when the eruption broke out again.

(42) A robust man, whose itch had been suppressed, was attacked with complete amaurosis and remained blind up to an advanced age.

(43) Complete amaurosis from a similar cause with terrible headache.

(44) Hemorrhoids re-appeared every month.

(45) Suppression of the itch was followed by a loss of blood of eight pounds within a few hours, colic, fever, etc.

(46) Suppression of the itch was followed by the most violent colic, pain in the left lumbar region, uneasiness, lingering fever, anxiety, and obstinate constipation.

(47) In a young peasant, suppression of the itch was followed

Erysipelas.—Unzer, Arzt, Th. V. p. 301.[48]

Discharges of acrid pus. Ulcers.—Unzer, Arzt, Th. V. p. 301;[49] Pelargus, Jahrg. 1723, p. 673;[50] Breslauer Samml. 1727, p. 107;[51] Muzell, Wahrnehm. II. cas. 6;[52] Riedlin, son, Cent. obs. 38.[53]

Cancer of the bones. Osteosarcoma of the knee. Pain in the bones. Rachitis and emaciation in children. Fever.—Ramazzini, Const. Epid. Urbis, II. No. 32, 1691;[54] J. C. Carl, in Act. Nat. Cur., VI. obs. 16.[55]

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by suppression of the urine, vomiting, and sometimes a pain in the left loin. Afterwards there was an occasional flow of urine, but in a small quantity and painful. The urine was dark red. They tried in vain to evacuate the bladder by means of a catheter. At last his whole body was distended; slow difficult breathing came on, and he died twenty-one days after the suppression of the itch. The bladder contained two pounds of dark red urine; and the abdominal cavity contained water which, when kept for some time over the fire, formed a thick substance like the white of an egg.

(48) A man having suppressed his itch by mercurial ointment, he had an erysipelatous inflammation on the neck, which ended his life in five weeks.

(49) A woman having used mercurial ointment against the itch, she had an eruption all over the body, which caused whole pieces of flesh to rot away, and ended her life in a few days amidst violent pain.

(50) A young man of 16 years having lost his itch, which he had had for some time, ulcers broke out on the legs.

(51) A man of 50 years having suppressed his itch, he had tearing pains for five weeks in the left axilla, after which several ulcers were forming in the pit.

(52) A quack gave a student an ointment against the itch. It disappeared, but an ulcer formed in the mouth, which could not be cured.

(53) A student who had been afflicted with the itch, suppressed it by an ointment. The suppression was followed by ulcers on the arms and legs, with glandular swellings in the axilla. The ulcers having been cured by external remedies, he was attacked with asthma, then with dropsy, and he finally died.

(54) Many observations may be made when the suppression of the itch was followed by fever and blackish urine, and when, after the reappearance of the itch, the fever disappeared and the urine resumed its healthy colour.

(55) A man and a woman had the itch upon their hands for many years. Each suppression of the itch was followed by an

Fever.—Reil, Memorab. Fasc. III. p. 169 ;[56] Pelargus, Jahrg. 1721, p. 276,[57] and the same, Jahrg. 1723 ;[58] Schiller, Diss. de Scabie Humida. Erford, 1747, p. 44 ;[59] J. J. Fick, Exercitatio Med. de Scabie Retropulsa, Hal. 1710, § 2 ;[60] Pelargus, Jahrg. 1722, p. 122 ;[61] also Jahrg. 1723 p. 14 ;[62] C. G. Ludwig, Advers. Med., II., p. 157 to 160 ;[63] Morgagni, X., art. 9,[64] XII., art. 31,[65] XXXVIII. art. 22,[66] LV., art. 3.[67]

attack of fever, which ceased as soon as the itch reappeared. The itch was only found upon a small portion of their bodies, nor was it ever suppressed by external remedies.

(56) Scabies a febre suborta supprimitur, remota febre redit.

(57) A boy of 9 years, whose tenia had been suppressed by ointments, had a violent attack of fever.

(58) A child of one year had for some time tenia and an eruption upon the face, which disappeared. A little while after, the child was seized with heat, cough and diarrhœa. Health was restored, when the tenia reappeared.

(59) A woman of 43 years suppressed the dry itch, with which she had been afflicted for a long time, by an ointment of mercury and sulphur. The suppression was followed by pain below the ribs of the right side, weariness in all her limbs, heat and feverish irritation. After having used diaphoretics for six days, large itch vesicles broke out over her whole body.

(60) Two young men, who were brothers, suppressed the itch by the same remedy. They lost all appetite, were attacked with dry cough, lingering fever, emaciation, and stupor, and would have died, if the eruption had not come out again.

(61) A child of three years was afflicted with tenia, which disappeared of itself. This was followed by inflammation of the chest, cough, and weariness. When the eruption came out again, the child recovered.

(62) A journeyman purser, who was told to make some kind of embroidery, freed himself from his itch by lead ointment. The itch had scarcely died away, when he was seized with chills, heat, asthma, and rattling cough, which caused his death by suffocating him on the fourth day.

(63) A man of 30 years, of a healthy and robust constitution, was affected with the itch. He removed it, and was afterwards attacked with catarrhal fever and an immense sweat, from which he recovered very slowly. All on a sudden he was again attacked with another fever without any perceptible cause. The attacks began with anxiety and headache, and continued increas-

(64) See page 44.
(65) Ibid
(66) See page 44.
(67) Ibid.

Fever.—Höchstetter, Obs. Med. Dec. VIII., cas. 8;[68] Wehle, Diss. Nullam Medicinam Interdum esse Optimam, Witemb. 1754;[69] Fick. § 1;[70] Amatus, Lusit.

ing with heat, quick pulse and morning sweat. These symptoms were combined with great sinking of strength, talking delirious, anxious tossing about and groaning, breathing with suffocation. In spite of all medicines, the disease ended in death.

(64) The spontaneous suppression of the itch in a boy was succeeded by fever. The itch coming out again, the fever disappeared. But the child grew thin, and the itch dried in a second time; diarrhœa, convulsions, and soon after, death, were the consequences of this suppression.

(65) The itch disappeared of itself; this was followed by a lingering fever, expectoration of pus, and at last death. The left lung was found full of pus.

(66) A woman of 30 years had for a long time pain in the joints and a considerable eruption of itch; she removed it by an ointment. This was followed by fever, with violent heat, thirst and violent headache, combined with talking delirious, immense asthma, tumefaction of the body, and great distention of the abdomen. Six days after the breaking out of the fever she was dead. The abdomen contained only much air; the stomach, which was replete with air, filled up half of the abdomen.

(67) A man whose tenia had been suppressed by cold, was seized with a malignant fever and vomiting, eight days after the suppression; at last hiccup came on and the patient died on the ninth day.

In the same article, Morgagni quotes the case of a man affected with porrigo on the arms and other parts, which he removed by means of a shirt fumigated with sulphur. He was immediately seized with drawing pains in the whole body, and fever, which prevented him from resting in the night, or from stirring from his place in day time. Tongue and fauces were also affected with the malady. With much trouble the eruption was brought out again upon the skin, and he recovered.

(68) Suppression of the itch was followed by a malignant fever and opisthotonos.

(69) In a young merchant, the suppression of the itch was suddenly followed by such a hoarseness that he was unable to utter a loud syllable; this was followed by dry asthma, loathing of food, violent cough, which tormented him, especially during the night, and robbed him of sleep; excessive and badly smelling night sweats, and finally death, in spite of all medical treatment.

(70) A mayor of sixty years had the itch, which caused him much suffering, especially in the night. He used many remedies against it in vain. A mendicant at last taught him a remedy

Cent. II., Curat. 33 ;[71] Fr. Hoffmann, Med. Rat. System. T. III. p. 175.[72]

Tertian.—Pelargus, Jahrg., 1722, p. 103, compare with p. 79.[73]

Quartan.—Fr. Hoffmann, Med. Rat. Syst., III., p. 175.[74]

Vertigo and total sinking of strength. Epileptic vertigo.—Fr. Hoffmann, Consult. Med. I., cas. 12.[75]

Epilepsy with vertigo.—Fr. Hoffmann, p. 30.[76]

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said to be infallible, composed of the Olium lauro-cerasi, flowers of sulphur and lard. This caused the eruption to disappear; but immediately after, he was seized with violent chills, then heat over the whole body, vehement thirst, panting breathing, sleeplessness, violent trembling in the whole body, and great lassitude; he expired on the fourth day.

(71) Suppression produced frenzy, and a fever, resulting in death.

(72) Suppression of the itch is generally followed by acute fevers and great sinking of strength. In a case of suppressed itch the fever had lasted seven days; after this period the eruption came out again, and the fever disappeared.

(73) A boy of fifteen years, who took a purge against tenia, was attacked with pain in the back, cutting pain during micturition, and afterwards a tertian fever; the disease was of long standing, and the purge administered by Pelargus.

(74) "Old people are mostly affected with dry itch. The suppression of this kind of itch is generally followed by a quartan fever, which ceases the moment the itch comes out again."

(75) A count of 57 years had been affected with dry itch for three years. The itch having been suppressed, he apparently enjoyed good health for two years, with the exception of attacks of vertigo, which increased to such an extent that on one occasion he would have fallen to the floor if he had not been caught. This occurred after a meal. He was covered with a cold clammy sweat, his limbs trembled, all the parts of the body had the appearance of being dead; he frequently vomited sour substances. The attack came on a second time six weeks after. It then came on every month for three months in succession. He retained his senses, but the attacks were followed by heaviness in the head and a sort of stupefaction such as is consequent upon intoxication. At last the attack came on every day, although the violence of the attacks had abated. He was not permitted to read, or to think; to turn quickly, or to stoop; he was also affected with sadness, sighing, and melancholy thoughts.

(76) A woman of 36 years had used mercurial ointment for

Convulsions.—Welle, Diss. Nullam Medicinam Interdum esse Optimam, Viteb., 1754, § 13, 14;[77] Sicelius, Decas Casuum I. cas. 5;[78] Pelargus, Jahrg. 1723, p. 545.[79]

the suppression of the itch; the consequence was that her menses became irregular, and were often interrupted for ten or fifteen weeks; moreover she was constipated. Four years ago, being pregnant, she was seized with vertigo; while standing or walking she fell to the floor when an attack came on. In the sitting position she retained her senses during an attack; she was able to speak, to eat, and to drink. When the attack came on there was a sensation of crawling and formication in the left foot, which terminated in the foot being violently raised up and down. The attacks gradually deprived her of her senses, and on a journey, in a carriage, she was attacked with real epilepsy, which returned three times during the winter. During these attacks she was unable to speak; the thumbs were not clenched, but there was foam at the mouth. The sensation of formication in the left foot announced the attack; when this sensation had reached the pit of the stomach, the fit came on. A woman removed this epilepsy by means of five powders; after this the vertigo reappeared with much greater violence than before: this too began with a sensation of crawling in the left foot, which rose to the pit of the stomach; this sensation was combined with great anxiety and fear, as though she fell from a height; she then became speechless, lost her senses, and the limbs were convulsively agitated. Even between the attacks her feet now are extremely painful to the slightest touch, like boils. Moreover, she has a violent pain and heat in the head, and her memory is gone.

(77) Suppression of the itch, in a girl, was followed by a deep swoon, horrible convulsions, and finally death.

(78) A girl of 17 years was affected with tenia, which disappeared of itself. After this she constantly had heat in the head and attacks of headache. Sometimes she suddenly started up as if by fright, and while waking she had convulsions, especially of the arms and hands; oppression in the pit of the stomach, consequent upon constriction of the chest; whining, then came on convulsions and startings of the limbs.

(79) Tenia dried in a full-grown man who had been affected for some years with tremor of the hands. This caused great lassitude; red patches, without heat, broke out all over his body; the tremor now passed into convulsive shaking, he coughed up bloody matter through the nose, the ears, and from the chest, and he died amidst convulsions on the twenty-third day.

Epileptic convulsions. Epilepsy.—J. C. Carl, in Act. Nat. Cur. VI. obs. 16;[80] E. Hagendorn, Hist. 9;[81] Fr. Hoffmann, Consult. Med. I. cas. 31;[82] Fabr. de Hilden, Cent. III. obs. 10;[83] Riedlin, Lin. Med. Ann. 1696, Maj. obs. 1;[84] G. W. Wedel, Diss. de Ægro Epileptico. Jen. 1673;[85] Herrm. Grube, de Arcanis Medicor. non Arcanis, Hafn. 1673. p. 165;[86] Tulpius, Obs. lib. I. cap. 8;[87] Th. Thompson, Medic. Rathpflege, Leipsic, 1779, p. 107, 108;[88] Hundertmark, p. 32;[89] Fr. Hoffmann, Consult. Med. I., cas. 28, p. 141.[90]

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(80) A man who had suppressed his frequently-returning itch by ointments, was attacked with epileptic fits, which disappeared on the reappearance of the eruption upon the skin.

(81) A young man of 18 years suppressed his itch by means of a mercurial ointment. Two months after, he was seized all on a sudden with convulsions attacking all the limbs of his body; they were accompanied with painful constriction of the chest and neck, coldness of the limbs and great weakness. On the fourth day epilepsy came on, with foam at the mouth and strange contortion of the limbs. The fits ceased the moment the itch broke out again.

(82) In a boy whose tenia had been suppressed by almond oil.

(83) In children, accompanied with suffocating catarrh.

(84) Epilepsy came on in a servant girl after the itch had been suppressed twice.

(85) A youth of 18 years had fits of epilepsy after having suppressed the itch by mercurial ointment a few weeks before. The fits returned in four weeks, about new moon.

(86) A boy of 7 years was attacked with epilepsy. The parents were unwilling to admit that it came from suppressed itch. The mother at last confessed to the carefully inquiring physician that the boy had had a few itch vesicles on the soles of the feet, which had soon yielded to lead ointment; but there had been no other eruption on any part of the body. The physician considered this, and correctly so, the cause of the fit.

(87) Two children were freed from epilepsy by the eruption of moist tenia; the fits however returned as soon as the tenia had been suppressed.

(88) Itch which had lasted for five years, disappeared from the skin; this disappearance caused epilepsy after a couple of years.

(89) A young man of 20 years had his itch suppressed by means of a purge. In consequence of this suppression he suffered for two years the most violent convulsions, until the itch was brought out again by birch-juice.

(90) A young man of seventeen years suppressed his itch;

Apoplexy. Paralysis.—Unzer, Arzt, VI. p. 301;[91] Hundertmark, p. 33;[92] Schubert, Diss. de Scabie Human. Corp. Lips. 1779, p. 23.[93]

Melancholy—Reil, Memorab. Fasc. III. p. 177.[94]

Frenzy.—Brune, Diss. Casus Aliquot Mente Alienatorum, Hal. 1707, cas. I. p. 5;[95] F. H. Waitz,

he was of a robust constitution and had a sound understanding. After the suppression of the itch, three years ago, he was first attacked with hemoptysis, then with epilepsy, which grew worse by medicine, so that he had two attacks in an hour. A surgeon procured him relief for four weeks, by bleeding and medicines. But soon after the fits returned during a nap, and he had two or three attacks every night, accompanied with an intense cough and a suffocating catarrh, especially during the night; with all this he threw up a fetid liquid. He was obliged to keep his bed. At last he had ten fits during the night and eight during the day; the fits were caused by taking much medicine. Nevertheless the thumbs were never clenched during an attack, nor was there any foam at the mouth. His memory is now weakened. The fits came on a little before the time of the meals, but principally after the meals. During the nightly attacks he remains in the deepest sleep without waking up. In the morning he feels bruised all over. The only indication of a coming fit is his rubbing the nose and drawing up the left foot, after which he suddenly falls.

(91) A woman's leg became paralysed, and remained so through suppressed itch.

(92) Hemiplegia ensued in a man of 53 years, after suppression of the itch by mercurial ointment.

(93) A minister had for a long time used internal remedies against the itch; of these remedies he got at last tired. He therefore employed ointments. The consequence was that the upper extremities became paralysed, and that a hard and thick skin formed in the palm of the hands, itching terribly and marked with bloody, shrivelled patches. At the same place mention is made of a woman whose finger contracted in consequence of suppressed itch. The contractions lasted long.

(94) Suppression of the itch was succeeded by melancholy and imbecility, which disappeared on the reappearance of the itch.

(95) A student of 20 years caught the itch. His hands became covered with it to such an extent that he was unfit for his business. The itch was suppressed by means of an ointment. Shortly after he became deranged, sang or laughed where it was improper to do so, and ran until he fell down exhausted. His sickness increased from day to day, until finally hemiplegia

Medic. Chirurg. Aufsätze, Th. I. p. 130;[96] Grossman, in Baldinger's Neuem Magazin. XI. 1.[97]

These few cases, drawn from the writings of the older physicians and from my own experience,* are sufficient to convince the intelligent observer that the itch, together with its varieties, tenia capitis, crusta lactea, herpes, etc., are the external vicarious symptoms of an internal disease affecting the whole organism, and that *psora* is the most pernicious of all chronic miasms. After reading the above cases no reasonable and inquiring physician will dare to assert that the itch, tenia, herpes, etc., are mere cutaneous diseases, which may unhesitatingly be removed from the skin by external applications, because the organism is not affected by them.

This kind of treatment is the most pernicious, the most infamous and the most unpardonable malpractice of which allœopathic physicians have made themselves guilty.

He who is blind against the wisdom which the above quoted examples teach, wilfully prepares the ruin of mankind.

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came on and he died. The intestines cohered like a firm mass. They were interspersed with little ulcers, with protuberances of the size of walnuts, which were filled with a viscid substance resembling plaster.

(96) The same phenomena.

(97) A man of 50 years was attacked with anasarca on account of having suppressed his itch by ointments. The itch returned and the dropsical swelling disappeared. A second suppression was followed by frenzy, with head and neck swelled up to suffocation, lastly there supervened blindness and complete suppression of urine. Artificial stimulants applied to the skin, and strong emetics brought the itch out again. After it had spread over the whole body, all the former accidents disappeared.

* An opponent from the old school has reproached me with not having shown, by examples from my own experience, that chronic ailments, which neither originated in syphilis nor in sycosis, are all of them derived from repelled *psora*. I should like to know whether examples, were they even drawn from my own experience, can be more strikingly convincing than those which I have quoted from both old and modern allœopathic works? Have not our opponents from the old school often denied us belief, because our observations were not made

Are my opponents ignorant of the fact, that all miasmatic diseases, accompanied with cutaneous eruptions, observe the same course from their very origin? and that all miasms first attack the whole organism internally, before the vicarious affection manifests itself upon the skin?

By examining that course a little more closely, we shall find that all miasmatic diseases which form local affections upon the skin, are *internal* diseases, the last result of which is the local cutaneous affection. In acute diseases, the local symptoms, together with the disease, leave the system as soon as they have run through their regular course. In chronic diseases, however, the local affection may either be removed or disappear of itself, without the internal disease leaving the organism either in part or entirely; on the contrary, the internal disease may increase in the progress of time, unless it is cured by art.

This circumstance relative to the course of chronic diseases, deserves so much more to be noticed, as the common physicians, especially the modern, have, from sheer blindness, overlooked it, although it was evidently the course of all acute miasmatic diseases. They neither suspected nor noticed that the local affection was a secondary vicarious symptom of an internal disease; on the contrary, they often denied the existence of the internal disease, and by removing the bubo, cauliflower excrescence and itch by external applications, they brought ineffable misery upon mankind.

In considering the formation of these three chronic maladies, as well as that of the acute miasmatic diseases, three cardinal points ought to be noticed much more carefully than has been the case heretofore. These are, 1st, the period when the infection took place; 2nd, the

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before their own eyes, and the names of the patients were only indicated by a letter, as if private patients were willing to have their names presented in full? I did not wish to expose myself to similar proceedings. Moreover, by quoting the cases of honest practitioners of the old school, I furnish the most indubitable and impartial proofs for my doctrines.

period when the whole organism began to be tainted with the miasmatic poison, until it had become a complete internal disease; and, 3rd, the manifestation of the external symptoms, by means of which nature indicates the complete development of the miasmatic disease in the internal organism.

My opinion is, that the miasmatic infection in acute as well as in chronic diseases, takes place in *a moment*, provided this moment is favourable to the contagious influence.

During the progress of inoculation or vaccination, the infection takes place at the time when the morbid matter introduced under the bleeding skin, is brought in contact with the exposed nerve. The whole nervous system becomes infected in a moment. After the infection has taken place, ablutions, cauterization and burnings are unavailable to annihilate the disease, or even to arrest its progress in the internal organism. Even amputation of the part infected is of no avail. The human small-pox, the cow-pox, the measles, etc., will run through their course, and the fever which is peculiar to each of those different forms of infection, together with the cutaneous eruption, will break out a few days after the internal disease shall have *completed its development.**

* The question whether any miasmatic infection by the skin can exhibit external symptoms before the internal disease has become completely developed, ought to be answered *in the negative.*

Do not three, four or five days elapse after vaccination before inflammation sets in? Does not a sort of fever, which is the symptom of a disease pervading the whole organism, show itself before the small-pox reaches its full development on the 7th or 8th day?

Do not ten or twelve days elapse after infection by the small-pox has taken place, before the fever comes on, and the small-pox breaks out upon the skin?

What has nature been doing, during that space of time, with the contagious miasm which was introduced from without? Was it not necessary that the disease should be first communicated to the whole organism, before nature became capable of

Among many other acute miasms, I may mention the infection of the human skin by the miasm of the epizootic carbuncle. As soon as the infection has taken place, ablutions are of no avail; the black blister, which is almost always fatal, and which generally appears upon the spot where the infection has taken place, comes out in about four or five days after this terrible disease has pervaded the whole organism.

This same rule obtains relatively to the half-acute miasms without eruptions. Thanks to the kind Ruler of the world, only a few of those who are bit by mad dogs, are infected—scarcely one in twelve; often only, to my knowledge, one in thirty; the rest, were they ever so much torn by a mad dog, generally recover with or without treatment.* Wherever the poison acts, the infection takes place at the moment when the bite occurs, by affecting at once the whole nervous system. In a few days, and often a few weeks, during which the internal disease becomes developed, the rage breaks out as an acute and quickly fatal disease. We know from experience that, whenever the poison has caught, the infection takes place at the moment when the bite occurs; for neither instantaneous exsection,† nor amputation of

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enkindling the fever, and bringing the eruption out upon the skin?

The measles also require ten or twelve days after the infection has taken place, before the eruption comes out upon the skin, and fever sets in. The infection by the virus of scarlatina generally requires seven days before the fever and redness appear.

What has nature been doing all this time with the miasm? What else except to communicate the disease to the whole organism, which communication must first take place before the fever and eruption can appear?

* These statements we owe especially to the experience of English and American physicians, to Hunter and Houlston; (in the London Med. Journ. Vol. V.;) also to Vaughan, Shadwell, Percival, whose observations may be found recorded in James Mease's treatise "On Hydrophobia," Philadel., 1793.

† A girl of 8 years, in the city of Glasgow, was bit by a mad dog on the 21st of March, 1792. The wound was immediately exsected with great care, the suppuration was kept up, togethe with ptyalism, for two weeks. Nevertheless hydrophobia broke

the bitten part, are capable of preventing the development of the disease in the internal organism; hydrophobia will occur in spite of the many boasted external applications for the purification, cauterization and suppuration of the wound.

From the course which these miasmatic diseases pursue, we clearly see that, after infection, the internal disease, whether measles, scarlatina, or small-pox, must first have become fully developed in the organism, before those eruptions can come out upon the skin.

Against all these acute miasmatic diseases, nature adopts a mode of cure which is inexplicable to us. They run through their course of about two or three weeks, when a *crisis* ensues, by means of which the fever, together with the eruption, are annihilated in the system. After this period man either dies of those diseases, or else recovers.*

The mode of contagion which nature follows in the chronic miasmatic diseases, and the formation of the internal disease previous to the external symptoms appearing upon the skin and indicating the completion of the internal malady, is *the same* as in the acute forms of the disease; but after the internal disease is completed,

out on the 27th of April, and on the 29th the patient died. See Duncan's Med. Com. Dec. II. Vol. 8., Edinb. 1793, and the new London Med. Jour. II.

* Have those acute, semivital miasms the peculiar nature of becoming extinct in the organism, after having affected the vital powers, at the moment of the infection, each in its peculiar manner, and having spread through the system like a parasitical growth, establishing each its peculiar fever, and leaving upon the skin an eruption which is, in its turn, capable of communicating the disease?

Are not the chronic miasms, on the contrary, continued by the peculiar contagious eruption which they leave behind, itch vesicle, chancre, cauliflower excrescence, whereas the acute miasms become extinct of themselves? The chronic miasms are semivital morbid miasms of a parasitical nature, which can only be neutralized and annihilated by a more powerful remedy producing analogous effects, (the antisporics;) it is by means of these alone that the patient can be freed from the effects of those miasms.

there is this remarkable difference between it and the acute diseases, that the chronic miasm continues in the organism, and even develops itself from year to year, unless it is extinguished and thoroughly cured by art.

To show this more fully, I shall here only mention those two chronic miasms which are best known, the *chancre* and the *itch*.

The infection most probably takes place, during the act of coition, at those places which come in contact with the syphilitic virus and receive it into themselves by friction.

If the poison has taken effect, the whole system is at once tainted with it. Immediately after the infection has taken place, the formation of the internal disease begins.

Those parts of the genital organs, where the infection has taken place, exhibit nothing unnatural, nothing morbid, no traces either of inflammation or corrosion; *all washing of the parts immediately after an impure coition is useless.* According to all appearances the parts remain healthy; only the internal organism is roused by means of the infection, (which generally takes place in a moment.) The internal organism endeavours to assimilate the syphilitic miasm, and becomes thoroughly tainted with the syphilitic disease.

This complete adaptation of its organs to the syphilitic virus is the first object of the human organism, after the infection has taken place. Not till the internal disease is completely developed, does nature try to alleviate and to hush her sufferings by forming at the spot where the infection has taken place, a local symptom as a substitute for the internal disease in the shape of a little blister, which is transformed to a painful ulcer, called bubo or chancre, about five, seven or fourteen days, or sometimes even three, four, and five weeks after the infection has taken place. This vicarious chancre has the power of communicating to other persons the same miasm, which is the internal disease.

If the internal disease is extinguished by means of the internal remedy, the chancre becomes also cured, and man recovers.

But if the chancre be removed by some local application,* as is done yet to this day by physicians of the old school, the miasmatic chronic venereal disease remains in the organism, and unless it be cured by internal remedies, it gets worse to the end of life; nor is the strongest constitution, by its own unaided efforts, capable of eradicating the virus.

The chancre is most easily and thoroughly cured by curing the internal disease which pervades the whole system. I have taught and practised this for years. The best mode is to employ the internal remedy alone, without any external application. The merely local removal of the chancre, without any previous cure of the internal disease, is invariably followed by the breaking out of the syphilitic disease, with all its sufferings.

Psora is, like *syphilis*, a miasmatic chronic disease, and resembles it in regard to the first development.

Psora is the most contagious of all chronic miasms, and much more so than *syphilis* or *sycosis*. The infection by the latter two miasms can only take place with readiness in wounds, and at those parts of the body which are covered with a very thin cuticle and provided with a delicate nervous tissue; such parts are the genital organs. Moreover a certain degree of friction is required to introduce the virus into the system. The *psoric miasm, on the contrary, taints the system, especially that of children, by simply touching the skin.*

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* Syphilis does not only break out through the removal of the chancre by cauteries—which is called by quacks, repelling the virus into the system, as though the system had been sound before the so-called repulsion had taken place;—even the sudden removal of the chancre without any stimulants, brings on syphilis, which may incidentally teach us that the syphilis must have existed in the system before the appearance of the chancre. "Petit cut off a small portion of the labia minora which had been affected with chancre for some days; the wound healed, but syphilis broke out nevertheless." See Fabre, Lettres, Supplément à son traité des Maladies Vénériennes. Paris, 1786.—How could this be otherwise, since the syphilitic disease pervaded the whole system even before the chancre had made its appearance!

Almost every body may, under any circumstances, be infected with the psoric miasm; this is different with the other two miasms.

As I said before, the infection by the psoric miasm is more common, more certain, more easy and more absolute than that by any other. This miasm may be so easily communicated that the physician often gives it to his patients in feeling their pulse.* It may be communicated by linen which has been washed together with the linen of persons afflicted with the itch; † by gloves which such a person had tried on before; by a bed or a towel which had been used by itch patients. Often even it is given to the child by the mother during its passage through the maternal organs, or by the midwife who just came from another parturient woman, or by the nurse upon whose arms the child is carried about, and who was either unclean herself or suffered the child to be touched by unclean hands. Considering the thousand different modes in which this miasm touches the various things which are necessary to man, and which he is far from suspecting and cannot help touching, we may say that those who remain free from the itch, constitute a lucky minority. Not only in hospitals, dungeons, factories, or in orphan asylums and the huts of the poor, need we seek the psoric infection; we find it just as well among the rich, or among those who live in society or in retirement. The hermit upon Montserrat escapes it just as little as the little prince wrapped up in his cambric swaddling-clothes.

The moment the psoric miasm has touched the hand, and has taken effect, it spreads through the system. Henceforth all washing and cleansing of the spot is useless. The skin during the first days, remains unchanged and apparently sound. There is neither eruption nor itching to be perceived upon the body, not even at the spot where the infection has taken place.

* Car. Musitani Opera, de Tumoribus, cap. 20.

† Willis observed this. See Turner, des Malades de la Peau traduit de l'Anglais, à Paris, 1783. Tom. II. cap. 3, p. 77.

The nerve in which the psoric miasm had first taken effect, had already communicated it to the remaining nerves by an invisible dynamic sympathy, and the living organism became so much disturbed by this specific influence, that it was forced to adapt itself to the action of this psoric miasm, until, by virtue of this universal adaptation, the internal disease had become completely and finally established.

Not till the whole organism has been adapted to the nature of the chronic miasmatic disease, do the morbidly affected vital powers endeavour to alleviate and to calm the internal disease by a local symptom, (the itch vesicle, for instance.) As long as this eruption continues upon the skin in its natural form, the internal *psora*, together with its secondary ailments, remain slumbering, latent and restrained.

The perfect adaptation of the whole organism to the nature of the psoric virus usually requires a period of six, seven, ten, sometimes even fourteen days. After this period, towards evening, the patient experiences a more or less considerable chill, and, during the subsequent night, heat all over the body, terminating in sweat. This heat is often supposed to be a little fever, which is believed to come from a cold, and is not regarded.* Then the eruption makes its appearance, first near the spot which has been the original seat of the infection, in the shape of fine vesicles, resembling rash, and increasing in size. They are distinguished by a *voluptuously* and *almost intolerably delightful itching*. This incessantly invites the patient to rub and to scratch the vesicles, and, if the itching is suffered to continue without scratching, there is a shuddering experienced over the whole skin. *Rubbing* and *scratching* may ease the patient for a moment, *but it is immediately*

* So far from being a separable local affection, the vesicles are on the contrary evident proofs of the *psora* having been completely developed in the system; the eruption is merely the ultimate boundary of the psoric development. This eruption, together with the itching, are a part of the whole disease in its natural, least dangerous form.

succeeded by long burning at the spots where the scratching took place. This itching occurs most frequently and is most intolerable, late in the evening and before midnight.

During the first hours of their existence, the vesicles contain a limpid lymph, which is quickly changed to pus, filling the tip of the vesicle.

The itching is so terrible that the patient not only rubs the vesicles, but scratches them open. The liquid which oozes out from the vesicles, furnishes an abundance of contagious material for those who come near the patient, and have not yet been infected. The extremities, linen, cloths, utensils of every kind, which have been touched by this liquid, propagate the disease.

The cutaneous eruption, which is an indication of the psora having pervaded the whole organism, (the Germans call it krätze, itch,) the ulcers consequent upon this eruption, and accompanied with their peculiar itching round the borders, and lastly, tenia and those forms of herpes which become moist on rubbing, and are distinguished by a sort of psoric itching, are alone capable of transferring the disease to other persons, because they alone contain the miasm susceptible of communication. On the contrary, the secondary symptoms of *psora* which appear both after the spontaneous and the artificial suppression of the eruption, and which are the common results of psoric reaction, never transmit the itch to other persons, no more than the secondary symptoms of syphilis transmit this disease to others. (This was first observed and taught by John Hunter.)

When the eruption is just coming out, and is not yet spread over the skin, the health of the patient seems to be unimpaired; there are as yet no traces of the internal psoric disease. The eruption acts as a sort of substitute for the internal disease, which, together with its secondary ailments, remains in a latent condition.*

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* In the same way the chancre acts as a substitute for the internal syphilis; which remains latent as long as the chancre remains at its place. I saw a woman who had been affected with

While the disease is in this condition, it is most easily cured by the specific remedies taken internally.

If the disease is permitted to develop itself according to its nature, without using an internally curative remedy, or some external application against the eruption,* the internal disease increases rapidly. This increase of the internal disease inducing a corresponding increase of the external symptoms, the eruption will finally cover the whole surface of the body, in order to calm the internal disease, and keep it in a latent condition.

Even at this stage of the disease man apparently enjoys good health, except the eruption. The external symptom keeping pace with the internal disease, keeps this one at bay. But the itching over the whole body becomes so intolerable, that even the robustest man cannot bear it in the end. He wishes to get rid of his torment at any price; and, for want of sound help, he contents himself with being freed from the eruption, even though it cost him his life. Unfortunately the

a chancre for two years. The chancre had constantly remained at the same place, and had now reached the size of an inch in diameter. Nothing had been done for it. There was no trace of secondary syphilis in this patient. The best preparation of mercury taken internally, cured both the internal disease and the chancre.

* Note of the translator.—This is not to be understood as if Hahnemann approved of the application of external remedies. The idea which Hahnemann means to convey is this, that the internal disease may be *apparently* checked in its course by external applications; in reality the internal disease is not checked; it is surprised, or stunned, as it were, by the external application, but not cured, not even checked by it; for, from the moment that its external symptom, in which the disease has embodied itself, is suppressed, the morbific virus concentrates itself, gathers its forces, and constructs its mines, by means of which it prepares the ultimate and unavoidable destruction of the organism. This gathering of the morbific virus and instilling itself into the inmost recesses of the animal economy, is necessarily the work of time, and often takes place so slowly and gradually that the patient is induced to believe that the suppression of the external vicarious embodiment of the internal disease was tantamount to a radical cure.

means are at once furnished him either by ignorant laymen or by allœopathic physicians and surgeons. All he cares for is to get rid of the external pain, without thinking of the evil consequences that attend the suppression of the vicarious external disease. By resorting to this suppression, he fares like the poor man who means to get rid of his poverty by stealing a large sum of money, and, instead of obtaining wealth, goes to dungeon or the gallows.

The longer the psoric disease has lasted, no matter whether the eruption has spread all over the skin, or whether it has been confined to a few vesicles, owing to a peculiar want of action in the skin,* in both these cases the suppression of even the smallest eruption is attended with the most pernicious consequences; for the internal psora which has been increasing all the time, now breaks forth with its host of terrible sufferings.

The badly informed layman may be pardoned for suppressing the troublesome itching and the eruption, by cold shower baths, rolling in the snow, cupping, or rubbing the skin or only the joints with sulphur ointment; he knows not what dangerous symptoms of the internal *psora* he calls up in his system. But who can pardon men whose duty it is to know, and by proper treatment,†

* See above, the observation in case 86.

† For, even at this stage of the disease, the eruption, together with the internal psora, may yet be cured more easily, and with more certainty, though less so than at the beginning of the disease, by the proper homœopathic remedies, than is possible after the external suppression of the eruption; for this external suppression is always succeeded by a host of nameless chronic diseases, into which the external *psora* develops itself. Before the suppression, the psoric disease forms yet a unit, and may, therefore, be met more easily, with infinitely more certainty and more thoroughly by the appropriate specific remedies, than after the suppression of the cutaneous symptoms. External remedies are no more required in this disease than in the venereal affection, where one small dose of the best mercurial preparation is often sufficient to convert the chancre into a benign ulcer. The ulcer heals in a few days of itself, and no secondary symptoms of syphilis ever appear, because the internal disease has been cured, together with the local affection. This is a doctrine which I

to prevent the accidents which will arise from the psoric reaction consequent upon suppressed eruption, when you see them treat their patients in an improper manner, and suppress the eruption with an incredible levity, by means of powerful internal and external remedies, drastic purgatives, the ointment of Jasser, washes of the acetate of lead, mercurial preparations, sulphate of zinc, and especially by an ointment composed of lard and flowers of sulphur or quicksilver, pretending all the while, "that it is simply an impurity in the skin, and that the skin being cleared, every thing is over, and man needs not to appre-

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have taught for years, and have constantly illustrated by my cures.

Can it be excused, that after a lapse of three hundred years since the venereal disease has been known, the physicians should have been so ignorant of its nature as not to perceive that the chancre is something more than a mere local affection? Can the physicians be pardoned for having failed to perceive that the chancre being the external symptom of an internal syphilitic disease, it ought not to be removed by external applications? Ought not experience to have shown them that the removal of the chancre by external applications deprives the internal disease of its vicarious symptom, and, therefore, forces it to show itself in the formidable and much more inveterate character of *syphilis*? Can this want of judgment be excused?

Why did physicians never reflect upon the origin of cauliflower excrescence? Why did they constantly overlook the internal disease which gives origin to these excrescences? Why did they not cure the internal disease by homœopathic remedies, which would have caused the excrescences to disappear without the use of an external agent?

But suppose we were willing to excuse this sad neglect and ignorance on the ground that the physicians had only three centuries and a quarter to obtain a correct knowledge of *syphilis*, which they certainly would have obtained by practising a little longer,—though I had several times tried to convince them of their error—nevertheless they cannot be excused for their obstinate blindness relative to the true treatment of psoric diseases, and for the pride with which they overlooked all those facts which had a tendency to show them that the itch originates in an internal *psora*; no, they were determined to deceive the world by the lamentable delusion, "*that the intolerably itching vesicles were only an external cutaneous disease, and that their local suppression freed man from all disease and restored him to health.*"

hend any further trouble." Who can pardon them for not profiting by the many thousand warning examples which they find recorded in the works of older, conscientious observers, or which the experience of modern physicians reveals to them? Ought not they to know that, by suppressing the eruption, they bring upon the patient either certain death, or a lingering disease, which lasts to the end of his life? Do they not let loose the psoric disease upon the deluded patient by tearing down the only barriers which kept the thousand-headed monster in bounds?

It may easily be imagined, and experience teaches, that the internal *psora* will finally reach its greatest development, if the eruption is permitted to remain upon the skin. The intensity of the internal disease becomes manifest by the evil consequences with which the suppression of an old eruption is constantly attended.

On the other hand, it is certain that the suppression of a few recently formed itch vesicles, when the internal psora had not time to develop its intensity, is attended with less *immediate* danger; and that there are no immediate evil consequences attending such a suppression. Hence it often happens that the children of rich parents are freed, in a day or two, from a few recently

Not only medical scribblers, but even the greatest and most celebrated physicians of modern times, have made themselves guilty of this gross error, (or shall I say, wilful crime?) from von Helmont down to the latest advocates of the allœopathic practice.

The above quoted remedies were indeed sufficient to remove both the eruption and the itching. In their delusion the physicians supposed to have destroyed the disease, and dismissed their patients with the assurance that they had entirely recovered.

The ailments which succeeded the suppression of the eruption, they explained as new maladies. They were heedless of those innumerable, striking testimonies of older and honest observers, which show that the consequences often follow the suppression so rapidly that every body in his senses must acknowledge them as results of an internal *psora*, which, being deprived of its primary cutaneous symptoms, was forced to embody itself in a host of secondary diseases.

formed vesicles by means of lead ointment or lead washes, without any one suspecting them of having been infected with the itch.

But, however trifling the ailments may be with which the suppression of a few recently formed vesicles is attended, and which the ignorant family physician attributes to other slight causes, nevertheless, the internal *psora*, be it ever so little developed, affects the whole organism; *the robustest constitution is incapable of annihilating it by its own unaided efforts, and unless it be extinguished by the aid of art, it will last to the end of life.* It is indeed true that the first development of this internal disease is slower, when the eruption upon the skin is removed as speedily as it shows itself, than in cases where the eruption has been upon the skin for a long time, and the internal *psora* has been permitted to increase in intensity in a corresponding degree. Nevertheless, even in the most favourable cases, the development of the internal psora goes on for years, often so slowly and imperceptibly that persons who are not perfectly acquainted with the symptoms, by which the existence of this slumbering enemy shows itself, would suppose the patient to be perfectly healthy.

Numerous observations* have, by degrees, made me acquainted with the symptoms by which the internal disease manifests itself, even in its incipient state of slumber.† By means of this knowledge I am able to

* Up to this moment, at the age of 79 years, I have never been infected with the itch, although I am extremely susceptible of being attacked by acute or epidemic diseases, and have undergone excessive mental exertions and moral sufferings. This may have been the reason why I should have had a better chance than hundreds of others to discover and to appreciate the symptoms of *psora*, whether in the latent condition, or existing in the form of great chronic ailments. I had the means and was in the habit of comparing those symptoms with the state of health that I have constantly enjoyed.

† The allœopathic physicians have likewise supposed latent forms of disease, in order to have a pretence for the inroads which they

apply proper and successful remedies before the internal *psora* has become a manifest secondary disease, and has reached that fearful height where its eradication is either very difficult or altogether impossible.

There are many symptoms that reveal the existence of *psora*, slumbering in the depths of the organism, before a complete outbreak of the disease has taken place; but they cannot all be found upon *one* person. One has more, the other less; in one they come out progressively, in another they remain suppressed; this depends in a great measure upon the constitution and the external circumstances of the patients.

Symptoms of latent Psora.

Frequent passing of ascarides, lumbricoides and vermiculares—they cause an intolerable itching in the rectum, (especially in children.)

Frequent distention of the abdomen.

Insatiable hunger and want of appetite following each other in alternation.

Paleness of the countenance and deficient tonicity of the muscles.

Frequent inflammation of the eyes.

Swelling of the cervical glands, (scrofula.)

Sweat upon the head, in the evening after having fallen asleep.

Epistaxis in girls and young men, often very violent, (it is less frequent in older persons.)

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make upon the system by their violent medicines, bloodlettings, anodynes, etc. These "qualitates occultæ Fernelii" are altogether chimerical, since, by the admission of the physicians themselves, there are no symptoms by which they can be recognised. Things which do not manifest themselves by phenomena, have no existence for man, who can only become aware of their existence by observation; they are mere creations of the fancy. It is different with the slumbering or latent powers of nature; in spite of their latent existence they reveal themselves under appropriate circumstances;—for example, the latent caloric in rubbing cold metals; the latent *psora* by drawing pain in the sheaths of the muscles, which comes on whenever the psoric patient exposes himself to a draught of air.

The hands are generally cold, and the palm of the hand is sweaty, (burning in the palm of the hand.)

The feet are cold and dry, or sweaty and badly smelling. (Burning upon the soles of the feet.)

The arms or hands, legs or feet become benumbed by a slight cause.

Frequent cramps in the muscles of the arms and hands.

Painless subsultus of parts of muscles, here and there.

Frequent or tedious coryza, or dry cold in the head,* or impossibility of catching cold, even though the person is much exposed to the causes of cold, and has been constantly affected with it formerly.

Tedious obstruction of the nares, one or both.

Ulcers in the nares, (sore nose.)

Disagreeable sensation of dryness in the nose.

Frequent inflammation of the throat, frequent hoarseness.

Short and light coughing, early in the morning, in quick repetition.

Frequent attacks of the asthma.

Either the whole body or only the head, neck, breast, abdomen, feet, easily catch cold, especially in a draught of air;† these parts are then generally covered with sweat; the cold is attended with various symptoms, which often last a good while.

Straining, which often occurs from the slightest cause, from carrying or lifting a light weight, from elevating and stretching the arms after high objects; this moderate stretching of the muscles is often succeeded by all sorts of ailments, headache, nausea, sinking of strength, painful tension in the muscles of the back of the neck, or the back, etc.

Frequent pain on one side of the head, or toothache, from even moderate mental emotions.

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* The catarrhal fevers, (for example, influenza,) which affect even the soundest constitution, do not come under this remark.

† Persons whose organisms are not tainted with the psoric virus, do not catch cold from being exposed to a draught, or damp and cold air, though they may find it disagreeable.

Frequent flushes of heat and redness in the face, sometimes combined with a sort of anxiety.

Frequent falling of the hair, dryness of the hair, scales upon the scalp.

Inclination to erysipelas, on different parts of the body.

Interruption of the menstrual functions; irregularities occurring in those functions; the menses either flow too abundantly or too little; they appear either too soon or too late, last too long, are watery, and are combined with many bodily ailments.

Twitches of the limbs on falling asleep.

Weariness on waking up in the morning; unrefreshing sleep.

Sweat, early, in the bed.

Too easy sweating during the day, even with little motion; also, absence of sweat which nothing can bring out.

The tongue is white, pale,—often parched.

Much phlegm in the fauces.

Bad smell from the mouth; this is either constant, or occurs only frequently, especially during the menses; the taste in the mouth appears insipid, or sourish, or as coming from a spoiled stomach; also musty and putrid.

Sourish taste in the mouth.

Nausea early in the morning.

Sensation of emptiness in the stomach.

Repugnance to boiled warm food, especially meat.

Repugnance (in children) to milk.

Dryness in the mouth, in the night and early in the morning.

Cutting pain in the bowels, frequently; often every day, especially early in the morning, (in children.)

Hard knotty stools, often delaying a whole day, and covered with mucus; or also, constantly soft, liquid, acrid stools.

Varices of the rectum; blood passes off with the stools.

Passing of mucus by the anus, with or without fæces.

Itching at the anus.

Dark urine.

Distended veins of the legs, (varices.)

Chilblains; they are painful even in the summer season.

The corns pain, even when the shoes do not pinch.

This or that joint is easily strained, in stepping or seizing.

One or more joints crack during motion.

Drawing, straining pains in the back of the neck, in the back, the limbs, especially the teeth, (in damp, stormy weather, when the wind is from the north-west or north-east,* after a cold, a strain consequent on lifting, or after disagreeable emotions, etc.

The pains manifest themselves again during rest, they disappear during motion.

The pains generally come on during night; they appear again and increase, when the barometer has fallen, when the wind is from the north or north-east, in the winter season and towards spring.

Uneasy, frightful, or too vivid dreams.

Unhealthy skin; every little wound ulcerates; the skin of the hands and the lower lips becomes easily chopped.

Frequent boils, frequent paronychias.

Dry skin upon the extremities, upper arms, thighs, also upon the cheeks.

Here and there scaly places upon the skin, causing a voluptuously delightful sort of itching, and a burning after the place has been scratched.

Here and there a vesicle characterized by an intolerable but voluptuously delightful itching. At the top it is filled with pus, and there is a burning after it has been scratched; it is often found upon a finger, on the wrist, or elsewhere.

Though frequently affected with some of these ailments, man may yet deem himself healthy, and is often considered so by others. These affections do not prevent him from leading a tolerably comfortable existence, provided he is young and robust, is not obliged to fatigue himself, has all his wants provided for, is not exposed to chagrin or grief, and has a cheerful, calm, patient and contented temper. In this case, the internal

* The north-easters in Europe are dry and cutting.

psora may continue slumbering in the organism for years, without being observed by any other except the attentive connoisseur, or without becoming developed into a permanent chronic disease.

However, in persons that are affected with those apparently slight infirmities, a trivial cause, an ordinary vexation, a cold, an irregularity in the diet, etc., may, in a more advanced age, *cause a violent though short attack of disease*, a violent colic, inflammation of the chest or throat, erysipelas, fever, and similar diseases, the vehemence of which often is out of proportion with the moderately exciting cause. Such diseases generally show themselves during the fall or winter season, but often also in spring more than at any other period.

It sometimes happens that the patient who is affected with the latent *psora*, whether he be a child or a full-grown man, seems to enjoy good health, but passes into circumstances which are the very opposite of those that I have described above; his organism may have been very much weakened and disturbed by some ruling epidemic fever,* by a contagious, acute disease, small-pox, measles, hooping-cough, scarlatina, purple-rash, etc., or by some severe injury, by a shock, a fall, a wound, a large burn, by fracturing a leg or an arm, by a hard labour, by the confinement consequent upon disease, and *by the allœopathic remedies which have been improperly given to the patient*; or the vital powers may have been weakened by leading a sedentary life in a close damp room; the soul may have been depressed by the death of beloved relatives, or the patient's life may have been embittered by daily chagrin and grief; or he may have become exposed to want, he may have become deprived of the needful, and his strength and his fortitude

* Acute fevers often terminate in causing a latent *psora*, which has become roused by the acute disease, to break out upon the skin in the form of itch. The physicians who were ignorant of the existence of a latent psora, declare this eruption to be a new itch bred by the bad humours with which the system of the patient is said to be filled. But the itch can, no more than the small-pox, measles or chancre, generate itself spontaneously; it can only show itself upon the skin after infection has taken place.

may have failed him in consequence of bad nourishment: in that case the latent *psora* becomes roused and develops that host of inveterate symptoms which will be found enumerated below; some one of the psoric chronic diseases breaks forth* and increases to a fearful height, *especially by the improper treatment of allœopathic*

* This kind of disease depends upon the original constitution of the patient, his peculiar mode of life, his character, the influences of education, or upon the weaker parts of the organism attracting the psoric miasms by their higher adaptation to its nature, and causing it to form the diseases which are inherent in the peculiar vital activity of the affected organs. The eruption of the psoric disease is especially favoured by an irritable, vehement temper, by the exhaustion consequent upon frequent pregnancy, excessive nursing of children, great bodily exertions, *improper*, *unsuccessful* treatment, excesses at table and dissolute habits. Owing to its peculiar nature, the psoric disease may remain latent under favourable circumstances. In this case the patient appears to enjoy good health, until unfavourable circumstances set in, which rouse the internal disease and cause it to break out. Neither the relatives, nor the patient, or the physician himself can comprehend how it is possible that his health should have declined in this way so suddenly. The diseases which then break out, often even after a trivial occurrence, such as being confined to the bed for five or six weeks in consequence of a fracture of the leg—as I have witnessed in my own practice—cannot be traced to any cause; they return in spite of a first successful treatment and of the strictest diet; they increase each time they appear again in the system, especially in the fall, winter or spring, and finally settle down in the form of a lingering malady, against which the mineral baths are of no avail, and which cannot be treated according to the rules of the allœopathic practice, without exposing the patient to the danger of having a more severe disease substituted in the place of his former ailment. There are innumerable causes which may rouse the internal psora and cause it to develop its manifold germs; the evil effects of those causes often bear no sort of apparent relation to them, which makes it impossible for a sensible man to consider them the true exciting causes of the secondary psoric disease, the often fearful character of which ought, on the contrary, to be explained by the existence of a deep-seated latent disturbance, which has broke out on this occasion, and is the common mother of all such chronic secondary affections.

Let us suppose, for example, the case of a young woman who has been infected with psora in her childhood, but who, according to appearance, enjoys good health, or what is commonly so

physicians, unless more favourable circumstances set in, diminishing the intensity of the disease, and making its ulterior development more moderate.

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called. In the third month of her pregnancy, she has the misfortune of being upset in her carriage. The consequence of this accident, beside a slight external injury and fright, is miscarriage, accompanied with considerable hemorrhage, which exhausts her strength. In a few weeks she has almost recovered her former strength and health, when the news of a dangerous illness of her beloved and absent sister puts her back in her recovery, and adds to her former disease a multitude of nervous complaints and spasms, which make her really sick. In a little while she receives better news of her sister; at last the sister, perfectly cured, pays her a visit. But the young woman remains sick in spite of these agreeable influences; and, though she may appear to do better for eight days or a fortnight, nevertheless, her ailments return without any visible cause. Every subsequent labour, be it ever so easy, every stormy winter, adds new complaints to the former, or these appear to have yielded their place to other more inconvenient affections. In this way the patient becomes affected with an important chronic disease, and it is impossible for us to comprehend why the full vigour of youth, existing moreover under favourable external circumstances, should not have succeeded in soon extinguishing the consequences of that miscarriage; still less do we comprehend why the evil effects of that sad news should not have become dissipated by the news of the sister's restoration to health, or, at any rate, by the presence of the sister.

If it be true that the cause is constantly proportionate to its effects, as is always the case in nature, it is difficult to understand how, in the case of this young woman, the subsequent ailments should not have disappeared as soon as the cause had ceased to act. The continuance of these ailments shows that they must have originated in a much more deep-seated cause, which remained latent in the system until the above mentioned contrary events (the miscarriage and the disagreeable news) had excited its action, and had roused it into a development hostile to the organism.

A merchant who seems to enjoy good health, with the exception of a few vestiges of *psora*, which are only known to the connoisseur, often loses his health in consequence of great losses which reduce him to the brink of bankruptcy. We will suppose such a case, and we will also suppose that the health of this merchant declines more and more. However, his losses are amply repaired by the death of a rich relative, or the gain of a high prize in the lottery. But in spite of this favourable turn of his affairs, his health continues to decline from year to year, nor can prescriptions, or the most celebrated mineral baths do any

But suppose that the rapid development of the disease should have been moderated, it cannot, however, be permanently cured, by the various fashionable remedies in use, such as baths, mercury, prussic acid, iodine, digitalis, china, starvation; they merely accelerate the

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thing to restore it; on the contrary, they make, perhaps, the evil worse.

A girl of good character, who, with the exception of a few symptoms of internal psora, enjoys good health, is forced to marry against her inclination. She feels wretched; her health declines, although there is no trace of venereal disease. Her sufferings are increasing without being relieved by the medicines which allœopathic physicians give her. After she has suffered for a year, her husband is taken from her by death. She now seems to revive in the conviction of being soon freed from all bodily and mental suffering; she even hopes soon to have recovered perfect health; for the cause of her disease has ceased to exist. She improves, indeed, but she remains sickly; and, despite of the vigour of her youth, she is frequently attacked with illness, which seems even to increase from year to year, without any apparent cause, especially in the rough season.

An unjustly suspected person, who has become entangled in a criminal suit, has become affected with various ailments during the time of the proceedings; before the suit commenced she seemed to enjoy good health, with the exception of a few symptoms of internal *psora*. Her innocence is at last acknowledged, and she is honourably acquitted. One should say that this happy event must infuse new life into her and free her from all her bodily sufferings. But this is not the case; on the contrary, at times her disease returns, and it seems even to increase from year to year, especially in the winter season.

If the disagreeable event had been the sole and *sufficient* cause of all these sufferings, does it not seem natural to conclude, that the cessation of the cause ought to be succeeded by a cessation of its effects? But the ailments do not cease; on the contrary, they are renewed from time to time in an increasing degree, which makes it manifest that the disagreeable event which we have supposed above, is not the real cause of the sufferings, but that it has merely roused into action a more deep-seated and much more formidable principle of disease, which was hitherto latent in the system.

Science has now revealed to us the nature of this internal enemy, and the means to conquer him; we know now that it is a deep-seated *psora* slumbering in the inmost recesses of the organism, and which the robustest constitution would have been insufficient to expel, unless aided by the efforts of art.

approach of death, which puts an end to the sufferings that physicians were unable to relieve.

If, under unfavourable external circumstances, the formerly latent *psora* has been roused from its slumber, the patient loses all chance of recovery in the hands of allœopathic physicians; they assail his organism without mercy, undermining its very foundations by their violent and improper remedies. Even if the external circumstances become favourable to the patient, the disease goes on in its course, and becomes worse and worse.

When the internal *psora*, which has been latent hitherto, and has been kept in bounds by a robust constitution and favourable circumstances, is roused from its latent state and passes into its secondary severe maladies, all the above named symptoms, by which the internal latent psora manifests its existence, become more distinct and violent; they vary in different individuals according to constitution, hereditary disposition, education, habit, mode of life, diet, occupation, the tendencies of the mind, morals, etc.

The following symptoms may be considered characteristic of the secondary diseases in which the internal psora generally terminates. I have collected them from my own experience at the bedside of patients whom I have treated successfully, and whom I knew, by their own confession, to have been infected with the itch, without the disease having been complicated either by syphilis or sycosis. I am willing to believe that others may have seen a great many more symptoms beside those which I shall now enumerate. I may observe, that among these symptoms there are many which are opposed to each other. This is owing to the constitutional differences of the patients, existing at the time when the psora first broke out, and is not in the way of a cure. One symptom often is met with more rarely than its opposing one.

Vertigo; the patient reels in walking.

Vertigo, on closing the eyes, every thing around him seems to turn; he is then attacked with nausea.

Vertigo; on turning briskly he almost falls over.

Vertigo, attacking him with a jerk in the head; he loses his senses for a moment.

Vertigo, accompanied with frequent eructations.

Vertigo, on looking down upon the floor, or on looking up.

Vertigo, in walking along a road in a plain, which is not enclosed on either side.

Vertigo; she appears to herself either too large or too small; other objects, likewise, appear either too large or too small.

Vertigo, resembling a swoon.

Vertigo, causing a loss of consciousness.

Numbness and giddiness of the head; the patient can neither think, nor accomplish any mental labour.

She cannot control her thoughts.

At times she seems to be deprived of thought; she sits there as if she were absent.

The head feels benumbed and drowsy in the open air.

Sometimes he sees everything dim or black on walking or stooping, or raising the head from stooping.

Rush of blood to the head.[1]

Heat in the head, and in the face.[2]

Feeling of cold pressure on the head.[3]

Dull headache in the morning, on waking up, or in the afternoon, either on walking fast or speaking loud.

Headache on one side, at certain periods, (after twenty-eight, fourteen, or a less number of days;) more frequently about the period when there is either full or new moon; or after vivid emotions, colds, etc., pressure or other pain on the top of the head or in the head, or a boring pain above one eye.[4]

(1) During which he is attacked with sadness, with anxiety and dread of labour.

(2) The hands and feet are often cold.

(3) Ordinarily accompanied with anxiety.

(4) At the same time often a great inward uneasiness.

Headache, daily, at certain hours; for example, shooting pains in the temples.[1]

Attacks of pulsating headache, (for example, in the forehead,) with nausea, which threatens to make him fall to the ground, or vomiting from morning till evening, every fortnight; sometimes before, sometimes after this period.

Headache as if the skull would tear open.

Drawing pain in the head.[2]

Headache, twinges in the head, (coming out by the ears.)[3]

Headache, shooting pains in the head coming out by the ears.[4] Din in the brain, singing, humming, noise, thunder, etc. The hairy scalp is covered with scales, with or without itching.

Eruptions on the head, scald, malignant scabs, (the crust being more or less thick,) with shooting pain when a liquid is oozing out; intolerable itching during the wet stage; the whole top of the head painfully affected

iety, especially in the abdomen, want of stools, or frequent, scanty, painful stools, weight in the limbs, tremblings in the whole body; tension of all the nerves, with great irritability and sensitiveness; the eye cannot bear any light; it is flowing, swells up; the feet are cold; sometimes the head is stopped up with a cold; chills, sometimes flushes of heat; continual nausea, also retching and vomiting; she is lying there either as if she were stunned, or throws herself about as if full of anguish; the attacks last twelve, twenty-four and more hours. After the attack, there is either great prostration, with sadness, or a feeling of tension in the whole body; before the attack, she frequently experiences twitches in the limbs during sleep; she starts in sleep; has painful dreams; grating of the teeth in sleep, and tendency to start at sudden noises.

(1) They sometimes swell up, with tears in one eye.

(2) In some cases a drawing pain, coming from the back of the neck, and going to the back part of the head, or extending over the whole head and face, which frequently swells up from the pain; the head is painful to the touch; frequently there is nausea.

(3) Usually in walking, especially in walking and taking exercise after eating.

(4) They often see everything black..

by the open air; at the same time hard glandular swellings on the back part of the neck.

Hair feels as if it were dried; hair falling out abundantly, especially on the forepart and on the top of the head, or in the centre of the crown, or baldness of some places.

Painful tubercles on the skin of the head, coming and going, like boils; round tumours.[1]

Sensation of constriction in the skin of the head and face.

Paleness of the face in the first sleep, with a blue circle round the eyes.

Frequent redness and heat of the face.[2]

Yellowish colour, yellowness of the face.

Gray, yellow colour of the face.

Erysipelas on the face.[3]

Aching pain above the eyes, especially late in the evening; he is obliged to close them.

He cannot look at anything long without everything appearing to flicker.

Objects appear to move.

The eyelids, especially in the morning, feel as if they were shut, (for minutes, sometimes even for hours;) he cannot open them; the eyelids are heavy, as if paralyzed or drawn together spasmodically.

Eyes extremely sensible to the daylight; it makes them smart, and they shut involuntarily.[4]

Sensation of cold in the eyes.

Corners of the eyes full of purulent mucus, (gum.)

Edges of the eyelids covered with dry scurf.

The meibomian glands round the edges of one of the eyelids are inflamed, either one or more, (stye.)

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(1) In rare cases they terminate in suppuration.

(2) He becomes very feeble, he feels exhausted or full of anxiety, and sweats all over the upper part of his body: sometimes the eyes become dim, they see black, he is sad, the head seems to be too full, with burning in the temples.

(3) In some cases there is much fever, sometimes also burning, itching, watery pustules with a shooting pain, in the face, which turn into scabs; (pustulous erysipelas.)

(4) Usually with more or less inflammation.

Inflammation of the eyes, of various kinds.[1]

Yellowness of the white of the eyes.[2]

Yellowness round the eyes.

Dark opaque spots on the cornea.[3]

Dropsy of the eye.

Obscuration of the crystalline lens; cataract; squinting.

Longsightedness. He sees at a distance, but cannot distinguish clearly small objects which are held near.

Nearsightedness. He can see distinctly even very small objects, when he holds them near; but the farther the object the less distinctly does he see it; and at a distance, not at all.

False sight. He sees objects double, or multiplied, or he sees only one-half of an object.

Muscæ volitantes, black points,dark stripes, or a net-work move before his eyes, especially on looking into the bright daylight.

Objects are seen as if through a gauze or a cloud, the sight is dim at certain periods.

Blindness by night. He sees very well in the day, but nothing during twilight.

Blindness by day. He sees well only in the twilight.

Gutta serena, uninterrupted dimness of the sight,[4] which finally increases to blindness.

Painful sensibility of several parts of the face, the cheeks, the cheek bones, the lower jaw, etc., either on touching those parts, or in speaking. or chewing; there is a sensation of subcutaneous festering, or of stinging and lancinating; in chewing[5] especially there is twitch-

(1) Fistula lachrymalis has probably no other origin than *psora*.

(2) Or gray colour of the lens.

(3) Even without having previously had an inflammation of the eyes.

(4) More frequently without an obscuration of the crystalline lens than with it.

(5) In chewing or speaking there is a similar twitching motion on the sides of his head; at these places protuberances, painful boils, etc, are often formed. If the pain is insupporta-

ing, shooting and straining in the muscles, which prevents him from eating.

Hearing is excessively irritable and sensitive; she cannot hear the sound of a bell without tremor; the noise of a drum throws her into convulsions, and the ear is painfully affected by various sounds.

He has shooting pains coming out by the ear.[1]

Crawling and itching in the ear.[2]

Dryness, dry scurf in the ears, without wax.

Running, from the ear, of a thin, usually fetid pus.

Pulsating sensation in the ear.

Noise and different sounds in the ear.[3]

Want of hearing in different degrees, even to complete deafness, with or without noise, varying according to the weather.

Swelling of the parotid glands.[3]

Bleeding from the nose more or less abundantly and frequently.

Nostrils as if stopped up.[4]

Troublesome sensation of dryness in the nose, even when the air passes freely.

Polypi of the nose, (usually with loss of smell,) which often extend through the meatus down the throat.

Smell either weak or lost.

Perversion of smell.[5]

Smell too strong, high and highest sensitiveness, even to the weakest odours.

ble and accompanied with a burning heat, it is called Fothergill's pain in the face.

(1) Especially while walking in the open air.

(2) Such as singing, rustling, whizzing, snorting, buzzing, chirping, ringing, drumming, thundering, fluttering, flapping, murmuring, etc.

(3) Often with shooting pains in the glands.

(4) Either one or both of them at once, or alternately the one or the other; often there is only a feeling of being stopped up, though the air passes through with ease.

(5) For example, a smell of manure, or some other peculiar smell in the nose.

Scurf in the nose, running of pus, or hardened clots of mucus.[1]

Fetid smell in the nose.

Nostrils frequently ulcerating, surrounded with pimples and scurf.

Swelling and redness of the nose, or of the tip of the nose, either frequently or permanently.

Under the nose or on the upper lip, long continued scurf, or itching pimples.

The vermilion border of the lips quite pale.

The vermilion border of the lips is dry, scurfy, scaly, it cracks.

Swelling of the lips, especially the upper one.[2]

The inside of the lips is set with little ulcers or pustules.[3]

Cutaneous eruptions, where the skin is covered with the beard, or at the roots of the beard-hair, with itching.

Innumerable kinds of eruption on the face.[4]

Glands of the lower jaw swollen, or passing into a state of chronic suppuration.

Glandular swellings down the sides of the neck.

Gums bleeding on the slightest touch.

The inside or outside of the gums feels sore.

Gnawing itching at the gums.

Gums whitish, swollen, painful to the touch.

Gums disappear, leaving the front teeth bare, even their roots.

Grating of the teeth during sleep.

Looseness or decay of the teeth, of various kinds, even without toothache.

Toothache of countless kinds, from many sorts of exciting causes.

Cannot remain in bed from the toothache.

(1) Sometimes also with running of an acrid mucus from the nose.

(2) Sometimes with a burning, biting pain.

(3) Often very painful, coming and going.

(4) Crusta lactea, pimples, herpes, carcinomatous ulcers on the nose, lips and face, with burning and shooting pain.

Painful pustules and sore places on the tongue.

Tongue coated white, or unevenly covered with a white substance.

Tongue pale, blueish white.

Tongue covered with deep furrows scattered all over; the tongue looks as if it had been torn on the upper surface.

Tongue dry.

Feeling of dryness on the tongue, though there is the usual quantity of moisture.

Stammering, stuttering, also sudden attacks of an incapacity of speaking.

Painful pustules, ulcerations on the inside of the checks.

Flow of blood from the mouth, often in great abundance.

Feeling of dryness on the whole inside of the mouth, or only at some places, or deep in the throat.[1]

Bad smell from the mouth.

Burning in the throat.

Constant flow of saliva, particularly in speaking, especially in the morning.

Continual spitting.

A quantity of pituitous matter in the throat, which he is obliged to loosen with great exertions; he often throws it up in the day, especially in the morning.

Frequent internal inflammation of the throat, and swelling of the parts which aid in the process of swallowing.

Insipid slimy taste in the mouth.

Intolerably sweet taste in the mouth, almost constantly.

Bitter taste in the mouth, especially in the morning.[2]

Sourish and sour taste in the mouth, especially after a meal, though the food tastes well.[3]

Fetid and putrid taste in the mouth.

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(1) Chiefly on waking up in the night or in the morning, with or without thirst; a high degree of dryness in the throat is often accompanied with pricking pains in swallowing.

(2) Sometimes uninterruptedly.

(3) In rare cases there is a repugnantly sweet taste in the mouth, even without eating or drinking.

Bad smell from the mouth, sometimes mouldy, sometimes putrid, like the smell of old cheese, or of fetid sweaty feet, or rotten sourcrout.

Risings from the stomach, empty, loud risings of air merely, incontrollable, lasting often for whole hours, and frequently in the night.

Checked risings from the stomach, which occasion spasmodic straining in the œsophagus, without coming out at the mouth.

Sour risings, either fasting, or after a meal, especially after having tasted milk.

Risings which excite vomiting.

Risings, rancid, especially after having eaten any thing greasy.

Risings, putrid or mouldy, early in the morning.

Frequent risings before eating, with a sort of rabid hunger.

Heartburn, more or less frequent; there is a burning all along the chest, especially after breakfast, or on moving the body.

Flowing of a sort of salivary fluid from the stomach, preceded by writhing pains about the stomach (the pancreas,) with weakness in the pit of the stomach; a fainting sort of nausea, and conflux of saliva in the mouth, even during the night;[1] (water-brash.)

The complaints which are prevalent in any part of the body, are excited by the use of fresh fruits, especially of acid fruits, and of vinegar, (eating salad, etc.)

Nausea, early in the morning.[2]

Nausea, even to vomiting, early in the morning, after rising from the bed; it is lessened by motion.

Nausea, always after having eaten greasy things or milk.

Vomiting of blood.

Hiccough after eating or drinking.

(1) It also degenerates into vomiting of water, mucus, or acid, acrid substances, especially after having eaten flour dumplings, flatuous vegetables, stewed prunes, etc.

(2) Often arising very suddenly.

Spasms of the œsophagus often prevent swallowing; this sometimes causes a man to die of hunger. Spasmodic, involuntary swallowing.

Frequent sensation of fasting, and emptiness in the stomach, (or abdomen,) often with much saliva in the mouth.

Violent craving for food, (rabid hunger,) especially in the morning; he is obliged to eat immediately, otherwise he feels sick and trembling, (and when in the open air, he is often obliged to stretch himself suddenly on the ground.)

Violent craving for food, with rumbling and grunting in the belly.

Appetite without hunger; a desire arises to swallow suddenly all sorts of things without the stomach craving them.

A kind of hunger; but by eating even ever so little, she is at once satisfied and feels full.

When she wishes to eat she has a feeling of fulness in the chest, and her throat is filled with mucus.

Want of appetite; only a gnawing, twisting and writhing in the stomach forces her to eat.

Repugnance to boiled and warm food, especially boiled meat; there is only a desire for black bread (and butter) or for potatoes.[1]

Thirst; constant thirst, or only in the morning on rising.

In the pit of the stomach there is a sensation of swelling, painful to the touch.

Feeling of cold in the pit of the stomach.

Oppression at the stomach, or in the pit of the stomach, as if there were a stone, like a cramp.[2]

Beatings and pulsations in the stomach, even fasting.

Spasm of the stomach; pain in the pit of the stomach, as if from constriction.[3]

Painful griping of the stomach;[1] there is griping of the stomach, especially after cold drinking.

(1) Sometimes accompanied with vomiting of mucus and water; unless this vomiting takes place, the griping continues unabated.

Pain at the stomach; the stomach feels sore, even on eating the most harmless food.

Oppression at the stomach, even before breakfast, but especially after eating any kind of food, or particular kinds, such as fruit, green vegetables, black bread, food prepared with vinegar, etc.[1]

While eating, he is attacked with giddiness, threatens to fall to one side.

After the slightest supper, he is affected with heat in the bed, (constipation and great lassitude early in the morning.)

After a meal, a feeling of anxiety accompanied with sweat, such as is consequent upon anxiety.[2]

On eating, sweat breaks out immediately.

Vomiting, immediately after a meal.

After a meal, oppression and burning at the stomach, or in the epigastrium, almost like heartburn.

After a meal, a burning sensation in the œsophagus, from below upwards.

After a meal, distention of the abdomen.[3]

After a meal, weary and sleepy.[4]

After a meal, he feels as if he were intoxicated.

After a meal, headache.

After a meal, beating of the heart.

Eating alleviates several, even remote, complaints.

The flatuosities, instead of passing off, become displaced; this causes a multitude of both bodily and mental ailments.[5]

(1) The slightest quantity of these things produces colic, pain or numbness in the jaws, tearing pain in the teeth, considerable accumulation of mucus in the throat, etc.

(2) Pains which reappear at different places, for instance, shooting pains in the lips, griping and grinding pains in the abdomen; pressure in the chest, heaviness in the back and small of the back, even to nausea; in this case vomiting, artificially excited, alleviates the suffering. In some persons the anxiety consequent upon eating increases to such an extent that they desire to destroy themselves by strangulation.

(3) Sometimes accompanied with lassitude in arms and legs.

(4) The patient is often obliged to lie down and sleep.

(5) Sometimes drawing pains in the limbs, especially the lower extremities, or stitches in the pit of the stomach, or in the sides of the abdomen, etc.

Flatuosities distend the abdomen;[1] the abdomen feels full, especially after a meal.

The patient feels as if the flatuosities ascended; these are then succeeded by eructations, frequent burning in the throat, or vomiting, by day and by night.

Pain in the hypochondria on being touched, or during motion, also during rest.

Painful constrictions in the epigastrium, close below the ribs.

Cutting pains in the abdomen, which seem to originate in displaced flatuosities, (or flatuosities that have become entangled;) these pains are always accompanied with a sensation of fulness in the abdomen; the flatuosities seem to rise.

Cutting pains in the abdomen, almost daily, especially in children; more frequently early in the morning than at any other time of the day; in some cases, day and night, without diarrhœa.

Cutting pains in the abdomen, especially in the hypogastric or lumbar regions of one side.[2]

A feeling of desolateness and wild confusion or unpleasant emptiness in the abdomen;[3] even immediately after a meal he felt as if he had not eaten at all.

After having been constipated for several days, she experiences a sensation of constriction below the stomach, as from a band; this sensation comes from the small of the back and passes round the abdomen.

Pain in the liver on touching the right hypogastric region.

(1) The flatuosities frequently ascend; sometimes, but less frequently, an enormous quantity of flatuosities passes off, especially early in the morning; they are without smell and without alleviating the rest of the complaints; at other times there passes off a large quantity of uncommonly fetid wind.

(2) The cutting pain sometimes descends all along the rectum and the thigh.

(3) Sometimes existing in alternation with painful constrictions of the abdomen.

Pain in the liver; pressure and tension; tension below the ribs of the right side.

Tension and pressure, coming from under the last ribs (in the hypochondria,) which arrests breathing, and produces a feeling of anxious care.

Pain in the liver; stitches, especially on stooping suddenly.

Inflammation of the liver.

Pressure in the hypogastric region, as from a stone.[1]

Hardness of the hypogastrium.

Spasmodic colic, a cramp in the intestines.

During the colic, coldness of one side of the abdomen.

Audible rumbling and grunting in the abdomen.[2]

Uterine spasms, resembling labour pains; cramp-like pains in the uterus, obliging the patient to lie down; they often distend the abdomen in a short time, without producing flatuosities.

Pressure in the abdomen towards the genital organs.[3]

Inguinal hernias; they become painful through singing and speaking.[4]

Swelling of the inguinal glands, sometimes terminating in suppuration.

Constipation; the stools often delay for several days, though there is frequently an unsuccessful desire for stool.

The stools are hard, look burnt, come out in little clots, like the excrements of sheep, sometimes covered with a slimy substance and even with streaks of blood.

(1) The pressure often rises to the pit of the stomach; it there causes a sensation of grinding, and excites vomiting.

(2) These symptoms sometimes only exist in the left side of the abdomen; during an inspiration they rise, during an expiration they descend.

(3) There is a pressure downwards, as if prolapsus were to come on; when the pressure ceases, she feels heavy in all her limbs; her limbs feel benumbed; she is obliged to stretch her arms and her body.

(4) Inguinal hernias generally spring from internal psora; if we except the few cases where these parts have been injured by great external violence, or where hernia has been caused by superhuman bodily efforts, through sudden lifting or pushing consequent upon anxious surprise.

Stools composed of mere slime (slimy hemorrhoids.)
Passing of ascarides by the anus.
Passing of fragments of tænia.
Stools, the first part of which is generally very hard and passes off with great pain; the latter half is liquid as in diarrhœa.
Stools very pale, whitish.
Gray stools.
Green stools.
Clay-coloured stools.
Stools smelling fetid and sour.
Cutting in the rectum on passing the stools.
Diarrhœa, lasting for weeks, months and years.[1]
Diarrhœa frequently returning, lasting for several days and accompanied with cutting pains in the abdomen.
Great and sudden loss of strength after having passed the stools, especially when they were rather soft and abundant.[2]
Diarrhœa soon weakens her so much that she canno walk alone.
Varices[3] of the rectum, either painless or painful (blind hemorrhoids.)
Bleeding varices of the rectum,[4] especially on passing the stools; afterwards the varices are painful for a long time (flowing hemorrhoids.)
Hemorrhage from the anus is accompanied with short breathing and orgasm.
Sensation of crawling and itching in the rectum, with or without the passing of ascarides.
Itching and gnawing in the rectum and perineum.
Polypi in the rectum.

(1) Generally there is much rumbling from fermentation in the abdomen, especially early in the morning.
(2 Especially loss of strength in the pit of the stomach, anxiety, uneasiness, sometimes chills over the abdomen, in the small of the back, etc.
(3) Sometimes a slimy liquid ekes out.
(4) *Fistulæ in ano* most probably generally originate in psora, especially when stimulating diet, an abundance of spirituous liquors, purgatives, a sedentary mode of life and sexual abuses supervene.

The patient complains of anxiety and loss of strength during micturition.

Urine sometimes passes off in too large a quantity; this causes a sudden loss of strength.[1]

Painful retention of urine (in children and old people.) When he feels cold (through and through) he is unable to urinate.

She is sometimes so distended that she is unable to urinate.

The urethra is constricted in different parts, especially early in the morning.[2]

Pressure upon the bladder, as if from a desire to urinate, immediately, after drinking.

He is unable to hold his urine, there is a sensation of pressure upon the bladder; urine passes off while the patient is walking, sneezing, coughing, laughing.

The patient is frequently obliged to pass his urine in the night; for that purpose he has to rise frequently.

After urinating, the urine continues to flow in drops for a long time.

Urine passes off in great abundance in the shape of a whitish, sweetish-smelling and sweetish-tasting liquid; this is accompanied with thinness and an inextinguishable thirst, (diabetes.)

In urinating there are burning and lancinating pains in the urethra and in the neck of the bladder.

Urine has an acrid and pungent smell.

Urine speedily deposits a sediment.

Urine passes off cloudy and turbid.

Red sand passes off from time to time together with the urine, (gravel.)

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(1) Dysuria, which is generally fatal when treated allœopathically, has probably no other origin than psora.

(2) The urine often passes off as thin as a thread, or it scatters; the urine often passes off in jerks, at long intervals. This passing off by intervals often comes from a cramp in the neck of the bladder, which antagonises the action of the bladder, and originates in the same psoric miasm. The inflammation of the bladder, arising from strictures of the urethra, and the fistulæ in vesica, consequent upon such strictures, likewise originate in psora, though it happens in a few rare cases, that there is a complication of *sycosis* and *psora*.

Dark yellow urine.

Brown urine.

Blackish urine.

Urine intermixed with blood, also hematuria.

The prostatic fluid often passes off after urinating especially after difficult stools; the fluid sometimes passes off without interruption, drop by drop.[1]

Nightly pollutions, once, twice, three times a week, and sometimes even every night.[2]

Nightly effusion of semen in the woman succeeding voluptuously-delightful dreams.*

Nightly pollutions; they are attended with evil consequences, not often, but immediately.[3]

Semen passes off during the day almost involuntarily, even when there is little irritation, and often, even without erection.

Erection, very frequent, long continuing, very painful, without pollutions.

The semen does not pass,[4] even after the embrace has lasted for a long time, and the erection has been sufficient; but afterwards it passes off either in nightly pollutions or with the urine.

Accumulation of water in the tunica vaginalis testis, (hydrocele.)

There is never any complete erection, even in spite of the most voluptuous sensations.

Painful twitches in the muscles of the penis.

(1) The constant loss of the prostatic fluid sometimes results in consumption.

(2) In healthy and chaste young men, these pollutions take place every 12 or 14 days; this is the order of nature, and induces cheerfulness, strength and contentment.

* Note of the Translator: According to modern physiologists, the woman does not emit semen, but merely mucus.

(3) Gloominess of the intellect, numbness, dimness of thought, diminished vividness of the imagination, want of memory, depression of spirits, sadness; sight, digestion and appetite are weakened; stools cease to pass, there arises a pressing of the blood towards the head, the anus, etc.

(4) During such an embrace the testes remain relaxed, and hang down more or less.

Itching at the scrotum; the scrotum is sometimes covered with pimples and scabs.

Chronic swelling or knotty induration of one or both testes, (sarcocele.)

Dwindling, lessening, disappearing of one or both testes.

Induration and enlargement of the prostatic gland.

Drawing pain in the testes and the spermatic chord.

Painful sensation of contusion in the testes.

Want of sexual desire in both sexes, either frequent or constant.[1]

Immoderate, insatiable desire for coition,[2] accompanied with a livid complexion and sickly body.

Sterility, impotence, without there being any organic defect of the parts of generation.[3]

Disorder of the menstrual functions; the menses do not appear regularly on the twenty-eighth day after the appearance of the former, do not appear without being accompanied by other morbid symptoms, nor do they come on suddenly; do not continue uninterruptedly for four days, with a moderate flow of healthy-coloured, good blood, until they gradually reach their end on the fourth day, without the general health of either body or mind being disturbed; they do not last until the forty-

(1) Often for many years. In this case, the sexual parts of either male or female are incapable of pleasurable sensations; the corpus penis hangs down relaxed, is thinner than the glans, which feels cold, and looks blueish or white; in the female parts, the labia majora are inaccessible to irritation, they are relaxed and small; the vagina is dull and incapable of being excited, generally dry; sometimes there is falling of hair, or total baldness of the female parts of generation.

(2) Metromania and nymphomania have the same origin.

(3) Too frequent embraces from impotent desires; the imperfect, and watery semen passes off too soon; want of erection; the semen passes off too scantily; want of sexual desire; monthly menorrhagia; constant flow of blood; menses either watery, or too scanty, or suppressed; abundant leucorrhœa, induration of the ovaries; the mammæ have either dwindled down or have become knotty; insensibility, or painful sensibility of the genital organs are the first and usual symptoms of sterility in both sexes.

eighth or fiftieth year, nor do they then disappear gradually and without pain.

The menses are delaying beyond the fifteenth year and later; or, after having made their appearance once or twice, they discontinue for months and years.[1]

The period is not regular; it returns too soon by some days; sometimes it returns every three weeks or even every fortnight.[2]

The menses flow only for one day, a few hours, or imperceptibly.

The menses flow five, six, or eight days; but there is only a little flow every six, twelve, twenty-four hours; there are intervals of half and whole days.

The menses are too abundant, last for weeks, or they return every day, (flowing of blood.)[3]

The menstrual blood is watery; it forms brown clots.

The menses smell badly.

The menstrual flow is painful, accompanied with swoons, shooting or spasmodically contracting pains in the head, cutting pains in the abdomen or in the small of the back; she is obliged to lie down or to vomit, etc.

Polypi in the vagina.

Leucorrhœa, sometimes a few days before, sometimes

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(1) Consequent upon this suppression is livid paleness, tumefaction of the face; heaviness in the legs; swelling of the feet; chilliness, lassitude, asthma, (chlorosis,) etc.

(2) It rarely delays a few days, and then the flow is excessive; the patient threatens to fall from weariness, and has a great many other complaints.

(3) This is followed by swelling of the face, of the hands and feet, painful spasms in the breast and abdomen, innumerable nervous complaints, nervous weakness, excessive sensitiveness, both general and of some particular senses, etc. Before the blood begins to flow there are anxious dreams, frequent waking up in a fit of orgasm; beatings of the heart, uneasiness, etc. When the flow of blood from the uterus is more considerable than usual, it is accompanied with cutting pains in one side of the abdomen and in the groin; the cutting sometimes descends along the rectum and into the thigh; combined with these symptoms there is a difficulty of urinating; and the pain often prevents her from sitting; after these pains the abdomen feels sore, as if it were festering.

after the menstrual flux, or during the whole time from one period to another; this leucorrhœa diminishes the flow of the menses, or continues in their stead; flows like milk, like a white and yellow mucus, or like pungent, badly smelling water.[1]

Premature delivery.

During pregnancy there is great lassitude, nausea, frequent vomiting, swoons, painful varices of the veins of the thighs or legs, also, sometimes of the labia; hysteric complaints of various kinds, etc.

Cold in the head, immediately on going out into the open air; in the room afterwards the head feels as if it were stopped up from the cold.

Head and nose feel as if they were stopped up from a cold, either continually so, or often so, or almost continually so.

Catarrh from the slightest exposition to cold, mostly during the rough season and in wet weather.

Catarrh, very frequently, or almost continually, sometimes even uninterruptedly.

Impossibility of catching cold, notwithstanding there are strong indications for it, and the patient is otherwise afflicted with great ailments originating in psora.

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(1) The leucorrhœa of a more malignant kind is accompanied by all sorts of complaints, even without mentioning the lesser ones, (itching at the pudenda and in the vagina; with soreness on the outside of the pudenda and the neighbouring part of the thigh, especially in walking;) the higher degrees of this troublesome discharge are frequently followed by hysterical symptoms of every kind, moral and mental derangements, melancholy, alienation of the mind, epilepsy, etc. It often attacks the patient all of a sudden, being then preceded by grinding pains on one side of the abdomen, burning in the stomach, in the abdomen, in the vagina, stitches in the vagina and the os tincæ, or cramp in the uterus, or pressure towards the vagina, as though every thing were to be pressed out; sometimes, also, intense pain in the small of the back; the flatuosities become displaced, which causes pain, etc. Has cancer of the womb any other origin except *psora*?

Hoarseness after the slightest talk; she has to throw up in order to clear the voice.

Hoarseness, sometimes aphony, (she cannot speak loud, has to speak in a low tone of voice.) after a slight cold.

Permanent hoarseness and aphony, often for years; he cannot utter a loud word.

Suppuration of the pharynx and larynx, (laryngeal phthisis.)[1]

Hoarseness and catarrh, very frequently, or almost continually; his chest is continually affected.

Cough; there is frequently an irritation and a crawling in the throat; the cough torments him, until sweat breaks out upon the face, (and upon the hands.)

Cough, which does not abate until there is retching and vomiting, mostly early in the morning or in the evening.

Cough, each attack terminating in sneezing.

Cough, mostly in the evening after lying down; it always comes on when the head lies deep.

Cough, which wakes the patient after he has slept but a short while.

Cough, especially in the night.

Cough; it is worse early in the morning on waking up.

Cough, most violent after a meal.

Cough, at each deep breathing.

Cough, producing a feeling of soreness in the chest, or sometimes stitches in the side of the chest or abdomen.

Dry cough.

Cough, with dry, pus-like expectoration, with or without spitting of blood.[2]

(1) Croup cannot come on in a child which is free from latent psora, or which has been freed from it by treatment.

(2) Suppuration of the lungs most probably always originates in psora, even when fumes of mercury or arsenic seem to be the cause; at any rate, most cases of suppuration of the lungs spring from inflammation of the chest, mismanaged by blood-letting; this disturbance ought always to be considered as an indication of excited psora.

Cough, inducing a considerable expectoration of mucus, and falling of strength (tabes mucosa).

Attacks of spasmodic cough.[1]

Violent, intolerable stitches in the chest at each breathing; pain will not allow him to cough; there is no inflammatory fever (spurious pleurisy).

Pain in the chest, on walking, as though the chest were to burst. Aching pain in the chest on breathing deep, and sneezing.

Frequently a lightly oppressive pain in the chest; unless it passes away soon, it degenerates into the deepest dejection of spirits.[2]

Burning pain in the chest.

Frequent stitches in the chest, with or without cough.

Acute pleurisy; there is great heat of the body, and stitches in the chest which prevent him from breathing; accompanied with hemoptysis and headache; he is confined to his bed.

Night-mare; during the night he generally starts from an oppressive dream, but he is unable to stir, to call, to speak; and when he endeavours to move, he suffers intolerable pain, as though he were being torn.[3]

Displacement of breath with stitches in the chest, coming on at the slightest motion:[4] he cannot advance a step, (pneumonia)

Asthma, on moving his arms, not in walking.

Attacks of suffocation, especially after midnight; the patient has to sit up, to leave his bed, to stoop, standing and leaning on his hands, to open the windows, or go into the open air, etc.; there is beating of the heart, fol-

(1) She is suddenly obliged to cough, but is not able to do so on account of her breath being suddenly cut off, which threatens suffocation; her face is dark-red, and tumefied; the œsophagus is generally constricted so that not a drop of water will pass; after the lapse of eight or ten minutes there is generally rising from the stomach, which terminates the spasm.

(2) The attacks generally last from evening till early in the morning, through the night.

(3) These attacks are sometimes repeated in one night; especially when he has not taken any fresh air during the day.

(4) Especially on ascending a height.

lowed by rising from the stomach or gaping; after this the spasm ceases with or without cough and expectoration.

Beating of the heart with anxiety, especially during the night.

Asthma; loud, difficult, sometimes sibilant breathing.

Shortness of breath.

Asthma during motion, with or without cough.

Asthma; generally coming on whilst the patient is seated.

Spasmodic asthma; her breath is cut short on going into the open air.

Asthma; the attacks last for weeks.

Dwindling of the mammæ, or excessive enlargement of the mammæ, with falling-in of the teats.

Erysipelas on one of the mammæ, (especially in nursing.)

A hard, enlarging and indurating gland, with painful stitches in one of the mammæ.[1]

Itching eruptions around the teats, (or moist and scaly.)

Drawing, tearing, straining pains in the small of the back, in the back, in the back of the neck.

Lancinating and painful stiffness in the back of the neck, in the small of the back.

Aching pain between the scapulæ.

Sensation of weight upon the shoulders.

Drawing, tearing, straining pains in the limbs, partly in the muscles, partly in the joints, (rheumatism.)

Aching and drawing pains in the periosteum, here and there, especially in the periosteum of the long bones.[2]

Stitching pain in the fingers and toes.[3]

Stitches in the heels and soles of the feet, on standing up.

(1) Have the different varieties of cancer of the breast any other cause but *psora*?

(2) In the places where the pain is located, the pain is excited by touching them; they feel bruised or sore.

(3) In worse and older cases, this pain becomes lancinating.

Burning in the soles of the feet.[1]

In the joints he feels a kind of tearing, like scraping upon the bones with red-hot swelling; touching it, or the contact with air gives him insupportable pain; he is at the same time extremely sensitive and peevish, (gout in the feet, hands, etc.)[2]

The joints of the fingers are swollen, aching; touching or bending them gives him pain.

Thickening of the joints; the joints remain hard-swollen; on bending them he suffers pain.

The joints feel stiff, with painful and difficult motion; the ligaments appear to be too short.[3]

Motion of the joints is painful.[4]

The joints creak on being moved.

The joints are easily strained by being pulled or bent.[5]

Increasing susceptibility of *straining* a joint, even by a very slight muscular effort, by light mechanical labour, on stretching the arms above the head for the purpose of reaching something elevated, on lifting light things, on turning the body quickly, on rolling something, etc. This, often slight, straining or extending the muscles, sometimes induces the most violent diseases, swoons, hysteric complaints of all degrees,[6] fevers, hemoptysis, etc., whereas a person that is not af-

(1) Especially during the night under a feather-bed.

(2) The pains grow worse either in the day or in the night. After every attack, and when the inflammation has ceased, the joints of the hand, the knee, the foot, the big toe, experience pain on motion, on standing up; they feel insufferably benumbed, and the limb is weak.

(3) For instance: the tendo Achillis on standing up, stiffness of the tarsus, the knees, partly momentary, (after having been seated, or on standing up, etc., partly permanent (contraction.)

(4) For instance: the shoulder-joint on elevating the arm; the tarsus experiences pain on standing up, as though it would break.

(5) For instance: The tarsus, the wrist-joint, the joint of the thumb.

(6) Often violent pain in the crown of the head—the pain is also felt externally on touching the head—it comes on all on a sudden; or sudden pain in the small of the back, or pain in

fected with psora, is able to lift any burdens he pleases, without any inconvenience.[1]

The joints are easily strained or dislocated, in consequence of slipping or any sort of wrong motion.[2]

In the tarsus there is a feeling of pain, as though the joint would break on standing up.

Mollities ossium, curvature of the spine, (hunch-back) curvature of the long bones in the thighs or legs, (rickets.)

Fragility of the bones.

Painful sensitiveness of the skin, of the muscles and of the periosteum on pressing moderately.[3]

Insufferable pain in the skin[4] (or in the muscles, or

the womb; sometimes stitches in the side of the chest, or between the scapulæ, that arrest breathing, or painful stiffness of the back of the neck or spine, frequent and loud eructations, etc.

(1) The common people, especially in the country, try, in this case, to alleviate their sufferings by a few magnetic strokes; it is often attended with some success, though this is not lasting; the disposition for straining the joint remains. A female, whom the Germans call "*Streichefrau*," makes a few passes with the tips of her thumbs, generally across the scapulæ towards the axillæ, or along the spine, sometimes starting from the pit of the stomach, and moving along the lower border of the ribs; she generally presses too hard.

(2) For instance, the tarsus on stepping wrong—also, the shoulder-joint. Under this head belongs the gradual luxation of the hip-joint; the head of the femur starts from the acetabulum, the leg becoming either longer or shorter, and causing limping.

(3) Upon striking moderately against something, he feels a violent and long pain; those places of the body, upon which he rests in bed, are excessively painful; hence it is that he frequently changes his position in the night; the ischia and the muscles, which he compresses by sitting, are very painful; a slight blow with the hand upon the thigh, causes great pain. slight knocking against something hard, leaves behind blue spots or streaks of blood under the skin.

(4) Extremely various. These pains which produce a corresponding sensitiveness of the mind, are often burning, shooting, lancinating, often they cannot be described; they affect especially the upper parts of the body, the face (tic douloureux), the skin of the neck, etc.; they come on on the parts being slightly touched, on speaking, chewing—they are excited in the shoulder by slight pressure or motion of the fingers.

the periosteum) of one part of the body, coming on in consequence of slightly moving this part or a part which is more remote ; the pain may come, for instance, from writing, in the axilla, or in the side of the neck, etc. whereas sawing, and other violent labour performed with that hand causes no pain ; a similar pain is excited by any kind of motion of the mouth, speaking for example, in the neighbouring parts ; the lips and the cheeks feel pain on the slightest motion.

Numbness of the skin or of the muscles of particular parts and limbs.[1]

Insensibility of particular fingers, or of the hands and feet.[2]

Crawling, sometimes pricking and crawling in arms, legs, and other parts, even in the tips of the fingers, as if the parts were benumbed.

Crawling or internal itching, especially of the lower extremities, (in the evening in bed, or early on waking up in the morning) ; the position of those extremities has to be changed every moment.

Painful coldness in some parts.

Burning pain in some parts, often without having changed the external temperature of the body.

Coldness, either frequent or constant, of the whole body, or of one side of the body ; also, coldness of particular parts, cold hands and feet, that cannot be warmed in the bed during night.

Constant chilliness, even when there is no change in the external temperature of the body.

Frequent flushes of heat, especially in the face, more frequently with redness than without it ; he feels suddenly, and excessively hot, in rest or on slight motion ;

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(1) Tact is wanting—the fingers feel like hollow bulbs, either periodically or permanently, (constant want of sensibility.)

(2) The limb is white, bloodless, without feeling and cold, often for hours, especially when the air is cool ; (moving a piece of zinc over the fingers or toes, towards their extremities, relieves the symptoms quickly and entirely, but acts merely as a palliative.)

often already, on speaking, with or without sweat breaking out.

Warm air in the room, or in church, is extremely offensive to her; makes her feel uneasy, causes her to move to and fro; sometimes there is a sensation of weight above the eyes, which is often alleviated by bleeding from the nose.

Orgasm; also a sensation of pulsating in all the arteries; this symptom is often accompanied by total paleness and a feeling of weariness through the whole body.

Rush of blood to the head.

Rush of blood to the chest.

Varices of the veins of the lower extremities, or of the pudenda, also of the arms, (even in men); there are often tearing pains in the varices, (in stormy weather,) or itching.[1]

Erysipelas in the face, with fever; or on the extremities, or on the mammæ of nursing mothers, especially on a place which is sore, (with a pricking and burning pain.)

Paronychia, (sore finger owing to festering skin,)

Chilblains, (even when there is no winter,) on the toes and fingers; the pain is itching and burning, lancinating.

Corns, that cause a burning and lancinating pain, even when there is no external pressure.

Boils, (furuncles,) returning from time to time, especially on the nates, the thighs, the upper arms and the neck. Touching them excites a sensation of fine pricking in the boils.

Ulcers on the thigh, especially upon the ancles, and above them, on the inferior parts of the calves; round the borders, there is a gnawing and itching pain; at the base of the ulcers, there is a biting pain, such as is caused by salt; round about the ulcers, the flesh is coloured brown and blueish; in the neighbourhood of the

(1) Aneurisms appear to spring from no other source than psora.

ulcers there are varices, with tearing pain, during stormy and rainy weather, especially in the night; often accompanied with erysipelas, consequent upon chagrin or fright, or with cramps in the calves.

Ramollissement and suppuration of the humerus, the femur, the patella, also the fingers and toes (spina ventosa.)

Thickening and stiffening of the joints.

Eruptions, some of them being agreeably-itching pustules, separate from each other, appearing from time to time and passing off again, especially on the fingers or other parts; the pustules burn after having been scratched, they are extremely similar to the genuine eruptions of the itch.

Some forming a sort of *nettle-rash*, the vesicles being filled with water, with a burning pain; some in the shape of *pimples*, painless, in the face, upon the chest, back, arms and thighs; some of the genus *herpes*, the fine grains being set near each other, in round, more or less large and thick clusters of a reddish colour, partly dry, partly moist; there is the same itching as in the eruption of the itch, and the same burning pain consequent upon friction. They are surrounded with a red border, continue spreading, while the centre appears to become freed from the eruption, with a smooth, shining skin. (Ringworm or herpes circinatus).

Some form elevated *crusts* upon the skin, round, with highly red borders, painless, a violent shooting pain often occurring in those spots upon the skin, that are not yet affected; some form *small round spots* upon the skin, covered with bran-like, dry scabs, which often fall off and come on again, without sensation; some forming *red places* upon the skin, feeling dry, with a burning pain, raised a little upon the skin.

Summer-freckles, spots in the face, upon the hands, and upon the chest, without sensation, small, round, brown or brownish.

Large, brownish spots, often covering whole limbs, arms, neck, chest, &c. without sensation or with itching.

Yellowness of the skin, yellow spots, homogeneous,

around the eyes, the mouth, on the neck, etc., without sensation.[1]

Wens in the face, on the fore-arms, hands, etc.[2]

Sarcomatous enlargements of the adipose or cellular tissue, or the bursæ mucosæ of the tendons, of various forms and sizes, cold, without sensation.[3]

Glandular swellings around the neck, in the groin, in the bends of the joints, the bend of the elbow, of the knee, in the axillæ,[4] also in the mammæ.

Dryness of the skin, either over the whole body without being able to perspire either through motion or heat, or only in some parts.[5]

Disagreeable sensation of dryness over the whole body, also in the face, at the mouth and in the mouth, in the throat or in the nose, although the air passes freely.

The patient sweats too easily by slight motion; he is even attacked with sweat over and over while he is seated, or there is sweat only on some parts of the body, for instance, almost constant sweating of the hands or feet,[6] in the axillæ, and around the genital organs.

Sweats, early in the morning every day; the patient drips with sweat, which ismells sour or pungent; this symptom often lasts for years.[7]

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(1) Riding in a carriage is followed by yellowness of the skin, in patients where the symptom is not lasting, but comes and goes.

(2) Especially in youth. Many wens only exist for a short while, and then disappear to make room for another infirmity.

(3) The fungus hematodes, which has lately become such a terrible disease, originates in psora; I am inclined to infer this from some cases.

(4) Those swellings, after having experienced shooting pains, pass into a state of chronic suppuration. which secretes however colourless mucus, instead of pus.

(5) Especially upon the hands, the external side of the arms and legs, and even in the face; the skin is dry, rough, parching, feels chopped, often scaly like bran.

(6) This sweat is generally very fœtid, and so abundant, that soles, heels and toes are already soaked, and feel sore, after very little walking.

(7) The sweating of psoric children about the head, in the evening after falling asleep, comes under this observation.

Sweat only on one side of the body, or only on the upper half of the body, or only on the lower extremities

Increasing susceptibility for cold, either of the whole body (wetting the hands with warm and then with cold water, as is done in washing, sometimes induces a cold), or of particular parts, head, neck, breast, abdomen, feet, etc. in a slight draught, or after slight moistening of the parts;[1] even already in a cool room, or when the air is moist with rain, or the barometer low.

The pains which have been formerly experienced in parts injured, wounded, broken, although they are now cured and cicatrized, become again very acute at the approach of an important change of the weather, intense cold, storm, atmosphere pregnant with electricity.

Œdematous swelling of the feet, or of one foot, of the hands or face, of the abdomen or scrotum, etc. (anasarca.

Attacks of sudden heaviness in the arms or legs.

Attacks of paralytic weakness, paralytic lassitude of one arm, one hand, one leg, without pain, either sudden and temporary, or beginning imperceptibly and continuing progressively.

Sudden bending of the knees.

Children fall without any perceptible cause. Similar attacks of weakness in the legs may be perceived in full-grown persons; in walking, one foot glides this way, the other that way, etc.

During a walk in the open air, he has sudden attacks of weakness especially in the legs.[2]

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(1) This susceptibility is attended with many important bad consequences which make their appearance immediately. Pains in the joints, headaches, cold in the head, sore throat and inflammation of the throat, catarrh, swelling of the cervical glands, hoarseness, cough, oppressed breathing, stitches in the chest, fever, dyspeptic complaints, colic, vomiting, diarrhœa, pain in stomach, rising of water from the stomach, sometimes convulsions in the face and other parts of the body, jaundice-like colour of the skin, etc. No one, who is not psoric, suffers the least inconvenience from such causes.

(2) Sometimes this feeling of weakness appears to reach the

While sitting the person feels insufferably tired; walking diminishes this feeling.

The joints are easily strained by wrong seizing or stepping; this often increases to dislocation; for example in the tarsus, the shoulder-joint, etc.

The creaking of the joints increases by slight motion; it is accompanied with a disagreeable sensation.

The limbs feel easily benumbed; this numbness is induced by slight causes, for example, leaning the head upon the arm, crossing the legs while sitting, etc.

The cramps in some muscles increase; this symptom comes on by slight causes.

Slow, cramp-like straining of the flexor muscles of the extremities.

Sudden twitches in some muscles and organs even in waking; for example, in the tongue, the lips, the muscles of the face, of the pharynx, the eyes, the jaws, hands and feet.

Tonic shortening of the flexor muscles (spasms.)

Involuntary turning and twisting of the head or the extremities with full consciousness (St. Vitus dance.)

Sudden attacks of fainting and sinking of strength with loss of consciousness.

Attacks of tremor in the limbs, without anxiety. Long continued tremor, sometimes striking with the hands, arms, and legs.

Attacks of loss of consciousness, lasting for a moment or a minute; during these attacks, the head is inclined upon the shoulder to one side, and in one or the other parts of the body, there is a jerking motion, sometimes not.

Different kinds of epilepsy.

Constant gaping, stretching and straining of the limbs.

Drowsiness during the day, often immediately after sitting down, especially after a meal.

pit of the stomach; here it assumes the form of a sort of rabid hunger, which deprives him of all his strength; he is attacked with tremor, and is obliged to lie down for a while.

He finds it difficult to fall asleep in the evening on lying down; he often lies awake for hours.

He spends the night in a sort of slumber.

Anxiety prevents him from sleeping, every night; this anxiety often is so violent that he has to leave his bed, and to walk about the room.

He is deprived of sleep, at any rate of sound sleep, from three o'clock in the morning.

On closing the eyes, he sees all sorts of fanciful images, grimaces.

On falling asleep she is disturbed by all sorts of fancies; she has to rise and walk about.

Vivid dreams as if in a state of waking; sad, frightful, anxious, vexatious, libidinous dreams.

Speaking or screaming during sleep.

Somnambulism; in the night he rises with his eyes shut; he does all sorts of things, even dangerous things, with ease, without knowing anything about it on waking up.

Suffocating fits during sleep, (night-mare.)

All sorts of troublesome pains in the night; thirst, dryness of the throat, mouth, frequent urinating.

On waking up early in the morning, he feels drowsy, unrefreshed, more tired than he did in the evening before, on lying down; after rising, it takes hours before he recovers from this weariness.

After having spent an uneasy night, he often feels stronger, than after an easy, sound sleep.

Intermittent fever, even when this disease is neither sporadic, nor epidemic,[1] nor endemic; the forms, duration, and type of the fever may be different; quotidian, tertian, quartan, quintan, or the fever may appear every seven days.

Every evening there are chills with blue nails.

Single chills every evening.

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(1) It may be asserted that epidemic intermittents never attack people free from *psora*; wherever these attacks take place, it may be supposed that there is a disposition for them, originating in *psora*.

Every evening the patient experiences heat with rush of blood to the head, red cheeks, often alternating with chills.

Intermittent fever of some weeks duration; this is followed by a moist, itching eruption which lasts for some weeks, and disappears as soon as the fever sets in again; this alternation may continue for years.

All sorts of moral and mental disturbances.[1]

Melancholy, either alone or united with alienation, sometimes alternating with frenzy and moments of rationality.

Oppressive anxiety early on waking up.

Oppressive anxiety in the evening on lying down.[2]

Repeated attacks of fearfulness during the day (with or without pain), or at certain hours of the day or night; during these attacks the patient has no rest, is obliged to move this way and that way; sometimes sweat breaks out.

Melancholy, beating of the heart and anxiety woke her up in the night (mostly immediately before the appearance of the menses.)

Mania of self-destruction;[3] (spleen ?)

(1) Neither in my practice, nor in a lunatic asylum have I ever met with a patient attacked with melancholy, madness or frenzy, in whom these diseases were not based upon *psora*, sometimes complicated with *syphilis*.

(2) In some patients these anxieties cause a violent perspiration to break out; others experience only orgasm and pulsations in all the arteries; in others again this anxiety causes a feeling of constriction in the throat, as if they were suffocating; others feel as though their blood ceased to flow, which causes the anxiety. In some the anxiety is accompanied with fear, exciting images and thoughts which seem to cause the anxiety; in others the anxiety exists without them.

(3) This kind of mental or moral disease which originates in *psora*, does not seem to have been sufficiently attended to. A certain feeling of necessity induces those patients to kill themselves, although they have no anxiety, no anxious thoughts, and seem to enjoy their full understanding. Nothing can save them except the cure of their *psora*, provided its manifestations are noticed *in time*. I say "*in time*," for in the last stages of the malady, these monomaniacs never speak to any one of their

Whining mood; they often weep for hours, without knowing the cause of it. [1]

Attacks of fear, for example: of fire, of being alone, of apoplexy, of mental alienation, etc.

Attacks of a species of angriness, which looks like insanity.

He is easily frightened, often by the most trifling occurrence; this causes the patient to sweat and to tremble.

Dread of labour, in persons who are otherwise extremely active; they have a decided repugnance to labour.

Excessive sensitiveness. } [3]
Irritability from weakness. }

fixed resolutions. This mania manifests itself in fits of half or full hours, at last daily, often at certain periods during the day. These persons however, beside these attacks of the mania of self-destruction, sometimes have attacks of anxiety which come at different periods and do not seem to be connected with the attacks of mania. These attacks of anxiety are generally accompanied with an oppression at the pit of the stomach, but they are free from the desire which the patients otherwise experience, of destroying themselves. These attacks of anxiety which appear to be of a physical nature and are not attended with peculiarly anxious thoughts, may be wanting whilst the attacks of the mania exist in a high degree; or the anxiety may return more frequently, when the mania had been almost cured by anti-psoric remedies. Thus, both affections appear to be independent of each other, although they originate in the same cause.

(1) This symptom is especially frequent in the female sex, and appears to be intended by nature to ward off for a time, more important nervous affections.

(2) A female was attacked with anxiety when she was about attending to some part of her domestic affairs; her limbs trembled and she became so faint, that she was obliged to lie down.

(3) All physical and moral impressions, were they ever so weak, excite an excessive morbid sensitiveness. Emotions of both a sad and vexatious and a cheerful nature, often cause astonishing complaints and suffering. Touching tales, even the recollection thereof, excite the nerves, drive the anxiety to the head, etc. Reading indifferent things, attentive looking at one object, for example: in sowing; attentive listening to indifferent things, strong light, loud talking of several men together, even a few sounds upon a musical instrument, ringing, etc., are

Sudden change of humour; often the patient is very gay and even extremely so, and then suddenly low-spirited, for instance: on account of his disease, or something of no importance.

Sudden transition from cheerfulness to sadness, or peevishness without any apparent cause.

These are some of the principal symptoms of latent *psora* which I have had occasion to observe. Their frequent occurrence, or their continuance, show that the latent *psora* is becoming active in the system. They are at the same time the elements which constitute the innumerable secondary complaints arising from the psoric reaction in persons unfavourably situated, and assuming all sorts of forms in proportion as a person's constitution, education, habits, occupation, external circumstances and the physical or moral impressions to which he is subject, differ. The number of those secondary ailments, which are described as distinct and independent diseases in the older pathological works,* far exceeds the morbid symptoms which we find enumerated in these works.

attended with disagreeable consequences; trembling, fainting, headache, chills, etc. Smell and taste are often excessively sensitive. In many cases, moderate exercise, talking, moderate warmth, coldness, open air, moistening the skin with water, etc. are injurious. Many are affected even in their rooms from the sudden changes of the weather; most of these patients complain in stormy and damp weather, few only when the sky is dry and bright. In some, the full moon, in others, the new moon make an unfavourable impression.

* Those secondary ailments bear the following names: scrofula, rickets, spina ventosa, atrophy, marasmus, consumption, pulmonary consumption, asthma, tabes mucosa, laryngeal phthisis, chronic catarrh, constant cold in the head, difficult dentition, worms, and consequent diseases, dyspepsia, spasms in the abdomen, hypochondria, hysteria, anasarca, dropsy, ovarian dropsy, dropsy of the uterus, hydrocele, hydrocephalus, amenorrhœa and dismenorrhœa, hemorrhage from the uterus, hematemesis, hemoptysis, hemorrhages, discharges from the vagina, dysuria, ischuria, enuresis, diabetes, catarrh of the bladder, hematuria, stricture of the urethra, nephralgia, gravel, stricture of the intestines, blind and flowing hemorrhoids, fistula in ano, difficult stools, constipa

Those ailments are the characteristic secondary symptoms* of the psoric miasm, which manifests itself by these symptoms as a hydra-headed monster pregnant with disease.†

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tion, chronic diarrhœa, induration of the liver, jaundice, blue disease, disease of the heart, beating of the heart, spasms of the chest, dropsy of the chest, miscarriage, sterility, metromania, impotence, induration of the testes, dwindling of the testes, prolapsus uteri, inversion of the womb, inguinal, femoral and umbilical hernia, dislocations from some internal cause, curvature of the spine, chronic inflammation of the eyes, fistula lachrymalis, short and long-sightedness, day and night-blindness; obscuration of the cornea, cataract, glaucoma, amaurosis, deafness, deficient smell or taste, chronic head-ache on one side, pain in the face, tinea capitis, scabs, crusta lactea, herpes, pimples, nettle-rash, lypoma, goïtre, varix, aneurisms, erysipelas, adipose sarcoma, osteo-sarcoma, scirrhus, cancer of the lips, cheeks, breast and womb; fungus hematodes, rheumatism, gout in the hips, in the joints and feet; apoplectic fits, spasms, convulsions, swoons, vertigo, paralysis, contractions, epilepsy, St. Vitus' dance, melancholy, insanity, imbecility, nervous affections, etc.

* Councillor Kopp, an allœopathic physician who is approaching to Homœopathy, pretends having seen chronic diseases disappear of themselves; he may have seen a few symptoms disappear, which the old school is so foolish as to consider complete diseases.

† I admit that my doctrine: "All non-venereal chronic diseases that can neither be cured by regular diet nor favourable circumstances, which on the contrary, increase in the course of time, originate in *psora*," is too comprehensive and even overwhelming for all who have not maturely reflected upon my arguments, or for narrow intellects. But my doctrine is not the less true. But because the patient is not able to recollect having had a few itch-vesicles between the time of his birth and the present moment, or because he is ashamed of confessing having had the itch on account of its being considered a shameful disease, is this a reason why such a chronic disease should not be considered psoric? The non-confessing of the patient proves nothing to the contrary.

As long therefore as the opponents of my doctrine cannot show that the chronic affections which I have alluded to in the preceding paragraphs, and which mere diet, were it ever so regular, a strong constitution and favourable external circumstances are not sufficient to eradicate from the system, can originate in some other than the psoric miasm, which maintains, strengthens and develops them; there is an overwhelming probability, based up-

on analogy, that all other complaints which are similar to the preceding, both in nature and development, originate in *psora*, although the patient may not be aware of having ever been infected with the itch.

It is an easy matter to doubt things which are not before us in visible forms; but this proves nothing; according to the old rule, proving is the business of those who deny, "*negantis est probare.*"

The antipsorics are therefore not necessary to prove the chronic nature of those maladies in case the infection by the itch-virus should be denied; the salutary action of the antipsorics only serves in the same sense as the counter-proof of an accurately-solved arithmetical problem.

Since it is proved that other medicines, even when chosen strictly homœopathically, do not heal the above mentioned chronic diseases as thoroughly and permanently as the so-called *antipsorics*, because the latter cover the whole extent of the progressively appearing symptoms of the psoric disturbance:—I do not see why these should not be called *antipsorics* in preference to all other remedies.

I sometimes consider certain acute diseases, such as inflammation of the throat, of the chest, etc., results of an excited *psora*. This, too, cannot be denied, as it is done, under the pretence, that those inflammations may be controlled by the antiphlogistic remedies, aconite, belladonna, mercury, etc. The proof that they originate in latent psora, is this, that their frequent return can only be prevented by the *antipsorics*.

TREATMENT OF CHRONIC DISEASES.

I SHALL now pass to the treatment of chronic diseases, the number of which is almost without end. Although I do not pretend to say that the fact of all chronic diseases having been traced by me to a three-fold origin, has made the treatment of those diseases an *easy* matter; yet I may say that the discovery of the remedies which are homœopathically adapted to those different classes of diseases, has secured the possibility of their successful treatment. Without a knowledge of that three-fold origin and these homœopathic remedies, the successful treatment of chronic diseases is absolutely impossible.

I shall first speak of those miasmatic chronic diseases which we designate by the terms *Syphilis* and *Sycosis*, including all their various ramifications. This will leave us free to treat at length of that immense host of chronic affections which originate in the most fearful, most common and most inveterate of all chronic miasms, *Psora*.

SYCOSIS.

THE chronic miasm which we designate by the term *Sycosis*, has only prevailed from time to time, and has given origin to the smallest number of chronic diseases. Sycosis was especially spread in Germany between the years 1809 and 1814, during the war with France; ever since then the disease has been decreasing.

Sycosis, being supposed to be homogeneous with syphilis, has been heretofore treated with mercury internally, and externally by cauterization, burning, cutting, or ligatures. This violent external treatment has been employed against the excrescences upon the genital organs. The excrescences first appear upon those parts of the body several days and often weeks, after the infection by the act of coition has taken place. They are accompanied with a sort of gonorrhœa* from the urethra, are sometimes dry and in the form of warts, but more frequently soft, spongy, emitting a fetid fluid, sui generis, of a sweetish taste, (almost resembling that of herring-pickle,) bleeding readily and having the form of a cox-comb or a cauli-flower (*brassica botrytes.*) In man they appear upon the glans and around or beneath the prepuce; in woman they cover the parts surrounding the pudenda, and the pudenda themselves, in great abundance.

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* In this kind of gonorrhœa the fluid which comes out of the urethra, looks like thick pus; micturition is not very painful, but the penis feels hard and swollen; upon its back it is sometimes covered with glandular tubercles, and it is very painfulto the touch.

The natural and immediate consequence of such violent treatment was, that the excrescences generally came out again, and were again subjected to painful and cruel treatment. In case, however, they did not re-appear in their original form, they broke forth in the shape of more disagreeable and more dangerous secondary ailments; for neither the violent removal of the external embodiment or vicarious symptom of *sycosis*, nor the internal administration of mercury, which is not homogeneous to the miasm of sycosis, had the least influence in diminishing the intensity of this miasm and preventing it from affecting the whole organism. Beside the general health being undermined by the mercury which, in the case of *sycosis*, was generally given in the largest doses and the most active preparations, there are other pernicious results consequent upon this abuse of mercury. There are excrescences formed in other parts of the body either in the shape of whitish, spongy, painful and flat elevations in the cavity of the mouth, upon the tongue, the palate, the lips; or in the shape of large, elevated, brown, dry tubercles in the axillæ, upon the neck, upon the hairy scalp, etc. The abuse of mercury may also be followed by other bodily affections, such as the contraction of the tendons of the flexor muscles, especially those of the fingers, etc.

Both the gonorrhœa* and the excrescences of *sycosis* are cured in the most thorough and durable manner by

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* The miasm of the common clap seems to affect the urinary organs only locally; it does not pervade the whole organism. The common gonorrhœa either yields to a drop of the recently obtained juice of parsley, provided its use is indicated by a frequent desire to urinate; or else to a small dose of cannabis, cantharides, or copaïva, according as the other symptoms indicate the use of these different remedies. The highest preparations of these remedies should always be used, unless the patient has previously been weakened by allœopathic stimulants, or a latent psora has made its appearance; in this case a secondary gonorrhœa is frequently formed, which can only be cured by antipsorics.

the internal administration of a few globules of the decillion preparation of thuya,* which ought to be allowed to act for the space of fifteen, twenty, thirty, or forty days. After this lapse of time you give an equally small dose of nitric acid, letting it act during an equally long period. These two remedies are sufficient to cure both the gonorrhœa and the excrescences of *sycosis*. In the most inveterate and most difficult cases, the larger excrescences may be touched once a day with the fresh juice of thuya half diluted with alcohol and squeezed out of the green leaves of the plant.

It sometimes happens that, in consequence of the violent allœopathic treatment of *sycosis*, other chronic affections may have been formed in the system, that, for instance, a latent psora may have become manifest,‡ and that the psoric and the syphilitic miasm may form a trinitary compound of disease, which will take place if the latter miasm should have been badly treated on a former occasion. In this case, the order of treatment is the following: First, we annihilate the psoric miasm by the subsequently indicated antipsorics; then we use the remedies indicated for *sycosis*, and lastly, the best mer-

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* Thuya is homœopathic to *sycosis*; see Materia Medica Pura, p. V. If other doses of thuya should be required, the inferior potencies may then be used, (VIII., VI., IV., II.;) these will then be found to affect the vital principle more efficiently.†

† Note of the translator.—In my inaugural thesis published by Mr. Radde, and also in the preface to this translation, I have conclusively shown that the remedial agent makes no *direct* impression upon the vital principle, but that the impression is made *upon the disease*, and that, by means of this impression, the vital principle is freed from its embarrassed condition.

‡ In young people, recent *sycosis* is seldom found complicated with *psora*. Wherever this complication exists, it is owing to the pernicious assaults which have been made upon the constitution by the improper administration of mercury for the cure of *sycosis*.

curial preparation against *syphilis*. These different orders of remedies are alternately employed, if necessary, until the cure is completed. Leave to each medicine the necessary time to complete its action.

In treating *sycosis* internally, according to my rule, no external remedies should be used, except the juice of the thuya in the cases indicated above. If there should be a watery discharge from the excrescenses, dry clean lint may be applied.

SYPHILIS.

THE syphilitic miasm is much more general than the miasm of *sycosis*. For the last four centuries, it has given origin to a vast number of chronic affections.

The treatment of *syphilis* is only difficult when there is a complication with the psoric miasm, after it has broke forth from its latent condition. Sometimes, but rarely, *syphilis* is complicated with *sycosis;* whenever this complication exists, it never exists without the additional complication of *psora*.

In the treatment of syphilis, three different conditions may occur. First, the syphilitic disease may exist in its genuine form, together with the chancre, or, in case the chancre should have been removed by external applications, it may exist with the bubo, which must then be considered as the representative of the chancre;* secondly, it may exist without being complicated with another miasm, though both the chancre and the bubo may have been removed; and thirdly, it may exist in a state of complication with another chronic miasm, either with the chancre or bubo, or after their removal by local applications.

The chancre generally appears between the seventh and fourteenth day after the infection has taken place;

* In rare cases, the bubo is the first and immediate result of an impure coïtion, without any previous chancre; generally, however, it is consequent upon the removal of the chancre by local applications, and is, in this case, a troublesome representative of the latter.

it rarely appears either sooner or later, and generally affects the parts which have been first tainted with the virus. The chancre first appears in the form of a little vesicle, which is soon changed to a painfully stinging ulcer, with an elevated border. This ulcer may remain upon the same spot during the life-time of the patient, and, although it may become enlarged, yet the secondary symptoms of syphilis will never make their appearance as long as the chancre remains.

The allœopathic physician, not knowing that the entire organism has become infected with the syphilitic miasm, even before the appearance of the chancre and immediately after the impure coïtion has been accomplished, looks upon the chancre as a simply local ulcer which ought to be removed by the external application of desiccating and cauterizing substances, and which will remain quite harmless, provided it is not left too long on the skin; for, in this case, the absorbing vessels might carry the poison into the internal organism, and, in this way, produce a general syphilitic affection, whereas these evil consequences might be avoided by a speedy removal of the chancre. This is both the doctrine and the practice. By this practice, the physician deprives the internal disease of its vicarious symptom, the chancre; and, by the removal of the chancre, he forces the disease to embody itself externally in the more troublesome and speedily suppurating bubo. And after this too has been removed, as is foolishly done, by external treatment, the disease is forced to manifest itself throughout the organism with all the secondary symptoms of a fully developed *syphilis*. This *unavoidable* development of the internal syphilitic disease generally takes place after the lapse of two or three months. So far from relieving the patient, the physician positively injures him.

John Hunter asserts:* "Not one patient in fifteen will escape *syphilis*, when the chancre is removed

* Treatise on the Venereal Diseases, Leipsic, 1787, p. 531.

merely by local treatment;" and in another part of his work,* he assures us: "that the local removal of the chancre, should it even have been accomplished ever so speedily, was *always* followed by an outbreak of the internal syphilitic disease."

The same doctrine is emphatically taught by Fabre,† who says "that the local removal of the chancre is always followed by *syphilis;* that Petit had cut off a portion of the labia of the genital organs of a woman, which had been affected, for some days, with venereal chancre; that the wound indeed healed, but that the syphilitic disease nevertheless broke out.

It is incredible that physicians, in spite of the experience and emphatic statements of such great observers, should have shut their eyes to the fact: that the venereal disease existed already in its fulness in the organism before the chancre had made its appearance, and that it was an unpardonable mistake to remove the chancre by external applications, and to consider this local removal of the chancre a complete cure of the disease. On the contrary, by this local removal of the chancre, the syphilitic disease was not only forced to ramify into its secondary symptoms, but the physician deprived himself of a sure and infallible indication of the thorough and permanent cure of the internal disease. As long as the chancre existed, the organism was yet tainted with the syphilitic virus; whereas, the disappearance of the chancre consequent upon the internal administration of appropriate remedies, was a sure sign of the internal disease having been completely and permanently cured.

In my practice of fifty years' duration, I have never seen syphilis breaking out in the system, whenever the chancre was cured by internal remedies, without having been mismanaged by external treatment; it mattered not whether the chancre had been left standing for

* The same work, p. 551—553.

† Fabre, Lettres, Supplément à Son Traité des Maladies Vénériennes. Paris. 1786.

years, increasing all the while, as every vicarious symptom of any other chronic miasm will do, for the simple reason that the internal disease is progressing all the time, and induces a consequent development of the external symptom.

As soon as the chancre is removed by external remedies, the syphilitic disease, which is engrafted upon the whole organism as soon as the infection has taken place, manifests its series of secondary symptoms.

As soon as the syphilitic miasm has taken effect, it ceases to be circumscribed by the spot where the infection first took place; the whole nervous system is at once tainted with it;* the miasm has, so to say, become the property of the whole organism. Washing and wiping the parts, with whatever liquid it may be, is fruitless; even exsecting the part is of no avail. During the first days, the infected spot does not show any morbid symptoms; but the internal organism, from the first moment of the infection, is being adapted to the action of the recently introduced miasm. When the syphilitic disease has been completely developed in the system by means of this progressive adaptation, then it is, that nature produces the chancre upon the primitively infected spot with a view, as it were, of hushing the internal affection.

Hence it is that the internal disease is most efficiently and most permanently cured while the chancre or the bubo are yet existing as its vicarious types. Of this genuine and unadulterated syphilis it may be said, *that there is no chronic miasm, nor a disease produced by a chronic miasm, which is more easily cured than syphilis.*

In that stage of the syphilitic disease where the chancre or the bubo are yet existing, one single minute dose of the best mercurial preparation is sufficient to effect a

* NOTE OF THE TRANSLATOR: Hahnemann expresses this result thus: "The whole living body has *perceived* the presence of the poison."

permanent cure of the internal disease, together with the chancre, in the space of a fortnight. Of course such a cure can only be effected when the syphilitic disease is not complicated by some psoric affection; it is especially in young persons of a cheerful temper that a speedy cure may be anticipated; *psora* being in a latent condition in such persons, neither syphilis nor sycosis can become adulterated by that miasm. A few days after the medicine has been taken, and without the use of any external application, the chancre is changed to a pure ulcer with a little quantity of laudable pus, which heals of itself without leaving the slightest cicatrix, or even a spot, the colour of which is different from that of the sound skin. This is a convincing proof that the internal disease has been completely annihilated. Inasmuch as the chancre is the external indication of the internal disease, this disease cannot be considered cured as long as the internal remedy has not acted sufficiently to remove even the slightest trace of chancre from the skin.

Already in the second edition of the Materia Medica Pura, Dresden, 1822, have I indicated the mode of obtaining the best mercurial preparation. Even at this moment I consider such a preparation the best antisyphilitic remedy, although it is difficult to obtain it perfect. In order to obtain it as perfect as possible, and with the least trouble, (for the greatest simplicity should be observed in preparing homœopathic remedies,) it is better to follow the method which I shall indicate below. Take a grain of the purest liquid quicksilver, and triturate it for three hours with three hundred grains of sugar of milk, taking one hundred grains at a time and triturating them for an hour. In this way you obtain the million degree of the trituration. Of this trituration you dissolve one grain in alcohol, continuing the process of dissolving through twenty-seven phials up to the decillion degree. (See the end of this volume, where the mode of preparing the different degrees of homœopathic medicines is more fully described.

Formerly I was in the habit of using successfully,

one, two, or three globules of the billion degree, for the cure of syphilis. The higher degrees, however, even the decillion degree, act more speedily, more thoroughly, and more mildly. If more than one dose should be required, which is seldom the case, the lower degrees may then be employed.

In the same way as the chancre or the bubo gave incontrovertible evidence of the internal disease, the disappearance of the chancre consequent upon the internal use of the best mercurial preparation, without, however, the concomitant use of any external application, is an infallible indication of the internal disease having been completely and radically cured.

But on the other hand, this correspondence between the internal disease and its vicarious symptom shows that the mere external removal of the chancre, inasmuch as it does not result from the cure of the internal disease, leaves the deluded patient just as syphilitic after the removal of the chancre as he was before.

The *second* stage of the disease is that rare stage, in which the chancre has been speedily, though foolishly, removed from the skin by external applications without the organism having been much disturbed by either internal or external violent remedies. Such a comparatively easy removal can only take place in persons that are not affected with a difficult chronic disease, in whom *psora* is consequently in its latent condition. Even in this stage, the disease, provided it is not complicated with psoric affections, may be easily cured, and the secondary symptoms of syphilis may be prevented by the internal administration of the above described mercurial preparation ; although the violent removal of the chancre by external remedies makes it more difficult to be certain of the cure of the internal disease, than if the chancre had first been transformed to a benign ulcer and had then disappeared of itself, in consequence of the internal disease having been cured by internal remedies.

However, even in the presence of these disadvantages, the attentive observer may discover a sign which

will tell him whether the internal disease is or is *not* completely cured. For, in case the chancre should have been removed by external, though mild remedies, and the internal disease should not, therefore, have been completely cured, the original spot upon which the chancre had been developed, will exhibit a reddish morbid-looking, red, or blueish scar; whereas, if the chancre have been removed by the internal remedy and be no longer necessary as the vicarious embodiment of the internal disease, the original spot of the chancre can no more be traced, on account of that spot being covered by as healthy-coloured a skin as the rest of the body.

If the homœopathic physician has discovered that blueish spot, and by this discovery has become convinced that the internal disease is not yet cured, the patient, provided he is perfectly free from all secondary symptoms of psora, may be perfectly cured by one single dose of the above described mercurial preparation; and, as a proof that the cure is perfect, the blueish scar will completely disappear, and the skin at that spot assume the same healthy appearance as the rest of the body.

Even in case the bubo should have already made its appearance, the patient may yet be completely cured by one dose of the above mentioned mercurial preparation, provided the syphilitic disease is not yet complicated with psora, and the bubo has not yet passed into the suppurative stage. Generally, however, syphilis, in this condition, is complicated with psora. The indication of the cure being completed is the same as above.

Neither in this latter, nor in the former case, an outbreak of syphilis needs to be apprehended, provided the treatment has been rightly conducted.

We have now to treat of the *third* stage of the disease in which the syphilitic disease is found complicated with *psora*. If this complication occur, the psoric miasm is not in the way of a thorough cure of the syphilitic disease, *but it is impossible to effect the cure of the syphilitic disease, complicated with psora, by one remedy only.*

This complication may take place in two ways. The patient may either have been already affected with a

psoric disease at the time when the syphilitic infection took place; or else, the psora which existed in the organism at the time when the syphilitic infection took place, may have been called out by the violent drugs and painful external remedies of the allœopathic physician, the effect of which was to remove the external symptom of syphilis after protracted efforts, to undermine the general health of the patient, and to force the psoric and the syphilitic miasms into a combination with each other. Such a combination can only take place between syphilis and psora in a state of manifest development.

These are the reasons why psora is so often found complicated with syphilis. The poor patient is often assailed for months with mercurial frictions, large doses of calomel, corrosive sublimate, and other violent mercurial preparations, inducing fever, dysentery, never-ending and exhausting salivation, pains in the joints, sleeplessness, etc. But all these violent remedies not only leave the syphilitic miasm uncured, but, in combination with the intermediate use of weakening warm baths and purgatives, they rouse the latent psora much before the time when a cure of the syphilitic disease could be effected by means of such an improper treatment, and, in this way, enable the psoric and the syphilitic miasms to combine.

It may here be observed that it is the nature of the psoric miasms to break forth in consequence of great concussions of the system, and violent inroads upon the general health.

By this combination of syphilis and psora a sort of *spurious, masked* syphilis is formed, which the English physicians designate by the term *pseudo syphilis*. This is a sort of monstrous double-disease,* which no physi-

* It is even more than a double-disease. The large and frequently repeated doses of the violent mercurial preparations have added their inherent medicinal disease, which, together with the exhaustion consequent upon such treatment, reduces the patient to a truly sad plight. In such

cian has been hitherto able to cure, because no physician has, up to this moment, known the extent and nature either of latent or developed psora, and has much less suspected its combination with syphilis. No one was therefore able to remove the psoric action which was the only cause of that pseudo-syphilis; no one was able to cure the syphilitic disease by freeing it from its horrible combination with *psora;* and, on the other hand, the psoric miasm withstood every attempt at cure, because it cannot be cured unless syphilis is cured at the same time.

In order to reach, with the greatest possible success, this so-called masked syphilis, the first thing which the physician has to do, is to remove from the patient all hurtful external influences, to put him upon an easily and vigorously nourishing diet, and to regulate his general mode of life to his greatest advantage. After this has been accomplished, the physician administers the most appropriate antipsoric, in the mode which will be indicated hereafter; this may be followed by a second antipsoric to be chosen agreeably to the new symptoms; and when this last remedy has completed its action, a dose of the anti-syphilitic mercury may be exhibited, being permitted to act three, five, or seven weeks, as long as it is capable of exercising a curative influence.

In old difficult cases this course is not sufficient to effect a cure. There may remain ailments which are neither purely psoric or syphilitic and therefore require the last assistance of the physician. A similar treatment is here to be repeated. First we exhibit one or more anti-psorics, in proportion as they are indicated by the symptoms, until the last trace of all psoric action has vanished. After this we repeat the mercury, using an inferior potency, and allowing it to act until not only the manifest syphilitic symptoms have vanished, but, inasmuch as this disappearance of these syphilitic symptoms, whose nature is so extremely changeable, is no

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cases hepar sulphuris may be given in preference to pure sulphur, on account of its anti-psoric virtue.

positive proof of their radical cure, we allow the mercury to act until the skin has recovered its healthy colour at the spot upon which the venereal chancre had been developed, and afterwards removed by cauteries. Manifest syphilitic symptoms may be considered the following: ulcers of the tonsils with lancinating pain, round copper-coloured spots shining through the skin, non-itching pustules, especially in the face, set upon blueish-reddish bottom; cutaneous ulcers on the hairy scalp, and upon the skin of the penis, smooth, pale, clean, covered with nothing but mucus, and on a level with the sound skin; boring nightly pains in the nodes, etc.

In my practice I have only seen two cases* of a complication of the three chronic miasms, sycosis, syphilis, and psora.

This complication I treated according to the principles laid down above. First, I directed my remedies against the psoric miasm; and then against the other two miasms, beginning with the one whose symptoms were most prominent at the time. Afterwards

* A bricklayer had caught the syphilitic virus from his wife. The genital organs were the seat of the affection. The patient was not able to describe the disease with sufficient clearness to enable me to decide whether the primitive infection had been chancre or sycosis. The violent mercurial preparations which had been used against the infection, had destroyed the uvula, had pierced the palate, and had affected the nose to such an extent that the fleshy parts were mostly eaten away, and the remaining portion was swollen and inflamed, and pierced like a honeycomb by ulcers. He suffered great pain, and emitted an intolerably fœtid smell. He had also a psoric ulcer on the leg. The anti-psoric remedies improved the ulcers to a certain degree, healed the ulcer upon the leg, and removed the burning pain, and also the fœtid odour of the nose considerably. The remedies employed against sycosis also helped some. But, upon the whole, very little was accomplished, until the patient received a small dose of the mercurial preparation, by means of which a cure was speedily effected. The nose, of course, was irretrievably lost.

the remaining portion of the psoric symptoms was removed by the corresponding antipsorics, and then the last traces of syphilis and sycosis by other adequate remedies. The complete and radical cure of sycosis, may be recognised by the same indications, as the cure of the syphilitic miasm, viz., by the healthy colour of the skin being restored at the places upon which the cauliflower excrescence had been located; whenever this excrescence is removed by mere external remedies, the place which had been covered with it, exhibits an unhealthy looking skin.

PSORA.

Before I enter upon the exposition of my views on the third chronic miasm, it appears important to me, to premise the following general remarks.

The infection by means of one of the three known chronic miasms is generally the work of a moment; but the complete development of the disease consequent upon such an infection, throughout the whole organism, requires more time. Not until several days have elapsed, during which the miasmatic disease has completed its internal development, does kind nature cause that disease to ultimate in some local symptom, which receives the internal disease into itself, as it were, and hushes or calms it. The vital forces enjoy a sort of protection in this local symptom, which is formed upon one of the least dangerous parts of the external skin, generally upon the spot, where the nervous system has first become affected by the contagious miasm.

It is astonishing that this mode of action on the part of nature should have escaped the observation of physicians. They might have seen it at least in the course which nature pursues in regard to the syphilitic miasm, which they had treated for the space of three hundred years, and would then not have failed in drawing conclusions relative to the two other chronic miasms.

It seems to me unpardonable that physicians, in spite of all this experience, should have mistaken the venereal chancre for a mere external cutaneous something, which had nothing to do with the internal organism, and which, therefore, ought to be unhesitatingly

removed by cauteries in order to prevent the venereal poison from being absorbed into the organism. This system of cauterization appears to me unpardonable, because it had already been adopted in hundreds of thousands of patients, and had invariably been followed by an outbreak of secondary syphilis.

Just as condemnable appears to me the reasoning of the allœopathic physicians, that the itch is a mere cutaneous affection with which the internal organism has nothing to do, and that the best way of healing it, is to remove it by some external application; whereas the only natural way to remove the external eruption, is, to cure first the internal psoric disease, upon the principle "*cessante causa, cessat effectus.*"

As long as the eruption is yet existing upon the skin, the psoric disease exhibits itself in its simple and most natural integrity, and may be cured in the easiest, quickest and safest manner.

But as soon as the internal disease has been deprived of its vicarious symptom, the psoric miasm is forced to spread over the most delicate parts of the internal organism and to develop its secondary symptoms.

How necessary it is carefully to avoid every removal of the cutaneous eruption by means of external influences, and never to attempt any other but internal cure of the psoric disease, may be inferred from the fact, that the most painful chronic sufferings which had followed the removal of the psoric eruption by means of external applications, and which frequently had lasted already for years, are often hushed, for a time, by the mere re-appearance of the psoric eruption upon the skin consequent upon powerful revolutions in the organism. See above Nos. 1, 3, 5, 6, 8, (9) 16, (17) (21) 23, 33, 35, 39, 41, 54, 58, 60, 72, 81, 87, 89, 91.

It must not be supposed, however, that, after the suppression of the psoric eruption has caused the internal disease to manifest itself in a series of secondary symptoms, the internal psora is brought back again into its former simple and natural condition by the mere reappearance of the eruption upon the skin, and that this

new eruption may be cured just as easily as the primitive eruption.

This is not the case. The primitive eruption is much less constant upon the skin than the chancre and the cauliflower excrescence; it often even disappears of itself, not by the use of external remedies, but by unknown causes. Hence the physician has no time to lose, if he means to cure the internal disease while the external symptom is yet existing upon the skin. But he has yet much less time to lose with the second eruption, which generally is so changeable, that the slightest cause drives it back again in a couple of days. This may be considered a proof that this second eruption was much less perfect than the primitive and that, therefore, the physician was not authorised to rely upon it for a thorough cure of the psoric disease.

This changeable nature of the second eruption appears to depend upon the fact, that the internal psora, having been in some degree forced into developing secondary affections, has lost somewhat of its power to embody itself fully in its vicarious symptom. This is the reason why the treatment of this condition of the psoric disease is difficult. It is conducted in the manner which will be indicated hereafter.

The cure of the psoric disease is therefore not promoted by this kind of pseudo eruption being brought out again upon the skin either by internal medicines (see Nos. 3, 9, 59, 89.) or by unknown causes (see Nos. 1, 5, 6, 8, 16, 23, 28, 29, 33, 35, 39, 41, 54, 58, 60, 72, 80, 81, 87, 89, 94.) especially however through a fever (see Nos. 64, also 55, 56, 74.); this kind of pseudo eruption is extremely changeable under any circumstances, and it should not be considered available by the physician in conducting his treatment.

But even if we could not only bring the eruption out again upon the skin, but keep it there for a time, we ought not to rely upon it for facilitating the treatment.*

* There was a time when I deemed it possible to facili-

It is therefore a self-evident truth that the cure of the internal psoric disease by means of the anti-psoric remedies, can only be accomplished *in an easy manner*, as long as the primitive eruption still exists upon the skin; and, on the other hand, we may infer from the above remarks, that the method used by allœopathic physicians of removing the eruption from the skin by external applications, is just as pernicious as the removal of this eruption by means of the appropriate homœopathic internal remedy is rational and beneficent. By this latter method the whole internal disease, together with its vicarious symptom, is effectually, thoroughly, and permanently banished from the organism, and that host of horrible secondary affections with which the patient is

tate the cure of the psoric disease by bringing the eruption out again by artificial means. My object was to check the secretive functions of the skin, and to induce it by this kind of homœopathic proceeding, to reproduce the eruption. For this purpose I ordered the patient to put a plaster upon his back, and, if possible, upon other parts of his body. The plaster was prepared by slowly melting six ounces of Burgundy pitch, which, after having been removed from the fire, was carefully mixed with an ounce of Venetian turpentine. A portion of this mixture was spread warm upon soft goat-skin. For this purpose may also be used yellow wax mixed with fir turpentine; also taffetas silk covered with elastic resin. It is not the stimulating virtue of the mixture which helped to reproduce the eruption; for, upon a person not affected with the psoric virus, the above plaster produces neither eruption nor itching. I found this method to be the most efficacious in exciting the skin for the reproduction of the eruption. Nevertheless, however patiently the patients bore the infliction of this plaster, a complete and sufficiently lasting eruption was never produced. All that I was able to obtain was, to produce a few itching vesicles, which, however, disappeared again from the skin as soon as the plaster was removed. More frequently the plaster induced a sort of moist soreness of the skin. The best result of the plaster was a more or

invariably assailed after the violent external removal of the psoric eruption is destroyed in its very germ.

The excuse of which the private physician (for the hospital physician has no excuse) avails himself, is quite delusive. He says that "not knowing when, where, and from what person the infection has been caught, he cannot be sure whether the few vesicles which appear upon the skin are really the itch, and that he cannot, therefore, be made responsible for the evil consequences which may attend the suppression of those vesicles by means of lead-water, or ointments of zinc and mercury; and that rich parents desired this suppression to be accomplished as speedily as possible."

Such an excuse cannot be regarded; for every *conscientious* physician ought to know that *no eruption whatsoever* ought to be removed from the skin* by external applications. The human skin never produces

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less violent itching which occurred upon the skin, especially at night, and often spread over those parts of the body that were not covered with the plaster. This itching produced indeed a striking alleviation of the most violent secondary psoric affections, such as tubercular phthisis. But, in most cases, such a result was either impossible (generally there was but a slight itching) or, if I obtained the itching in a high degree, the patient found it so intolerable that he could not have borne it for a sufficient length of time to obtain permanent relief from his psoric affection. On removing the plaster, even the most vehement itching was stopped, the eruption disappeared again, and the disease remained the same. This shows that the second eruption does not possess the same character as the primitive eruption did, and that it is therefore of no avail for the purpose of facilitating the cure by internal remedies.

Moreover the troublesome itching of the artificially produced eruption, and the exhaustion consequent upon that itching by far outweigh the little value which the method here indicated might otherwise possess.

* See Organon of the Healing Art, fifth edition, § 187–208.

an eruption out of itself; it never assumes a morbid condition without being invited, or rather, obliged to do so, by the abnormal activity of the whole organism. As every external eruption results from an abnormal activity of the whole organism, so ought the disappearance of that eruption from the skin to be the spontaneous result of the complete and radical cure of the internal disease by means of appropriate internal remedies. In this way the eruption often disappears sooner than by the use of external contrivances.

In the second place, no intelligent physician can be deceived as to the nature of the eruption, whether it be the original, genuine, transparent itch vesicle, which becomes afterwards filled with pus, and is then surrounded with a narrow, red border, or whether it look like the rash granule, or have the appearance of pimples, or little scabs which have become scattered by means of friction: every physician ought to know that the itch is constantly indicated when the child or even the recently-born baby incessantly scratch the spot upon which the eruption is seen, or when full-grown people complain of a voluptuously itching eruption, (were it but a single pimple,) which is especially vehement in the evening and during the night, and becomes intolerable unless it be scratched, after which they experience a burning pain. In this case, it is undoubtedly the itch, although rich people seldom are able to tell when, where, and from whom they have caught the infection. As I said above, the unseen opportunities of catching the itch are innumerable.

As soon as the family physician perceives this, one or two globules of sulphur, prepared according to the rules to be indicated hereafter, will be more than sufficient to cure the internal psoric disease, and to free the patient from the eruption.

The homœopathic physician, in his private practice, seldom is called to a patient at the time when the eruption first shows itself. The patient, being tortured by the intolerable itching, first applies to some old woman, to an apothecary or to a barber, who cover him with

a sulphur ointment, with a view, as they suppose, of helping him speedily. Only in military barracks, in prisons, hospitals, orphan asylums, the patients are obliged to apply to the physician, provided the surgeon of the establishment does not forestall him.

Even in the remotest ages, *sulphur* was looked upon as a specific against the itch; for the psoric miasm did not, in every instance, form leprosy; but it was used only as an external remedy. A. C. Celsus, (V. 28,) proposes several kinds of grease and ointment by means of which he imagines the itch may be cured. One of those ointments is made of sulphur mixed with tar; others contain copper. The oldest physicians already used warm sulphur baths against the itch, as is the custom now. The eruption generally disappeared by these means. But subsequent ailments showed already then that the patients did not always recover. An Athenian, for instance, was attacked with anasarca on account of having removed his itch by using the warm sulphur baths upon the island of Melos, (now Milo.) He died of this disease 300 years before Celsus, as is reported by the author of the fifth book Epidemion, which is considered due to Hippocrates.

Sulphur was never given internally, for the simple reason that neither the older nor the modern physicians understand that the itch is chiefly an internal disease.

Modern physicians, too, never give sulphur only internally, because they do not regard the itch chiefly as an internal disease. They give sulphur internally, as a mere adjuvans of the external ointments, in frequently repeated doses of 10, 20, 30 grains, purging the patient and making it impossible to determine how far this excessive internal use of sulphur had been either hurtful or useful; at least it was impossible that the whole psoric disease should ever be thoroughly cured by this treatment. The only object which was obtained by giving the sulphur as a purgative, was to facilitate the removal of the external eruption; but this removal was just as pernicious as when no sulphur at all had been

taken internally. Such excessive doses of sulphur* can never thoroughly cure a psoric disease, even though no ointment should have been used at all. Such excessive doses rouse the vital principle into a hostile attitude, and cause it to reject the sulphur altogether without having appropriated to itself the curative virtue of the drug; in some cases they even increase the disease or excite an altogether new disease in the system. The itch can only be cured by the homœopathic preparation of sulphur.

Since experience teaches that the itch, even the recently formed itch, with the eruption existing upon the skin, cannot be cured by sulphur ointments used in combination with large quantities of sulphur taken internally, it may easily be conceived that, when the eruption has been thus violently removed from the skin, and the psoric disease has already pervaded all the recesses

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* It may not be amiss to quote here, by way of illustration, the words of an impartial and profound savant and indefatigable inquirer, Count Buquoy, who is practically acquainted with Homœopathy. We find them recorded in his "*Anregungen für phil. wissens. Forschung.*" (Leipsic, 1825, p. 386. and f.) Having first supposed that the pathogenetic symptoms of a remedy a, b, g, have received into themselves the symptoms exhibited by the disease, which we will designate A, B, V, and have impressed upon them the character of the medicinal symptoms, the character of mutability, perishability, etc., he continues in this way: "The medicinal symptoms, a, b, g, which have received into themselves the symptoms of the disease, A, B, V, easily pass off on account of the extremely small dose which has produced them. If the homœopathic physician gives too large a dose, the natural morbid symptoms A, B, V, may indeed be changed to the medicinal symptoms a, b, g; but the new disease *is now just as firmly rooted* as the primitive disease was; hence the organism finds it just as difficult to free itself from the new disease as it did to free itself from the primitive. If a *very large* dose is given, a new, often *life-endangering* disease is formed, or else the organism tries with all its might to free itself from the poison by means of diarrhœa, vomiting, etc." -

of the organism in the form of secondary chronic affections, these can much less be cured by powders of sulphur, by sulphur baths, by drinking sulphuretted mineral water, or any other water of this kind; in short, by the excessive use and repetition of sulphur, though it be a specific remedy against the itch.* It is indeed true, that many patients appear to be freed, for a time, from the original psoric affection by the use of sulphur baths, (hence the multitude of patients affected with all sorts of chronic affections, who flock to the baths of Teplitz, Baden, Aix-la-Chapelle, Neundorf, Warmbrunn, etc.;) but they are not cured for all that; the sulphur may have occasioned a medicinal disease, which, for a time, may take the place of the natural disease, and is much less troublesome than this one; but the medicinal disease soon passing off again, the original disease returns, either with its original or with new and more troublesome symptoms, sometimes affecting the more delicate parts of the organism. The ignorant physician, on perceiving this change, rejoices at the primitive group of symptoms having, as he supposes, given place to a new disease, and persuades the patient that the renewed use of the baths will cure this new disease as well as it did the former; he knows not that this new disease is a mere modification of the former symptoms, and is doomed to witness the sad result that the patient obtains much less relief from using the baths a second time, yea, that the repeated use of those baths positively aggravates the sufferings of the patient.

I may, therefore, positively assert, that sulphur has done much injury in the hands of allœopathic physicians; and that excessive use and frequent repetition

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* Sulphur, when administered in a small dose, seldom fails in effecting an incipient cure of the chronic non-venereal diseases. I know a physician in Saxony who obtained a great reputation for curing chronic diseases, by adding, without knowing why, flowers of sulphur to every one of his prescriptions. *In the beginning*, they produced a good effect, but only in the beginning, for, in a little while, the good effects ceased.

have made this drug almost useless for the homœopathic physician in the treatment of those endless secondary psoric affections, for the cure of which allœopathic doctors had employed it in vain.

In all those mismanaged cases of psoric diseases, sulphur will be much less useful to the homœopathic physician than it is in a recently formed itch, with the eruption still existing upon the skin. Sulphur will indeed show a curative effect, whether the psoric disease after the violent suppression of the eruption, be still slumbering in the system, or whether it have already broke forth in the shape of all sorts of secondary chronic affections; but it can only be rarely exhibited in those mismanaged cases, on account of its virtues having been already misused by the allœopathic physicians; whereas, sulphur, and, indeed, most other antipsoric remedies, should never be given more than three or four times, even with suitable intermediate remedies, if the physician does not wish the cure to retrograde in consequence of the too frequent use of that powerful antipsoric.

Whether the violent suppression of the eruption have forced the internal psora to manifest itself in the form of secondary chronic affections, or whether it be still slumbering in the system, sulphur alone is never sufficient to effect the cure of such a psoric disturbance. Hence it is, that sulphur baths, either natural or artificial, are of no avail in the treatment of such secondary psoric affections.

I repeat that, (with the exception of a recently formed itch with the eruption still existing upon the skin,)* every other psoric disturbance of the organism, whether the psora be yet in a latent condition or whether it have already assumed the various forms of secondary chronic affections, can never be cured by one antipsoric reme-

* Recent itch, with the eruption, has often yielded to *one* small dose of homœopathically prepared sulphur in the space of 2, 3 or 4 weeks. On one occasion such a cure was effected in a family of seven persons by means of half a grain of the million potency of carbo vegetabilis; and on three other occasions by means of a like dose of the same potency of Sepia.

dy, but that complete and radical cure of such secondary psoric affections in bad cases, requires the use of a large number of antipsorics.

The psoric miasm, having pervaded millions of organisms for thousands of years, has gradually developed out of itself an endless number of symptoms, varied according to differences of constitution, climate, residence, education, habits, occupation,* mode of life, diet, and various other bodily and spiritual influences. Hence it cannot appear strange that not one antipsoric should be sufficient to correspond to that endless number of different psoric symptoms, and that the use of several antipsoric remedies should be required for a complete and radical removal of the psoric miasm.†

As I have said before, only the recent itch, with the eruption still existing upon the skin, can be completely cured by one dose of sulphur. I am not prepared to assert that such a speedy cure is possible in every case; the age of the patient has a great influence upon the result of the treatment. When the eruption has already existed for some time upon the skin and begins to disappear of itself, in that case the internal psora has already obtained preponderance in the system. The eruption now ceases, to a certain extent, to be a vicarious symptom for the internal disease; and the signs of latent psora or secondary psoric affections begin to manifest themselves. In such a case as this, sulphur is no longer sufficient to effect a cure; nor is any single antipsoric remedy capable of producing that result; several antipsorics are required for that purpose, according as their use is indicated by the existing symptoms.

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* I mean occupations which exert a special influence upon particular organs of the system, which affect certain functions of the mind more than others.

† I forbear indicating the great exertions, the innumerable and careful observations, the inquiries, reflections and various experiments by means of which I have succeeded, after the lapse of eleven years, in filling up that large chasm in the system of the homœopathic healing art, in indicating the cure of the countless chronic diseases, and in thus completing, as much as possible, the blessings which homœopathy has bestowed upon mankind.

THE homœopathic treatment of the chronic non-venereal diseases generally accords with what has been taught in the Organon of the healing art, relatively to the treatment of acute diseases. The particular rules to be observed in the treatment of chronic diseases I shall now point out.

In regard to *diet* and *mode of life* I shall only give general directions, which the physician will have to apply in a special case according to his own discretion. Of course, whatever is injurious to the action of the remedies, must be carefully avoided. However, it will sometimes be necessary to modify, more or less, the dietetic rules which homœopathy enjoins upon the patient with so much strictness and emphasis; this modification must especially take place when we have to treat lingering diseases which often last for a long time, and when it becomes necessary for the physician to consider the age, the occupation, and the social condition of the patient.

Strict diet is not the curative agent in the treatment of chronic diseases, as is asserted by the opponents of homœopathy, with a view of lessening its merit; the cure depends chiefly upon the medical treatment. This is proved by the fact that many chronic patients have followed, for years, the strictest diet without being able to obtain relief; the disease increases, as is the case with all chronic miasms.

In order to make the cure possible and practicable, the homœopathic practitioner is, therefore, often obliged to modify the severe diet prescribed by homœopathy. By wisely yielding to circumstances the physician effects the cure more certainly and more perfectly than by obstinately insisting upon a mode of life which it is impossible for the patient to follow.

If their strength permit, the journeyman ought to continue his labour, the artizan work at his trade, the farmer attend to his business in the fields, the housekeeper to her domestic concern; only that which is generally injurious to health, ought to be carefully avoided.

Persons whose business confines them to a room, and obliges them to lead a sedentary life, ought to take as much exercise as possible in the open air, without, however, totally abandoning their usual pursuits.

Rich patients must walk more than they usually do. The physician may permit them moderate and proper dancing, rural entertainments, provided they do not conflict with the necessary dietetic precautions, conversation with friends; he may also permit them innocent music, and listening to amusing lectures; they may sometimes even go to the theatre, but they must never play cards. The physician ought to lay restrictions upon riding, either on horseback or in the carriage, and to interdict all exciting intercourse; for, bad moral effects re-act upon the body. All amorous intercourse and sensual excitement, reading lewd novels, and superstitious or exciting books, are to be carefully avoided.*

The literary man ought to take much exercise in the open air, and, in bad weather, do some light mechanical work in the house. While the treatment lasts, he ought to limit his intellectual labour to writing essays of his own composition; reading ought either never to be permitted, or, at any rate, the quality and quantity

* Some physicians are apt to give themselves importance by interdicting all sexual intercourse to married chronic patients. If both parties are capable of enjoying it, such an interdiction is, to say the least of it, ridiculous; for, in this case, the interdiction neither can be nor will be obeyed; otherwise a great family misfortune might come out of it. No laws should be passed which cannot be kept, or the observation of which would induce greater mischief than that which they were intended to prevent. In case one of the parties should be incapable of sexual intercourse, the interdiction becomes useless. Sexual intercourse is a thing which can neither be properly recommended nor interdicted. All that homœopathy ought to do in regard to sexual intercourse, is, to enable the parties to enjoy it (either by antipsoric or antisyphilitic remedies,) and to restore the morbidly excited desire of either party to its natural tone.

of the reading matter ought to be carefully indicated. In mental diseases, reading is to be positively forbidden.

Chronic patients of all classes must carefully avoid the arbitrary use of domestic remedies, or of intermediate medicines of any kind; patients of the higher classes must carefully abstain from perfumes, scented water, tooth powders, etc. If the patient is accustomed to wear wool over the bare skin, he may continue to do so; but in proportion as the cure progresses, and the weather becomes warmer, cotton, and finally linen ought to be substituted. Fontanels, in important chronic diseases, should only be discontinued when the cure has already been progressing for some time. This remark is especially applicable to patients advanced in age.

Baths have to be discontinued; ablutions may be substituted in their stead; they may be used for the sake of cleanliness. Bleeding and cupping must be strictly forbidden, no matter how much the patient may have been accustomed to such depletions.

In regard to diet, I may observe, that men of all classes may consent to impose some restrictions upon themselves, in order to be freed from a troublesome chronic disease. If the abdomen is not the chief seat of the chronic disease, in this case, all severe restrictions may be dispensed with, especially among the lower classes, and when the patient is capable of taking the necessary exercise by working at his trade. The poor may live on bread and salt, and yet recover from his disease by proper treatment; he may safely eat potatoes, boiled flour and fresh cheese, (moderately, of course;) but onions and pepper, he ought to use in a limited quantity.

He who cares for his health may, even at the king's table, find something which will abundantly satisfy a moderate and natural appetite.

What is the most difficult part of the treatment, is to regulate the drinks of the patient. Coffee has pernicious effects upon both body and soul; they may be found enumerated in my little work, (Wirkungen des

Kaffees, Leipsic, 1803.) Unfortunately coffee has become so necessary to the so-called civilized nations that, unless the homœopathic physician interdicts the use of coffee once for ever during the treatment, he will find it just as difficult to abolish the use of that beverage as it is difficult to eradicate superstition and prejudice. Young people of twenty and even thirty years, may be deprived of it at once, without any injury. Persons of a more advanced age ought to be persuaded to abstain from the use of coffee little by little, taking a little less of it every day; most of them will be found willing to leave off the use of that beverage at once, and they do so without experiencing any disagreeable consequences, except perhaps for the first two or three days. Even as late as six years ago I was under the impression that coffee might be permitted, in a small quantity, to old people, in case they should find it difficult to give it up. But I am now convinced that the protracted use of coffee does not make it harmless, and that the physician who is bound to take care of the best interests of his patients, ought to insist upon their depriving themselves of coffee altogether. If they have the necessary confidence in their physician, they will all conform to his reasonable wishes with great readiness. Roast rye or wheat smell and taste very much like coffee, and procure a beverage which is now much used by both rich and poor people in different countries.

The same criticism may be passed upon Chinese tea. Both the coarser and the finer kinds of this beverage are alluring to the taste and secretly and infallibly weaken the nerves. Tea, whether it be weak or strong, and whether it be taken by young or old people, were it only once a day, is always more or less injurious, and ought, therefore, to be avoided during the treatment of chronic diseases. I have constantly found that also in regard to tea, the wishes of an intelligent and respected physician are at once obeyed.

Wine needs not to be completely interdicted to chronic patients. Old people cannot well be suddenly and completely deprived of wine, especially if they have

been in the habit of using it without water ever since their childhood.* This would be followed by sinking of strength; the cure might be retarded and even life endangered. During the first weeks the patients will mix their wine with equal portions of water; gradually they will mix the wine with two, three, four, five and even six portions of water and a little sugar; this last beverage may be recommended as a common drink to all chronic patients.

As regards brandy, chronic patients must absolutely abstain from it. The physician will require a good deal of firmness in diminishing the quantity of brandy usually taken by the patient. In case the strength of the patient should sink in consequence of his being deprived of brandy, a little pure wine may be substituted in the place, which may gradually be mixed with water according to circumstances.

We know it to be a law of nature that the condition which a medicinal or spirituous substance realizes in the system, is followed by an opposite condition on the part of the organism, provided such an opposition is at all possible. Hence we may infer that the increase of strength and animal heat consequent upon the use of ardent spirits will be followed by a state of depression and diminution of heat. The physician is bound to shield the chronic patient against the injury which those opposing extremes would inflict upon him. Only the allœopathic physician who cares nothing about conscientious observation, and does not wish to become convinced of the injurious effects of his palliatives, advises his patients to drink every day some pure wine as a tonic; the homœopathic doctor never makes himself guilty of such mal-practice, (*sed ex ungue leonem!*)

* It is both improper and injurious, even for healthy men, to use pure wine as an habitual drink; this can only be admitted on extraordinary occasions. The young man who uses spirituous drinks in abundance, will find it impossible to control his sexual desire until he is married; gonorrhœa and chancre are the consequences of such excesses.

The use of beer is liable to many restrictions. Brewers are now-a-days too much in the habit of mixing with the beer all sorts of vegetable substances, partly to preserve it from turning sour, partly and especially to tickle the palate, and to produce an intoxicating effect. Those substances are injurious to health. The different kinds of ale, though they contain a diminished quantity of malt, are also mixed with narcotic substances for the purpose of producing an intoxicating effect.

The use of acetic and citric acid is likewise to be prohibited. Vinegar and lemon juice are especially hurtful to those who are affected with nervous and abdominal complaints; moreover, those substances either neutralize or increase the effects of certain remedies. Sour fruit, such as sour cherries, unripe gooseberries, currants, ought to be used only in very small quantities; sweet fruit may be used moderately; stewed prunes should not be used by those who are inclined to constipation. Young veal ought not to be used by those whose digestive organs are affected. Those whose generative powers are weakened, must moderate themselves in the use of chickens or eggs, and must avoid vanilla, truffles, caviare, all of which act as palliatives. From this last reason women whose menses flow too scantily, must avoid using saffron and cinnamon. Dyspeptic persons have to avoid cinnamon, cloves, ammonium, pepper, ginger, and bitters; all these substances act as palliatives and are injurious to homœopathic medicines. Flatuous vegetables of all kinds ought to be avoided by those who are inclined to constipation and difficulty of passing their stools. Beef, wheat and rye-bread, cow's milk, and a moderate quantity of fresh butter appear to be the most natural and the most harmless food for man, hence also for chronic patients. These substances ought not to contain much salt. Next to beef may be ranked mutton, game, old chickens, young pigeons; goose and duck are yet less admissible to chronic patients than pork. Salt and smoked meat must be used with great moderation.

Raw chopped herbs, spices and old rancid cheese are to be carefully avoided.

Fish ought to be used boiled, not too much of it, without any spiced sauces; no smoked fish or such as has been dried in the air; herrings and sardines in moderate quantity.

Moderation in eating and drinking is a sacred duty for all chronic patients.

Tobacco may be permitted in some chronic diseases to patients who have constantly used tobacco, and who do not spit in using it. However, restrictions are to be imposed when the intellectual functions are affected, when the patient does not sleep well, is dyspectic and constipated. When there is opening of the bowels every time the tobacco is used, this is an additional reason why its use should be prohibited, and why suitable antipsorics should be employed towards removing the constipation entirely. The use of snuff against habitual catarrh, obstruction of the nose and chronic inflammation of the eyes is a great obstacle to the cure of chronic diseases; it, therefore, ought to be gradually abolished as soon as possible. There is another reason why the use of snuff should be interdicted. The medicinal preparations with which the snuff is moistened injure the olfactory nerve with which they are brought in immediate contact; this the smoking of tobacco is much less able to do on account of its virtues being considerably diminished by the fire.

There are other *obstacles* to the cure of chronic diseases which I shall now enumerate.

Those events which are capable of rousing the latent psora which has hitherto manifested its existence in the organism by some of those slight deviations from its normal condition that have been enumerated above, are also capable, if they should attack a patient in whom the chronic disease is fully developed, to make its cure difficult and even impossible, unless they speedily yield to more favourable circumstances.

These events being different in their nature, they are injurious in different degrees.

Excessive fatigue, working in marshy regions, great injuries and wounds, excessive heat or cold, starvation, poverty, unwholesome food are less capable of rousing latent psora or aggravating a manifest psoric disease than an unhappy marriage or a gnawing conscience. Yes, ten years of hard labour in the penitentiary is much less injurious to the health of an innocent man than spiritual sufferings. The psoric miasm, which had been hitherto latent in his system and gave the favorite of a king the appearance of blooming health, quickly breaks forth into a chronic affection or induces a state of insanity, when contempt and indigence are substituted in the place of his former brilliant position. The psoric mother whose health had already been vacillating, is attacked with an incurable suppuration of the lungs or with a cancer of the breast in consequence of the sudden death of her only son; disdained love induces a state of melancholy in the sensitive young woman, who had been affected with psoric hysteria.

In such cases, even the best antipsoric treatment is scarcely capable of procuring relief to those unfortunate patients.

Grief and sorrow are the principal causes which either develop latent psora, or aggravate an already existing secondary psoric affection.

Even the least remains of the psoric miasm are by *permanent grief and vexation* developed into all sorts of chronic psoric affections; grief and vexation act more certainly, more frequently, and more suddenly than any other contrary influences could do.

The physician ought to make it his duty and his delight to remove from the patient all those influences that might be an obstacle to the cure, and especially in the case of chronic patients, he ought to shield them, to the best of his ability, against grief and vexation.

If both philosophy and religion should forsake the patient; if the patient is not capable of bearing with resignation the sufferings and tribulations which may befal him without his fault; if the patient is constantly assailed by grief and vexation without the physician

being able to ward off those pernicious influences, then it is better that the patient should be left to his fate;* for even the wisest, most skilful, and most conscientious physician will find it impossible to procure the patient relief under those unfavourable circumstances. It would be foolish to continue the construction of an edifice upon a ground which is every day undermined by the waves slowly washing away one portion after the other.

There is another class of chronic patients whose affections are just as difficult to cure. They are those patients among the higher classes, who have used for years mineral baths,† and have resorted to those boasted methods of cure and nostra which are sent over the whole world from France and England. These nostra being taken in repeated doses, develop the psoric miasm, even when uncombined with syphilis, so irresistibly, and aggravate the secondary psoric affections to such an extent, that those inroads upon the vital powers of the organism, if they should be continued for some years, make the cure of chronic affections impossible. Why this should be so, is difficult to say. It may be presumed that new affections have been added to the original malady by means of those heroic non-homœopathic remedies, and that the magnitude and frequent repetition of these remedies have impressed upon those affections the character of chronic permanency. Or, the different powers of organic life, irritability, sensibility, the faculty of reproduction may have become so

* This grief may be a symptom of the general disease without being occasioned by external influences. In this case, regard must be had to this symptom in the selection of an antipsoric. Such morbid states of the mind are sometimes cured with great ease.

† Even if the water itself is not contrary to the disease; nevertheless, the frequent use of baths must be considered a repetition of powerful doses, which often exercise a pernicious effect upon the disease, and very seldom do much good.

much weakened by this abuse, that all those causes united may have produced a disturbance which no sensible man will consider elementary; and no homœopathic physician will lightly undertake to regulate the chaos of sufferings which is exhibited in such wofully misused organisms.

Such violent and exhausting modes of treatment are not only incapable of curing the primitive psoric disease, but they aggravate it by producing dangerous medicinal affections, and finally threaten to overwhelm the vital powers altogether.

If the pernicious effects of the old method of cure merely resulted in dynamic derangements of the organism, the organism would soon recover from those effects, after the treatment should have been discontinued for a time, or else homœopathic remedies would be able to neutralize those bad effects. But these effects never disappear. It is probable that the sensible and irritable fibre is unnaturally affected by the large and frequently repeated doses of allœopathic medicines, and that the vital principle protects itself against their destructive agency, either by modifying or changing the viscera of organic life in such a manner as will effectually shield them against the assaults of subversive remedial agents. It is for a purpose like this, for instance, that the vital powers cover the delicate skin of the hand with a horny surface, in order to protect that part of the body against the bad effects which it might otherwise suffer from the contact with corrosive or otherwise injurious substances. In the same way, if the delicate viscera of organic life are assailed by medicines which are not in homœopathic relation with the disease, those viscera are protected by the vital principle by having their sensibility and irritability diminished. Moreover, the more delicate fibre is found abnormally thickened or hardened; the stronger fibre, on the contrary, consumed or even annihilated, as is shown by the adventitious, irregular, or degenerate formations or growths which post-mortem examinations exhibit to us, and which are then attributed to the malignant charac-

ter of the primitive disease. Such a crippled condition of things occurs very often, and is, in many cases, incurable. Only in patients who are not too far advanced in age, and whose powers have not been too deeply sunk by the destructive drugs of allœopathic physicians, as is unfortunately almost always the case, the careful and intelligent homœopathic physician may succeed in restoring the original health of the patient. But such a result can only be obtained under the most favourable external circumstances. When these occur and are maintained, the physician may enable the vital principle, by disembarrassing it first from the influences of the psoric miasm, to gradually remove the degenerations which the unnatural doses of the allœopathic doctor had forced the vital powers to form for the sake of preserving the system from utter ruin. Daily experience proves the fact that the system sinks more and more, in proportion as the allœopathic physician, even if he should proceed with attention and care, assails it with his drugs.

It is impossible that such mismanaged cases should be cured in a short time, by means of an art which has never pretended to have it in its power *directly* to act upon organic defects.

In these cases the physician has not to deal with a simple psoric disease. These cases are often so complicated that the physician is obliged to abandon them at once. But were they ever so favourable, he ought never to promise more than relief after a long lapse of time. The first thing to be done is, that the various medicinal influences which undermine the system in all directions, should be removed from the system. This result may be obtained without the patient taking any new medicine, by going for a few months into the country, following a strict diet, and carefully regulating his mode of life. Medicine can do almost nothing against these chaotic devastations, of allœopathic drugs. The vital principle, aided perhaps by an antipsoric in some degree, must first clear away all those artificial symptoms before the true image of the original disease is reproduced.*

* The most horrible chronic diseases, such as may be

Wo to the homœopathic physician who means to make his reputation by the cure of such wofully mismanaged diseases! He will fail in spite of all his care.

An other obstacle to the cure of chronic diseases is the enervation of the system consequent upon excesses. The sons of rich parents especially, carried away by the allurements of wealth, are too much inclined to injure themselves by destructive passions, debauchery, abuse of the sexual organs, gambling, etc. By the practice of these vices the robustest bodies often dwindle down to a shadow; yea, the latent psora entering into combination with the badly managed syphilitic poison, this union gives origin to the most distressing disease. Even if the patient mends his ways, remorse will constantly assail the vital forces and will impede the action of the antipsoric remedies so much that the homœopathic practitioner will have to be very cautious in promising a successful treatment.

Among poor people, where the aforesaid obstacles do not exist,* there are other difficulties in the way of a successful treatment. Among the poor the infection has generally been caught more than once and the cutaneous eruption has, as many times, been repelled by external applications. By these means the internal psoric

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found in the families of poor peasants and mechanics, whom no fashionable physician visits, are cured *in the most simple manner* by antipsorics; the cure is often effected in so short a time that it appears almost miraculous.

* A pretty frequent obstacle to the cure of chronic diseases is "*suppressed sexual intercourse.*" In some cases this suppression does not depend upon the physician; in other cases a foolish physician feels called upon to interdict sexual intercourse on account of the delicate health of one of the parties. Such an interdiction often induces hysteria, hypochondriasis and even frenzy. A sensible physician will cure these symptoms by permitting the moderate enjoyment of sexual intercourse. This subject deserves much more attention than is generally bestowed upon it.

disease has gradually assumed a fearful character. But even in these cases a cure is possible in the course of time, provided the patients are not too far advanced in age, and are docile and not too much exhausted.

But even in those difficult cases kind nature shows a disposition to facilitate the cure, provided we know how to understand and profit by her indications. Experience teaches this important fact that, though the patient have caught the itch several times in succession, and though the psoric miasm have subdued the organism more completely now than during the first attack, yet the last infection may be cured as easily as if it were the first, provided the eruption still exist upon the skin in its integrity. By means of one or two doses of the suitable antipsoric remedy, the psoric miasm may be removed from the system, and all secondary chronic affections may be effectually prevented.*

It would not be expedient, however, to favour the cure of psoric chronic affections by repeatedly producing an artificial infection of the patient by means of the psoric virus, even though the patient should not dread such a course, although he often does reject it.

The psoric miasm rarely takes effect in patients afflicted with inveterate psoric diseases, such as suppuration of the lungs, paralysis of one or more parts of the body, etc. I may observe that the psoric miasm takes effect much sooner when it is caught naturally, than when it is communicated by artificial inoculation.

I have little else to say, relatively to the treatment of chronic diseases; I content myself with referring the in-

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* This is also the case with syphilis. Suppose the chancre or bubo have been violently suppressed and secondary syphilis has made its appearance. Suppose now that the patient has caught the syphilitic infection a second time; in this case as long as the chancre is yet existing, the syphilitic disease is cured by one dose of the best mercurial preparation. Of course, there must not be any complication with psora; if this should be the case, the psoric affection must be removed first, as has been taught above.

telligent homœopathic physician to the list of antipsoric remedies which he will find recorded at the end of this volume, and which he may use with advantage for the attainment of his noble ends. A few rules of precaution may, however, not be amiss.

First, let me recall to mind the great truth, that most chronic diseases, excepting however those few diseases which spring from syphilis, originate in psora, and can, therefore, only be cured by antipsoric remedies, that is to say, remedies which produce, in a healthy organism, all those symptoms which characterise both latent and developed psora.

It is for this reason that the homœopathic physician should not pay any attention to the names which he finds arrayed in works on pathology, and that he should above all, study the symptoms, and select a remedy in harmony with them.

The physician must be on his guard against interrupting the action of the antipsoric remedy which he has given to the patient; let him not exhibit an intermediate remedy, on account of a little headache which may perhaps come the day after the antipsoric remedy was given; or another remedy for a sore throat, or diarrhœa, or a little pain, etc.

The rule is, that the carefully selected homœopathic remedy should act until it has completed its effect.

Suppose the remedy calls out symptoms which have existed already weeks or months ago; in this case, the apparent aggravation and the development of new symptoms show that the remedy has attacked the disease in its inmost nature, and will prove of great use hereafter. Therefore, the remedy ought to be left undisturbed.

But, if the remedy produces symptoms which had never been witnessed before, and which may, therefore, be supposed to be inherent in the medicine; in that case, the remedy should be permitted to act for a while; generally those symptoms disappear of themselves without retarding the course adopted by the physician; but if they are troublesome and important, they ought not to be tolerated; they show that the homœopathic reme-

dy has not been properly chosen. The effect of such a remedy must either be checked by an antidote, or, if no antidote should be known, another suitable antipsoric must be administered. After this, the false symptoms may continue for a while, and occasionally re-appear, but they will speedily and permanently vanish, and make room for adequate treatment.

The physician needs not to feel the least uneasiness, if the ordinary symptoms of the disease are called out by the anti-psoric remedies, in a higher degree of intensity than they usually manifest. They will diminish more and more one day after the other. This so-called homœopathic aggravation is a proof that the cure is not only probable, but may even be anticipated with certainty.

But if the original symptoms of the disease continue with the same intensity in the succeeding days as in the beginning, or if this intensity increases, this is a sure sign that, although the remedy may be homœopathic, yet the magnitude of the dose makes the cure impossible. The remedial agent, by its powerful action, not only neutralizes its genuine homœopathic effects, but establishes moreover, in the system, a medicinal disease by the side of the natural disturbance which is even strengthened by the medicine.

This pernicious effect of too large a dose may be seen already in the first 16, 18, 20 days of its action. In such a case it becomes necessary either to give an antidote, or, if the antidote should not be known, to administer a very small dose of such an anti-psoric as corresponds most homœopathically to the symptoms both of the natural and the artificial disease. If one anti-psoric should not be sufficient, another may be selected, of course, with the same care.*

* The accident which is mentioned in this paragraph, I have witnessed in my own practice, at the time when I was not yet fully acquainted with the remedial virtues of *Sepia*, and especially *Lycopodium* and *Silicea*. I was then in the habit of giving 4, 5 or 6 globules of the billion potency at a dose. *Discite moniti!*

The excessive action of the otherwise homœopathic remedial agent having been subdued by the proper antidote or by anti-psoric remedies, the same agent may then be exhibited again, but of a *much higher potency* and in a *more minute dose.*

There are three mistakes which the physician cannot too carefully avoid; the first is to suppose that the doses which I have indicated as the proper doses in the treatment of chronic diseases, and which long experience and close observation have induced me to adopt, are too small; the second great mistake is the improper use of a remedy; and the third mistake consists in not letting the remedy act a sufficient length of time.

Nothing is lost by giving even smaller doses than those which I have indicated. *The doses can scarcely be too much reduced*, provided the effects of the remedy are not disturbed by improper food. The remedial agent will act even in its smallest quantity, provided it corresponds perfectly to all the symptoms of the disease and its action is not interfered with by dietetic transgressions. The advantage of giving the smallest doses is this, *that it is an easy matter to neutralize their effects in case the medicine should not have been chosen with the necessary exactitude.* This being done, a more suitable anti-psoric may then be exhibited.

The second fault is generally owing to carelessness, laziness and levity. Many homœopathic physicians, alas! remain guilty of these trespasses to the end of their lives; they understand nothing of the homœopathic doctrine.

The first duty of the homœopathic physician who appreciates the dignity of his character and the value of human life, is, to inquire into the whole condition of the patient, the cause of the disease as far as the patient remembers it, his mode of life, the nature of his mind, the tone and character of his sentiments, his physical constitution, and especially the symptoms of the disease. This inquiry is made according to the rules laid down in the *Organon.* This being done, the physician then tries to discover the true homœopathic remedy. He

may avail himself of the existing Repertories with a view of becoming approximatively acquainted with the true remedy. But, inasmuch as those Repertories only contain general indications, it is necessary that the remedies which the physician finds indicated in those works, should be afterwards carefully studied out in the Materia Medica. A physician who is not willing to take this trouble, but who contents himself with the general indications furnished by the Rêpertories, and who, by means of these general indications, dispatches one patient after the other, deserves not the name of a true homœopathist. He is a mere quack, changing his remedies every moment, until the poor patient loses his temper and is obliged to leave this homicidal dabbler. It is by such levity as this that true homœopathy is injured.

This ignominious propensity for laziness, in the most important of all professions, determines these pseudo-homœopathists to choose their remedies *ab usu in morbis*, by the directions which are found recorded at the head of each medicine. This proceeding is entirely wrong, and smells strongly of allœopathy. Those general indications which are found at the head of each medicine in the different Repertories, only refer to special symptoms and most of them have no other object except to inform the homœopathic physician that certain medicines, the virtues of which had been tried upon the healthy organism, have been found curative in the diseases named in the Repertories. Alas! there are even authors who advise this kind of empiricism.

The *third* great mistake which the homœopathic physician cannot too carefully avoid in the treatment of chronic diseases, is the too hasty repetition of the dose. This haste is highly indiscreet. Superficial observers are very apt to suppose that a remedy, after having favourably acted for eight or ten days, can act no more; this delusion is strengthened by the supposition that the morbid symptoms would have shown themselves again on such or such a day, if the dose had not been renewed.

If the medicine which the patient has been ordered to take, produces a good effect in the first eight or ten

days, this is a sure sign that the medicine is strictly homœopathic. If, under these circumstances, an aggravation should occur, the patient need not feel uneasy about it; the desired result will be ultimately obtained, though it may take 24 or 30 days. It takes 40 and even 50 days before the medicine has completed its action. To give another remedy before the lapse of this period, would be the height of folly. Let no physician suppose that, as soon as the time fixed for the duration of the action of the remedy shall have elapsed, *another remedy must at once be administered with a view of hastening the cure.* This is contrary to experience. The surest and safest way of hastening the cure is, to let the medicine act *as long as the improvement of the patient continues*, were it even far beyond the period which is set down as the probable period of the duration of that action.* He who observes this rule with the greatest care, will be the most successful homœopathic practitioner. A new remedy should only be given when the older symptoms which had disappeared for a time, begin to appear again, and show a tendency to remain or to increase in intensity. Experience is the only arbiter in these matters, and, in my own long and extensive practice it has already decided beyond the shadow of a doubt.

Considering the complex nature of the human organism and the delicate structure of its organs, it cannot appear strange that the psoric miasm which ramifies through the organism as a parasitical growth, should tenaciously resist the action of remedial agents. The intelligent observer will find it natural that the remedial

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* On one occasion I gave *Sepia* against a chronic headache which came on at intervals. The attacks became both less frequent and less violent. Another dose stopped the headache for the period of 100 days, from which I infer that the remedy acted during all that time. At the end of 100 days another slight attack came on. A third dose of Sepia was given, and it is now seven years since the headache has completely disappeared.

agent, acting as it does for a long period, should occasionally appear to make a sort of inroad upon the organism. Such exacerbations are only apparent aggravations of the disease. They simply show that the disease is writhing, as it were, under the action of the remedy,* and may occur even 16, 20, or 24 days after the period when the medicine was taken.

The duration of the action of anti-psoric remedies is generally proportionate to the chronic character of the disease. And, vice-versa, even such remedies as belladonna, sulphur, arsenic, etc., which act for a considerable length of time in the healthy organism, have the duration of their action diminished in proportion as the disease is acute and runs speedily through its course. In chronic diseases the physician will therefore let the remedy act 30, 40, and even 50 days, as long as the improvement continues. Nature permits the remedy to act for so many days; and, as long as this action continues, it ought not to be interfered with by a new remedy.†

* If the anti-psoric remedy have been chosen with strict regard to its homœopathic nature, and have been exhibited in the smallest dose, such exacerbations will progressively diminish both in frequency and intensity; whereas, if the dose is too strong, they may appear very often to the great prejudice of the patient.

† It will be difficult to induce physicians to avoid the mistakes which have been censured in these paragraphs. My doctrines in regard to the magnitude and the repetition of the doses will be doubted for years, even by the greater number of homœopathic physicians. Their excuse will be, "that it is quite difficult enough to believe that the minute homœopathic doses have at all the power to act upon the disease, but that it is incredible that such small doses should be able to influence an inveterate chronic disease even for two or three, much less for forty or fifty days; yea, that, after so long a space of time, important results should be obtained from those imperceptible doses." My proposition, however, is not one of those which ought to be compre-

The whole cure fails if the anti-psoric remedies which have been prescribed for the patient, are not per-

hended, nor one which ought to be blindly believed. No one is bound either to comprehend or believe that proposition; I do not comprehend it, but the facts speak for themselves. The truth of my proposition is demonstrated by experience, in which I have more faith than in my intelligence. Who will undertake to weigh the powers which nature conceals in her depths? Who will doubt of their existence? Who ever thought that the medicinal virtues of drugs could be developed in an infinite series of degrees by means of triturating and shaking the raw material? Does the physician risk any thing by imitating a method which I have adopted from long experience and observation? *Unless the physician imitates my method,* he cannot expect to solve the highest problem of medical science, that *of curing those important chronic diseases* which have indeed remained uncured up to the time when I discovered their true character, and proper treatment. This is all that I have to say on this subject. I have fulfilled a duty by communicating to the world the great truths which I have discovered. The world was sadly in need of them. If physicians do not carefully practice what I teach, let them not boast of being my followers, and, above all, let them not expect to be successful in their treatment.

Is it proper that we should reject a method of cure until the play of those natural forces upon which the method rests shall have been revealed to the sight and shall have been made accessible to the minds of children? Would it not be foolish to reject the practice of eliciting sparks from flint by striking against it with steel, for no other reason than this: that we do not understand how so much caloric could be latent in the flint, or how this caloric after being elicited from the flint, could melt the little particles of steel which separate from the steel when we strike it against the flint, and, in the shape of incandescent globules, set the tinder on fire? We understand nothing of all this, and we nevertheless have followed for thousands of years the practice of eliciting sparks from flint by means of steel. It would be foolish to decline learning to write because we do not

mitted to act uninterruptedly to the end. Even if the second anti-psoric should have been selected with the greatest care, it cannot replace the loss which the rash haste of the physician has inflicted upon the patient. The benign action of the former remedy, which was about manifesting its most beautiful and most surprising results, is probably lost to the patient for ever.

The *fundamental rule*, in treating chronic diseases, is this: *to let the carefully-selected homœopathic anti-psoric act as long as it is capable of exercising a curative influence and there is a visible improvement going on in the system.* This rule is opposed to the hasty prescription of a new, or *the immediate repetition of the same, remedy*. Indeed nothing can be more desirable to a physician than to let the improvement of his patient continue without interfering with it. By means of a single dose of a carefully selected remedy, the homœopathic practitioner often produces an improvement in the state of his patient, which continues even to the restoration of health. This result could not have been obtained if the dose had been repeated, or if another remedy had been given. It is probable that an anti-psoric remedy of the highest potency manifests its curative influence for such a length of time, and finally cures the disease by developing in the organism an analagous chronic disease, which has a stronger hold upon the natural disease than the natural disease has upon the organism. (See Organon, § 45, fifth edition.) This seems to be the course that nature adopts. The artificially-excited disease is indeed analogous to the natural disease, both as regards symptoms and pain; but, in the organism, the artificial disease being the stronger, it annihilates the natural, which is the weaker. (See Organon, § 33.) This shows why every hasty repetition of the

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understand how thought can be embodied in written words? Just as foolish would it be to reject the method which I have discovered for the cure of chronic diseases, on the ground that we do not comprehend the mysterious agency which that method involves.

same remedy, or every new dose of another remedy, would produce an increase of morbid symptoms and interrupt the process of cure. It often requires a long time before so much mischief can be remedied.*

* NOTE OF THE TRANSLATOR: The explanation which Hahnemann gives of the modus operandi of the homœopathic drug, is not satisfactory. With all due reverence for the great master of Homœopathy, I take the liberty of offering the following remarks relative to his explanation:—

In § 29 of his "Organon," Hahnemann says, in explanation of the law *similia similibus*, "that every disease (which does not belong exclusively to surgery) being a purely dynamic and peculiar change of the vital powers in regard to the manner in which they accomplish sensation and action, a change that expresses itself by symptoms which are perceptible to the senses, it therefore follows, that the homœopathic medicinal agent, selected by a skilful physician, will convert it into another medicinal disease which is analogous, but rather more intense. By this means, the natural morbific power which had previously existed, and which was nothing more than a dynamic power without substance, *terminates*, while the medicinal disease which usurps its place, being of such a nature as to be easily subdued by the vital powers, is likewise extinguished in its turn, leaving in its primitive state of integrity and health the essence or substance which animates and preserves the body."

What is meant by "*terminates*," may be easily and clearly inferred from § 45 of the Organon, where Hahnemann discourses as follows: "Two diseases that differ greatly in their species, but which bear a strong resemblance in their development and effects—that is to say, in the symptoms which they produce, always mutually destroy each other when they meet together in the system. *The stronger annihilates* the weaker; nor is it difficult to conceive how this is performed. Two dissimilar diseases may co-exist in the body, because their dissimilitude would allow of their occupying two distinct regions. But, in the present case, the stronger disease which makes its appearance, exercises an influence upon the *same* parts as the old one, and even throws itself, in preference, upon those which have till now been attacked by the latter, so that the old disease finding no other organ to act upon, is necessarily extinguished. Or, to express it in other terms, as soon as the vital powers, which have till then been deranged by a morbific cause, are attacked with greater energy by a new power very analogous to the former, but more intense, they no longer receive any impression but from the latter; while the preceding one, *reduced to*

If any given dose of a remedy should produce symptoms which are not homogeneous to the symptoms of

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a mere state of dynamic power, without matter, must cease to exist.

In the preceding paragraph it is distinctly stated that the artificial disease cures the natural, *on account of the former being stronger than the latter;* and it is also said that the *natural disease reduced to a mere state of dynamic power without matter must cease to exist.*

The former of these assertions is too equivocal to be of any scientific value. If the natural disease has been powerful enough to reduce the organism to the last stage of vitality, how can we suppose, that a subversive agent which develops in the system a disease more powerful than the former, will not completely destroy the organism? Nor is the latter of those propositions more intelligible. How can a thing which continues to be a "*dynamic power*" cease to exist? How can any thing which is "*power*" cease to exist? Such explanations have given rise on the part of the opponents of the homœopathic system to objections like these: To cure a burn, you must burn the limb a little more; to cure a simple fracture, you must make it compound. To be sure, such objections are absurd; but they are justified by the incompleteness of Hahnemann's own explanations of his theory.

Hahnemann seems to entertain the notion which many other physiologists, especially the vitalists, advocate, that the remedial agent acts by making an impression upon the vital powers, and causing them to *re-act* by an increase of depression within conservative limits. This explanation is plausible, but not sufficient; indeed, it is only the smallest portion of the true explanation of the homœopathic method of cure. In my inaugural thesis, published by Mr. Radde, 322 Broadway, I have indicated the true reasons why the homœopathic remedy should exercise such a great influence upon the disease. The reasons which I have stated there, do, by no means, explain the inmost agency of the homœopathic drug; but they constitute, and will for ever constitute, the immoveable basis upon which the mysterious workings of the homœopathic remedial agent have to be investigated and explained. In my thesis I have demonstrated that every homœopathic cure is a materialisation of that abnormal vital state which we call disease; that the homœopathic remedy acts by reducing the disease to its own natural order or form of existence, which is the medicinal substance; and that the disease leaves the organism by a compound force, first by virtue of the irresistibly attractive power which the medicinal substance exercises over the disease and by the consequent restoration of free agency imparted to the vital principle. Hence, in the ho-

the disease, and if the mind of the patient should become more and more depressed, though the progressive increase of this depression may be very gradual, then the next dose of the same remedy may become very prejudicial to the patient. Even if a remedy should produce a sudden great improvement in the condition of the patient, there is danger that the remedy may have acted as a mere palliative; in this case it never should be exhibited a second time, not even after other intermediate remedies.

There are *exceptions* to this rule, which it is, however, not the business of *every* beginner to discover.*

A second dose of the same remedy may be given *immediately* after the first, when the remedy had been chosen with strict regard to its homœopathic character, and had produced a good effect, but had not acted long

mœopathic process of curing there is no forcing, the disease leaves the organism of its own accord, in perfect freedom, for the simple reason that the human organism is not its natural order of existence, and that the medicinal substance is this order. Nor is the disease annihilated. On the contrary, it is developed by the medicinal substance *into its ultimate type;* it is upon an ultimate physical type that all intellectual, spiritual and vital states of existence rest, whether they be normal or abnormal; the ultimate types of all abnormal vital states of existence are the medicinal substances.

* Nevertheless, the immediate repetition of the doses of one and the same remedy, has been much abused lately. The young homœopathic physician finds it convenient to resort to this repetition, especially when the remedy has produced some good effects in the beginning; he imagines to hasten the cure by this repetition.

It is the practice with many homœopathic physicians to furnish the patient with several doses of the same remedy, advising him to take them at certain intervals according to his discretion. This is empiricism. The homœopathic physician ought to examine the symptoms every time he prescribes; otherwise he cannot know whether the same remedy is indicated a second time, or whether a medicine is at all appropriate.

enough to cure the disease. This occurs but seldom in chronic diseases; but it frequently occurs in acute diseases, and in those chronic diseases that border upon the acute. The same remedy may be given a second time, "*when the improvement which the first dose had produced by causing the morbid symptoms gradually to become less frequent and less intense, ceases to continue after the lapse of fourteen, ten, or seven days; when it becomes, therefore, evident that the medicine has ceased to act, the condition of the mind is the same as before, and no new or troublesome symptoms have made their appearance. All this would show that the same remedy is again indicated.*"

To secure the second dose a stronger action upon the disease,* it would be expedient to exhibit the same remedy in a lower potency, the dose being of the same magnitude.† By way of example, I may state that the eruption of the itch is one of those diseases which admit more readily than other diseases of an immediate repetition of the remedy, (sulphur,) but only when the eruption is quite recent; for, in this case, it has somewhat the nature

* If the remedy is perfectly homœopathic, it may be dissolved in about four ounces of water, by stirring it; one-third of this solution is taken immediately, the second third in the morning on rising, and the last third the next day; the solution may be stirred at each swallow, by which means the inherent power of the drug becomes more developed. This mode of exhibiting the remedy seems to secure it greater supremacy over the organism, in persons that are not too irritable or weak.

† If the 30th degree have been chosen first, the 18th may be used next; then the 24th, after this the 12th, or 6th, etc.; these lower degrees are chosen when the chronic disease has assumed an acute character. It may also occur that the action of the remedy has been interrupted, and perhaps destroyed, by some important transgression of the dietetic rules, or some other cause; in this case, if the above-named conditions are fulfilled, the same remedy may be repeated.

of an acute disease, and exhausts the curative power of a remedy in a shorter space of time; in six, eight, or ten days. The second dose of the same remedy is to be given in the same quantity, but in a different degree of potency. Sometimes such a modification in the symptoms may occur, as will make it necessary to alternate the sulphur with hepar sulphuris. If several doses of this latter remedy should be required, they are to be given in different degrees of potency, though always of the same magnitude. Sometimes even a dose of nux vomica $\overline{X}$., or of mercury $\overline{X}$.,* may have to be given as an intermediate remedy.

Sulphur, hepar sulphuris, and sepia excepted, the other anti-psorics seldom admit of a favourable repetition of the same drug. This repetition is, moreover, unnecessary on account of the great number of anti-psorics which we possess. One anti-psoric having fulfilled its object, the modified series of symptoms generally requires a different remedy. To repeat the same remedy for these modified symptoms would be a censurable piece of daring. In cases of disease, which have been mismanaged by allœopathic practice, it is often necessary to give at intervals sulphur or hepar sulphuris, according as either remedy is indicated. These remedies ought to be given, even when the patients had taken much sulphur, or had used sulphur-baths; in such cases, however, a dose of mercury $\overline{X}$. ought to be given first, before the sulphur is exhibited.

Several anti-psorics are generally required for the cure of a chronic disease. If the physician alternates his remedies in rapid succession, this is a sure sign that he has not chosen his remedies with strict reference to their homœopathic action, or has but carelessly studied the existing series of symptoms. The homœopathic physician is very apt to commit this mistake in urging cases of both chronic and acute diseases, especially when the

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* It is a matter of course that the psoric patient should carefully avoid, during the treatment, the use of washes, brown soap, etc.

patient is dear to him. The practitioner cannot be sufficiently on his guard against this practice.

By mismanagement like this, the patient's system becomes so irritated that remedial agents seem to lose all their power over it,* and that the least medicinal influence is sufficient to extinguish completely the last spark of irritability. Under these circumstances medicines cease to be useful; but mesmeric action may succeed in calming the system. Let the palm of both your hands rest for about a minute upon the vertex; then move them slowly down the body, across the neck, shoulders, arms, hands, knees, legs, feet, and toes. This pass may be repeated.

Beside these passes, the irritability of the patient may also be soothed by directing him to smell of a globule moistened with the highest potency of the homœopathic remedy. This globule is kept in a corked vial, the mouth of which being inserted in one of the nares, the patient takes one quick inspiration.† By smelling of the medicine the influence of any medicine may be communicated to the patient in any degree. There may be one or more globules in the vial. By increasing the number of inspirations the power of the medicine may be increased a hundred fold. The remedy acts just as powerfully by communicating its medicinal influence to the system through the nasal fossa and the lungs, as if a dose of the remedy had been swallowed.

Such globules, when they are kept in corked vials, and protected from heat and sunshine, often preserve their

* I have never seen a properly chosen homœopathic remedy producing no effect, when the treatment is properly conducted. Such a thing appears to me impossible.

† This mode of inspiring the imperceptible emanations from the globule contained in the vial, benefits those who are born without the sense of smell, or who had lost it, as much as those who are endowed with the finest olfactory apparatus. We may infer from this that the general nerves of sensation receive the impression of the remedial agent, and transmit that impression to the whole nervous system.

medicinal power for years. This kind of smelling of the remedy has great advantages in the many *accidents* which often interrupt and prevent the cure. To neutralize the consequences of such accidents, the patient may smell of the antidote. By this means it acts more powerfully upon the nerves, and affords the greatest use; moreover, it does not establish any medicinal influence in the system which might be in the way of a cure. When the *accident* has been relieved by the process of smelling, it often happens that the anti-psoric remedy, which had been given before the accident occurred, continues to act for a certain time. To obtain this result for certain, the inspirations and the number of the globules must be regulated with the greatest care, so as to prevent any undue medicinal action being created in the organism.

If the patient should wish to take medicine every day,*

* No popular habit, were it ever so injurious, can be abolished all at once. This is the reason why the homœopathic physician cannot avoid giving to his patients a powder every day; though this appears considerable, nevertheless, there is a good deal of difference between this daily administration of a powder and the allœopathic practice. It is a great blessing for the patient, in taking these powders, marked with successive numbers, especially when he has been predisposed against the more rational method of cure by the artful insinuations of calumniators, not to be able to distinguish the powders containing the medicine from those containing the pure sugar of milk. If he knew that the medicine, of which he expects such brilliant results, is contained in any particular powder, he would often be imposed upon by his fancy; he would imagine to experience effects which he would set down as real, and he would be in a constant state of excitement. By the system which I propose, all these disagreeable consequences are avoided. The patient, who knows from experience that he need not expect any painful effects from the medicine he takes, calmly observes the changes which are really going on in his system, and reports to his physician facts, and not illusions. By taking a powder every day, the patient will expect the

the homœopathic physician may give him every day a dose of sugar of milk of about three grains, all these powders being marked with successive numbers.* The sugar of milk is admirably adapted to this kind of innocent deception.†

If the most troublesome symptoms of a chronic disease, such as old, constant, acute pains, spasms or

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same effects from each. Of course, he ought not to know whether any or all of the powders contain medicine.

* Patients who have firm confidence in the honesty and skill of their physician, will have no hesitation to be satisfied with a dose of sugar of milk, which may be exhibited every two, four, or seven days, agreeably to the wishes of the patient; such a course will never lessen their confidence.

† There are hypercritical homœopathic physicians who were afraid that even the sugar of milk might obtain medicinal qualities from being long kept in a bottle, or from long trituration. Long-continued experiments have convinced me that this apprehension is unfounded. Both the raw and the prepared sugar of milk may be taken as nourishment in considerable quantity without the least disagreeable symptoms being experienced from it. Fears have also been entertained that, in triturating the medicinal substance in a porcelain mortar, particles might become detached from this latter, and that the triturating process might change them to powerfully active silicea, (Ī.) To ascertain whether such fears were founded, I caused one hundred grains of sugar of milk to be triturated with a new porcelain pestle in a porcelain mortar, the bottom of which had been recently polished; thirty-three grains were taken at a time. They underwent the process of trituration eighteen times, each trituration lasting six minutes. Every four minutes the mass was stirred up with a spatula. The object of this frequently repeated trituration, which lasted in all three hours, was to impart medicinal qualities, either to the sugar of milk, or, at any rate, to the particles of silicea which might have been separated from the mortar; but, from experiments which I have made upon highly susceptible subjects, I have been obliged to infer that the prepared sugar of milk is no more medicinal than the sugar in its raw state; its only quality is that of being nutritious.

cramps, etc., disappear speedily and entirely, as if by magic, to such a degree as to make the patient suppose that he is entirely free from pain, and has almost recovered, this is no reason why the physician should flatter himself, that he has chosen an anti-psoric which will certainly promote the cure. This deceptive success shows that the medicine has acted enantiopathically, as a mere contrarium or palliative, and that a considerable exacerbation of the original disease will shortly show itself. As soon as this exacerbation sets in, it becomes necessary either to give the antidote of the previous remedy, or else, in case no such antidote should be known, to prescribe a new remedy which will act more homœopathically. Such antipathic medicines seldom produce good effects after an exacerbation has taken place. Some medicines produce effects and counter-effects. In this case, after an exacerbation has taken place, a second dose of the same remedy may be given, which, by its antipathic action, will produce a permanent improvement. I know this to be the case with ignatia.

The exacerbation which is consequent upon an antipathic remedy, may sometimes be removed by means of a remedy which may be chosen to that effect from the materia medica, the archives of the homœopathic art, or the annals. In a few days, the psoric disease will resume its original form, when a new anti-psoric may be given.

The following are some of the accidents by which the cure of chronic diseases may be temporarily disturbed: immoderate eating, the effects of which may be remedied by eating thin broth and taking a little *coffee;* derangement of the stomach by eating fat meat, especially pork, (cured by fasting and *pulsatilla;*) derangement of the stomach producing eructations tasting of the ingesta; nausea and inclination to vomit (by the highest potency of *antimonium crudum;*) coldness of the stomach, consequent upon eating fruit, (by smelling of *arsenic;*) troublesome consequences of using spirituous drinks, (by *nux vomica;*) derangement of the stomach with gastric fever, chills and coldness, (by *bry-*

onia ;) fright, (cured by *opium*, if this remedy can be administered immediately, and especially in cases where fearfulness is consequent upon fright ; if the physician is called in late, or, if chagrin and fright are combined, *aconite* may be exhibited ; *ignatia* ought to be exhibited when the fright is succeeded by sorrow ;) vexation producing anger, vehemence, an irritated state of mind, peevishness, (by *chamomile ;* if this peevishness is combined with chills and coldness, give *bryonia ;*) irritation combined with indignation, deep internal grief, (when the patient throws aside those things which he was just holding in his hands, by *staphysagria ;*) indignation with silent internal grief, (by *colocynthis ;*) unhappy love, with silent grief, (by *ignatia ;*) unhappy love with jealousy, (by *hyosciamus ;*) a violent cold, the patient being confined to his room or bed, (by *nux vomica ;*) when the cold produces diarrhœa, give *dulcamara ;* when the cold excites pain, give *coffea cruda ;* cold with fever and heat, (by *aconite ;*) cold, accompanied with suffocating fits, (by *ipecacuanha ;*) cold with subsequent pain and a desire to weep, (by *coffea cruda ;*) cold, inducing a loss of smell and taste, (by *pulsatilla ;*) straining in consequence of lifting or walking, (by *arnica*, but with more certainty by *rhus toxicodendron ;*) contusions and wounds inflicted by blunt substances, (by *arnica ;*) burning of the skin, (by applications of water mixed with arsenic of the higher degrees of potency, or by applying for hours spirits of wine which have been heated in very hot water ;) weakness consequent upon the loss of blood or humours, (by *cinchona ;*) home-sickness with redness of the cheeks, (by *capsicum.*)

During the treatment of chronic diseases we are often required to use the other non-anti-psoric remedies constituting our materia medica. This is especially the case, when the patient is attacked with one of those intermediate diseases (*morbi intercurrentes,*) which owe their origin either to malaria or meteoric influences. By these diseases the anti-psoric treatment is not only disturbed, but positively *interrupted*. If our patient

should be attacked with such an epidemic or sporadic disease, the anti-psoric treatment ought to be entirely suspended as long as that disease lasts ; the cure of this disease may sometimes require several weeks. If the intermediate attack is not too violent, the cure may sometimes be considerably abbreviated by causing the patient to smell of the homœopathic non-anti-psoric remedy ; smelling is sometimes sufficient to produce recovery.

An intelligent homœopathic practitioner will easily observe the period when the intermediate disease* has

* These intermediate diseases are generally fevers, a continuous acute fever, a slow remittent, or an intermittent fever ; they may also be one of the permanent miasms, small-pox, measles, dysentery, hooping-cough, etc. Intermittent fevers occur almost every year in a somewhat modified form. Ever since I discovered and practised the successful treatment of chronic diseases by means of anti-psoric remedies, I have observed that intermittent fevers appear every year in a more or less modified form both as regards character and symptoms. The treatment had to be varied accordingly. Arsenic, belladonna, antimonium crudum, spigelia, aconite, nux in alternation with ipecacuanha, sal ammoniacum, natrum muriaticum, opium, cina, either alone or in alternation with capsicum, or capsicum only, menyanthes trifoliata, calcarea carbonica, pulsatilla, carbo vegetabilis or animalis, arnica, or arnica in alternation with ipecacuanha, etc., have been used in different years, and effected a cure in a few days. I do not wish to exclude any of the other non-anti-psoric remedies provided they are indicated by the totality of the symptoms in the beginning as well as in the apyrexia of the symptoms, (See : Von Bönninghausen, Essay on the Homœopathic Treatment of Intermittent Fevers, 1833, Münster.) I should except, however, cinchona. To suppress the *type* of an intermittent fever by means of cinchona, large doses of this drug are required, even in its concentrated form, *quinine ;* such large doses establish in the system an artificial morbid action which it is difficult to cure. Cinchona is only homœopathic against the *endemic* intermittent fevers of marshy regions ; nevertheless they can only be cured by cinchona

left the patient, and the primitive chronic disease has resumed its course.

It frequently happens that, after the intermediate disease has left the patient, the symptoms of the original chronic disease appear a little modified; sometimes even other parts of the body manifest morbid symptoms. In this case the homœopathic physician will prescribe his remedy with strict regard to the existing symptoms, and will not give a remedy which he may have imagined to be the proper remedy, before a careful examination had been instituted.

Sometimes the physician is called to a patient affected with this intermediate disease, whom he had never before treated as a chronic patient. The fever having been subdued by those specific remedies which had been found available with other patients, the physician may nevertheless not be able to procure complete recovery in spite of the most regular diet and mode of life. Other troublesome symptoms (generally called *after-symptoms*, *after-diseases*) will appear and will threaten to become chronic. These symptoms indicate the development of an internal psoric disease, and have to be removed according to the principles taught in this work.

in conjunction with the anti-psorics. In *epidemic* intermittent fevers the treatment should *always* begin with a dose of highly-dynamised sulphur, or hepar sulphuris, if this remedy should be indicated. This medicine should be permitted to act until no farther improvement is observed. In a few days after the sulphur had been administered, the physician exhibits the non-anti-psoric remedy which is indicated by the character of the prevailing epidemic; one or two doses may be exhibited, always after the termination of the attack. Sulphur or hepar sulphuris are exhibited before any other remedy is given, for this reason, that all epidemic intermittent fevers chiefly owe their existence to the psoric miasm. The previous action of sulphur or hepar sulphuris makes the subsequent treatment so much more safe and easy.

I may here observe that the great epidemic diseases, such as : small-pox, measles, purpura, scarlatina, hooping-cough, fall-dysentery, and other typhoid fevers, if they are improperly treated, and are permitted to complete their course, shake the organism so thoroughly, that the latent psoric miasm becomes roused in such patients and gives origin to cutaneous eruptions,* or to other chronic affections. Owing to the exhausted state of the organism, they often reach a high degree of intensity in a short while. If the patient should then die in spite of all the drugs which the allœopathic physician gives him, the doctor declares that the patient has died *of the effects* of hooping-cough, measles, etc.

These *effects* are nothing more than the visible consequences of the latent psoric miasm which may manifest itself in innumerable forms, and which never had been cured on account of its nature and mode of action having been unknown heretofore.

The physician may now feel convinced that epidemic and sporadic fevers, as well as miasmatic acute diseases, unless the patient recovers from both the diseases and their effects in a short while, require an anti-psoric after-treatment, even if a homœopathic specific remedy should have been discovered and successfully employed against them. For this purpose the best anti-psoric is sulphur. This may only be given in case the patient should not have been put upon the use of that drug previously. If this should have been the case, another anti-psoric must be selected.

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* If these eruptions are numerous, authors call them *scabies spontanea*, (self-originating itch.) This is a mere chimera, a monstrum ; the itch has originated, time out of mind, in a contagious miasm, and cannot now originate without being caught. The so-called scabies spontanea is merely the secondary phenomenal development of the internal psoric miasm, whose first manifestation upon the skin had either been repelled by external applications or had gradually disappeared of itself. This scabies spontanea often leaves the skin again very quickly ; we know not whether it is contagious.

The strikingly obstinate character of endemic diseases is due to some psoric complication, or the action of the psoric miasm modified by the peculiar influence of the locality and the peculiar mode of life of its inhabitants. This is the reason why people from marshy regions, in spite of cinchona, drag their intermittent fevers even to healthier parts of the country, and do not recover till they have undergone an anti-psoric treatment. It is to the anti-psoric treatment that their recovery is chiefly due. The marshy exhalations, especially of hot countries, appear to be one of the most powerful excitants of the psoric miasm which is latent in the system;*) without resorting to a thorough anti-psoric treatment, damp regions, so far from being inhabitable, will exercise a life-endangering influence. Man may accustom himself to the highest as well as the lowest temperature; in both these temperatures he may be cheerful and healthy; why should he not become acclimated in marshy regions as well as upon dry mountains, if there were not some secret enemy lying in ambush, whose energies are roused into fatal action by the influence of marshy regions to the prejudice of all new settlers? This secret enemy is the psoric miasm. By stagnant waters and by the vapours which warm air causes to exhale from the damp or swampy soil, the psoric miasm is more certainly and more irresistibly roused than by any other physical influence, and is then developed into chronic diseases of all kinds, and especially such as affect the liver.

The symptoms which have been recently developed by the inherent action of the psoric miasm, without having been superadded by the mismanagement of the doctor, are the first to yield to the action of the anti-

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* The reason probably is, because those exhalations possess the power of paralyzing the vital forces of the organism and predispose this for the so-called putrid, and for nervous fevers. While in their normal state, the vital forces are able to keep down the psoric miasm which always strives to get the upper hand.

psorics; the older symptoms which have permanently existed disappear the last. Of this number are the local affections. These local symptoms only disappear after the general health has been completely restored. The general symptoms which show themselves periodically, hysteria, the different forms of epilepsy, etc., may easily be suppressed by a suitable anti-psoric; but the complete and permanent removal of those symptoms presupposes the radical cure of the whole of the internal psoric miasm.

The patient sometimes desires his physician to cure a certain troublesome symptom first of all; this cannot be done, though the ignorant patient may be excused for having made such a foolish request.

If the patient lives at a distance from his physician, the patient ought to be directed to *underline* in his written report both those older symptoms which had been suppressed for a time, and which have now reappeared; and all new symptoms which have come out this very day. The former symptoms are *underlined once*, the latter *twice*. The former symptoms show that the anti-psoric remedy has attacked the disease in its foundation, and will be of great service in the radical cure of the disease; the latter symptoms, on the contrary, if inordinately developed, inform the physician that the anti-psoric remedy is not quite homœopathic, and ought to be replaced by a better one.

About the period when the cure is half completed, the psoric miasm begins to become again latent; the symptoms decrease more and more, until, at last, mere vestiges of the psoric miasm are perceptible to the acute observer. But these too must be eradicated, for the least remains of a germ may eventually reproduce the full disease.* If we were to rely upon the disease curing itself, as common people and even the better classes

* In the same way, a polypus in the water, though several of its branches may have been cut off, produces new branches in the course of time.

of the public do, we should be very much mistaken. For, little by little a new chronic disease is developed out of the remaining portion of the psoric miasm, and gradually conquers the organism.

The patient may legitimately expect that he should be treated by any physician, especially, however, the homœopathic doctor, according to the principle of Celsus, "tuto, cito et jucunde," (safely, speedily and agreeably.) This principle ought to hold good both in acute diseases originating in occasional causes, as well as in those periodical diseases which we designate by the term *intercurrent* (morbi intercurrentes.)

As regards the short duration of the treatment of inveterate chronic diseases, this is made impossible by the nature of the malady.*

A great chronic disease may be cured in the space of one or two years, *provided it has not been mismanaged by allœopathic treatment to the extent of having become incurable.* One or two years ought to be considered a short treatment. In young robust persons half this space of time is sufficient; in older people, on the contrary, this period has to be considerably prolonged, in spite of the greatest care on the part of the doctor, and the strictest obedience on the part of the patient. If the patient consider that the psoric miasm, which the doctor is called upon to cure, without, however, affecting the organism, has gradually ramified into its inmost recesses, then the patient will easily understand why the strictest mode of life on his own part, and the greatest attention on the part of the doctor should be required for a long period of time, in order to

* No one but an ignorant quack can promise to cure an inveterate chronic disease in four or six weeks. He does not consider himself bound to keep his word. He risks nothing by making the disease worse by his treatment. Can he lose any thing? Honour perhaps? Indeed not, for his colleagues act like him. But conscience? is not his conscience already lost?

master this parasitical enemy that had assailed the most delicate roots of the tree of life.

If the anti-psoric treatment be properly conducted, the strength of the patient ought to increase from the very beginning of the treatment. This increase of strength will continue during the whole treatment, until the organism is completely freed from the enemy, and unfolds anew its regenerate life.*

The best time for taking an anti-psoric remedy is in the morning before breakfast; the evening is less appropriate. The powder may either be taken dry upon the tongue, (in this case the medicine acts less powerfully,) and is kept upon the tongue until it is dissolved; or else it may be moistened in a tea-spoon with two or three drops of water, and taken in this fashion. The patient should wait an hour, or at least half an hour, after having taken the medicine before eating or drinking any thing.† The other powders are to be marked with successive numbers.‡

* It is inconceivable that allœopathic doctors should have continually assailed the organism in the treatment of chronic diseases, without having ever been deterred by their bad success. The intermediate use of *amara* joined to cinchona, induces new affections without doing any good.

† To increase the effect of the remedy, it may be dissolved in a larger quantity of water; this quantity may still be augmented, if it is desired that the effect should be increased still more. The solution may be divided into several parts, one part being taken every two or three days. Every time when a part is taken, the solution is stirred up again; by this means the solution increases in potency, and becomes more closely related to the disease. It is not advisable to give of the same solution for several days to come, for the reason that the water begins to spoil, if kept too long. I have shown above, how a dose is prepared for smelling in the various degrees of potency.

‡ This marking of the powders with successive numbers has the advantage of enabling the physician to measure the effect which the medicine has produced. To accomplish

After having taken the medicine, the patient ought to remain quiet for an hour, without sleeping, however, (sleep retards the first effect of the medicine.) During this hour, as well as during the whole time of the treatment, the patient ought to avoid all contrary emotions, nor ought he to fatigue his mind either by reading, or cyphering, writing, or by conversations that require much attention.

The anti-psoric medicine should neither be taken immediately before, nor during the period of the menses; it may, however, be taken on the fourth day, about ninety-six hours after their appearance. If the menses appear too soon, are too abundant, or last too long, the patient may, on the fourth day, smell of a globule of the highest potency of nux vomica; four, five, or six days after this, the anti-psoric may be taken. If the female be extremely irritable and nervous, she ought to smell of such a globule, even during the anti-psoric treatment, seventy-two hours after every appearance of the menses.*

Pregnancy in every stage, so far from being an obstacle to an anti-psoric treatment, makes it, on the contrary, essentially necessary, and offers a brilliant sphere of action to anti-psoric remedies.†

this, the patient must prefix to every report the number of the powder and the date when he took it. By this means the physician is enabled to compare the different reports.

* In such irritable and nervous patients, whose menstrual functions are deranged, the anti-psorics would not do the least good, without the intermediate use of nux vomica. Nux is especially adapted to restore in such patients the harmony of the nervous functions, and to calm that excessive irritability which would be an insurmountable obstacle to the curative action of anti-psoric remedies.

† Is there a more adequate means to prevent the return of miscarriage, which originates almost exclusively in a psoric habit, except an anti-psoric treatment either before or during pregnancy? In what way can we more effectually prevent the fatal circumstances which so often occur to the parturient woman, in spite of a proper presentation and na-

During pregnancy the anti-psoric treatment is more *necessary* than at any other period, because then the chronic ailments are more fully developed, the organism and the mind of the pregnant female being highly susceptible of receiving impressions. During the period of pregnancy—which is altogether an essential and natural condition of the female—the action of anti-psoric remedies during that period is more marked and precise.* This should be a warning to the physician to reduce his doses as much as possible, and to employ only the highest potencies.

Sucklings never are given any medicine. The mother or nurse takes the remedy which is intended for the baby; the medicinal effect is conveyed by the milk in a sufficient degree.

When in chronic diseases the vital force is left to itself, it is only capable of shielding itself by palliatives against the pernicious assaults of the psoric miasm, and the acute diseases which that miasm develops from time to time. Such palliatives are the frequent secretions and evacuations which spontaneously occur in chronic diseases, diarrhœas, vomitings, sweats, ulcers, hemorrhages, etc. All such palliatives produce only an appa-

tural labour, than by a timely anti-psoric treatment during pregnancy? Is not the unnatural presentation of the child frequently owing to the psoric habit of the mother? Hydrocephalus and other defects of the child always originate in psora. By subjecting the female to an anti-psoric treatment either before or during pregnancy, her incapacity for suckling her baby will be removed; soreness of the nipples; soreness, abscesses, and erysipelatous inflammation of the mammæ, and all uterine hemorrhages consequent upon weaning, are removed.

* The reverse is sometimes the case. The female, who is constantly weak and complaining when she is not pregnant, sometimes enjoys excellent health during pregnancy. Also in this condition of things anti-psoric remedies act very well. They ought to be given against the symptoms which existed before pregnancy.

rent alleviation of the primitive malady; and, in fact, increase it on account of the great loss of nutritious humours which the patient has suffered.

The allœopathic practice has been just as powerless in the treatment of chronic diseases as unaided nature. All that this practice has been able to accomplish, has been, to imitate the palliating process of nature, with this difference, that the artificial secretions consequent upon allœopathic drugs, inflict much greater losses upon the organism than natural evacuations do. So far from diminishing the primitive disease, the allœopathic practice, on the contrary, favours the universal ruin by its pretended dissolvants, purgatives, bloodletting, cupping, leeching, which is now in immoderate use, diaphoretics, blisters, setons, fontanels, issues, etc.

God be praised, the homœopathic physician has dispensed with the necessity of employing those barbarous and homicidal contrivances. He ought even to be watchful that the patient, carried away by the allœopathic routine, may not employ them in secret during the treatment. The physician must positively forbid the patient ever to let blood, as he may have been in the habit of doing once a year, or to resort to cupping, purges, warm baths, etc.

Homœopathic physicians, who are masters of their art—and there are now many—never draw a single drop of blood; he carefully avoids a process which weakens the patient, and is a sort of *direct protest* against cure. Only those homœopathic doctors who are but half initiated into homœopathic practice, feel obliged to resort to that sort of *pseudo-curing*, the bleeding process.*

* Note of the Translator: No practitioner who has a clear perception of the homœopathic principle and the nature of disease, will feel disposed to blame Hahnemann for using this condemnatory language.

Disease, as I have shown in my preface, is not a negative something; on the contrary, it is a positive existence, or we may call it an influence, an agency, or, if you please, a dynamic force, whose action, with respect to the genuine action of the

There is but one exception to this general condemnation of all artificial evacuations. *At the beginning of*

harmonious vital principle, may be called, and in fact *is* subversive. There is an order of subversive dynamic forces. There is an order of such subversive dynamic forces, which, in a manner which is absolutely unknown to us, subdues the circulatory system and endeavours to adapt it to its own nature and to govern it according to its own laws. By those subversive forces the action of the circulatory system may either be unnaturally excited or depressed.

Let us suppose that it has been unnaturally excited. Upon what principle should we bleed, in such a case?

If my idea of disease be correct, and, I may say that, although it does not explain the inmost nature of disease, yet it indicates its general character—we must bleed the patient in the supposition of depriving the subversive forces of their sphere of activity in the animal economy. But do we accomplish such a result by bleeding? I maintain that we do not.

There is always a portion of the circulating fluid left, which secures the subversive forces a hold upon the circulatory system. And then, is it not rational to suppose, that the subversive forces having been violently deprived of the sphere of action which they had conquered for themselves by virtue of their superior power, and which they now claim as their legitimate property, they will not leave the system, but will rather attack some other organ? Because we have it in our power to diminish the volume of blood, is this a proof that by diminishing the volume of blood we diminish the violence of the subversive forces? Why should not these forces throw themselves upon other parts of the organism, since the organism is in their power, and it cannot be a difficult matter for those forces to choose any of the intimately connected organic viscera as their principal seat of action?

There is another serious objection to bleeding and one which shows the absurdity of such a remedy. Not only do the subversive forces remain intact in the organism—though I am willing to grant that they may be less disposed to attack other organs of the animal economy than the circulatory system, and may therefore, in some rare cases, be induced to leave the organism after a powerful depletion;—but, on the other hand the true or harmonious vital forces are positively deprived of their support by every act of depletion. The vital forces are constantly engaged in restoring the losses which the organs undergo by motion; this restoration is a process of assimilation which can only be effected by means of the blood; and this assimilative process continues as long as a vestige of the vital forces remains in the organism. Death ensues the moment that process stops. Now

the treatment, when the anti-psoric remedy has not had time to act, it sometimes happens that the patient can-

let us consider for a moment. The blood is the material out of which the vital forces restore the metamorphosed organs. It is a self-evident truth that the vital forces, impressed with the necessity of harmony from the divine fountain out of which they flow, will not assimilate more substance than the organs consume by motion. Hence, in an individual whose organs are bound by disease, there will be a disproportionate surplus of blood, which the vital powers will leave a prey to the subversive forces. A hold is thus secured to the subversive forces upon the organism. Unless the subversive forces are induced to relinquish that hold, their action might become fatal. The advocates of blood-letting suppose that the subversive forces can be separated from the circulating fluid by violently depriving those forces of what they consider their legitimate property. I have shown that this is extremely speculative and that it is much more probable that depletion will rouse the energies of the subversive forces to new and reiterate assaults upon the organism, than separate them from it. We know that such a separation does not take place, that the fever may be momentarily subdued by depletion, but that the subversive forces exhibit again their full action in proportion as the loss of blood is restored by the vital forces.

But suppose this separation is effected, and the fever leaves the organism? What will take place in the organism, if the volume of blood which the vital principle had formed as the legitimate result of its activity, before the organism was assailed by disease, has been violently diminished? The enemy having departed, the vital principle will claim to be reinstated in the enjoyment of its former property, which was the organism in its normal state, and having attained a certain degree of development and power. But the vital principle finds itself deprived of the very material out of which the wants of the newly active organs can alone be supplied. Hence the vital principle is forced to satisfy its claims to the full exercise of its former power, as developed and embodied in certain organs, by first creating the necessary quantity of blood, and taxing for that purpose the very organs that require the restorative action of the vital principle, for the purpose of recovering the losses which they have undergone by successive bleedings, and of attaining that degree of strength and fulness which they would have acquired by their natural development and activity, if disease had not invaded the organism. The organs *demand*, as it were, of the vital principle, that it should restore the damage which it had suffered disease to inflict upon them. This demand is made by them through that necessity of harmony, which maintains among all the organs

not pass his stools, and that this kind of constipation causes him some trouble. In this case, the physician

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a system of true and counter-balancing relations, and stimulates each organ to that degree of activity which is necessary to the maintenance and development of the individual life of the organ, and to the perfect restoration of its integrity and progressive growth, in case its harmonious life should have been disturbed by disease.

All derivatives are essentially wrong, for this reason, that they destroy the basis which the organic viscera had worked out as the legitimate results and true manifestations of their vital activity; it is in those results that the vitality of the organs is *embodied*. We have no more right to destroy or diminish those results than to take the property which a man has legitimately acquired through the free exercise of his various powers.

Blood-letting is a hazardous process, originating in ignorance and speculation; no homœopathic practitioner can resort to it without suffering himself to be classed among those half homœopathists whom Hahnemann condemns in the paragraph to which this note is annexed.

What then is to be done in a case of fever?

The illustrious Rush felt that blood-letting is not entailed upon the practice of physic by a law of fatality. "In reviewing the prejudices of blood-letting in consumption," says Rush, "I have frequently wished to discover such a substitute for it as would with equal safety and certainty take down the morbid excitement and action of the arterial system. At present we know of no such remedy; and, *until it be discovered*, it becomes us to combat the prejudices against bleeding, and to derive all the advantages from it which have been mentioned."

The homœopathic practitioner knows that we have an abundance of remedies which will prove useful in fever, and will invariably and infallibly effect that separation of the organism and the feverishly-exciting subversive forces, which the various processes of depletion accomplish either never or only after protracted and repeated assaults upon the organism. But why do aconite, belladonna, phosphorus, etc., effect such a separation? Simply because these substances are the natural order or mode of existence, in the physical world, of those subversive forces which, acting down upon this world of effects from the world of causes, have succeeded, by means of an evil spirit or some other hostile influence, in introducing themselves into the circulating fluid, exciting it to undue action and producing that state of the system which we call fever. Aconite, belladonna, phosphorus, coffea, etc., *contain*, and therefore are the natural or physical *types* of those subversive symptoms the aggregate of which we designate by the term fever. As soon as these types are intro-

may relieve him by prescribing an injection of pure, tepid water; if one will not answer, he may prescribe

duced into the organism, the subversive forces, being in the same inseparable connection with those types as cause and effect, are drawn to them, embody themselves in them and are, in this way, easily and of their own accord, separated from the organism.

There is a state of the system which is the opposite of what we commonly designate by the term fever: coldness, chills, thin and weak pulse. This state of the system evidently indicates the presence of subversive forces in the organism, which have depressed the action of the circulatory system. If blood-letting be the true mode of separating this part of the organism from the subversive forces, why do we not resort to that remedy in the condition of the system which I have supposed just now? If, in this condition of the system, the advocates of depletion do not bleed, it is because they either do not know upon what principle they bleed at all, or because they bleed upon such fanciful principles that facts are all the time rebelling against them. The homœopathist knows that this condition of the system corresponds to its types, bryonia, etc.

To the advocates of blood-letting Hahnemann addresses the following severe remarks in a note: "Beginners and learners may be pardoned for using depleting processes; but if they dare to pride themselves on their pretended improvements, and to promulgate blood-letting and cupping as processes that are eminently homœopathic, then they make themselves ridiculous; they ought to be pitied for their dabbling and for their bungling blindness, which inflicts suffering upon their patients. Is it laziness, or is it a foolish predilection for the pernicious routine of allœopathy, which prevents them from making themselves acquainted with the true homœopathic remedy that always acts with certainty and success? It is only by means of persevering study, and indefatigable searching that the student of homœopathy can penetrate to its inmost recesses and acquire that mastery of the science which is now possessed by some."

Blood-letting and all the other violent allœopathic practices of artificial evacuation, are on a par with the system of corporeal punishment in education, and with the doctrine of self-sacrifice, or mortification of the passions from the standing-point of an absolute and irretrievable necessity. Those who profess such a doctrine, of course, will be in favour of blood-letting; those, on the contrary, who have faith in the integral goodness of human nature; who understand and feel that the true development of human nature is a free and unbounded evolution of all its

another in a quarter of an hour, and even a third; this last will certainly act. This kind of injection is devoid of all mercurial influence; it acts mechanically by distending the rectum and may be repeated every three or four days, until the anti-psoric remedies shall have succeeded in regulating the process of intestinal evacuation. Next to sulphur Lycopodium acts most favourably under such circumstances.*

Fontanelles should not be suddenly suppressed by the homœopathic physician, if the patient has used them already for a long time, often for years. The anti-psoric treatment ought to have progressed already considerably before that suppression is accomplished. But already in the beginning of the treatment they may be diminished, if this can be done without suppressing them entirely.

Physicians often incommode the patient by direct-

genuine tendencies and forces, and who have demonstrated to their minds the glorious truth that human nature is destined and therefore able to work out for itself a circumambient order of things which will be an exact reflex of nature's varied and inmost life, and a solemn and consecrated acknowledgment of all its manifestations: all such will look upon blood-letting with abhorrence, and will preach and practise the doctrine that vital harmony cannot be the result of a violent and chaotic invasion of the constitution of man.

* Note of the Translator: To produce this kind of mechanical distention, a tampon may be inserted in the rectum, which sometimes acts very promptly and to the great relief of the patient. A potato answers the purpose of a tampon better than anything else. It may be cut in the shape of a wedge, and be gradually introduced into the rectum. To patients who are affected with chronic constipation I take the liberty of suggesting the following advice. Let them go to stool every morning, either before or after breakfast, even when there is no occasion for it; let them bear down for a while, and continue this practice for some days. In ninety-nine cases out of a hundred they will succeed in regulating their bowels in this way. But they must be careful of always going to stool at the same hour and even minute. It is a matter of course that the practice which I here recommend, is a mere adjuvans of the general treatment.

ing him to wear woollen fabrics upon the bare skin as preventatives against colds. These ought only to be discontinued when the patient's susceptibility for catching cold has been considerably diminished by the anti-psoric treatment, and when the mild weather has set in. They may first be replaced by cotton, which produces less friction upon the skin, and excites it less than wool. Little by little the patient may be accustomed to wear linen upon the bare skin.

There are many self-evident reasons, one of which is the delicate nature of homœopathic drugs, why the homœopathic physician should not permit the use of scents in any shape or manner, medicinal tea, mint, pastry, aniseed, bitters, liquors, lichen, spices of any kind, spiced chocolate, electuaries, tooth-tinctures, tooth-powders, and the various other fashionable compounds.

Warm or hot baths cannot be permitted; they always interfere with the treatment, and are, moreover, unnecessary, if they are merely used for the sake of cleanliness. The body may be kept clean by washing it quickly with soap-water that has the temperature of the body. This kind of washing does not injure the effects of the anti-psoric treatment.

In the first edition of this treatise I have recommended to use the smallest possible electrical sparks for the purpose of aiding the anti-psoric treatment by animating those parts of the body which had been long affected with paralysis or insensibility. I am sorry that this advice should have been given. I know from experience that, so far from following it strictly, it has been constantly transgressed. Large sparks have always been used to the great detriment of the patient, although it has been constantly asserted that they were as small as could be obtained. My advice now is, to abandon the use of sparks altogether. We should avoid the least suspicion of using enantiopathic aid, and then, we have an efficient homœopathic local remedy for partial paralysis or insensibility: cold water, from mountain sources

or deep wells *—(10° of Reaumur.) The water may be used conjointly with the anti-psorics. The parts may either be sprinkled with cold water every minute, or every two or three minutes; or else the whole body may be sprinkled over with fine water, in the form of dust, for one, two, three, or five minutes. This sprinkling may be resorted to more or less frequently according to circumstances, once or several times.

THE REMEDIES

That have been found most efficacious in the treatment of chronic diseases, shall be described in the subsequent volumes according to the symptoms which they are capable of producing upon the healthy organism. I shall point out those which may be given against diseases of psoric origin, the syphilitic diseases, and the diseases from sycosis.

The remedies against syphilis and sycosis are much less numerous than those against psora. This is no reason with the intelligent observer why psora should not be a chronic miasm and the head-fountain of most chronic diseases.

It is not astonishing that the psoric miasm, having spread for thousands of years through millions of organisms all of which differ in constitution and are exposed to a variety of influences, should have produced that host of chronic diseases which become manifest by the suppression of the psoric eruption upon the skin, whether that suppression be the result of violent ex-

* Water of this temperature, or still lower, possesses the primary power of diminishing the sensibility and mobility of the living body; hence it may afford homœopathic aid in the treatment of paralysis or insensibility.

ternal contrivances or of some accidental concussion of the system.

Owing to these causes the psoric miasm has succeeded in ingrafting its parasitical existence upon the organism, and has produced varieties which always betray their common origin, but all of which are distinguished by some peculiar properties. These varieties depend either upon the physical differences of clima and abode, or upon the different modes of life of the psoric patients.* In the impure air of cities children become affected with *rickets*, *spina ventosa*, *ramollissement of the bones*, *curvatures*, *cancer of the bones*, *tinea capitis*, *scrofula*, ring-worm; in full-grown persons there are nervous affections, nervous irritability, gout of the joints, etc. The various chronic affections originating in the psoric miasm, and assuming so many different forms on account of the constitutional differences of patients and the different physical influences to which they are exposed, require, for their radical cure, the use of a large number of anti-psorics.

I have often been asked the question by what signs an anti-psoric remedy may be recognised beforehand? There are no such external visible signs. The remedial virtue of certain remedies in psoric affections has been revealed to me by trying those remedies upon the healthy organism. Some of them were known to possess curative powers which seemed to me to hint at the anti-psoric character of the remedies. In Poland, for instance, the herb *lycopodium* is reputed to prove curative in trichiasis; hence I inferred the anti-psoric

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* In Norway and in the north-west of Scotland we have the Sibbens or Rade-Syge; in Lombardy Pellagra; in Poland and Carinthia koltum or trichiasis; the leprous tumours of Surinam; the raspberry-like excrescences of Guinea, known there by the name of yaws, and in America by that of pian; in Hungary the exhausting fever called tsömör; in Virginia the asthenia virginensium; goïtre in the valleys of the Alps, etc.

virtues of the pollen in similar diseases. I suspected the anti-psoric nature of the common table-salt from the fact that hemorrhages had been arrested by that substance when given in large quantities. In former times already it was known that venereal diseases complicated with the psoric miasm, could not be cured by mercury unless this miasm had first been removed by means of guaïacum, sassaparilla or mezereum.

As a general rule I have found that most of the earths, alkalis, and acids, and their salts, together with several metals, are indispensable to the cure of the innumerable symptoms of the psoric miasm. The similarity of action existing between sulphur, phosphorus, and other combustible substances from the vegetable and the mineral kingdom, led me to rank all these substances in the same family with the chief anti-psoric remedy, which is sulphur. Analogy of action has also induced me to add some animal substances.

Generally, however, only such remedies have been arrayed under the head of anti-psorics, as have developed in the healthy organism symptoms analogous to those, which were known to emanate from repelled itch. In proportion as our knowledge of the pure effects of medicinal substances increases, we may find it necessary to add a few more remedies to the anti-psorics which are now known. Nevertheless, with the anti-psorics that are now known, we are able to cure all secondary psoric diseases provided the patients have not been overwhelmed by large portions of allœopathic drugs, or too great a depression of the vital forces or other unfavourable causes do not make the cure impossible. There are certain conditions occurring in psoric diseases, where the other homœopathic remedies, even *mercury* not excepted, become indispensable.

The peculiar mode adopted for the preparation of homœopathic remedies, enables us to develop the medicinal virtues of a drug into a series of degrees of potency, and by this means, to adapt the remedial influence of the drug with great precision to the nature of the disease. Some of those drugs do not seem to have

many medicinal properties in their unprepared form, (such as common salt, lycopodium ;) others, (such as gold, silicea, argilla,) do not seem to possess any. But their medicinal properties exist in a latent state, and may all be developed to a high degree by the peculiar mode of preparation prescribed by homœopathy. Other substances, on the contrary, act so powerfully in their natural form that the smallest portion of them, upon coming in contact with the animal fibre, exercises a corroding and destructive action upon it ; such substances are arsenic, corrosive sublimate, etc. By the homœopathic mode of preparing those substances, their otherwise powerful action is suitably modified by being developed into a series of degrees of potency, many of which were never known before.

The alteration which is effected in the properties of natural substances, especially medicinal substances, either by triturating or shaking them in conjunction with a non-medicinal powder or liquid, is almost marvellous. This discovery is due to homœopathy.

Beside this alteration of their medicinal properties, the homœopathic mode of preparing medicines produces an alteration in their chemical properties. Whereas, in their crude form, they are insoluble either in water or alcohol, they become entirely soluble, both in water and alcohol, by means of this homœopathic transformation. This discovery is invaluable to the healing art.

The brown-black juice of the sea-insect *sepia*, which was formerly used only for painting and drawing, is soluble in water only, while in its unprepared form. When homœopathically prepared by trituration, it becomes also soluble in alcohol.

Nothing can be extracted from *petroleum* by means of alcohol, except when that drug is adulterated with vegetable ethereal oil ; in its unadulterated form, petroleum is neither soluble in water nor in alcohol, (nor ether.) By means of trituration it becomes soluble in both those substances.

Lycopodii pollen floats in alcohol and on the surface

of water, without either of these substances having the least effect upon the drug; lycopodium in its crude state, on being introduced into the stomach, is both tasteless and inactive. Trituration makes it soluble in both alcohol and water, and develops such a powerful medicinal action in the drug that its use requires great care.

Who ever found marble or the shell of an oyster soluble in water or alcohol? This mild calcarea, as well as baryta carbonica, and magnesia, become perfectly soluble by means of the homœopathic process of trituration, which, moreover, develops their medicinal powers to an astonishing degree.

No one will feel disposed to suspect that quartz, rock-crystal,—some of those crystals containing drops of water which had been enclosed there unaltered for thousands of years,—or white sand, are soluble in water or alcohol, or are endowed with medicinal properties. However, silica may be made soluble both in water and alcohol by triturating it after it had first been melted by means of an alkali, and then precipitated again from that compound.* By this process, the medicinal properties of silica are developed to an almost infinite extent.

All metals and sulphurets become soluble in alcohol and water, after having undergone the homœopathic mode of preparation, by means of which their medicinal virtues are also fully, yea, infinitely, developed.

The medicinal chemical substances which have been thus prepared, are no longer subject to chemical laws.

A dose of phosphorus of the highest potency may remain for years enclosed in its paper in a desk, without

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* Quartz, or silica, unless they have first undergone this preparation will not show any medicinal properties. This is the reason why medicinal substances may be triturated in the porcelain mortar together with the non-medicinal sugar of milk, without any silica becoming mixed with it. Some hyper-critical homœopathists have apprehended such a result.

losing its medicinal properties, or even changing them to those of phosphoric acid.

A remedy which has been elevated to the highest potency, and, by this means, has become almost spiritualized, is no longer subject to the laws of neutralization. Highly dynamized natrum, ammonium, baryta, calcarea, magnesia, when taken into the system, cannot, like their bases, be changed to neutral salts by acetic acid; their medicinal properties are neither changed nor destroyed.

The homœopathic preparation of nitric acid, provided it is taken in a sufficient quantity, is not affected by a little crude calcarea, or natrum; its strong specific action remains the same.

All those homœopathic drugs which constitute the pure materia medica,* are prepared in the manner pointed

* Vegetable substances which can only be had dry are triturated in the same way. The millionth trituration may then be dissolved, like all the other substances, either in water or alcohol. In this state they may be preserved much better and longer than the common tinctures which easily spoil. Of the juiceless *vegetable* substances, oleander, thuya, mezereum, you may take one grain and a half, the fresh leaves, bark, roots, etc., and convert them to the millionth trituration with three times one hundred grains of sugar of milk. Of this trituration you take one grain and carry it through the vials, obtaining in this way, any degree of potency that may be desired. Shake each vial twice, first carrying the arm up, then down. The same process of trituration may be resorted to in regard to the recently obtained medicinal juices. Squeeze the juice out of the substance, triturate one drop of it with the necessary quantity of sugar of milk to obtain the millionth trituration. Of this you take one grain, dissolve it in a mixture of half water and half alcohol, and then carry a drop of this mixture through the series of the twenty-seven vials, obtaining in this way the degree of potency that is desired. By triturating the juice first, the medicinal virtues of the drug are better developed than by simply mix-

out below; the following anti-psorics come under this remark:* silica, barita carbonica, calcarea carbonica, natrum carbonicum, ammonium carbonicum, magnesia carbonica, carbo vegetabilis, carbo animalis, graphites, sulphur, antimonium crudum, antimonium, gold, platina, iron, zinc, copper, silver, tin,—lumps of those metals, not the foil, are triturated upon a hard, fine, grinding-stone under water, or sometimes under alcohol, like the iron. Of these pulverized substances, you take one grain; mercury may be used in the liquid state; of petroleum, you take one drop instead of one grain. Pour this grain into a non-glazed porcelain mortar, having before covered the bottom of it with sand slightly moistened and triturated. Then you take thirty-three grains of sugar of milk, and mix them with the drug by triturating the mass with some force for about six minutes by means of a porcelain pestle; before you triturate, stir the mass for a little while with a spatula. Having triturated the mass, you stir it again for about four minutes, scraping up that part which covers the bottom of the porcelain mortar, and also that which is adherent to the pestle†; then you triturate again with great force for six minutes, without however adding anything new. This mass you scrape up again, for four minutes, add another thirty-three grains of sugar of milk, stir the new compound for a moment with the

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ing the juice with the alcohol by means of two shakes. I know this from experience.

* Phosphorus, which is so easily oxydized in the open air, is dynamized in the same manner, and may be dissolved in both liquids. There are some precautionary rules to be observed, which will be pointed out below.

† When the process of trituration is completed, mortar, pestle, and spatula, are to be repeatedly immersed in boiling water, being carefully wiped and dried after each immersion. The mortar, pestle, and spatula, may then be exposed to a heat which would make them red-hot. This will suffice to satisfy even the most anxious minds that no atom of the medicinal substance has remained adhering to either mortar, pestle, or spatula.

spatula, then triturate it for six minutes with the pestle, scrape it up for four minutes, triturate again with great force for six minutes, scrape the mass up again for four minutes, then add the last thirty-three grains of sugar of milk, and with this last added portion proceed as with the two former. This powder you enclose in a well-corked glass, and mark it with the name of the substance, and the figure $\overline{100}$, to show that this is the one hundredth potency of the substance.*

In order to prepare the degree $\overline{10000}$, you take one grain of the degree $\overline{100}$ and add to it thirty-three grains of sugar of milk. Stir up this mass for a moment with the spatula. Then triturate it for six minutes, stir it up for four minutes, triturate again for six minutes, and then stir up again for four. After this you add the second

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* The preparation of the one hundredth potency of phosphorus by pulverisation requires some modifications. First you take one hundred grains of sugar of milk, and, by means of fifteen drops of water you make them into a sort of dough or pap in the mortar. Then you cut one grain of phosphorus into twelve pieces, kneading them into a dough by means of the moistened pestle, together with the one hundred grains of sugar of milk, the portions of the mass which remain adhering to the pestle being scraped off again while the process of kneading is carried on. In this way the phosphorus molecules may be triturated during the first two periods of six minutes each, into invisible atoms without a spark being elicited. During the third period of six minutes, the mass being sufficiently pulverised, the kneading may be replaced by trituration. During the next eighteen minutes the process of trituration is carried on with moderate force, the mass being scraped up every six minutes; this scraping can be easily accomplished on account of the mass being but slightly adherent either to the mortar or the pestle. After the sixth trituration the powder shines but feebly in the open air, and has but little smell. It is then enclosed in well corked vials and marked Phosphorus 100. The next two degrees of potency $\overline{10000}$ and $\overline{1}$ are prepared in the same way as those of the other dry medicinal substances.

thirty-three grains of sugar of milk, proceed then as before; afterwards add the last thirty-three grains of sugar of milk, stir up and triturate again as before, and enclose the mass in a well corked vial marked $\overline{10000}$.

To prepare the degree $\overline{1000000}$ or $\overline{1}$, you take one grain of the degree $\overline{10000}$, and go through the processes of stirring and triturating in the same way as before, employing upwards of an hour for the preparation of each different potency.

For the sake of establishing a sort of uniformity in preparing homœopathic remedies, and especially the anti-psorics, I never carry the process of trituration above the million degree. From this degree I derive the solutions in their various degrees of potency.

For the process of trituration a certain force should be employed; not too much, however, to cause the mass to adhere too tenaciously to the mortar to be scraped up in the space of four minutes.

From the million degree of trituration the solutions* in the various degrees may be obtained by dissolving these triturated substances in alcohol or water. Chemistry is not acquainted with the fact that all substances after having been triturated up to the million degree, can be dissolved either in alcohol or water.

Sugar of milk cannot be dissolved in pure alcohol; this is the reason why the first solution should be composed of one half water and one half alcohol.

To one grain of the million trituration you add fifty drops of distilled water, and turn the vial several times around its axis. By this means the sugar of milk becomes dissolved. Then you add fifty drops of good

* In the beginning of my practice I gave a small portion of a grain of the millionth trituration at a dose. But the uncertainty of this mode of exhibiting the remedy, led me to the discovery of preparing the solution, and to the use of the globules, any definite number of which may be moistened with the dissolved drug. Homœopathy being based upon a law of nature, it should avoid and exclude all uncertainties.

alcohol,* and shake the vial twice, first carrying the arm up and then down. Only two thirds of the vial ought to be filled with the solution.†

This vial is then marked with the name of the medicine, and the number $\overline{100}$ I. Of this solution you take one drop, and mix it with 99 or 100 drops of pure alcohol, shaking the vial twice after it has been corked. This vial is marked $\overline{10000}$ I. Of this solution you again take one drop, mixing it with 99 or 100 drops of pure alcohol. Then shake the vial twice, and mark it $\overline{10000}$ I. Of this potency you again take a drop, and mix it with 99 or 100 drops of pure alcohol, shaking this third vial twice, and marking it $\overline{\text{II}}$. In the same way you continue the preparation and marking of the higher potencies $\overline{100}$ II, $\overline{10000}$ II, $\overline{\text{III}}$.‡ The intermediate vials are put in perpendicular boxes, and are kept in the dark in order not to be affected by the light of day. In practice only the full vials are used.

The shaking being accomplished by means of moderate strokes with the arm, it is expedient that the vials should be large enough to have only two thirds of their volume filled with the hundred drops. Vials that have

* These quantities are measured by means of vials which contain exactly fifty drops. It would be too tedious to count fifty drops of water, especially when the water does not flow easily out of the vial.

† It is well to provide the vial with a mark stating the number of shakes and the date when the solution was prepared.

‡ Frequent observation has convinced me that it is better to shake the vials twice only in order to develop the medicinal virtue of the drug just enough to affect the disease in a proper manner. By shaking the vial ten times as I was in the habit of doing, the proportion between the progressively developed intensity of action of the medicinal properties of the drug and the degree of the potency was destroyed in favour of the former. The object of the dynamising process is to develop the intensity of action of the medicinal properties of the drug, at the same time as

contained one medicine ought never to be used for any other, even if they should have been previously rinsed ever so much.

The globules of sugar of milk should be prepared of the same magnitude all over the world. I use them of the size of a grain of flaxseed. By establishing uniform-

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that action is reduced to a milder tone. Two shakes are sufficient to establish the true proportion between these two effects.

The degrees of potency may be indicated in various ways, thus: —

The first degree,	$\frac{1}{100}$	$\overline{100}$
The second degree,	$\frac{1}{10000}$	$\overline{\overline{10000}}$ or 100 (2) meaning hundred multiplied by itself.
The third degree	$\frac{1}{1000000}$	$\overline{\overline{\text{I}}}$ or 100 (3)
The fourth degree,	$\frac{1}{100000000}$	$\overline{100\ \overline{\text{I}}}$ or 100 (4)
The fifth degree,	$\frac{1}{10000000000}$	$\overline{10000\ \overline{\text{I}}}$ or 100 (5)
The sixth degree,	$\frac{1}{1000000000000}$	$\overline{\overline{\text{II}}}$ or 100 (6)
The seventh degree,	$\frac{1}{100000000000000}$	$\overline{100\ \overline{\text{II}}}$ or 100 (7)
The eighth degree,	$\frac{1}{10000000000000000}$	$\overline{10000\ \overline{\text{II}}}$ or 100 (8)
The ninth degree,	$\frac{1}{1000000000000000000}$	$\overline{\text{III}}$ or 100 (9)
The tenth degree,	$\frac{1}{100000000000000000000}$	$\overline{100\ \overline{\text{III}}}$ or 100 (10)
The eleventh degree,	$\frac{1}{10000000000000000000000}$	$\overline{10000\ \overline{\text{III}}}$ or 100 (11)
The twelfth degree,	$\frac{1}{1000000000000000000000000}$	$\overline{\overline{\text{IIII}}}$ or 100 (12) etc.

[Added by the translator.]

ity both in the preparation and exhibition of medicines, the homœopathic physicians will be enabled to compare with great certainty the results which they may obtain in their practice.

The globules are moistened with the liquid in this way. A vessel of the size of a thimble, made either of earthenware, china, or glass, is filled with globules weighing in all a few grains; upon these you drop several drops of the medicine, taking a few drops more rather than less, in order to make sure that the liquid has reached the bottom of the vessel, and all the globules have been moistened. This process may last about a minute. The vessel is then turned over upon a double sheet of blotting paper; if any of the liquid should remain in the vessel, it is poured upon the globules, that will be found adhering to each other like a cone. After a while the globules are spread upon the paper, and dried. When dry, the globules are filled in a glass vial, which should then be well corked and marked.

The globules having been moistened with the liquid, they obtain a faint appearance. The non-moistened globules look whiter and more shining.

In order to take the globules you first prepare a capsule of white paper, filled with two or three grains of sugar of milk. The globules having been deposited in this sugar, the upper surface of the capsule is pressed upon with a spatula or the nail of the thumb, until the globules are crushed; the powder may then be easily dissolved in water.

When I speak of globules, I mean those mentioned above, two hundred of which, or thereabout, weigh a grain.

In the subsequent list of anti-psoric remedies no *isopathic* remedies are mentioned, for the reason that their effects upon the healthy organism have not been sufficiently ascertained. Even the itch miasm, (psorin) in its various degrees of potency, comes under this objec-

tion. I call psorin a *homœopathic* anti-psoric, because if the preparations of psorin did not alter its nature to that of a homœopathic remedy, it never could have any effect upon an organism tainted with that same identical virus. The psoric virus, by undergoing the processes of trituration and shaking, becomes just as much altered in its nature as gold does, the homœopathic preparations of which are not inert substances in the animal economy, but powerfully acting agents.

Psorin is a *simillimum* of the itch virus. There is no intermediate degree between *idem* and *simillimum ;* in other words, the thinking man sees that simillimum is the medium between simile and idem. The only definite meaning which the terms " isopathic and æquale" can convey, is that of simillimum ; they are not *idem* (ταυτὸν.)

DEFINITION

OF THE MOST IMPORTANT TECHNICAL TERMS CONTAINED IN THIS VOLUME.

(*Some of these definitions have been copied from Hooper's Dictionary.*)

Adipose tissue,—see tissue.

Adventitious,—any thing that accidentally, and not in the common course of natural causes, happens to make a part of another. It is used in medicine in opposition to hereditary.

Allœópathy,—under this denomination Hahnemann ranges all those medical theories that are based upon principles different from his own doctrine.

Amenorrhœa,—accidental cessation of the menstrual flux.

Anasarca,—a species of dropsy from a serous tumour, spread between the skin and flesh.

Aneurism,—a pulsating tumour formed by the dilatation of an artery.

Atrophy,—nervous consumption. This disease is marked by a gradual wasting of the body, unaccompanied either by a difficulty of breathing, cough, or any evident fever, but usually attended with a loss of appetite and impaired digestion.

Bursa mucosa,—a mucus bag, containing a kind of mucous fat. These bursæ are generally found where tendons or muscles glide over bones. By means of those bursæ, tendons and muscles glide easily over the bones.

Cataract,—a species of blindness, arising almost always from an opacity of the crystalline lens or its capsule.

Cornea,—the thick and transparent part of the eye, placed between the two lids.

Coryza,—running at the nose.

Chlorosis,—green sickness, a species of disease which affects young females labouring under a retention or suppression of the menses.

Carcinoma,—or cancer.

Crusta lactea,—this disease mostly attacks some part of the face of infants at the breast. It is known by an eruption of broad pustules, full of a glutinous liquor, which form white scabs when they are ruptured.

Diabetes,—an immoderate flow of urine.

Diaphoretics,—a class of remedies which increase the discharge by the skin.

Degeneration,—a morbid alteration of some organic viscus.

Dysuria,—suppression or difficulty in discharging the urine.

Ecstasy,—a trance.

Empyema,—a collection of pus in the cavity of the thorax.

Enantiopathic,—the same as allœopathic.

Enuresis,—incontinence of urine.

Endemic,—a disease is so termed that is peculiar to a certain class of persons, or country. The goïtre is endemical to the inhabitants of certain low regions in Switzerland.

Epistaxis,—bleeding from the nose.

Epizootic carbuncle,—a species of anthrax common to the larger mammalia. In man it forms on the cheek, neck, or back, and, in a few days, becomes highly gangrenous.

Erysipelas,—the rose or St Anthony's fire. This disease is an inflammatory affection of the skin or of the mucous membrane.

Exanthema,—an eruption of the skin.

Expectorants,—a class of medicines which increase the discharge of mucus from the lungs.

Fistula,—a term in surgery applied to a long and sinuous ulcer that has a narrow opening, and which sometimes leads to a larger cavity, and has no disposition to heal. Fistula may be formed in the lower part of the rectum, in the bladder, in the inner canthus of the eye, etc.

Fomentations,—a sort of partial bathing, by applying hot flannels to any part, dipped in medicated decoctions, whereby steams are communicated to the parts, and their vessels are relaxed.

Fontanelles,—the French name for artificial issues.

Fungus hematodes,—bleeding fungus, also called soft cancer or medullary sarcoma. It attacks most parts of the body, particularly the eye, breast, testicle, and the extremities. It begins with a soft enlargement of the part, which is extremely elastic and, in some cases, painful. As it increases, it often has the feel of an encysted tumour, and at length becomes irregular, bulging out here and there. When it ulcerates, it bleeds, and shoots up a mass of a bloody fungus.

Gland,—an organic part of the body, composed of blood-vessels, nerves and absorbents, and destined for the secretion or alteration of some peculiar fluid.

Glaucoma,—a cataract of the crystalline lens.

Goïtre,—an enlargement of the thyroid body in front of the trachea.

Gutta serena,—a diminution or total loss of sight, arising from a paralytic affection of the retina and optic nerve.

Hematemesis,—vomiting of blood from the stomach.

Hematuria,—hemorrhage from the bladder.

Hemoptysis,—spitting of blood from the lungs.

Hemorrhoïds,— or piles, excrescences arising from the inferior part of the rectum. They are divided into bleeding and blind piles.

Hernia,—a rupture, or a protrusion of a part of the intestine. The places in which this protrusion most frequently takes place, are the groin, the navel, the labia pudendi, and the upper and fore-part of the thigh.

Herpes, tetter,—a genus of disease distinguished by an assemblage of numerous little creeping ulcers, in clusters, itching very much, and difficult to heal; they terminate in furfuraceous scales.

Humerus,—the long bone of the upper-arm.

Hysteria, hysterics,—a disease common to females. The disease attacks in paroxysms or fits.

Hypochondria,—those parts of the body, which lie under the cartilages of the spurious ribs.

Idiopathic,—this name is given to diseases originating in some peculiar and distinct miasm.

Inoculation,—the insertion of a poison into any part of the body; it was mostly practised with that of the small-pox.

Ischuria,—a suppression of urine.

Issue,—an artificial ulcer made by cutting a portion of the skin, and burying a pea or some other substance in it, so as to produce a discharge of purulent matter.

Leucorrhœa,—the whites, a secretion of whitish or milky mucus, from the vagina of women.

Lypoma,—a solitary, soft, unequal, indolent tumour, arising from a luxuriancy of adeps or fat in the cellular membrane.

Menorrhagia,—an immoderate flow of the menses.

Mollities ossium, or ramollissement of the bones,—softness of the bones, arising from a want of the phosphate of lime. In children this disease is called the rickets.

Muscæ volitantes,—particles of dust or motes which the patient imagines to see upon the eye or in the air.

Oedema,—a synonyme of anasarca. See Anasarca.

Oesophagus,—the membranous and muscular tube that descends in the neck from the pharynx to the stomach; it carries the food into the stomach.

Orgasm,—an unnatural agitation of the blood.

Osteo-sarcoma,—a swelling of the bone; the bone and the surrounding flesh become one putrefying mass.

Paronychia,—a collection of pus formed in the fingers.

Patella,—the bone in front of the knee.

Parotid gland,—the gland situated directly behind the ear; the swelling of this gland is called the mumps.

Prostatic fluid,—a fluid secreted by the prostatic gland situated in front of the bladder.

Polypus,—a bleeding tumour generally found in the nose, uterus, or vagina.

Ptyalism,—a morbid flow of saliva.

Ramollissement,—see Mollities Ossium.

Region,—in surgery, a circumscribed part of the body.

Sarcoma,—a fleshy excrescence.

Sedatives,—a class of medicines which diminish the animal energy.

Sphacelus,—the highest degree of mortification.

Sporadic,—this is an epithet for such infections and other diseases as seize a few persons at any time or season.

Spina Ventosa,—a tumour arising from an internal caries of a bone.

Tabes Mucosa,—a wasting away of the mucous membranes.

Tarsus,—the ankle-joint.

Tinea Capitis,—the scald head; a disease characterized by small ulcers at the root of the hairs of the head, which produce a friable white crust.

Tissues,—or textures which compose the different organs of animals.

Tonics,—medicines which are supposed to increase the tone of the muscular fibre (in the old school of course.)

Trichiasis, Plica Polonica,—a disease of the hairs, in which they become long and coarse, and matted and glued into inextricable tangles. It is peculiar to Poland, Lithuania, and Tartary, and generally appears during the autumnal season.

Tunica Vaginalis Testis,—one of the covering membranes of the testicles.

Vaccination,—the insertion of the matter of cow-pox.

Varix,—a dilatation of a vein.

Vesicatories,—applications which, exciting inflammation on the skin, occasion a thin serous fluid to be poured from the exhalants, raise the cuticle, and form the appearance of a vesicle.

THE END.

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ERRATA.

Page 13, line 21, instead of doses, read portions.

Page 13, line 24, instead of cauteries, read issues.

Page 22, line 4, instead of local, read erratic.

Page 36, line 14, and elsewhere, instead of tenia, read tinea.

Page 72, line 12 and 13, instead of has, read had.

Page 145, line 15, place a comma after nostra.

14. The Saxon 'Idol of the Moon', a goddess wearing a chapron representing the head and shoulders of a Hare, and holding a Moon-disk *facing page* 169

15. Greek coin depicting Two Eagles feasting upon a Hare *facing page* 208

16. Greek vase-painting of a Satyr playing with a Hare *page* 213

17. Apollo riding upon a swan, accompanied by a Hare *facing page* 214

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20. Greek vase-painting of a Man offering a Hare to a Youth *page* 218

21. Greek vase-painting of a Victorious Athlete receiving tribute from a friend, including a Hare *facing page* 218

PART III

22. The buck-rabbit burns down the doe-rabbit's hut to 'send her underground' ***page*** 234

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The author's gratitude is due in the first place to the Lady of the Hare, appearing in this work under the pseudonym of 'Mrs. Wright', who has kindly allowed it to be published and from whom the author learnt quite as much as she learnt from him; and in the second place to the members of the Psychological Study Group in Oxford to whom Part I, dealing with the Dream Analysis, was first communicated, and who by their encouragement, criticism, and support have materially assisted him. In accordance with his view that Psychology should not restrict itself to the narrow field of curative medicine, but should illuminate and be illuminated by all the Humanities, this study group has as its foundation members a Professor of Logic, a Professor of the Philosophy of the Christian Religion, a College Tutor, a College Chaplain, a Priest, an Anthropologist, a Psychologist, and a Psychiatrist, whose initials with their consent appear here as a mark of his grateful esteem.

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be done is, to draw a line E F parallel to C D, at 100 feet below it; then, by drawing perpendiculars from the surface line to this new datum, as shown by the dotted lines, the transfer will be complete, as the height of any point can be measured by the scale of the section. We need not go through a further explanation of this subject, as an inspection of our engraved example will explain whatever further may be required.

WORKING SECTION.

For the purposes of carrying into execution any work, the section should be much more minute than is requisite for general purposes; it is then called a working section. The following are the field notes taken for such a section, the line having first been carefully set out and a stake driven into the ground at the extremity of each chain's length: these stakes were about 18 inches long and 2 inches square (and were furnished by a country wheelwright at the price of ten-pence per dozen); every tenth stake was circular, and somewhat larger, and had an iron ring round its top, and together with every fifth stake had their tops painted white, the more easily to identify them; they were all numbered (or considered to be numbered) from one end of the line to the other. Plate III. shows the section of the ground and railway at the extreme end of the line where the numbers terminate at 1103 chains or 13¾ miles and 3 chains: we would recommend the student to plot this section from the notes several times, and to various scales, that he may not only better understand the subject, but also for the sake of practice, it being an

actual example from the working section of a line of railway now completed and opened to the public.

FIELD NOTES—WORKING SECTION.

Rise.	Back Sight.	Fore Sight.	Fall.	Distance.	Reduced Levels.	Remarks.
feet.	feet.	feet.	feet.	Links.	feet.	
					270·72	Brought forward (from
	4·47	4·53	0·06	103300	270·66	last page of NOTES).
	4·53	9·22	4·69	103400	265·97	
4·15	9·22	5·07		103500	270·12	
4·83	5·07	0·24		103600	274·95	
4·49	6·36	1·87		103700	279·44	
4·67	6·14	1·47		103800	284·11	
4·52	6·62	2·10		103900	288·63	Side of clapping post of field gate in occupation road.
	2·10	2·24	0·14	103916	288·49	
0·95	10·42	9·47			289·44	Lower hanging hook of gate.
	9·47	13·22	3·75	103944	285·69	Centre of occupation road.
0·07	13·22	13·15		103956	285·76	Edge of road.
4·40	13·15	8·75		103966	290·16	Top of bank.
4·27	8·75	4·48		103976	294·43	Do. do.
0·16	4·48	4·32		104000	294·59	
	2·44	8·84	6·40		288·19	B.M. south side of line.
6·01	8·84	2·83		104100	294·20	
	0·74	2·18	1·44	104200	292·76	
	2·18	5·35	3·17	104300	289·59	
	6·77	7·28	0·51	104400	289·08	
0·03	7·28	7·25		104490	289·11	Edge of ditch.
	7·25	8·36	1·11	104492	298·00	Bottom of ditch.
4·79	8·36	3·57		104500	292·79	Stump, top of bank.
0·62	3·37	2·75		104600	293·41	
1·32	2·75	1·43		104700	294·73	
	1·10	2·25	1·15	104800	293·58	
	2·25	8·88	6·63	104900	286·95	Enter alder plantation.
	5·65	9·53	3·88	104920	283·07	
	9·53	11·50	1·97	105000	281·10	
0·33	5·85	5·52		105021	281·43	
	5·52	12·01	6·49	105100	274·94	
	12·01	12·87	0·86	105148	274·08	
2·10	12·87	10·77		105190	276·18	
2·18	10·77	8·59		105200	278·36	Foot of bank, which rises perpendicularly 1 foot.
7·19	8·59	1·40		105300	285·55	

FIELD NOTES—Working Section.

Rise.	Back Sight.	Fore Sight.	Fall.	Distance.	Reduced Levels.	Remarks.
					285·55	Brought forward.
3·80	8·22	4·42		105400	289·35	
1·45	4·42	2·97		105500	290·80	
	2·97	3·39	0·42	105600	290·38	
	3·39	5·51	2·12	105700	288·26	
	5·51	7·67	2·16	105800	286·10	
	5·41	6·68	1·27	105827	284·83	Edge of ditch.
	6·68	8·56	1·88	105832	282·95	Bottom of ditch.
2·48	8·56	6·08	6·30	105837	285·43	Top of bank.
	6·08	12·38	4·34	105854	279·13	Foot of bank.
	12·38	16·72	0·62		274·79	
	2·04	2·66	3·82	105900	274·17	
	2·66	6·48	2·38	105940	270·35	Edge of ditch.
	6·48	8·86		105944	267·97	Bottom of ditch.
2·86	8·86	6·00	1·58	105952	270·83	Top of bank.
	6·00	7·58	3·16	105960	269·25	Foot of bank.
	7·58	10·74	4·91	106000	266·09	
	3·33	8·24	0·91	106095	261·18	Top of bank.
	8·24	9·15	4·19	106100	260·27	Stump side of bank.
	9·15	13·34		106105	256·08	Bottom of ditch.
1·69	13·34	11·65	1·15	106110	257·77	Edge of ditch.
	11·65	12·80	0·51	106200	256·62	
	3·62	4·13		106300	256·11	
0·75	4·13	3·38		106349	256·86	Foot of bank.
2·88	3·38	0·50	3·85	106359	259·74	Top of bank.
	0·50	4·35		106368	255·89	Bottom of side drain.
0·27	4·35	4·08	0·23	106386	256·16	Centre of parish road.
	4·08	4·31		106405	255·93	Foot of bank.
3·74	4 31	0·57	2·45	106415	259·67	Top of bank.
	0·57	3·02	0·41		257·22	
	0·99	1·40	1·43	106430	256·81	Foot of bank.
	1·40	2·83	1·58	106500	255·38	
	2·83	4·41	0·07	106600	253·80	
	4·41	4·48		106700	253·73	
0·46	7·80	7·34		106800	254·19	(Crosses foot-path at 106831.)
2·93	7·34	4·41		106900	257·12	
3·67	4·41	0·74		107000	260·79	
4·20	10·63	6·43		107100	264·99	
5·06	6·43	1·37		107200	270·05	
5·79	10·76	4·97		107300	275·84	
3·85	4·97	1·12	0·05	107400	279·69	
	5·42	5·47		107500	279·64	
0·91	5·47	4·56	0·44	107600	280·55	
	4·56	5·00	0·56	107637	280·11	Edge of ditch.
	5·00	5·56		107640	279·55	Bottom of ditch.

FIELD NOTES—Working Section.

Rise.	Back Sight.	Fore Sight.	Fall.	Distance.	Reduced Levels.	Remarks.
					279·55	Brought forward.
3·16	5·56	2·40	0·56	107647	282·71	Top of bank.
	2·40	2·96		107654	282·15	Foot of bank.
1·58	2·96	1·38		107700	283·73	
8·84	9·45	0·61		107800	292·57	
5·11	8·44	3·33		107853	297·68	Enter plantation.
2·91	3·33	0·42		107857	300·59	B. M. on timber stub.
	12·78	14·28		107882	299·09	
4·27	14·28	10·01		107900	303·36	
8·75	10·01	1·26		107947	312·11	
10·42	14·49	4·07		108000	322·53	
1·21	4·07	2·86	0·49	108008	323·74	
	2·86			108024	323·25	
2·98	3·35	0·37		108047	326·23	
15·33	16·35	1·02		108098	341·56	Top of bank, edge of plantation.
	1·02	1·32	0·30	108100	341·26	
2·74	8·66	5·92		108200	344·00	
0·78	5·92	5·14		108300	344·78	
	5·14	8·43	3·29	108400	341·49	
	1·05	4·50	3·45	108500	338·04	
	4·50	4·94	0·44	108520	337·60	
	4·94	6·83	1·89	108530	335·71	Edge of bank.
	6·83	12·54	5·71	108540	330·00	Foot of bank.
	12·54	16·82	4·28	108600	325·72	
	1·11	9·04	7·93	108700	317·79	
	1·18	9·09	7·91	108800	309·88	
	1·57	9·70	8·13	108900	301·75	
	1·28	9·58	8·30	109000	293·45	
	1·44	9·41	7·97	109100	285·48	
	1·34	9·14	7·80	109200	277·68	
	1·15	8·12	6·97	109300	270·71	
	3·04	4·43	1·39	109386	269·32	Edge of ditch.
	4·43	6·22	1·79	109390	267·53	Bottom of ditch.
1·06	6·22	5·16		109400	268·59	Stump, top of bank.
	5·16	11·10	5·94	109405	262·65	Foot of bank.
1·81	11·10	9·29		109500	264·46	
3·10	8·87	5·77		109600	267·56	At post and rail fence.
1·17	4·63	3·46		109700	268·73	Edge of slope.
	3·46	7·06	3·60	109800	265·13	
	1·96	4·60	2·64	109900	262·49	Foot of slope.
	4·60	4·60		110000	262·49	
0·93	4·60	3·67		110149	263·42	
	4·58	5·03	0·45	110377	262·97	Stump, end of curve.
0·63	5·03	4·40			263·60	On rails at end of curve.
	4·40	4·58	0·18		263·42	B. M. foot of post.
3·53	4·58	1·05			266·95	Top of said post.

In taking levels for a minute section where the observations must be very numerous, and consequently the back and fore sights not very far from each other, the observer will frequently be able to make a number of observations at each setting up of the level at one side of his line, so that his instrument may be about equally distant from his back and fore observations. Due attention to this will save much time and labour, and experience will enable the surveyor at a glance to see where he can set up his level at every remove forward with the greatest advantage. Upon looking down our field notes above, it will be seen it seldom occurred that only one back and one fore sight was obtained at a setting up of the level, and this only took place where the ground was very steep: by the first setting up of the instrument four forward sights were observed, and of course as many back ones; thus the first back sight was 4·47, the corresponding fore sight 4·53; this latter number was also placed as the back sight for the next observation, which was 9·22; this number was in like manner placed as the back sight for the next forward observation, 5·07, which also became the back sight for the last forward observation we could obtain at that setting up of the instrument, namely, 0·24: it should here be remarked that there was a necessity to place each forward reading as a back observation to the next forward reading, otherwise the difference of level between each point of observation would not have been obtained without more arithmetical work; the numbers otherwise only show the difference of level between each and the first point of observation; besides, by this arrangement, the whole section is continuous, however numerous the

intermediate observations may be, and having the distances opposite, the whole can be plotted off with facility. The columns of "Rise" and "Fall" need no observation after what has already been said upon this subject. The column of Distances denotes the continuous measurements from the commencement, Gunter's chain being the unit employed. Our notes commence at the 1033rd chain, and terminate with the end of the work, 1103 chains and 77 links, which we consider an ample extract for the purposes of the student. The column headed "Reduced Levels" contains the height of each point of observation above the datum line, which in this case was Trinity high-water mark, London Bridge: these numbers are obtained by adding the "rises" and subtracting the "falls" from the preceding reduced level, which in our notes commence with 270·72 feet.

THE SECTION.—SEE PLATE III.

The datum line must be drawn, every chain should then be pricked off and the perpendiculars erected; the chains or stakes should then be numbered beneath the datum line, to prevent mistakes, and just above the datum line the height of the surface at each stake should also be inserted; then the said heights can be pricked off upon the perpendiculars respectively, and the intermediate heights plotted from the field notes without fear of error, which otherwise, without great care, would be likely to occur in consequence of so many points falling near to each other, unless the scale be very large: the horizontal scale of the example is 1 inch to 5 chains, and the vertical scale 1 inch to 25 feet. Having

drawn the undulating line of the surface through these points upon the perpendiculars, the gradients or intended line of railway may next be laid down; the extreme left-hand point was given, being the level of the rails at the point of junction with another line. The railway is represented by two parallel lines, the upper one being the upper surface of the rails, and the lower one the bottom of the ballasting or formation level, being 2·25 lower than the surface of the rails: for a short distance the line is level, then it rises at the rate of 20 feet per mile, for the two-fold object of diminishing the great cutting and of getting sufficiently high over the road at stake 1064, to allow (with the lowering the surface of the said road a small quantity) of sufficient headway for the public carriages to pass under the railway: from this point the line falls at the rate of 20 feet per mile for a considerable distance, the object being to get as low down as possible further to the eastward, where there was to be a considerable embankment, and by these means such embankment was reduced in dimensions; and furthermore, the earth from the cutting to the right of the road was to be taken eastward to form the said embankment, and therefore the down-hill gradient was favourable for carrying on the work as well as for the drainage of the cutting. Part of the earth from the large cutting was also to be taken to the eastward; the ascending gradient, up to the bridge, was unfavourable for this purpose, however, so far as the bringing out the bottom of the cutting, the upper part being brought down by means of inclined planes: the ascending gradient was unavoidable in this case, but by judiciously working the excavation, little

inconvenience and extra expense attended it. Each change of gradients is denoted by a strong vertical line from the datum to the point of change, and the height marked thereon. The quantity of earth-work to form the cuttings and embankments with different slopes should be written upon them, as shown in our example; also over the line of figures denoting the height of the surface above the datum should be placed the depth of the cutting from the surface to formation level at the same point, or the height of the embankment, as the case may be: these heights and depths are those from which the calculations of the quantities are to be made, and therefore must be strictly correct; they should not be taken from the section by the scale, but should be obtained by calculation: the former method being liable to error. The calculation may be thus performed. Let it be required to find the depth of cutting at stake No. 1083, where the height of the surface above datum is 344·78 feet; at stake No. 1064, the height of formation level above datum is 269·20, from which point the gradient descends at the rate of 20 feet per mile, or 0·25 feet per chain, towards No. 1083; the distance from 1064 to 1083 is 19 chains, which multiplied by 0·25, gives 4·75 for the fall of the railway in the interval between the two points; consequently the height of the railway above datum at No. 1083 is 269·20, minus 4·75=264·45; this sum, subtracted from the whole height of the surface, gives 344·78−264·45=80·33, for the depth of the cutting at that point, and so of all the remaining numbers. After giving the above particulars nothing need be added upon this subject. It may be worth observing, that in laying down the

gradients care should be had so to dispose them as to produce the minimum quantity of work in the execution, and that the cuttings should equalize the embankments, or, if anything otherwise, they should be a little in excess, to allow for subsidence or slips in the embankments. The facilities for working the excavations and carrying the earth to bank should also be considered; a down-hill gradient in that direction is most suitable, provided it can be obtained without interfering with other and often more important considerations: the drainage of the works during the formation and after the line is completed should also be considered at the time of determining the gradients. We have inserted (Table I. at the end of the work) a very extensive and useful Table of Gradients, which is sufficiently self-explanatory as not to require further notice.

When a surveyor is required to level through a country in a perfectly straight line, and has not the advantage of its being picketed or poled out, his only means to keep a rectilineal course is by ascertaining, as accurately as possible, the magnetic bearing of one extremity from the other, and work in that direction by means of a compass. We once had business of this kind, and determined the bearing of our intended line from the map of the Ordnance survey (allowing for the variation of the needle), and after pursuing the route thus determined, we were surprised and delighted at finding how exactly we came to our required point, convincing us (if a proof had been required) how justly the public confidence has been placed in our national survey.

It is seldom the case in practice that the instrument can be placed precisely equi-distant from the back and

forward staves, on account of the inequalities of the ground, &c. It would appear, therefore, to be necessary, to make our results perfectly correct, to apply to each observation the correction for curvature and refraction, as explained in the early pages of our book; this, however, we believe, is seldom done unless in particular cases, where the utmost possible accuracy is necessary, on account of the smallness of such correction, as may be seen by referring to our Table, page 9, where the correction for eleven chains is shown to amount to no more than $\frac{1}{100}$ of a foot; and as the difference in the distances of the instrument from the back and fore staves can in no case equal that sum, it is evident that such correction may be safely disregarded in practice.

Several machines have been constructed or designed for the purpose of describing a section of any ground passed over by the instrument, which at the same time would register the distance passed over, as well as the undulations: perhaps the best of this kind was the one designed and constructed by George Edwards, Esq., Civil Engineer, of Lowestoft, which is fully described and illustrated in the forty-fourth volume of the "Transactions of the Society of Arts," page 123, to which we refer. The use of such machines, however, must, from the nature of the work to be performed, be of a very limited character.

We have now described the leading principles and practice of levelling as employed in engineering operations; and although our observations may appear to be confined to its applicability to railroad purposes, yet the intelligent student will find no difficulty in applying to practice the same principles to every other branch of the

profession where levelling operations may be required. We might indeed have multiplied instances and examples which would in reality have had no other effect than to swell our volume, as it must have been, to a great extent, but simply a repetition of the details already given.

Before closing this subject we cannot refrain from stating, that it has long been our opinion that if a register could be kept by some public body (as the Institution of Civil Engineers) of the height of particular spots throughout the kingdom, above some given datum as Trinity high-water mark, London Bridge, or any other that might be agreed upon, such a record would be invaluable both in a particular and national point of view: to the engineer and geologist it would be most important, and the whole register could be prepared from time to time at a trifling cost, if each engineer and surveyor would but contribute to the common stock by sending to head-quarters the level of any particular spots as he, in the course of his professional engagements, may have opportunity of determining them. We consider that no time is likely to be so favourable for the purpose as the present, as nearly the whole country has been levelled over for railway purposes within the last few years; and no doubt the field notes of the greater part are still in existence, from which a great many such standard levels could be extracted by the parties who took the levels, and which in a few years it will be impossible to eliminate. By way of showing more fully our meaning, we have extracted from our own levelling books a few such standard levels, and arranged them after the manner we have above alluded to.

COUNTY OF KENT.

	Height in feet above Trinity high-water mark, London Bridge.
Upper edge of tablet over door of No. 1 Martello Tower, near Folkestone	256·4
Top of first milestone on the road from Folkestone turnpike to Dover	402·9
Top of second milestone, do.	510·7
Surface of ground at Folkestone turnpike gate	534·6
Dock wall at Dover, opposite Railway Office	7·4

COUNTY OF SURREY.

Surface of ground at New Chapel turnpike gate	188·0
Waste board of Godstone Ponds, back of White Hart Inn	319·2
Top of twentieth milestone (from Westminster Bridge) on the road from Godstone to East Grinstead	287·6
River Medway (tributary stream) meadows, west side of turnpike road, at Blundley Heath	151·2
Broadham Green, near Oxted, foot of pointing post	268·2

COUNTY OF SUSSEX.

Honey-pot Lane, South Chailley Common	122·5
Gullage Farm, source of the Medway, near the barn	324·6
Waste weir canal (east side of Lindfield)	82·1
Summit of South Downs at Plumpton Plains	682·5
„ „ at Mount Harry	573·3
Turnpike road, Brighton to Lewes, near the barracks	85·1
Cross roads, at Turner's Hill turnpike gate	535·2

LEVELLING WITH THE THEODOLITE.

The application of the theodolite to the practice of levelling is an operation of great simplicity. We must suppose the reader to be already acquainted with the construction and method of measuring angles with that

valuable instrument; and those who have no such knowledge, we refer to the Treatise on Mathematical Drawing Instruments spoken of, where every particular respecting it may be found. The ordinary 5-inch theodolite, of the best construction, is the one we recommend to the use of the surveyor, it being sufficiently accurate for most purposes that fall within his province, and is convenient to use on account of its portability. A larger theodolite is seldom employed, except on surveys of great extent upon trigonometrical principles, as those of the United Kingdom under the direction of the Board of Ordnance, where theodolites of 3 feet diameter have been employed to obtain the requisite degree of accuracy.

To use the theodolite in the common purposes of levelling, it is only necessary to set the instrument up at every spot on the line of country to be levelled, where the inclination changes, without regard to the minor inequalities of the surface, taking care that the adjustments have been carefully examined and rectified, as explained in the book above alluded to, especially those adjustments which set the line of collimation, and the spirit-level attached to the telescope, parallel to each other. Then set the instrument level by means of the parallel plate screws, and direct an assistant to go forward with a staff, having a vane, or cross piece, fixed to it exactly at the same height from the ground as the centre of the axis of the telescope. Having gone to the forward station, the assistant must hold the staff upright, whilst the observer measures the vertical angle, which an imaginary line connecting the instrument and staff makes with the horizon; the instrument and staff should

then change places, or, to save time, another staff should take the place of the instrument, and the instrument be removed to the former staff, and from thence the same angle should be taken back again, and the *mean* taken as the correct result.

The distance must then be measured, which will furnish all the data required to find the difference of level between the places of the instrument and staff; this, it will appear evident, is a matter of trigonometrical calculation,* the measured distance being considered as the hypothenuse of a right-angled triangle, of which the perpendicular is the difference of level. It scarcely appears necessary to give the rule for the calculation, but for the sake of uniformity we shall do so.†

Add together the logarithm of the measured distance, and the log. sine of the observed angle; the sum, rejecting 10 *from the index, will be the log. of the difference of level, in feet or links, &c., the same as the distance was measured in.*

If the distance be measured with Gunter's chain, the result (in chains) can at once be obtained in feet, by simply adding to the above two logarithms the constant 1·8195439, which (10 being rejected from the index) will give the log. of the height in feet.

In this manner, by considering the surface of every principal undulation as the hypothenuse of a right-angled triangle, the operation of levelling may be carried on with great rapidity, but, it must be remarked, without pretensions to great accuracy; in fact, in that particular, the use of the spirit-level will never be superseded.

* Capt. Frome's Work, in 8vo., published 1840.

† See Appendix I.

Another method of applying a theodolite to the purposes of levelling was introduced by Sir John Macneill. He caused to be constructed, by Messrs. Troughton and Simms, a more powerful instrument for the purpose. It was a combination of the level and the theodolite. He set it up at the foot of an inclination, and sent a man on with a staff as above described; and whilst the observer was looking through the telescope, another assistant walked along the line, holding up another staff at every rise and hollow of the intervening surface, and thereby the observer could note how much such rises and hollows were below the line of his vision. The distances from the instrument to the points where the staves were held up could then be measured, and the section drawn by simply ruling a line at the angle of elevation given by the instrument (or, more correctly, by computing the total elevation and setting that up as a perpendicular; and drawing the hypothenusal line thereto), and marking thereon the measured distances, and from such marks drawing perpendiculars of the various lengths indicated by the staff at its different positions: a line connecting the extremities of the perpendicular will represent the section of the surface line.

Instead of measuring the distances, Sir John Macneill had attached to the eye-end of the telescope a beautifully-made wire micrometer, similar to those applied to astronomical telescopes, by which he could tell with sufficient accuracy the distances required. This method of levelling, like the former by the theodolite, will give but a general approximation to the truth, depending in a great degree upon the quality of the instruments, and the care bestowed upon the operation.

PART III.

COMPUTATION OF EARTH-WORK—ROAD-MAKING—THE CLINOMETER, ETC.

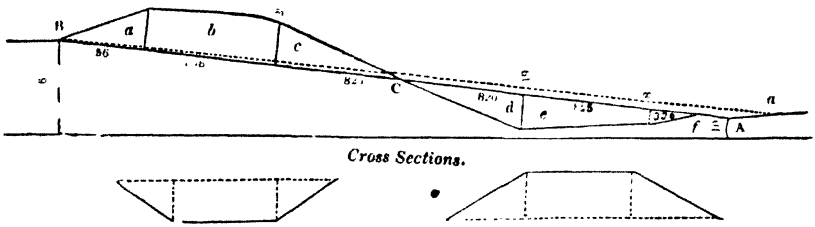
We have now to show the manner of applying a section to practical purposes. If the object to be attained is the making of a railroad, it is essential that it be formed as nearly level, and as perfectly straight, as the surface of the ground will admit of; for the nearer it approximates thereto, the more profitably will it be worked when completed, as locomotive steam-engines perform the most work with the least expense when the resistance they have to overcome is uniform and invariable. The same remarks hold with respect to a turnpike road; but the inclinations on the latter may be made greater and more variable, being worked by animal power, which is capable of putting forth, on a sudden emergency, a greater exertion for a short time, which is not the case with elemental or mechanical power beyond limits much short of what an animal is capable of.

Sir Henry Parnell, in his valuable Treatise on Roads, recommends that a road should not be made steeper than 1 in 35; that is, for every 35 feet in length of road surface, the difference of level will be 1 foot, that being an inclination which presents no difficulty to fast driving either in ascending or descending. But on a line of

railroad to be traversed by locomotive engines, no rate of inclination, or gradient, as it is called,* should exceed 20 feet in a mile, or 1 in 264. To draw the lines of proposed surface (or gradient) upon a section, which shall be the most suitable for the purposes intended, and at the same time to be the most economical in the execution, that is to say, to have the least possible quantity of earthwork in cuttings and embankments, requires judgment and experience: no definite rules can be given for this purpose, as no two sections present the same undulating surface. There is one material point we would suggest, and which should be carefully attended to; viz., that for every piece of cutting, there should be an equal, or *rather less*, quantity of embankment. We say rather less because every newly formed embankment experiences a settlement to a greater or less degree, and therefore more earth will be required to raise it to a proper level. The excess of the cuttings above the embankments should never be great, otherwise the surplus would have to be disposed of in mounds, termed spoil-banks. In no case whatever should the required embankments exceed in cubical contents the quantity of cuttings; for then a serious difficulty occurs—land has to be purchased for the purpose of digging earth to supply the deficiency, which is usually called side cutting.

* Sir John Macneill, in his preface to his valuable translation of M. Navier's little work on the "Means of comparing the respective Advantages of different Lines of Railway," says, "I have rendered the word *peute* by *slope*, in preference to *inclination*, *inclined plane*, or *gradient*, considering the two former, though generally used, as improper expressions; and the latter, to say the least of it, as having so little to recommend it, that I hope it will have an extremely short existence in our nomenclature."

Suppose in the cut below the upper figure to represent the section of an old line of road, and that it were required, by cutting and embankment, to reduce it from its present hilly surface to one uniform rate of inclination from the point A to the point B. The lower



Cross Sections.

extremity A is 10 feet above the datum line of the section, and the higher point B 46 feet above the datum; consequently, 46−10=36 feet, the rise from A to B, and the distance 4356 feet, which, divided by the rise (36), will give 1 in 121 for the rate of inclination the road may be brought to.

Upon the section draw the straight line AB, which will show the extent of cutting and embanking to be made. The number of cubic yards of earth to be removed in the cutting between the points B and C, and the cubical contents, in yards, of embankment between C and A, may then be computed in the following manner:

Divide the quantities of cuttings and embankments, as shown upon the longitudinal section, into triangles and trapeziums, determined by the undulations of the surface lines, as shown in the above engraving, where, in the cuttings, *a* and *c* are triangles, *b* a trapezium; and in the embankments *d* and *f* are triangles, *e* a trapezium. The form of the excavation and embankment

is shown by the transverse or cross sections. Let the width of the roadway (or base of the cutting, and top of the embankment) be 50 feet, including the footpath, &c., on each side; the slope of the cutting to be $1\frac{1}{2}$ to 1, that is, $1\frac{1}{2}$ horizontal to 1 perpendicular: consequently, where the depth is 20 feet, the width of the slope at the surface will be 30 feet; the slope of the embankment to be 2 to 1, that is, for 19 feet perpendicular, the base is to be 38 feet. With these data, the cubical quantities, as computed by the valuable Tables of Sir John Macneill,* are as follows:

Excavation . . .	81517	yards
Embankment . .	57081	,,
	24436	surplus cutting.

We have an excess of 24436 cubic yards of excavation, which is a quantity far too great. In order, therefore, to make the quantity of cutting and embankment more nearly balance each other, it would be necessary to continue the embankment beyond the point A, which would lengthen the inclination, as shown by the dotted line drawn from the point B to *a*; this dotted line would now represent the proposed surface of the road. By such means we diminish the quantity of cutting, and, at the same time, increase that of the embankments; and also by lengthening the inclination, we reduce its steepness. The alteration of the proposed surface line must be so made, that the cubical quantities of excavation and embankment are nearly equal;

* "Tables for calculating the cubic quantity of earthwork in the cuttings and embankments of canals, railways, and turnpike roads." By Sir John Macneill, Civil Engineer, F.R.A.S., &c.

leaving, however, a preponderance in favour of the latter of about 10 per cent. to supply the deficiency occasioned by the consolidation and shrinking of the earth; and if any portion of the excess be then remaining, it may be disposed of in flattening the slopes of the embankments, when no more convenient mode presents itself.

The quantities of earthwork on a given section depend upon the arrangement and disposition of the *gradients*, or proposed surface lines; and there is no practical consideration of more consequence to the engineer, in laying out a proposed line of surface upon a section, especially if it be of any great extent (as the present projected lines of railway), than the most judicious distribution of the cuttings and embankments, which should not only be nearly equal to each other in quantity, but the circumstances must be considered under which the various embankments have to be supplied, it not being alone sufficient that for every hollow on the section there should be a corresponding protuberance, but that such protuberances be advantageously situated for filling the hollows; for otherwise the work assumes a character of difficulty, in consequence of the great additional expense of removing the earth to a considerable distance; and if, in addition, the material has to be conveyed up an ascent, it will be more tedious in the execution.

Knowing the value of practical examples in elementary books, we shall here give the calculations of the above results in full, both by the common method; viz., *The Prismoidal Formula*, and Sir John Macneill's Tables, by which the saving of labour by the use of the Tables will be made apparent.

Prismoidal Formula.—The area of each end added to four times the middle area, and the sum multiplied by the length divided by 6, will give the solid content. If the measures used in the calculation are yards, the result will be the content in cubic yards; but if they are feet, the result must be divided by 27, to obtain the corresponding number of yards.

CALCULATION OF THE TRIANGULAR PORTION *a*.

		Height 0	
		2) 18	
Height . .	18	9	mean height.
Slope . . .	1·5	1·5	slope.
	9·0	4·5	
	18	9	
	27·0	13·5	
Base . . .	50	50·0	base (bottom of cutting, or top of embankment).
	77	63·5	
Height . .	18	9	mean height.
	616	571·5	middle area.
	77	4	
Area of greater end	1386	2286·0	4 times middle area.
		1386·0	area of greater end.
		3672	
		561	length.
		3672	
		22032	
		18360	
		6) 2059992	
		3) 343332	cub. content in feet.
		9) 114444	
		12716	cub. content in yards.

COMPUTATION OF *b*.

Height 18. Area, as before, 1386.

20 height.	18 }	heights.
1·5 slope.	20 }	
	2) 38	
10·0		
20	19	mean height.
30·0	1·5	slope.
50 base.		
	9·5	
80	19	
20 height.		
	28·5	
1600 { area between *b* and *c*.	50	base.
	78·5	
	19	mean height.
	7065	
	785	
	1491·5	middle area.
	4	
	5966·0	4 times middle area.
	1386	area of lesser end.
	1600	area of greater end.
	8952	
	858	length.
	71616	
	44760	
	71616	
	6) 7680816	
	3) 1280136	cub. content in feet.
	9) 426712	
	47412	cub. content in yards.

COMPUTATION OF *c*,

Area 1600, as before.

20 }	heights.
0 }	
2) 20	
10	mean height.
1·5	slope.
50	
10	
15·0	
50	base.
65	
10	mean height.
650	middle area.
4	
2600	4 times middle area.
1600	area of greater end.
4200	
825	length.
21000	
8400	
33600	
6) 3465000	
3) 577500	cub. content in feet.
9) 192500	
21389	cub. content in yards.

a = cub. content	12716
b = cub. content	47412
c = cub. content	21389
Total cuttings	81517 cub. yards.

COMPUTATION OF EMBANKMENT *d*.

19 height.	0	heights.
2 slope.	19	
38	2) 19	
50 base.		
	9·5	mean height.
88	2	slope.
19 height.		
	19·0	
792	50	base.
88		
1672 area.	9·5	mean height.
	34·5	
	621	
	655·5	middle area.
	4	
	2622·0	4 times middle area.
	1672	area of greater end.
	4294	
	820	length.
	85880	
	34352	
	6) 3521080	
	3) 586847	cont. in cub. feet.
	9) 195616	
	21735	cont. in cub. yards.

COMPUTATION OF *e*.

Height 8. Area, as before, 1672.

8 height.	19 }	heights.
2 slope.	8 }	
16	2) 27	
50 base.		
	13·5	mean height.
66	2	slope.
8 height.		
	27·0	
528 area.	50	base.
	77	
	13·5	mean height.
	385	
	231	
	77	
	1039·5	middle area.
	4	
	4158·0	4 times middle area.
	1672	area of greater end.
	528	area of lesser end.
	6358	
	825	length.
	31790	
	12716	
	50864	
	6) 5245350	
	3) 874225	cub. content in feet.
	9) 291408	
	32379	cub. content in yards.

COMPUTATION OF *f*.

Area, as before, 528.

8 }
0 } heights.

2) 8

4 mean height.
2 slope.

8
50 base.

58
4 mean height.

232 middle area.
4

928 4 times middle area.
528 area of greater end.

1456
330 length.

43680
4368

6) 480480

3) 80080 cub. content in feet.

9) 26693

2966 cub. content in yards.

d = cub. content	21735	
e = cub. content	32379	
f = cub. content	2966	
Total embankment	57080	cubic yards.

The same quantities computed by Sir John Macneill's Tables.

THE CUTTINGS.

COMPUTATION OF *a*.

Tabular No. . . .	= 22·67
Length	561
	2267
	13602
	11335

Cont. of *a* in cub. yds. = 12717·87

COMPUTATION OF *b*.

Tabular No.	= 55·26
Length	858
	44208
	27630
	44208

Cont. of *b* in cub. yds. = 47413·08

COMPUTATION OF *c*.

Tabular No.	= 25·92
Length	825
	12960
	5184
	20736
Cont. of *c* in cub. yards .	= 21384·00

THE EMBANKMENTS.

COMPUTATION OF *d*.

Tabular No. . . .	= ·3519
Base	50
	17·5950
Tabular No. . . .	+ 8·914
	26·509
Length	820
	530180
	212072
Cub. content .	= 21737·380

COMPUTATION OF *e*.

Tabular No. . . .	= 5000
Base	50
	25·0000
Tabular No. . . .	+ 14·247
	39·247
Length	825
	196235
	78494
	313976
Cub. content .	= 32378·775

COMPUTATION OF *f*.

Tabular No.	= ·1481
Base	50
	7·4050
Tabular No.	+ 1·580
	8·985
Length	330
	269550
	26955
Cub. content	2965·050

RESULTS BY THE TABLES.

CUTTINGS.	EMBANKMENTS.
a = 12717·9	d = 21737·4
b = 47413·1	e = 32378·8
c = 21384·0	f = 2965·0
81515·0	57081·2

By comparing these results with those obtained by the former process, it will be seen that the cubical quantity of cuttings differs but two yards, and that of the embankments but one yard. The computation by the Tables may be abbreviated by using but one place of decimals, which would be sufficiently accurate for practical purposes. Our object is to show the calculations, by the Tables, in their greatest extent, which even then produce a great saving of labour, and, of course, a much greater probability of accuracy, in consequence of the fewer figures employed than the former process.

It will be seen that the calculation of the embankments by the Tables is a longer process than that of the cuttings, the latter being done by simply multiplying a

number taken from the Tables (answering to the height or depth at each end) by the length; whilst, for the embankments, the tabular number is first multiplied by the base (or width of roadway), and to the product is added a second tabular number taken out at the same time as the first. The first series of Sir John Macneill's Tables contain the numbers corresponding to a base of 50, and a slope of $1\frac{1}{2}$ to 1 (which is the slope of the cuttings in our example). But for a slope of 2 to 1, reference must be had to the second series of the same Tables, which are applicable to every width of base, and from slopes varying from $\frac{1}{2}$ to 1, to 3 to 1. We have adopted this example to show the calculations both by the *particular* and *general* Tables, as the first and second series of the valuable work referred to may be called.

The following is an extract from Sir John Macneill's preface to his Tables:—"All practical engineers are well aware, by experience, of the inconveniences which arise from the length of time necessary for calculating the cubic quantity of earthwork in the cuttings and embankments of canals, railways, and turnpike roads, especially when the section is of considerable extent, and the ground very uneven. As calculations of this kind are frequently, on a short notice, required to be completed within a limited period, the consequence is, that errors are almost sure to be made, as a multiplicity of figures is necessary, though the calculations in themselves are so very simple.

"To save time in making these calculations, and ensure accuracy in the results, were the principal objects I had in view in constructing the following Tables; how

far I have succeeded, must be left to the decision of practical men, for whose use they were intended, and who are best able to judge of their utility.

"An advantage may arise from the use of these Tables, which I had not at first contemplated. By the common but erroneous method of calculation, the cuttings may appear to be equal to the embankments; yet when the work is carried into effect, a large quantity of earth may be required to make up the embankments, or there may be too much earth in the cuttings for the embankments, according to the shape or figure of the section, as will be shown hereafter. Such a circumstance as this cannot take place if the following Tables be used to ascertain the cubic quantities; for, as they are calculated from the prismoidal formula, they will give the true cubic quantity in any cutting or embankment; and consequently, if the cuttings be laid down on the section to balance the embankments, they will be found in practice to do so, when the work comes to be executed.

"Contractors very frequently find that they have more earth to move than they had previously calculated upon from the section, and are, therefore, often great losers. This, in most cases, arises from erroneous calculations; for the common practice is, either to add the two extreme heights together, and to take half the sum for a mean height; or to take half the sum of the areas at each end for a mean area. Both these methods are erroneous; one makes the quantity too much—the other too little."

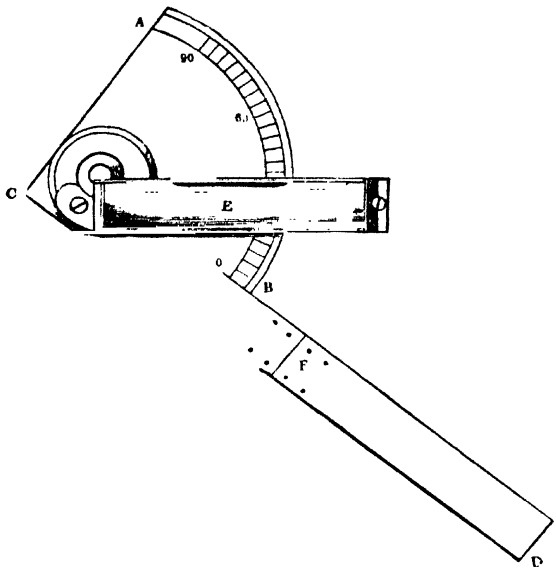
SLOPES, ETC.

As connected with the subject of earth-work, we may insert in this place some particulars respecting the arrangement of slopes in cuttings and embankments. They are usually expressed in terms of the height or depth of cutting, as half to one, one to one, two to one, &c., signifying that for every foot perpendicular, the cutting shall batter half a foot, one foot, two feet, &c.

The slope adopted must depend upon the nature of the material worked upon. Solid rock may be left perpendicular, whilst loose friable material, or sand, will stand but at a very small angle with the horizon. The true criterion to judge of the proper slope to work to, is to observe, if convenient, what slope or angle the materials naturally assume when left to themselves. To determine this by measurement would be troublesome and tedious: but by the aid of a small instrument called a clinometer, the angle which any sloping surface makes with the horizon may be at once measured, and the ratio of the slope to the perpendicular, as one to one, &c., be readily deduced. As this very useful portable instrument is not generally known, we shall subjoin an engraving and description of it.

The following figure represents a clinometer, or, as it is called in some parts of the country, a *batter level.* It consists of a quadrant A B, of about two inches radius, attached to a flat bar C D, six inches long. The quadrant is graduated to degrees, from B towards A, and adjoining the divisions may be inserted, if required, the corresponding ratio of the slopes, one to one, &c.

An index bar, E, turns upon the centre of the quadrant, and carries a spirit-level by which the index may be set



truly horizontal by the hand; and whatever angle is there denoted on the quadrant, will be that of the slope required. At F is a hinge joint, by which the bar C D may be folded up, and the instrument can then be deposited in a box of very small dimensions, and carried in the pocket without inconvenience.

To use this instrument, open the hinge-joint, and rest the edge of the bar C D on the face of the slope to be measured; then gently move the index E round its centre until the attached spirit-bubble assumes a central position in its glass tube, and the angle, indicated by the index on the graduated arc, will at once measure the inclination. The ratio of the slope to the perpendicular is represented by the natural co-tangent of the angle thus measured; but as the observer may not have

at hand a Table of natural co-tangents, &c., we have annexed a Table at once showing the slopes corresponding to the various angles of inclination likely to be required.

It will appear evident, that the longer the bar C D is, the more accurate will the measure of the slope be; but there is no necessity for the instrument to be encumbered with a long bar, which would destroy its portability, because it can easily be attached, by tying, to the end of a long straight rod, which can be furnished by any neighbouring carpenter, and the real slope of an undulating inclined surface can then be accurately measured.

Table of Slopes.

Slope or Batter to 1 foot perpendicular.	Ratio of Slope to perpendicular.	Angle of Slope.		Slope or Batter to 1 foot perpendicular.	Ratio of Slope to perpendicular.	Angle of Slope.	
		With vertical.	With horizon.			With vertical.	With horizon.
ft. in.		° ′	° ′	ft. in.		° ′	° ′
0 ¼	1/48 to 1	1 12	88 48	1 0	1 to 1	45 0	45 0
0 ½	1/24 „ 1	2 23	87 37	1 3	1¼ „ 1	51 20	38 40
0 ¾	1/16 „ 1	3 35	86 25	1 6	1½ „ 1	56 19	33 41
0 1	1/12 „ 1	4 46	85 14	1 9	1¾ „ 1	60 15	29 45
0 1¼	1/10 nearly 1	5 57	84 3	2 0	2 „ 1	63 26	26 34
0 1½	1/8 to 1	7 8	82 52	2 3	2¼ „ 1	66 2	23 58
0 1¾	1/7 nearly 1	8 18	81 42	2 6	2½ „ 1	68 12	21 48
0 2	1/6 to 1	9 28	80 32	2 9	2¾ „ 1	70 1	19 59
0 2½	1/5 nearly 1	11 46	78 14	3 0	3 „ 1	71 34	18 26
0 3	1/4 to 1	14 2	75 58	3 6	3½ „ 1	74 3	15 57
0 3½	7/24 „ 1	16 16	73 44	4 0	4 „ 1	75 58	14 2
0 4	1/3 „ 1	18 26	71 34	4 6	4½ „ 1	77 28	12 32
0 4½	5/16 „ 1	20 34	69 26	5 0	5 „ 1	78 41	11 19
0 5	5/12 „ 1	22 37	67 23	5 6	5½ „ 1	79 42	10 18
0 5½	6/13 „ 1	24 37	65 23	6 0	6 „ 1	80 32	9 28
0 6	7/12 „ 1	26 34	63 26	7 0	7 „ 1	81 52	8 8
0 7	2/3 „ 1	30 15	59 45	8 0	8 „ 1	82 53	7 7
0 8	3/4 „ 1	33 41	56 19	9 0	9 „ 1	83 39	6 21
0 9	10/12 „ 1	36 52	53 8	10 0	10 „ 1	84 17	5 43
0 10	11/12 „ 1	39 48	50 12	11 0	11 „ 1	84 48	5 12
0 11	11/12 „ 1	42 31	47 29	12 0	12 „ 1	85 14	4 46

It is very important, in fixing upon the slopes for the sides of an excavation or embankment, to approximate very nearly to the inclination at which the ground would

naturally stand without slipping; for if they be made greater than necessary, a large quantity of labour, and of the surface of the ground, will be uselessly devoted. The proper slope for each particular soil can only be determined by observation and experience. "An embankment that would stand perfectly firm, and bear the action of the weather, when formed of sand, gravel, or the débris of rocks, and other materials that do not retain water in their fissures, would not last one winter, if it chiefly consisted of clay. The same remark applies with equal force to cutting, where it is made through a stratum of clay." * "A slope of 1 to 1, that is, a slope of 45°, is found sufficient for ordinary earth; for clay 1½ to 1, or a slope of 33° 41′ with the horizon, may often be required, unless it can be mixed with open materials to prevent water collecting in the fissures produced by its shrinkage in dry water. In other cases, so steep a face may be left as ¾ to 1, or even ½ to 1; and the slope that will be likely to stand may easily be judged of, by knowing the nature of the strata which will be cut through, and examining its state when exposed in the surrounding district."

At Boughton Hill, near Canterbury, there is a large cutting through London Clay, which, together with the embankment at the foot of the hill, formed of the same material, has been constantly giving way. The slopes of the embankment have been flattened from time to time, and now assume some appearance of consolidation; but the slopes of the cutting near the summit of the hill continue to slip down upon the roadway. From some cross-sections we were able to take a short time since, it

* Tredgold on Railroads, first edition, page 117.

appears that the original slope of the cuttings was about 2 to 1, forming an angle with the horizon of 26° 34′; but the natural slope assumed by the soft clay where it has slipped is about 9°, or a little more than 6¼ to 1.

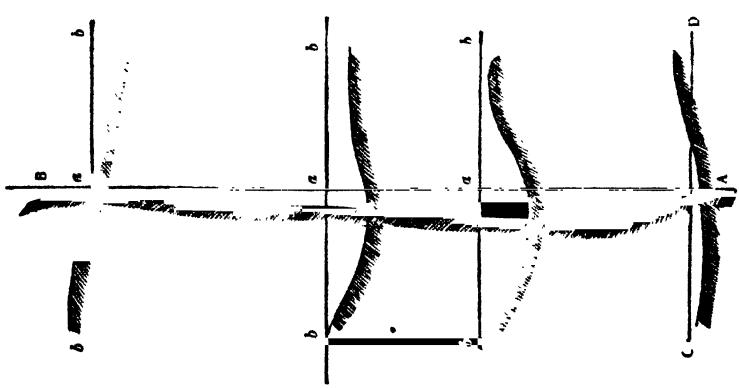
ON SELECTING A LINE OF COUNTRY FOR A ROAD OR RAILWAY.

The choice of a suitable line of country for the formation of a turnpike-road, a railroad, or a canal, preparatory to the levels being taken, requires both judgment and care; otherwise a fruitless expenditure of time in taking a number of trial-sections may be the result, if attended with no more serious and permanent inconvenience. A person undertaking such a work should previously devote a little time to obtain a knowledge of the country, its localities, its structure, and geological character: such knowledge will lead to the choice of several lines of direction, which appear to the eye as equally favourable; it then becomes necessary to make such preliminary surveys as will enable the engineer to adopt the one which, under all circumstances, is likely to prove the most advantageous.

At p. 113 (1st edition) of the late Mr. Tredgold's work upon Railroads, we find the following observations upon this subject: "In order to facilitate the choice of a line as it regards the surface of the country, the engineer may be reminded, that even in the disposal which nature has made of hills and valleys there is much system. Those things which to the first glance of the better-informed, and at all times to the ignorant, appear to be without order or arrangement, are the result of the uniform action of natural causes, and are, in reality,

capable of being traced and described with less difficulty than would be expected. Where a considerable tract of country is to be surveyed, the best index to its elevations and depressions is its streams and rivers; these indicate every change of inclination, and to the experienced eye, with considerable precision. It will also be observed, that each river has its system of valleys; and except in a few instances, where the draining is effected by the outburst of an open stratum, a district, whose bounding ridge is easily traced, is drained by its river and system of valleys.

" Having formed a tolerable idea of the best direction for the road, the next step must be to make a more particular survey, with a view to fix nearly the precise line. We would recommend the principal engineer to have this done by rectangular lines, as infinitely superior to surveying by triangles, in giving him an exact knowledge of the surface of the country. Perhaps, with the assistance of a diagram, we shall be able to render the advantage of this method obvious.



" Let A B be a portion of the intended line, and C D the breadth of the country to be included in the survey. At any suitable distances choose stations, *a*, *a*, *a*, their

distances apart depending on the changes of level, and let the principal line A B, and also the cross lines *b b*, *b b*, &c., be accurately levelled, and then drawn, as shown in the figure, on the plan of the line of road. If the distance *b b* is required to be considerable, perhaps an additional line in the principal direction may be necessary. The etched lines show the form of the surface at the lines A B, *b b*, *b b*, &c., on the plan; and the latter being sections at right angles to A B, there is no difficulty in seeing the extent of cutting, or of embankment, that may be avoided by varying the position of the principal line. In fact, a plan of this kind, to a person familiar with sections, is better than a model of the country."

The most advantageous direction for a line, either of roadway or railroad, intended to connect two places, is evidently that of a right line, both horizontally and vertically: if one extremity of the line is more elevated than another, the straight line connecting them will be an inclined plane, having one uniform rate of inclination; but if a uniform slope cannot be obtained in the direct line, it is necessary to deviate therefrom to obtain, as nearly as the circumstances of the country will admit, such an inclined plane, or at least to obtain continued progressive rises, avoiding as much as possible the introduction of useless ascents, that is, ascending where we must descend again, and *vice versâ*. When a line of road is encumbered with numerous and extensive useless ascents, the wasteful expenditure of power in the conveyance of goods is very great, as the number of feet actually ascended is increased many times more than is necessary, if each height, when once gained, were not lost again.

Sir Henry Parnell, in his valuable treatise on Roads, gives the following instances of this kind of road-making:—"As one instance, amongst others, of the serious injury which the public sustain by this system of roadmaking, the road between London and Barnet may be mentioned, on which the total number of perpendicular feet that a horse must now ascend is upwards of 1300, although Barnet is only 500 feet higher than London; and in going from Barnet to London, a horse must ascend 800 feet, although London is 500 feet lower than Barnet."

Another instance of this defect in road-engineering is observable in the line of the old road across the island of Anglesea, on which a horse was obliged to ascend and descend 1283 perpendicular feet more than was found necessary by Mr. Telford, when he laid out the present new line, as shown by the annexed Table:

	Height of summit above high water.	Total rise and fall.	Length.	
			Miles.	Yards.
Old road .	339	3540	24	428
New road .	193	2257	21	1596
Difference .	146	1283	2	592

In choosing the best direction for a line of roadway, the rate of inclination which can be obtained, with a moderate outlay in cuttings and embankments, is a consideration of greater importance than the mere maintaining of a direct line. For though the measured length of a circuitous route may be considerably greater than the length of a direct line, yet if the inclinations in

the former case are much more favourable than those in the latter, it must be evident that more may be gained in speed, with the same expenditure of power, than is lost by the increase of distance. Thus, if two roads rise, one at the rate of 1 in 15, and the other at the rate of 1 in 35, the same expenditure of power will move a weight through 15 feet of the one and 35 feet of the other, at the same rate.

Upon the subject of the maintenance of turnpike roads, we shall annex an abstract of the General Rules for Constructing and Repairing Roads, laid down by the late Mr. Telford, and which is so fully treated upon in the important work of Sir H. Parnell on Roads.

SHAPE, OR TRANSVERSE SECTION.

The roadway should be 30 feet broad; the centre should be 6 inches higher than the level of the sides, where the junction of the surface, with the sloping edge of the footpaths, or other defining bounds of the roadway, form the side channels; at 4 feet from the centre (on each side) the surface should be half an inch lower; at 9 feet, it should be 2 inches lower; and at 15 feet, its extreme edge, it should be 6 inches lower; this will give the form of a flat ellipse, which is well adapted for carrying off the water to the side channels, without making the cross section of the road too round, and allow the sun and wind to have a greater effect in evaporation, and keeping the road dry. In giving the surface one uniform curvature from side to side, the surveyor should use such a level as is described at page 96.

The footpaths should be 6 feet broad, and have an inclined surface of 1 inch in a yard towards the road; its surface should not be lower than the level of the centre of the road, and the edge should be sloped down (and covered with green sod) to meet the roadway, and form the side channel to carry off the water from the surface.

DRAINAGE.

All open main drains should be cut on the field side of the road fences, and should lead to the natural water-courses of the country; in general, they should be 3 feet deep below the bed of the road, 1 foot wide at bottom, and from 3 to 4 feet wide at top. Stone drains and culverts should also be made under the road, and continued to the open side drains, or ditches; side channels (before named) must be made on the road side, with openings of masonry into the cross drains, to prevent any water lying on the road, it being necessary, in order to preserve the surface of a road perfect, that it be kept completely dry. All land springs ought to be carried from the site of the road by under-draining.

FENCES.

"All road fences should be kept as low as possible, never being allowed to exceed 5 feet in height, in order that they may not intercept the sun and wind, and diminish their effects in producing evaporation;" and for the same reason no tree should be allowed to grow by the side of a road; for by keeping the roads wet, they occasion the rapid wear of the materials of which they are formed.

ROAD MATERIALS.

The hardest description of stone should always be preferred, such as basalt, granite, quartz, &c. "The whinstones found in different parts of the United Kingdom, Guernsey granite, Mountsorrel and Hartshill stone of Leicestershire, and the pebbles of Shropshire, Staffordshire, and Warwickshire, are among the best of the stones now commonly in use. The schistus rocks, being of a slaty and argillaceous structure, will make smooth roads, but they are rapidly destroyed when wet by the pressure of the wheels, and occasion great expense in scraping, and the constantly laying on of new coatings. Limestone is defective in the same respect. Sandstone is generally much too weak for the surface of a road; it will never make a hard one. The hardest flints are nearly as good as the best limestone; but the softer kinds are quickly crushed by the wheels of carriages, and make heavy and dirty roads. Gravel, when it consists of pebbles of the harder sorts of stones, will make a good road; but when it consists of limestone, sandstone, flint, and other weak stones, it will not; for it wears so rapidly, that the crust of a road made with it always consists of a large portion of the earthy matter to which it is reduced, and prevents the gravel from becoming consolidated, and the road from attaining that perfect hardness it ought to possess." * When the materials are stone, they should be broken to a size of a cubical form not exceeding $2\frac{1}{2}$ inches in their largest dimensions,

* Abridged from Sir H. Parnell on Roads, page 271.

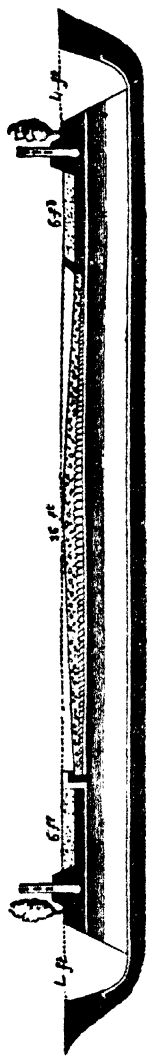
and should be capable of passing through a ring of that diameter. When it consists of gravel, the pebbles which are from 1 to 1½ inch in size only should be used for the middle part of the road; all larger pebbles should be broken; the smaller stones may be used for the sides of the roads and the footpaths.

THE FOUNDATION AND DISPOSITION OF MATERIALS.

Before the foundation is laid, the surface on which it is to rest must be prepared, by making it level from side to side, and, if necessary, raising it so that the finished surface of the road may not be below the level of the adjoining fields. If the subsoil be wet and elastic, it must be rendered non-elastic by whatever means is best adapted to overcome the cause, as drainage, &c. The foundation should consist of a rough close-set pavement, of any kind of stones that can be most readily procured; those set in the middle of the road should be 7 inches in depth; at 9 feet from the centre, 5 inches; at 12 feet from the centre, 4 inches; and at 15 feet, 3 inches. They should be set with their broadest faces downwards, and lengthwise across the road; and no stone should be more than 5 inches broad on its face. "The irregularities of the upper part of the pavement should be broken off with the hammer, and all the interstices should be filled with stone chips, firmly wedged, or packed by hand with a light hammer; so that, when the pavement is finished, there may be a convexity of 4 inches in the breadth of 15 feet from the centre.

"The middle 18 feet of pavement should be coated

with hard broken stones, of the form and size described under the head 'Road Materials,' to the depth of 6 inches. Four of these 6 inches to be first put on, and worked in by carriages and horses; care being taken to rake in the ruts until the surface becomes firm and consolidated, after which the remaining 2 inches are to be put on.



"The paved spaces on each side of the 18 middle feet should be coated with broken stones, or well-cleansed strong gravel, up to the footpath, or other boundary of the road, so as to make the whole convexity of the road 6 inches from the centre to the sides of it; and the whole of the materials should be covered with a binding of an inch and a half in depth of good gravel, free from clay or earth."

The footpaths should be made with a coating of strong gravel, or small broken stones, at least 6 inches deep. The annexed engraving exhibits a section of a road constructed according to the above rules.

REPAIRING ROADS.

Towards the latter end of the autumn of each year, a road should be put into a complete state of repair, to preserve it from being broken up during the following winter, between which time and the preceding spring, all repairs, by laying on of new materials, should be done. If thin coatings be laid on at a time, and when the ground is

wet, they will soon be worked into the surface without being crushed into powder.

All ruts and hollows should be filled up as soon as they appear. The side channels and drains should be continually kept clean, and free from obstruction; and all damage they may have sustained be made good as soon as discovered.

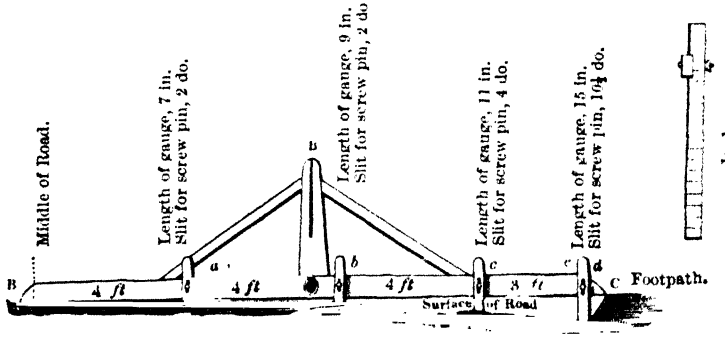
"A road should be scraped from time to time, so as never to have half an inch of mud upon it; the mud should not be scraped into, or allowed to remain in, the side channels, so as to stop the running of water in them.

"The hedges should be kept constantly clipped and cut as low as possible, without rendering them unfit for confining cattle; and all projecting branches of the trees in the fences should be lopped."

In the minutes of evidence given before a Select Committee of the House of Commons on the subject of Steam Carriages, we find the following paragraph as part of the evidence given by Sir John Macneill:

"Well-made roads, formed of clean, hard, broken stone, placed on a solid foundation, are very little affected by changes of atmosphere; weak roads, or those that are imperfectly formed of gravel, flint, or round pebbles, without a bottoming or foundation of stone pavement or concrete, are, on the contrary, much affected by changes of the weather. In the formation of such roads, and before they become bound or firm, a considerable portion of the subsoil mixes with the stone or gravel, in consequence of the necessity of putting the gravel on in thin layers: this mixture of earth or clay, in dry warm seasons, expands by the heat, and makes the road loose and open; the consequence is, that the

stones are thrown out, and many of them are crushed and ground into dust, producing considerable wear and diminution of the materials: in wet weather, also, the clay or earth, mixed with the stones, absorbs moisture, becomes soft, and allows the stones to move and rub against each other when acted upon by the feet of horses or wheels of carriages. This attrition of the stones against each other wears them out surprisingly fast, and produces large quantities of mud, which tend to keep the road damp, and by that means increase the injury."



The above engraving represents the level employed by road-surveyors in laying out new works. On the horizontal bar B C are placed four sliding gauges, *a*, *b*, *c*, *d*, which move in dovetailed grooves cut in the horizontal bar, and when adjusted to their proper depth below the bottom edge of the level, can be firmly fixed in their position by a thumb-screw. A section of this portion of the instrument, taken through the line at *e*, is given on the right, drawn to a larger scale; the remaining parts of the instrument require no explanation.

For laying out slopes, the clinometer, described at page 82, is the best instrument that can be used.

TABLE I.- *Showing the reduction upon each chain necessary to reduce hypothenusal to horizontal measure.*

Angle of ascent or descent.		Reduction in links.	Angle of ascent or descent.		Reduction in links.	Angle of ascent or descent.		Reduction in links.
°	′		°	′		°	′	
4	0	¼	23	48	8½	33	55	17
5	44	½	24	30	9	34	25	17½
7	2	¾	25	11	9½	34	55	18
8	7	1	25	51	10	35	25	18½
11	28	2	26	30	10½	35	54	19
12	50	2½	27	8	11	36	24	19½
14	5	3	27	45	11½	36	53	20
15	13	3½	28	22	12	37	21	20½
16	15	4	28	58	12½	37	49	21
17	15	4½	29	33	13	38	17	21½
18	12	5	30	8	13½	38	45	22
19	6	5½	30	41	14	39	12	22½
19	57	6	31	15	14½	39	39	23
20	47	6½	31	48	15	40	6	23½
21	34	7	32	20	15½	40	33	24
22	20	7½	32	52	16	40	58	24½
23	5	8	33	24	16½	41	25	25

TABLE II.—*Gradients or Inclined Planes.*

Ascent or descent.		Rate of inclination.	Angle of inclination.	Ascent or descent.		Rate of inclination.	Angle of inclination.
In 1 mile.	In 1 chain.			In 1 mile.	In 1 chain.		
feet.	ft. dec.		° ′ ″	feet.	ft. dec.		° ′ ″
1	0·013	1 in 5280·0	0 0 39	51	0·638	1 in 103·5	0 33 12
2	0·025	... 2640·0	0 1 18	52	0·650	... 101·5	0 33 51
3	0·038	... 1760·0	0 1 57	53	0·663	... 99·6	0 34 30
4	0·050	... 1320·0	0 2 36	54	0·675	... 97·8	0 35 10
5	0·063	... 1056·0	0 3 16	55	0·688	... 96·0	0 35 49
6	0·075	... 880·0	0 3 55	56	0·700	... 94·3	0 36 28
7	0·088	... 754·3	0 4 34	57	0·713	... 92·6	0 37 7
8	0·100	... 660·0	0 5 13	58	0·725	... 91·0	0 37 46
9	0·113	... 586·7	0 5 52	59	0·738	... 89·5	0 38 25
10	0·125	... 528·0	0 6 31	60	0·750	... 88·0	0 39 4
11	0·138	... 480·0	0 7 10	61	0·763	... 86·6	0 39 43
12	0·150	... 440·0	0 7 49	62	0·775	... 85·2	0 40 22
13	0·163	... 406·1	0 8 28	63	0·788	... 83·8	0 41 1
14	0·175	... 377·1	0 9 7	64	0·800	... 82·5	0 41 40
15	0·188	... 352·0	0 9 46	65	0·813	... 81·2	0 42 19
16	0·200	... 330·0	0 10 25	66	0·825	... 80·0	0 42 58
17	0·213	... 310·6	0 11 4	67	0·838	... 78·8	0 43 37
18	0·225	... 293·3	0 11 43	68	0·850	... 77·6	0 44 16
19	0·238	... 277·9	0 12 22	69	0·863	... 76·5	0 44 55
20	0·250	... 264·0	0 13 1	70	0·875	... 75·4	0 45 34
21	0·263	... 251·4	0 13 40	75	0·938	... 70·4	0 48 50
22	0·275	... 240·0	0 14 20	80	1·000	... 66·0	0 52 5
23	0·288	... 229·6	0 14 59	85	1·063	... 62·1	0 55 20
24	0·300	... 220·0	0 15 38	90	1·126	... 58·7	0 58 36
25	0·313	... 211·2	0 16 17	95	1·188	... 55·5	1 1 51
26	0·325	... 203·1	0 16 56	100	1·250	... 52·8	1 5 6
27	0·338	... 195·6	0 17 35	110	1·375	... 48·0	1 11 37
28	0·350	... 188·6	0 18 14	120	1·500	... 44·0	1 18 7
29	0·363	... 182·1	0 18 53	130	1·625	... 40·6	1 24 38
30	0·375	... 176·0	0 19 32	140	1·750	... 37·7	1 31 8
31	0·388	... 170·3	0 20 11	150	1·875	... 35·2	1 37 38
32	0·400	... 165·0	0 20 50	160	2·000	... 33·0	1 44 8
33	0·413	... 160·0	0 21 29	170	2·125	... 31·1	1 50 39
34	0·425	... 155·3	0 22 8	180	2·250	... 29·3	1 57 9
35	0·438	... 150·9	0 22 47	190	2·375	... 27·8	2 3 39
36	0·450	... 146·7	0 23 26	200	2·500	... 26·4	2 10 9
37	0·463	... 142·7	0 24 5	220	2·750	... 24·0	2 23 9
38	0·475	... 138·9	0 24 44	240	3·000	... 22·0	2 36 9
39	0·488	... 135·4	0 25 23	260	3·250	... 20·3	2 49 9
40	0·500	... 132·0	0 26 3	280	3·500	... 18·9	3 2 8
41	0·513	... 128·8	0 26 42	300	3·750	... 17·6	3 15 7
42	0·525	... 125·7	0 27 21	320	4·000	... 16·5	3 28 6
43	0·538	... 122·8	0 28 0	340	4·250	... 15·3	3 41 4
44	0·550	... 120·0	0 28 39	360	4·500	... 14·7	3 54 2
45	0·563	... 117·3	0 29 18	380	4·750	... 13·9	4 6 59
46	0·575	... 114·8	0 29 57	400	5·000	... 13·2	4 19 56
47	0·588	... 112·3	0 30 36	425	5·313	... 12·4	4 36 7
48	0·600	... 110·0	0 31 15	450	5·625	... 11·7	4 52 17
49	0·613	... 107·8	0 31 54	475	5·938	... 11·1	5 8 26
50	0·625	... 105·6	0 32 33	500	6·250	... 10·6	5 24 35

TABLE III.—*To convert Links into Feet.*

Links	CHAINS.									
	0	1	2	3	4	5	6	7	8	9
	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.
0	0·0	66·0	132·0	198·0	264·0	330·0	396·0	462·0	528·0	594·0
1	0·7	66·7	132·7	198·7	264·7	330·7	396·7	462·7	528·7	594·7
2	1·3	67·3	133·3	199·3	265·3	331·3	397·3	463·3	529·3	595·3
3	2·0	68·0	134·0	200·0	266·0	332·0	398·0	464·0	530·0	596·0
4	2·6	68·6	134·6	200·6	266·6	332·6	398·6	464·6	530·6	596·6
5	3·3	69·3	135·3	201·3	267·3	333·3	399·3	465·3	531·3	597·3
6	4·0	70·0	136·0	202·0	268·0	334·0	400·0	466·0	532·0	598·0
7	4·6	70·6	136·6	202·6	268·6	334·6	400·6	466·6	532·6	598·6
8	5·3	71·3	137·3	203·3	269·3	335·3	401·3	467·3	533·3	599·3
9	5·9	71·9	137·9	203·9	269·9	335·9	401·9	467·9	533·9	599·9
10	6·6	72·6	138·6	204·6	270·6	336·6	402·6	468·6	534·6	600·6
11	7·3	73·3	139·3	205·3	271·3	337·3	403·3	469·3	535·3	601·3
12	7·9	73·9	139·9	205·9	271·9	337·9	403·9	469·9	535·9	601·9
13	8·6	74·6	140·6	206·6	272·6	338·6	404·6	470·6	536·6	602·6
14	9·2	75·2	141·2	207·2	273·2	339·2	405·2	471·2	537·2	603·2
15	9·9	75·9	141·9	207·9	273·9	339·9	405·9	471·9	537·9	603·9
16	10·6	76·6	142·6	208·6	274·6	340·6	406·6	472·6	538·6	604·6
17	11·2	77·2	143·2	209·2	275·2	341·2	407·2	473·2	539·2	605·2
18	11·9	77·9	143·9	209·9	275·9	341·9	407·9	473·9	539·9	605·9
19	12·5	78·5	144·5	210·5	276·5	342·5	408·5	474·5	540·5	606·5
20	13·2	79·2	145·2	211·2	277·2	343·2	409·2	475·2	541·2	607·2
21	13·9	79·9	145·9	211·9	277·9	343·9	409·9	475·9	541·9	607·9
22	14·5	80·5	146·5	212·5	278·5	344·5	410·5	476·5	542·5	608·5
23	15·2	81·2	147·2	213·2	279·2	345·2	411·2	477·2	543·2	609·2
24	15·8	81·8	147·8	213·8	279·8	345·8	411·8	477·8	543·8	609·8
25	16·5	82·5	148·5	214·5	280·5	346·5	412·5	478·5	544·5	610·5
26	17·2	83·2	149·2	215·2	281·2	347·2	413·2	479·2	545·2	611·2
27	17·8	83·8	149·8	215·8	281·8	347·8	413·8	479·8	545·8	611·8
28	18·5	84·5	150·5	216·5	282·5	348·5	414·5	480·5	546·5	612·5
29	19·1	85·1	151·1	217·1	283·1	349·1	415·1	481·1	547·1	613·1
30	19·8	85·8	151·8	217·8	283·8	349·8	415·8	481·8	547·8	613·8
31	20·5	86·5	152·5	218·5	284·5	350·5	416·5	482·5	548·5	614·5
32	21·1	87·1	153·1	219·1	285·1	351·1	417·1	483·1	549·1	615·1
33	21·8	87·8	153·8	219·8	285·8	351·8	417·8	483·8	549·8	615·8
34	22·4	88·4	154·4	220·4	286·4	352·4	418·4	484·4	550·4	616·4
35	23·1	89·1	155·1	221·1	287·1	353·1	419·1	485·1	551·1	617·1
36	23·8	89·8	155·8	221·8	287·8	353·8	419·8	485·8	551·8	617·8
37	24·4	90·4	156·4	222·4	288·4	354·4	420·4	486·4	552·4	618·4
38	25·1	91·1	157·1	223·1	289·1	355·1	421·1	487·1	553·1	619·1
39	25·7	91·7	157·7	223·7	289·7	355·7	421·7	487·7	553·7	619·7
40	26·4	92·4	158·4	224·4	290·4	356·4	422·4	488·4	554·4	620·4
41	27·1	93·1	159·1	225·1	291·1	357·1	423·1	489·1	555·1	621·1
42	27·7	93·7	159·7	225·7	291·7	357·7	423·7	489·7	555·7	621·7
43	28·4	94·4	160·4	226·4	292·4	358·4	424·4	490·4	556·4	622·4
44	29·0	95·0	161·0	227·0	293·0	359·0	425·0	491·0	557·0	623·0
45	29·7	95·7	161·7	227·7	293·7	359·7	425·7	491·7	557·7	623·7
46	30·4	96·4	162·4	228·4	294·4	360·4	426·4	492·4	558·4	624·4
47	31·0	97·0	163·0	229·0	295·0	361·0	427·0	493·0	559·0	625·0
48	31·7	97·7	163·7	229·7	295·7	361·7	427·7	493·7	559·7	625·7
49	32·3	98·3	164·3	230·3	296·3	362·3	428·3	494·3	560·3	626·3

TABLE III.—*To convert Links into Feet* (continued).

Links	CHAINS.									
	0	1	2	3	4	5	6	7	8	9
	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.	feet.
50	33·0	99·0	165·0	231·0	297·0	363·0	429·0	495·0	561·0	627·0
51	33·7	99·7	165·7	231·7	297·7	363·7	429·7	495·7	561·7	627·7
52	34·3	100·3	166·3	232·3	298·3	364·3	430·3	496·3	562·3	628·3
53	35·0	101·0	167·0	233·0	299·0	365·0	431·0	497·0	563·0	629·0
54	35·6	101·6	167·6	233·6	299·6	365·6	431·6	497·6	563·6	629·6
55	36·3	102·3	168·3	234·3	300·3	366·3	432·3	498·3	564·3	630·3
56	37·0	103·0	169·0	235·0	301·0	367·0	433·0	499·0	565·0	631·0
57	37·6	103·6	169·6	235·6	301·6	367·6	433·6	499·6	565·6	631·6
58	38·3	104·3	170·3	236·3	302·3	368·3	434·3	500·3	566·3	632·3
59	38·9	104·9	170·9	236·9	302·9	368·9	434·9	500·9	566·9	632·9
60	39·6	105·6	171·6	237·6	303·6	369·6	435·6	501·6	567·6	633·6
61	40·3	106·3	172·3	238·3	304·3	370·3	436·3	502·3	568·3	634·3
62	40·9	106·9	172·9	238·9	304·9	370·9	436·9	502·9	568 9	634·9
63	41·6	107·6	173·6	239·6	305·6	371·6	437·6	503·6	569·6	635·6
64	42·2	108·2	174·2	240·2	306·2	372 2	438·2	504·2	570·2	636·2
65	42·9	108·9	174·9	240·9	306·9	372·9	438·9	504·9	570·9	636·9
66	43·6	109·6	175·6	241·6	307·6	373·6	439·6	505·6	571·6	637·6
67	44·2	110·2	176·2	242 2	308·2	374·2	440 2	506·2	572·2	638·2
68	44·9	110·9	176·9	242·9	308·9	374·9	440·9	506·9	572·9	638·9
69	45·5	111·5	177·5	243·5	309·5	375·5	441·5	507·5	573·5	639·5
70	46·2	112·2	178·2	244·2	310·2	376·2	442·2	508·2	574·2	640·2
71	46·9	112·9	178·9	244·9	310·9	376·9	442·9	508 9	574·9	640·9
72	47·5	113·5	179·5	245·5	311·5	377·5	443·5	509·5	575·5	641·5
73	48·2	114·2	180·2	246·2	312·2	378·2	444·2	510·2	576·2	642·2
74	48·8	114·8	180·8	246·8	312·8	378·8	444·8	510 8	576·8	642·8
75	49·5	115·5	181·5	247·5	313·5	379·5	445·5	511·5	577·5	643·5
76	50·2	116·2	182·2	248·2	314·2	380·2	446·2	512·2	578 2	644·2
77	50·8	116·8	182·8	248 8	314·8	380·8	446·8	512·8	578·8	644·8
78	51·5	117·5	183·5	249·5	315·5	381·5	447·5	513·5	579·5	645·5
79	52·1	118·1	184·1	250·1	316·1	382·1	448·1	514·1	580·1	646·1
80	52·8	118·8	184·8	250·8	316·8	382·8	448·8	514·8	580·8	646·8
81	53·5	119·5	185·5	251·5	317·5	383·5	449 5	515·5	581·5	647·5
82	54·1	120·1	186·1	252·1	318·1	384·1	450 1	516·1	582·1	648·1
83	54·8	120·8	186·8	252·8	318·8	384·8	450·8	516·8	582·8	648·8
84	55·4	121·4	187·4	253·4	319·4	385·4	451·4	517·4	583·4	649·4
85	56·1	122·1	188·1	254·1	320·1	386·1	452·1	518·1	584·1	650·1
86	56·8	122·8	188·8	254·8	320·8	386·8	452 8	518 8	584·8	650·8
87	57·4	123·4	189·4	255·4	321·4	387·4	453·4	519·4	585·4	651·4
88	58·1	124·1	190·1	256·1	322·1	388·1	454·1	520·1	586·1	652·1
89	58·7	124·7	190·7	256·7	322·7	388·7	454·7	520·7	586·7	652·7
90	59·4	125·4	191·4	257·4	323·4	389·4	455·4	521·4	587·4	653·4
91	60·1	126·1	192·1	258·1	324·1	390·1	456·1	522·1	588·1	654·1
92	60·7	126·7	192·7	258·7	324·7	390·7	456·7	522·7	588·7	654·7
93	61·4	127·4	193·4	259·4	325·4	391·4	457 4	523·4	589·4	655·4
94	62·0	128·0	194·0	260·0	326·0	392·0	458 0	524·0	590·0	656·0
95	62·7	128·7	194·7	260·7	326·7	392·7	458·7	524·7	590·7	656·7
96	63·4	129·4	195·4	261·4	327·4	393·4	459·4	525·4	591·4	657·4
97	64·0	130·0	196·0	262·0	328·0	394·0	460·0	526·0	592·0	658·0
98	64·7	130·7	196·7	262·7	328·7	394·7	460·7	526·7	592·7	658·7
99	65·3	131·3	197·3	263·3	329·3	395·3	461·3	527·3	593·3	659·3

TABLE IV.—*To convert Feet into Links.*

Feet.	FEET.									
	0	100	200	300	400	500	600	700	800	900
	links.	links.	links.	links.	links.	links.	links.	links.	links.	links.
0	0·0	151·5	303·0	454·5	606·1	757·6	909·1	1060·6	1212·1	1363·6
1	1·5	153·0	304·5	456·1	607·6	759·1	910·6	1062·1	1213·6	1365·2
2	3·0	154·5	306·1	457·6	609·1	760·6	912·1	1063·6	1215·2	1366·7
3	4·5	156·1	307·6	459·1	610·6	762·1	913·6	1065·2	1216·7	1368·2
4	6·1	157·6	309·1	460·6	612·1	763·6	915·2	1066·7	1218·2	1369·7
5	7·6	159·1	310·6	462·1	613·6	765·2	916·7	1068·2	1219·7	1371·2
6	9·1	160·6	312·1	463·6	615·2	766·7	918·2	1069·7	1221·2	1372·7
7	10·6	162·1	313·6	465·2	616·7	768·2	919·7	1071·2	1222·7	1374·2
8	12·1	163·6	315·2	466·7	618·2	769·7	921·2	1072·7	1224·2	1375·8
9	13·6	165·2	316·7	468·2	619·7	771·2	922·7	1074·2	1225·8	1377·3
10	15·2	166·7	318·2	469·7	621·2	772·7	924·2	1075·8	1227·3	1378·8
11	16·7	168·2	319·7	471·2	622·7	774·2	925·8	1077·3	1228·8	1380·3
12	18·2	169·7	321·2	472·7	624·2	775·8	927·3	1078·8	1230·3	1381·8
13	19·7	171·2	322·7	474·2	625·8	777·3	928·8	1080·3	1231·8	1383·3
14	21·2	172·7	324·2	475·8	627·3	778·8	930·3	1081·8	1233·3	1384·8
15	22·7	174·2	325·8	477·3	628·8	780·3	931·8	1083·3	1234·8	1386·4
16	24·2	175·8	327·3	478·8	630·3	781·8	933·3	1084·8	1236·4	1387·9
17	25·8	177·3	328·8	480·3	631·8	783·3	934·8	1086·4	1237·9	1389·4
18	27·3	178·8	330·3	481·8	633·3	784·8	936·4	1087·9	1239·4	1390·9
19	28·8	180·3	331·8	483·3	634·8	786·4	937·9	1089·4	1240·9	1392·4
20	30·3	181·8	333·3	484·8	636·4	787·9	939·4	1090·9	1242·4	1393·9
21	31·8	183·3	334·8	486·4	637·9	789·4	940·9	1092·4	1243·9	1395·5
22	33·3	184·8	336·4	487·8	639·4	790·9	942·4	1093·9	1245·5	1397·0
23	34·8	186·4	337·9	489·4	640·9	792·4	943·9	1095·5	1247·0	1398·5
24	36·4	187·9	339·4	490·9	642·4	793·9	945·5	1097·0	1248·5	1400·0
25	37·9	189·4	340·9	492·4	643·9	795·5	947·0	1098·5	1250·0	1401·5
26	39·4	191·9	342·4	493·9	645·5	797·0	948·5	1100·0	1251·5	1403·0
27	40·9	192·4	343·9	495·5	647·0	798·5	950·0	1101·5	1253·0	1404·5
28	42·4	193·9	345·5	497·0	648·5	800·0	951·5	1103·0	1254·5	1406·1
29	43·9	195·5	347·0	498·5	650·0	801·5	953·0	1104·5	1256·1	1407·6
30	45·5	197·0	348·5	500·0	651·5	803·0	954·5	1106·1	1257·6	1409·1
31	47·0	198·5	350·0	501·5	653·0	804·5	956·1	1107·6	1259·1	1410·6
32	48·5	200·0	351·5	503·0	654·5	806·1	957·6	1109·1	1260·6	1412·1
33	50·0	201·5	353·0	504·5	656·1	807·6	959·1	1110·6	1262·1	1413·6
34	51·5	203·0	354·5	506·1	657·6	809·1	960·6	1112·1	1263·6	1415·2
35	53·0	204·5	356·1	507·6	659·1	810·6	962·1	1113·6	1265·2	1416·7
36	54·5	206·1	357·6	509·1	660·6	812·1	963·6	1115·2	1266·7	1418·2
37	56·1	207·6	359·1	510·6	662·1	813·6	965·2	1116·7	1268·2	1419·7
38	57·6	209·1	360·6	512·1	663·6	815·2	966·7	1118·2	1269·7	1421·2
39	59·1	210·6	362·1	513·6	665·2	816·7	968·2	1119·7	1271·2	1422·7
40	60·6	212·1	363·6	515·2	666·7	818·2	969·7	1121·2	1272·7	1424·2
41	62·1	213·6	365·2	516·7	668·2	819·7	971·2	1122·7	1274·2	1425·8
42	63·6	215·2	366·7	518·2	669·7	821·2	972·7	1124·2	1275·8	1427·3
43	65·2	216·7	368·2	519·7	671·2	822·7	974·2	1125·8	1277·3	1428·8
44	66·7	218·2	369·7	521·2	672·7	824·2	975·8	1127·3	1278·8	1430·3
45	68·2	219·7	371·2	522·7	674·2	825·8	977·3	1128·8	1280·3	1431·8
46	69·7	221·2	372·7	524·2	675·8	827·3	978·8	1130·3	1281·8	1433·3
47	71·2	222·7	374·2	525·8	677·3	828·8	980·3	1131·8	1283·3	1434·8
48	72·7	224·2	375·8	527·3	678·8	830·3	981·8	1133·3	1284·8	1436·4
49	74·2	225·8	377·3	528·8	680·3	831·8	983·3	1134·8	1286·4	1437·9

TABLE IV.—*To convert Feet into Links* (continued).

Feet.	FEET.									
	0	100	200	300	400	500	600	700	800	900
	links.	links.	links.	links.	links.	links.	links.	links.	links.	links.
50	75·8	227·3	378·8	530·3	681·8	833·3	984·8	1136·4	1287·9	1439·4
51	77·3	228·8	380·3	531·8	683·3	834·8	986·4	1137·9	1289·4	1440·9
52	78·8	230·3	381·8	533·3	684·8	836·4	987·9	1139·4	1290·9	1442·4
53	80·3	231·8	383·3	534·8	686·4	837·9	989·4	1140·9	1292·4	1443·9
54	81·8	233·3	384·8	536·4	687·9	839·4	990·9	1142·4	1293·9	1445·5
55	83·3	234·8	386·4	537·9	689·4	840·9	992·4	1143·9	1295·5	1447·0
56	84·8	236·4	387·9	539·4	690·9	842·4	993·9	1145·5	1297·0	1448·5
57	86·4	237·9	389·4	540·9	692·4	843·9	995·5	1147·0	1298·5	1450·0
58	87·9	239·4	390·9	542·4	693·9	845·5	997·0	1148·5	1300·0	1451·5
59	89·4	240·9	392·4	543·9	695·5	847·0	998·5	1150·0	1301·5	1453·0
60	90·9	242·4	393·9	545·5	697·0	848·5	1000·0	1151·5	1303·0	1454·5
61	92·4	243·9	395·5	547·0	698·5	850·0	1001·5	1153·0	1304·5	1456·1
62	93·9	245·5	397·0	548·5	700·0	851·5	1003·0	1154·5	1306·1	1457·6
63	95·5	247·0	398·5	550·0	701·5	853·0	1004·5	1156·1	1307·6	1459·1
64	97·0	248·5	400·0	551·5	703·0	854·5	1006·1	1157·6	1309·1	1460·6
65	98·5	250·0	401·5	553·0	704·5	856·1	1007·6	1159·1	1310·6	1462·1
66	100·0	251·5	403·0	554·5	706·1	857·6	1009·1	1160·6	1312·1	1463·6
67	101·5	253·0	404·5	556·1	707·6	859·1	1010·6	1162·1	1313·6	1465·2
68	103·0	255·5	406·1	557·6	709·1	860·6	1012·1	1163·6	1315·2	1466·7
69	104·5	256·1	407·6	559·1	710·6	862·1	1013·6	1165·2	1316·7	1468·2
70	106·1	257·6	409·1	560·6	712·1	863·6	1015·2	1166·7	1318·2	1469·7
71	107·6	259·1	410·6	562·1	713·6	865·2	1016·7	1168·2	1319·7	1471·2
72	109·1	260·6	412·1	563·6	715·2	866·7	1018·2	1169·7	1321·2	1472·7
73	110·6	262·1	413·6	565·2	716·7	868·2	1019·7	1171·2	1322·7	1474·2
74	112·1	263·6	415·2	566·7	718·2	869·7	1021·2	1172·7	1324·2	1475·8
75	113·6	265·2	416·7	568·2	719·7	871·2	1022·7	1174·2	1325·8	1477·3
76	115·2	266·7	418·2	569·7	721·2	872·7	1024·2	1175·8	1327·3	1478·8
77	116·7	268·2	419·7	571·2	722·7	874·2	1025·8	1177·3	1328·8	1480·3
78	118·2	269·7	421·2	572·7	724·2	875·8	1027·3	1178·8	1330·3	1481·8
79	119·7	271·2	422·7	574·2	725·8	877·3	1028·8	1180·3	1331·8	1483·3
80	121·2	272·7	424·2	575·8	727·3	878·8	1030·3	1181·8	1333·3	1484·8
81	122·7	274·2	425·8	577·3	728·8	880·3	1031·8	1183·3	1334·8	1486·4
82	124·2	275·8	427·3	578·8	730·3	881·8	1033·3	1184·8	1336·4	1487·9
83	125·8	277·3	428·8	580·3	731·8	883·3	1034·8	1186·4	1337·9	1489·4
84	127·3	278·8	430·3	581·8	733·3	884·8	1036·4	1187·9	1339·4	1490·9
85	128·8	280·3	431·8	583·3	734·8	886·4	1037·9	1189·4	1340·9	1492·4
86	130·3	281·8	433·3	584·8	736·4	887·9	1039·4	1190·9	1342·4	1493·9
87	131·8	283·3	434·8	586·4	737·9	889·4	1040·9	1192·4	1343·9	1495·4
88	133·3	284·8	436·4	587·9	739·4	890·9	1042·4	1193·9	1345·5	1497·0
89	134·8	286·4	437·9	589·4	740·9	892·4	1043·9	1195·5	1347·0	1498·5
90	136·4	287·9	439·4	590·9	742·4	893·9	1045·5	1197·0	1348·5	1500·0
91	137·9	289·4	440·9	592·4	743·9	895·5	1047·0	1198·5	1350·0	1501·5
92	139·4	290·9	442·4	593·9	745·5	897·0	1048·5	1200·0	1351·5	1503·0
93	140·9	292·4	443·9	595·5	747·0	898·5	1050·0	1201·5	1353·0	1504·5
94	142·4	293·9	445·5	597·0	748·5	900·0	1051·5	1203·0	1354·5	1506·1
95	143·9	295·5	447·0	598·5	750·0	901·5	1053·0	1204·5	1356·1	1507·6
96	145·5	297·0	448·5	600·0	751·5	903·0	1054·5	1206·1	1357·6	1509·1
97	147·0	298·5	450·0	601·5	753·0	904·5	1056·1	1207·6	1359·1	1510·6
98	148·5	300·0	451·5	603·0	754·5	906·1	1057·6	1209·1	1360·6	1512·1
99	150·0	301·5	453·0	604·5	756·1	907·6	1059·1	1210·6	1362·1	1513·6

APPENDIX.

In the former edition of this work there was an error in the Rule which appears, in the present edition, at page 65, the word "tangent" having been written for "sine." A scientific friend, in noticing this mistake, has suggested a convenient method of arranging the figures of the calculation when the perpendicular and base of a right-angled triangle are *both* to be computed from the base-angle and hypothenuse. The directions are as follows:—

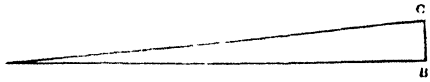
"1st. Write down the log. of the measured hypothenuse taken from the table of numbers.

"2nd. Over it place the log. sine of the measured angle from table of log. sines, &c., and draw a line *above*.

"3rd. Under the log. of the hypothenuse write down the cosine of the angle, and then draw a line *under* it. Add the hypothenuse to the sine *upwards*, and it will give the length of the perpendicular sought in the table of numbers. Add the hypothenuse and cosine together *downwards*, and it will give the length of the base in the table of numbers.

"Note.—I reject 10 from the log. index in both sums, because radius 10 stood in the first term, as a divisor, in both proportions.

"EXAMPLE.



"From A to C, I found the angle to be 6° rising—and the length of the hypothenuse A C measured 1240 links.

"I state the calculation thus:

2·112657 = log. $129\frac{6}{10}$ the perp^{r}.

2nd, Sine of 6°	=	9·019235
1st, Hypothenuse 1240	=	3·093422
3rd, Cosine of 6°	=	9·997614

3·091036 = log. $1233\frac{2}{10}$ the base.

Answer:

Perpendicular . .	$129\frac{6}{10}$ links.
Base	$1233\frac{2}{10}$ do.
Hypothenuse . . .	1240 do."

We may add here, in reference to the precept in italics, at page 65, that the constant number 1·8195439 is the logarithm of 66, the number of feet in a chain.

ON SETTING OUT THE WIDTHS OF GROUND REQUIRED

FOR THE WORKS OF A

RAILWAY OR CANAL,

ETC., ETC.

DEPENDING UPON THE DEPTH OF CUTTING OR
HEIGHT OF EMBANKMENT,
AND THE TRANSVERSE SLOPE OF THE NATURAL SURFACE.

BY

FREDERICK WALTER SIMMS, F.G.S., M.I.C.E.

ON SETTING OUT THE WIDTHS OF GROUND REQUIRED

FOR THE WORKS OF A

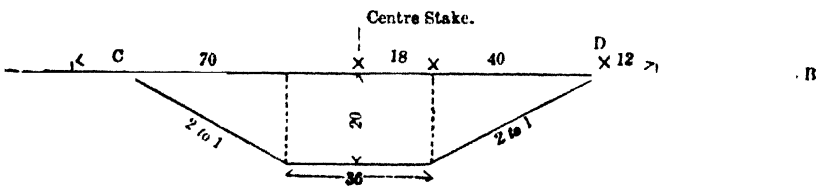
RAILWAY OR CANAL,

&c., &c.

WHEN the natural surface of the ground, both longitudinally and transversely, is upon the same level as that of the intended works, the process of setting and staking out the widths is very simple. Let us take, for example, the case of a railway, the base or bottom width of which, when prepared for the reception of the ballasting and permanent way, is to be 36 feet; the ratio of the inclination, or batter, of the slopes to the heights, both in the cuttings and the embankments, to be 2 to 1; beyond which, or at the outward edge, a slip of land 12 feet wide is to be taken on each side of the railway for the fences, &c. First, the centre line must be staked out and carefully levelled: it is customary to drive a stake, about 2 feet long and about $1\frac{1}{2}$ inch square, into the ground at each chain's length, their tops to be upon the fair level of the natural surface, thus affording good stations for the levelling staves to be held upon; the relative level of each stake being then very accurately determined with respect to some given datum, they become so many zero points for reference in the subsequent operations. From each of the centre stakes

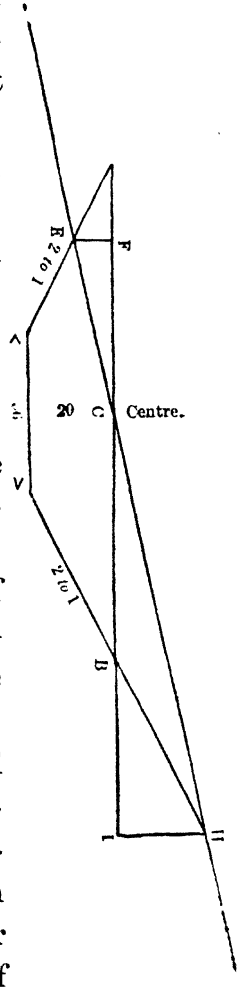
a line must be set out on both sides, and at right angles to the centre line, or at right angles to a tangent to the centre line at that point, if the centre line be curved: upon these transverse lines the required widths of land must be set out. Now, if the ground at any of the centre stakes is upon the same level as the intended base of the railway, nothing more will be required than to measure on each transverse line, and in both directions from the centre stake, one half the required width, which, in our supposed case, is 18 feet for the half width of the railway, and 12 feet for the fences; in all 30 feet on each side of the centre. But when, as it mostly happens, the ground is not on the proposed level of the railway, the operation is not quite so simple; and if in addition thereto the ground slopes sidewise or at right angles to the general direction of the line, the business is still more complicated, and requires some skill and care to do the work correctly. The method of doing this it is now our business to explain.

The next most simple case to the above is when the cross section of the ground is horizontal, be the depth of cutting or height of embankment what it may.



This is shown in the above diagram, which represents a cross section of a 20 feet cutting, with slopes of two horizontal to one perpendicular. The horizontal line A B at right angles to the centre line represents the natural surface of the ground. Under these circumstances it

will readily be seen that the half width of the cutting, or the distance from the centre to the edge of the slopes C and D, equals the half width of the base (18) added to the batter of the sloping sides (40), and including the 12 feet for the fences, the total half width of land required for the purposes of such railway would be 18 + 40 + 12 = 70 feet, and consequently the whole required width to be appropriated and fenced in for a 20 feet cutting or embankment, when the ground does not slope sidewise, would be 140 feet.



The next and more complicated, and also the most frequently occurring case, is, when the cross section of the natural surface is not horizontal, as shown in the annexed diagram, which also represents a cutting of 20 feet.

Let the line A B represent a horizontal line passing through the centre line C of the railway, which, if it coincided with the surface of the ground, would give A C and C B (each half width) 70 feet, as in the former example, the depth of cutting and the slopes being assumed the same.

Let the line E H represent the natural surface of the ground upon this transverse section; it will readily be perceived that the real half width C E (on the left of the diagram) is much shorter than the horizontal or computed half width A C, because the ground-line is depressed on that

side of the centre; likewise the half width C H on the other side of the centre is greater than the said horizontal or computed half width, because the ground is there elevated above the horizontal line A B passing through the centre. To determine *exactly* the distances C E and C H in actual operations in the field, would be attended with some difficulty, and consume much time; but the following method, at the same time that it gives a sufficiently correct approximation in practice, is also a very expeditious one:

Let us suppose that the point E or distance C E be known, and that with a spirit-level we determine the difference of level between the points C and E, this difference is represented by the line E F, which suppose to be one foot; now we have a small right-angled triangle A E F, of which E F is determined, being the difference of level (one foot), and the slope or ratio of A F to E F also given (2 to 1), therefore the side A F is known (2 feet), which, subtracted from the computed half width A C, leaves F C approximately equal to E C, the required half width, sufficiently exact for all practical purposes, where the cross section of the ground does not differ materially from a horizontal line.

We have been supposing that the point E is known, whereas that point is the object of our search; in practice, therefore, we proceed thus:—Take the computed half width, and if the ground is *depressed*, let a levelling staff be held somewhat *nearer* the point C than the said computed half width, for a first approximation to the point E; then determine the *difference of level* between this assumed point and the centre point C, *multiply this difference of level by the ratio of the slopes* (which

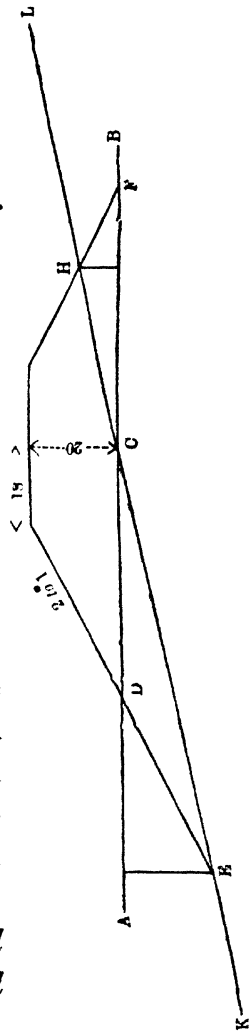
doubles it when the slope is 2 to 1), and *subtract* the result from the computed half width, which gives a more correct approximation to the point E ; now hold the staff at this *new point* and find the difference of level as before, again multiply by the ratio of the slopes, and deduct the result from the computed half width, which second result will in most cases be sufficiently near the real half width for a *depressed* line for all practical purposes.

EXAMPLE.—Central height (or depth of cutting), 20 feet, slopes 2 to 1, base 36 feet; the computed half width was therefore 58 feet; the ground being depressed, we estimated that the point E might fall short of the computed half width 2 feet: we therefore directed a levelling staff to be held at 56 feet from the centre line (or stake) C, at which point another staff was held, and, by means of a spirit-level set up at a convenient distance, we found the difference of level between these points to be 0·87 foot, which multiplied by the ratio of the slopes (2 to 1), gave 1·74 foot to be subtracted from the computed half width 58 feet, leaving 56·26 feet for a first approximation to the half width C E (see last diagram). Now, upon removing the staff to this new point, the difference of level was again taken (or rather we should say that the staff was again read off, as the level had not been disturbed), and found to be 0·91 foot, which, also multiplied by the ratio of the slopes (2 to 1), gave 1·82 foot to be subtracted from 58 feet, leaving 56·18 for the second approximation, and which was adopted as the correct half width for the depressed side of the centre; indeed, in such a case as is above given, where the ground is so nearly horizontal, the first approximation

(taken by a person after a little practice) may be assumed as the correct result, for in the above example it differed but ·08 from the second determination, and if it had been taken a third time it could not have been more accurate as far as practice is concerned; this, however, is not the case where the inclination or slope of the ground is considerable, for then (if this method be followed) several approximations will be necessary to bring the result within admissible limits.

When the ground is *elevated* above the horizontal line, as shown on the right hand of the diagram, the mode of procedure will somewhat differ: thus, instead of holding the staff and finding the difference of level at a *less distance* than the computed half width, it must be held at a *greater distance* to obtain the point H by approximation; the difference of level between that point and the centre point C being equal to H I, which multiplied by the ratio of the slopes, will give the distance B I to be added to the computed half width C B, to obtain the half width C H; this may likewise be repeated to obtain a more correct result, as described for the other or depressed side of the centre C. It will also here be obvious to a person possessing but the smallest share of mathematical knowledge, that this result is not strictly correct, inasmuch as the line C H can never be equal to C I, but for practical purposes it is, as before observed, sufficiently correct. It may not be altogether unnecessary to observe, in this place, that the corrections B I, &c., as shown in the foregoing diagrams, are much exaggerated, being far greater in proportion to the computed half width C B, than ever occurs in ordinary practice, but this has been done to make our explanations more distinct than they otherwise would be.

The above particulars have been confined to the case of excavations; we must now show in what the process differs when the ground is to be covered with an embankment.



By reversing page 108 we invert the diagram, which then represents an embankment. The rule for finding the half width for an embankment where the transverse section of the ground is horizontal, remains the same as for the cuttings under like circumstances, as may be seen by an inspection of the inverted figure of the first diagram; but upon inverting the second diagram, it will at once be seen that some variation in the process is required. Thus:

The horizontal line is represented by that marked A B; C D and C F are the computed half widths; C E the required half width on the depressed side, and C H the required half width on the elevated side, the line K L representing the natural surface of the ground. In the case of an excavation, we have shown that the *real* half width is greater on the *elevated* side than the computed half width, and less on the *depressed* side; but it will be seen by the above diagram that for an embankment the *real* half width is *less* on the *elevated* side, and *greater* on the *depressed* side, than the computed half width; therefore,

in determining the approximate place of the point E on the depressed side for an embankment, the staff must be held *further* from the centre than the computed half width; and for the point H, or the elevated side, it must be held *nearer* to the centre than the computed half width; and finally, for computing the real half widths from the differences of level between the points E and the centre, and H and the centre; on the *depressed* side the difference of level multiplied by the ratio of the slopes is to be *added* to the computed half widths to obtain the point E, and to be *subtracted* from the computed half widths to obtain the point H.

The process above described may appear to the reader a very tedious one; it perhaps is so to read; but a little practice will convince him that it is a very expeditious method, for in most cases one setting up of the level will answer for several stations, and the multiplication by the ratio of the slopes upon such small numbers as mostly occur is easily performed, especially if it be an even number, as 2 to 1. The columns of the field-book may be arranged as in the following example for making the calculations in the field, or may be abridged to suit a more convenient sized book for the pocket, at the pleasure of the surveyor; indeed, all that can be accomplished now of this kind is to give general rules, which can be altered and arranged to suit the convenience of the surveyor, as experience may point out a more suitable mode of proceeding. The example is taken from an extensive field operation by the writer, and shows the work both for a cutting and an embankment; the change from one to the other, or the tailing out of the cutting, as it is called, being included therein. The slope of the

cutting is calculated at 1½ to 1, and that of the embankment at 2 to 1. The width of the railway was 36 feet, consequently half the said width was 18 feet.

EXAMPLE.

No. of Stake.	Depth of Cutting or Embankment.	Computed half width.	Section or Level Readings at right angles to Line.			Difference of Level. + −		Difference of Level, × ratio of Slope. + −		Required half width for edge of Cutting or foot of Embankment.	
			South.	Centre.	North.	South.	North.	South.	North.	South.	North.
EMBANKMENT.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
285	16·97	51·94	10·90	7·50	3·96	+ 3·40	− 3·54	+ 6·80	− 7·08	58·74	44·86
286	1·43	0·86	7·06	4·74	3·24	+ 2·32	+ 0·07 − 1·50	+ 4·64	+ 0·11	25·50	20·97
287	2·77	23·54	8·00	5·80	4·26	+ 2·20	− 1·54	+ 4·40	− 3·08	27·94	20·46
288	3·06	24·12	8·82	6·42	5·12	+ 2·40	− 1·30	+ 4·80	− 2·60	28·92	21·52
289	2·01	22·02	7·02	5·13	3·74	+ 1·89	− 1·39	+ 3·78	− 2·78	25·80	19·24
290	1·22	20·44	6·00	4·10	2·76	+ 1·90	+ 0·12 − 1·34	+ 3·80	+ 0·18	24·24	20·62
291	1·91	21·82	7·52	6·95	5·20	+ 0·57	− 1·75	+ 1·14	− 3·50	22·96	18·32
CUTTING.											
292	1·39	20·78	12·20	11·35	10·52	− 0·85	+ 0·83	− 1·27	+ 1·24	19·51	22·02
293	4·51	27·02	9·56	7·98	6·22	− 1·58	+ 1·76	− 2·37	+ 2·64	24·65	29·66
294	5·72	29·44	8·40	6·52	4·27	− 1·88	+ 2·25	− 2·82	+ 3·37	26·62	32·81
295	6·85	31·70	7·06	5·10	3·02	− 1·96	+ 2·08	− 2·94	+ 3·12	28·76	34·82
296	8·61	35·22	7·53	5·28	2·76	− 2·25	+ 2·52	− 3·37	+ 3·78	31·85	39·00

The first column contains the number of the central stakes, reckoned from the commencement of the work, which are convenient for reference.

The second column contains the depth of cutting or the height of embankment, as the case may be, at that point on the centre line.

The third column, the computed half width from the centre line to the edge of the cutting, or foot of embankment, upon the supposition that the ground is horizontal at right angles to the centre line; this half width, as before explained (p. 109), is found by multiplying the central height by the ratio of the slopes, and adding to the product half the width at the base of the railway.

The fourth, fifth, and sixth columns contain the readings from the levelling staves at the centre stake, and at the approximate points E and H (see last diagram).

The seventh and eighth columns contain the differences of level between the centre stake and the above approximate points. These numbers are simply the differences of the quantities in the three preceding columns (except at stakes 286 and 290, which we will presently explain), and the signs + and − denote whether they are positive or negative quantities, as respects the centre and the approximate points E and H.

The ninth and tenth columns contain the differences of level (contained in columns 7 and 8) multiplied by the ratio of the slopes, and must have the same signs + or − as the corresponding numbers in the preceding columns.

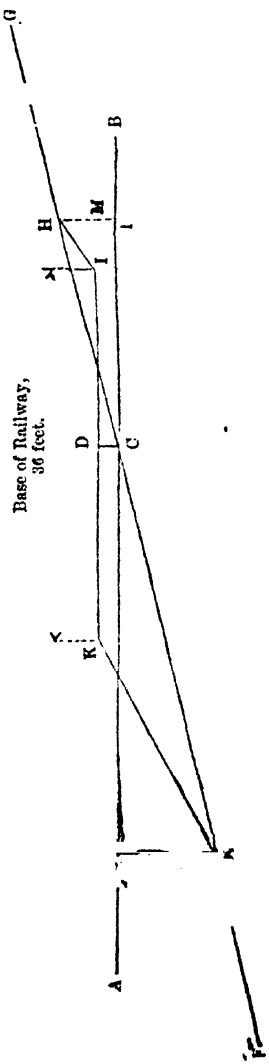
The last two columns contain the final half widths obtained by adding or subtracting, according to the prefixed signs + or −, the numbers in the two pre-

ceding columns to the computed half width contained in column 3.

After the explanations already given, the reader can find no difficulty in tracing the steps of the example, except perhaps with the stakes 286 and 290, where the difference of level on the north side is represented by two numbers bracketed together, one having the sign +, and the other − : for the stake 286 the real difference of level on the north side the centre is a rise of 1·50, that is, the approximate point H is 1·50 foot above the centre stake: but it happens that the height of the embankment itself at that point is to be but 1·43 foot (column 2); therefore the approximate point H is above the intended top of the embankment, and consequently will not represent the foot of an embankment, but the edge of a cutting, and therefore the calculation for the half width on the north side must be treated as for a cutting whose depth is equal to the *height of the approximate point* H *above the intended top of the embankment*; or, in other words, the *excess* of the difference of level between the centre stake and the approximate point H, above the intended height of the embankment, is the quantity to be entered in the column (7 or 8) "Difference of Level," and to be computed as for a cutting instead of embankment. In the case of stake 286 this excess is 0·07, to which is prefixed the sign plus; this sum multiplied by the ratio of the slope being additive (for a cutting) on the elevated side of the centre, as before explained.

For the stake 290, the north side of the line (column 6) is 1·34 higher than the centre stake, and it, being embankment, would have the sign − prefixed (as shown

by the lower number, column 8): but the central height of the embankment at that point is but 1·22 (column 2); therefore, 1·34 – 1·22 = 0·12, which is the depth of cutting on the elevated side, and when multiplied by the ratio of the slopes is to be added to the computed half width to obtain the correct result. When the surface of the ground is much inclined at right angles to the centre line, the numbers to be operated upon become proportionally large.



As it is a case of frequent occurrence that one side will be a cutting when the other is an embankment, we wish it to be well understood, and therefore annex the accompanying diagram to illustrate it

The line F G represents the natural surface of the ground, A B the horizontal line at the centre stake, C D the intended height of the embankment, K L the width or base of the railway, 36 feet, part of which is an embankment and part a cutting; the point E, or foot of the embankment, will be determined in the usual way, as explained at page 113; but the point H, which is to be the edge of the cutting, must be found by subtracting D C (the height of embankment) from H I (the dif-

ference of level); the remainder, H M (which is the *excess of the difference of level between the centre stake and the approximate point* H *above the intended height of embankment*), multiplied into the ratio of the slope, must be added to the computed half width, or, in other words, treated as for a cutting, to obtain the said point H, as before stated. By reversing the diagram the corresponding case will become evident; namely, when the centre line is in cutting, and one side on embankment, while the other is in excavation; and the mode of proceeding will at once strike the reader after perusing what we have above written.

EXAMPLES OF THE MODES

OF SETTING OUT

RAILWAY CURVES.

By HENRY LAW.

EXAMPLES OF THE MODES OF SETTING OUT

RAILWAY CURVES.

THERE are very few lines of railway so favourably situated as to be free from curves of greater or less extent, and occurring more or less frequently in their course; and consequently a knowledge of the method of correctly and readily laying down these curves upon the ground becomes a very necessary and important qualification in those engaged in setting out lines of railway. It has not therefore been considered out of place to append to a work treating on one of the most important branches of railway surveying, a description of the various methods which may be employed for this purpose.

Previously, however, to proceeding to the more practical part of the subject, it may be desirable to make a few observations upon railway curves in general. The curve which has been almost universally employed in laying down lines of railway, is the arc of a circle, although it may be shown, that under certain circumstances this curve is not *theoretically* that which should be employed, as affording the least danger from the centrifugal tendency of the carriages. It has been generally considered, that the *true curve* was one which commenced with an infinite radius, decreasing in a regular manner

in advancing on the curve, until the minimum radius of curvature required had been attained. This form of curve has, however, been deduced upon the assumption, that the *whole* of the centrifugal tendency of the carriages is balanced by the superelevation of the outer rail, an assumption which is only correct on the supposition of the wheels of the carriages being cylindrical, or no play being allowed between the flanges and the rails —conditions which are never fulfilled in practice. For it may be shown, that with conical wheels, and a certain amount of play, a portion of the centrifugal tendency will always be counteracted by the self-acting adjustment produced by the lateral deviation of the carriage on the rails, however small the radius of curvature may be; and that when the radius exceeds a certain limit, this adjustment is perfect, no superelevation of the outer rail being then required.

It is obvious, therefore, that in curves whose radii are *within* this limit, the true form for the curve is one whose radius of curvature at its commencement should equal this limit, and should decrease in advancing upon the curve, according to such a law, that (assuming the rise in the outer rail to form a regular inclined plane) the unbalanced centrifugal tendency should at every part of the curve be exactly counteracted by the amount of the superelevation of the rail at that part; until the top of the incline being reached, the radius of curvature should then remain constant, being such that the centrifugal tendency of the train should be exactly balanced by the combined effect of the lateral deviation of the carriages on the rails, and the superelevation of the outer rail. When, however, the radius of curvature ex-

ceeds this limit, it may be shown that the arc of a circle is preferable to any other form of curve.

Now if we put d for the diameter of the wheels of the carriages, w for the width of the gauge of the line, and p for the lateral play allowed *on each side*, between the flanges of the wheels and the rails (all the dimensions being expressed in feet), and $\frac{1}{n}$ being the ratio of inclination of the tire of the wheel; then

$$\frac{n\,d\,w}{4\,p} = \mathrm{R} \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{I.}$$

will be the limit above referred to; that is, R will be the least radius of curvature which may be used without the necessity of raising the outer rail. And for any other smaller radius, putting v for the velocity of the train in miles per hour, and r for the radius of the curve in feet; then

$$\frac{\cdot 782\, v^2\,(n\,d\,w - 4\,p\,r)}{n\,d\,r} = \epsilon \quad . \quad . \quad \text{II.}$$

will be the superelevation of the outer rail in inches, which will be required for that radius, in order that the whole of the centrifugal tendency of the train may be destroyed.

Although we have thus shown, that for all curves having a smaller radius than R, it would not be correct, *theoretically*, to employ the arc of a circle, it is nevertheless very questionable whether it would be advisable, *in practice* (except under peculiar circumstances), to substitute the theoretical curve in its stead, inasmuch as the circular arc possesses the practical advantage of being laid down upon the ground with far greater facility; and the only real objection which can be made to its use—namely, that of requiring a sudden and instantaneous superelevation of the outer rail at the point where

the curve commences—may in a great measure be removed by commencing to raise the rail before arriving at this point, and making the rise form a gradual inclined plane, whose summit shall be attained at the commencement of the curve. By the adoption of this plan, although the centrifugal tendency (as without it) commences suddenly, the counteracting force, produced by the superelevation of the outer rail, at the same instant attains its maximum, and the two forces therefore balance each other. Whereas, without it, the sudden commencement of the centrifugal force, being entirely unopposed, would at first tend to throw the carriages off the line, until, by the gradual elevation of the outer rail, it had been entirely destroyed.

Having thus far pursued the inquiry as to which form of curve it is most expedient to employ in practice in laying down a line of railway, and having shown that with hardly an exception the arc of a circle is practically the best, we shall confine ourselves to describing a few of the most generally applicable methods by which the circular arc may be traced on the ground.

The first method which we shall describe is that which has in practice been perhaps the most extensively used, although it possesses some objections, which we shall point out in the sequel. Let A B and C D (fig. 1, plate 6) be the two straight portions of the line which it is desired to connect by a curve, B and C being the two points at which the curve falls into the straight lines; and let B b_1, b_1 b_2, b_2 b_3, &c., be the distance which it is desired that the points to be found in the curve shall be apart: then measure upon the straight line A B produced, the distance B a_1, equal δ_1 in formula IV. below,

and from the point a_1 set off, perpendicular to the same line, the distance a_1 b_1 equal to o_1 in formula III., which will give the first point required in the curve; then range a straight line through the points B, b_1, and upon this line lay off the distance b_1, a_2, equal to δ_2 in formula VI., and from the point a_2 set off, perpendicular to the line B a_2, the distance a_2 b_2, equal to o_2, in formula V., and the point b_2 will be the second point in the curve; then in a similar manner range another line through the points b_1 b_2, upon which measure the distance b_2 a_3, equal to the distance δ_2 or b_1 a_2, and from a_3 set off as before, perpendicular to the line b_1 a_3, the distance a_3 b_3, equal to o_2, which will determine the third point in the curve: and thus proceed until the whole extent of the curve has been set out.

In order to obtain the values of δ_1, δ_2, o_1, and o_2, let r equal the radius and d equal the distance B b_1, or b_1 b_2, &c., which it is desired that the points found in the curve shall be apart (both expressed in feet): then

$$\frac{d^2}{2r} = o_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{III.}$$

$$\sqrt{d^2 - o_1^2} = \delta_1 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{IV.}$$

$$\frac{d\,\delta_1}{r} = o_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{V.}$$

$$\frac{d\,(r - o_1)}{r} = \delta_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{VI.}$$

As an example of the application of this method, let the radius of the curve (r) be 15 chains or 990 feet, and the distance B b_1 (d) one chain or 66 feet; then from formula III.

$$\frac{66^2}{2 \times 990} = 2{\cdot}2 \text{ feet} = o_1$$

will be the first offset at a_1; and

$$\sqrt{66^2 - 2{\cdot}2^2} = 65{\cdot}963 \text{ feet} = \delta_1$$

will be the distance B a_1, to be laid off upon the line A B produced to give the place for this offset. Again,

$$\frac{66 \times 65{\cdot}963}{990} = 4{\cdot}397 \text{ feet} = o_2$$

will be the offset at a_2, a_3, a_4, &c. ; and

$$\frac{66 \times (990 - 2{\cdot}2)}{990} = 65{\cdot}85 \text{ feet} = \delta_2$$

will be the distance b_1 a_2, b_2 a_3, &c., to be measured from the points b_1, b_2, &c., in order to give the points a_2, a_3, a_4, &c., from which the offsets o_2 are to be taken.

To this method there are, as has been already stated, some practical objections, inasmuch as any error which may be committed, in setting out only one of the points in the curve, will occasion a corresponding error in every succeeding one; and a very trifling inaccuracy in calculating either the distance δ_2, or the length of the offset o_2, from its being frequently repeated, may ultimately cause a very considerable deviation from the true curve. Both these objections, however, may be in a great measure removed by the adoption of the following method of checking the position of about every fifth point; or, which would be better, first determining the position of these points, and then filling in the intermediate ones; and as we consider this modification does away almost entirely with the above-mentioned sources of error, we shall give an example of its application.

Let us suppose r and d, or the radius, and the distance the points B, b_1, b_2, &c., are apart (see figure 2, plate 6), to be the same as in the last example—viz., 990 feet and 66 feet respectively, and let it be determined to check the position of every *fourth* point: then the values of δ_1, δ_2, o_1, and o_2, will be the same as before; but previous to

setting out the points b_1, b_2, b_3, &c., we must calculate the distance $B B_1$ to be measured along the line A B produced, and the distance $B_1 b_4$ to be set off from the point B_1 to give the position of the fourth point (b_4) in the curve, which may be done as follows: Let the distance $B B_1$ equal Δ_1, and $B_1 b_4$ equal O_1; and let D_1 be the length of the chord line connecting the two points B and b_4, and β be the angle a_1 B b_1; then

$$\frac{o_1 \text{ rad}}{d} = \sin \beta,$$

and

$$\frac{2 r \sin 4 \beta}{\text{rad}} = D_1.$$

Then, by substituting D_1, O_1, and Δ_1, for d, o_1, and δ_1, in the formulæ III., IV., V., and VI., we shall obtain the values of O_1, Δ_1, O_2, and Δ_2, where Δ_2 is the distance b_4 B_2 to be measured upon the chord line $B_1 b_4$ produced, and O_2 is the distance $B_2 b_8$ to be set off from B_2 in order to give the eighth point (b_8) in the curve; for the values of r and d given above we shall obtain

Log o_1	= 0·342423	= log 2·2
Log rad	= 10·000000	
	10·342423	
Log d	= 1·819544	= log 66
Log sin β	= 8·522879	

and $\beta = 1° 54' 37'' \therefore 4\beta = 7° 38' 28''$; then

Log $2r$	= 3·296665	= log 1980
Log sin 4β	= 9·123745	
	12·420410	
Log rad	= 10·000000	
Log D_1	= 2·420410	= log 263·27.

Then from formula III.

$$\frac{263{\cdot}27^2}{2 \times 990} = 35 \text{ feet} = O_1;$$

from formula IV.

$$\sqrt{263{\cdot}27^2 - 35^2} = 260{\cdot}92 \text{ feet} = \Delta_1;$$

from formula V.

$$\frac{263{\cdot}27 \times 260{\cdot}92}{990} = 69{\cdot}4 = O_2;$$

and from formula VI.

$$\frac{263{\cdot}27 \times (990 - 35)}{990} = 253{\cdot}96 = \Delta_2.$$

These being obtained, the position of every fourth point, b_4, b_8, b_{12}, &c., should be first determined by the dimensions Δ_1, O_1, Δ_2, and O_2; and then the intermediate points b_1, b_2, b_3, b_5, b_6, &c., by δ_1, o_1, δ_2, and o_2, as first described.

The second method which we shall describe may be advantageously employed when the radius of curvature is large and the centre can be seen from every part of the curve.

Let the lines (figure 3, plate 6) A B and C D as before represent the two straight portions of the line required to be connected by a curve having a radius of 80 chains or 1 mile. First set up a theodolite at B and another at C (the two terminations of the straight portions of the line) and from each point range a line at right angles to the lines A B and C D respectively, and at the intersection of these lines (E), which will be the centre of the curve, put up a signal sufficiently conspicuous to be seen from any point between B and C. Then produce the straight lines A B and C D until they intersect in the point F, and on these lines drive in stakes at equal distances, a_1, a_2, a_3, &c., commencing from the points

B and C. If r equal the radius, and δ equal the distance between the points a_1, a_2, a_3, &c., both in feet, then

$$\sqrt{r^2+\delta^2} - r = o_1$$

will be the distance which must be set off from the first point a_1, not perpendicular to the line B F, but in the direction a_1 E; in like manner

$$\sqrt{r^2+2\,\delta^2} - r = o_2$$

will be the distance to be set off from the point a_2 in the direction a_2 E; and generally

$$\sqrt{r^2+n\,\delta^2} - r = o_n$$

will be the distance to be set off at the nth points from B and C.

For example, let r be 5280 feet and δ equal 100 feet: then

$$\sqrt{5280^2+100^2} - 5280 = \cdot 94 \text{ feet} = o_1$$

will be the distance $a_1\ b_1$, which must be set off from a_1 in the direction a_1 E to obtain the first point b_1 in the curve; and proceeding in a similar manner with the others, the following Table will exhibit the distances to be set off at the respective points a_1, a_2, a_3, &c.:

At a_1	or	100 feet from B,	the offset will be	·94 feet.
a_2		200 ,,	,,	3·79
a_3		300 ,,	,,	8·52
a_4		400 ,,	,,	15·13
a_5		500 ,,	,,	23·62
a_6		600 ,,	,,	33·98
a_7		700 ,,	,,	46·19
a_8		800 ,,	,,	60·26
a_9		900 ,,	,,	76·16
a_{10}		1000 ,,	,,	93·86
a_{11}		1100 ,,	,,	113·36
a_{12}		1200 ,,	,,	134·65
a_{13}		1300 ,,	,,	157·68
a_{14}		1400 ,,	,,	182·45
a_{15}		1500 ,,	,,	208·93

If the extent of the curve is such that the length of the offsets before reaching the point F, where the two tangent lines intersect, become inconveniently long, so as to occasion a loss of time in setting them off, it will be advisable to make use of another tangent line as shown at G I, fig. 4, plate 7; for determining the position of which line the following method may be made use of. Let r, as before, be the radius, ϵ the number of degrees contained by the angle B E C, and n the number of tangent lines (as B G, G H, H I, I C) intended to be employed; then

$$\frac{r \sin \frac{\epsilon}{n}}{\cos \frac{\epsilon}{n}} = r \tan \frac{\epsilon}{n}$$

will be equal to the length of any one of these tangent lines. As an example, let r be equal to 5280 feet, ϵ equal to 60°, and n equal to 4, so that the quotient of ϵ divided by n will be 15°: then the calculation for the length of each of the lines B G, G H, &c., will be as follows:—

$$\begin{aligned} \text{Log } r &= 3{\cdot}722634 \\ \text{Log tan } \frac{\epsilon}{n} &= 9{\cdot}428052 \\ & \\ & 3{\cdot}150686 = \log 1414{\cdot}8. \end{aligned}$$

Hence the length of each of the lines B G, G H, &c., will be 1414·8 feet.

Now, having ascertained this length, nothing more remains than to set it off from B and C towards F, and then to range a line G I from the two points thus obtained, which will be the required tangent line: this line must then be bisected in the point H, which may

readily be done by ranging a line from F to E, which having been done, proceed as already described to set off the equal distances a_1, a_2, a_3, &c., from B and H towards G, and from H and C towards I; and then by setting off the distances a_1, b_1, a_2, b_2, &c., contained in the Table already given, from the several points a_1, a_2, &c., in directions radiating to the centre E, the course of the curve will be marked by the points b_1, b_2, b_3, &c., thus obtained.

One advantage possessed by the above method is, that, knowing exactly the direction in which to lay off the offsets (and that by the range of a comparatively distant object), the errors which have frequently arisen from their not having been set off perpendicularly, where the eye has been the only criterion, are entirely obviated; and this method is also entirely free from the objections made to the former method.

When the centre point E cannot be seen from every part of the curve, so as to allow the offsets being laid off radially, the more usual method may be adopted of laying off the offsets perpendicularly to the tangent B F, but in this case a cross staff should always be employed to insure accuracy, and the distances to be set off from the points a_1, a_2, a_3, &c., will be greater than those employed in the previous method, and must be calculated from the formula

$$r - \sqrt{r^2 - c^2} = o_1$$

instead of that given at page 131.

The third method is most applicable where the radius of the curve is small as compared with its extent, and is deduced from the well-known theorem, that all angles

contained in the same segment of a circle are equal to one another.* The method is as follows:—Place a theodolite at B and another at C (figure 5, plate 7), the two terminations of the straight portions of the line, setting the telescope of the instrument at B on C, and that at C on F, the point of intersection of the lines A B and C D produced; then if the former be moved through an arc of any number of degrees, towards F, and the latter the same number of degrees towards B, the point a_1, where the lines of collimation of the two telescopes intersect, will be a point in the curve; now let both theodolites be again moved the same number of degrees and in the same directions as before, and their axes produced, or lines of collimation, will again intersect at a_2, another point in the curve; and in fact, to whatever extent the theodolites are moved, so long as the arc described is equal in both, the point of their intersection will always be in the required curve. Or more generally, suppose the two theodolites to be placed as first described, and then simultaneously to commence to revolve with the same uniform angular velocity, the point of intersection of their lines of collimation will describe the circular arc C, a_1, a_2, a_3, ... B; and in equal intervals of time, equal portions of the arc will be described, which will be half as great as the arc, which would have been described in the same time, by the same angular velocity, at the centre of the circle (E); from which last-mentioned circumstance, we may readily calculate the magnitude of the angle through which the theodolites at B and C must be successively moved, in order that the points a_1, a_2, a_3, &c., at which their axes intersect, may

* Euclid, Book III., prop. 21.

be at the distance apart which it is desired that they should be. If r equal the radius of the curve, d the required distance, and β the angle a_1 B C; then

$$\frac{d \text{ rad}}{2r} = \sin \beta \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{VII.}$$

As an example of the application of this method, let r equal 20 chains, or 1320 feet, and let it be required to determine points in the curve at distances of about 100 feet; now, from the above formula we shall obtain

$$\begin{aligned} \text{Log } d &= 2{\cdot}000000 = \log 100 \\ \text{Log rad} &= 10{\cdot}000000 \\ & \quad 12{\cdot}000000 \\ \text{Log } 2r &= 3{\cdot}421604 = \log 2640 \\ \text{Log sin } \beta &= 8{\cdot}578396 \therefore \beta = 2^\circ\ 10'\ 15''. \end{aligned}$$

As it would be inconvenient, however, in practice, to lay off so frequently as would be required, an angle with odd minutes and seconds, we may instead of the above take an angle of 2 degrees, which will make the distance d equal 92·13 feet. Having thus determined the angle, and placed the theodolites as previously described—viz., that at B in the direction B C, and that at C in the direction C F—the former must be moved 2° towards F, and the latter 2° towards B, and a stake driven down at their point of intersection a_1; the former must then be moved 2° more towards F, and the latter 2° more towards B, and another stake put down at their point of intersection a_2, and so on until the theodolite at B is brought to the direction B F, and that at C to the direction C B, when the whole of the curve will have been staked out as required, the stakes being 92·13 feet

apart. This method, the same as the last, is not liable to the objections that the first method was, and in addition possesses the very important practical advantage, that its accuracy is entirely independent of any undulation or change of level in the surface of the ground, an advantage which is not possessed by any of the other methods which we have described, the whole of which would require to have the distances and offsets corrected in proportion to the slope of the surface of the ground. In a hilly country—and it is in such districts that curves most frequently occur—this circumstance will render the last-described method far superior to either of those which precede it.

The next method which we shall give, is that described by Mr. Rankine, in a communication to the Institution of Civil Engineers, and depends on the theorem * that the angle subtended by any arc of a circle at the centre of a circle, is double the angle subtended by the same arc at any point in the circumference of the circle. The method of proceeding is as follows: first place a theodolite at B (figure 6, plate 7), the point where the curve commences; and then lay off from the line BF the angle B, calculated from formula VII. (supposing as before r to represent the radius of the curve and d the distance required between the points in the curve), and in the direction of the axis of the instrument set off the distance d, which will give the first point a_1 in the curve; in the same manner lay off from BF the angle 2β, and from a_1 set off the same distance d, and the point where it cuts the axis of the instrument produced will be the second point a_2; and generally by

* Euclid, Book III., prop. 20.

laying off the angle $n\beta$, and setting off from the preceding point a_m the distance d, the point a_n will be given.

As an example of the application of this method, let r equal 19 chains, or 1254 feet, and d equal 100 feet; then from formula VII. we obtain

$$\begin{aligned} \text{Log } d &= 2{\cdot}000000 = \log 100 \\ \text{Log rad} &= 10{\cdot}000000 \\ & \quad 12{\cdot}000000 \\ \text{Log } 2r &= 3{\cdot}399328 = \log 2508 \\ \text{Log sin } \beta &= 8{\cdot}600672 \therefore \beta\ 2^\circ\ 17'\ 6'' ; \end{aligned}$$

then having placed the theodolite at the point B, lay off this angle 2° 17′ 6″ from the line B F, and upon the line B a_1 thus obtained set off 100 feet, which will give the first point in the curve a_1; then with an angle of 4° 34′ 12″ or 2 β set off another 100 feet from a_1, which will give the second point a_2, and thus proceed until the whole extent of the curve has been set out.

Having now pointed out several methods of procedure, in setting out the curved portions of a line of Railway, and having stated generally their relative advantages and disadvantages, we must leave it to the person using them to determine, from the circumstances attending any particular instance, which of these methods it would be preferable to employ. It may perhaps be necessary to add, that in passing from a curve of greater to one of less radius, and *vice versâ*, or in passing at once from a line curving in one direction to a line curving in the contrary direction, or a curve of contrary flexure, nothing more is requisite than to set off the

tangent line to the curve at the point where the alteration occurs, and then to work from that line as from the line A B in any of the methods given above.

In conclusion, we would urge that too much care cannot be employed in the operations described above, much of the durability of the permanent way, freedom from jerks and uneasy motion, and also safety in travelling upon lines of Railway, depending upon the accuracy with which the rails are laid, the more especially on the curved portions of the line.

THE FIELD PRACTICE

OF

LAYING OUT CIRCULAR CURVES

FOR

RAILROADS.

By JOHN C. TRAUTWINE,

CIVIL ENGINEER.

PREFACE.

THIS little volume has been prepared almost entirely with reference to the wants of young men who desire to qualify themselves for field service in an Engineer Corps. On that account the plainest language has been used to render the subject intelligible,—dispensing with mathematical brevity.

The Table of Natural Sines and Tangents to single minutes, in a form sufficiently portable for field use, will supply a want which is frequently experienced, not only in the operation of laying out curves, but on many other occasions.

One object in preparing it, was to furnish the profession with a Table that should be not only portable, but *absolutely reliable.* Those whose occupations compel them to resort to the Tables in common use, must have frequently experienced the embarrassment which attends the inaccuracies to which they are all subject. So long as a Table is known to contain a single error, the position of which is not ascertained, its employment is attended with doubt in every instance in which we are obliged to refer to it.

As Hutton's Tables of Natural Sines and Tangents are those most in use among the profession, it will be desirable to those persons who possess them, to be able to correct the following errors, which I detected in comparing them.

In Hutton's Tables, Fifth Edition, 1811.

Sine of 6° 8′, for ·1063425, read ·1068425.
Page 328, at top, for 25 Deg., read 40 Deg.
Tangent of 44° 60′, for ·1000000, read 1·000000.
Tangent of 41° 60′, for ·8994040, read ·9004040.

In Dr. Gregory's corrected Edition (the 8th) of Hutton's Tables, 1838.

Sine of 49° 14′, for ·7576751, read ·7573751.

In Hassler's Tables, 1830.

Sine of 78° 24′, read ·9795752.
Sine of 20° 60′, „ ·3583679.
Sine of 66° 19′, „ ·9157795.
Sine of 56° 39′, „ ·8353279.
Sine of 55° 20′, „ ·8224751.
Sine of 53° 4′, „ ·7993352.
Sine of 48° 12′, „ ·7454760.
Sine of 45° 3′, „ ·7077236.

The discrepancies of 1 in the 7th decimal, are not considered as errors, as they are occasioned by a neglect of the value of the 8th decimal. For calculating curves, it is not necessary to use more than 4 decimals.

It is scarcely necessary to remark that, beyond 44°, the Sines, Tangents, &c. are read *upwards*, from the bottom of the page, using the corresponding column of minutes. To find the sine of an angle exceeding 90°, subtract the angle from 180°, and take out the sine of the remainder—because the sine of an angle, and that of what it wants of 180°, are the same.

J. C. T.

THE FIELD PRACTICE

OF

LAYING OUT CIRCULAR CURVES

FOR

RAILROADS.

ARTICLE I.

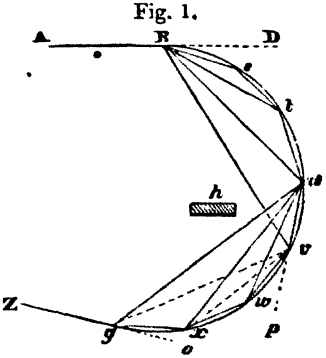
PRINCIPLES OF LAYING OUT CURVES.

METHOD 1.

To lay out a Curve by means of Tangential Angles.

If from any point B, fig. 1, in a straight line A D, we lay off a number of equal angles, as D B s, s B t, t B u, u B v, &c., and at the same time make the chords B s, s t, t u, u v, &c., equal to each other, then the points B, s, t, u, v, &c., will be situated in the circumference of a circle, which is tangential to the line A D at the point B.

Fig. 1.



The first of these angles, D B s, is called the *tangential angle*, as being that by which the curve is connected with the tangent A D; but inasmuch as the others are all equal to it, they also are called tangential angles.

If any obstacle, as h, should prevent our seeing from B farther than to v, the curve may be continued by removing the instrument to u, the point preceding v: thence sighting first on v, continue to lay off additional tangential angles v u w, w u x, &c., as before. Or else, moving the instrument to v itself instead of to u, sight back to u, and lay off first the exterior angle p v w, equal to *double* the tangential angle, and afterwards continue the tangential angles w v x, x v g, &c., as before, to the end of the curve.

Finally, in order to pass from the end of the curve at g, on to a tangent $g\ z$, place the instrument at g, and sighting back to x, lay off the tangential angle $x\ g\ o$; then $o\ g$ continued towards Z will be the required tangent. (See Art. IV.)

For the tangential angles corresponding to different radii, and chords of 100 feet, see page 160.

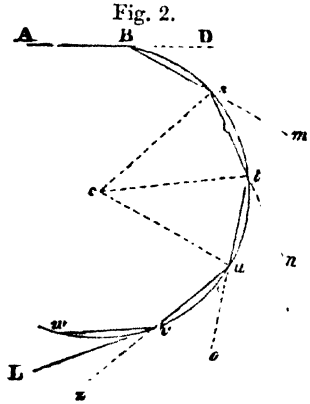
ARTICLE II.

METHOD 2.

To lay out a Curve by means of Deflection Angles.

Fig. 2. First, having, as in method 1, laid off a tangential angle D B s, and measured the chord B s, remove the instrument to the end s of the chord, and make the exterior angle $m\ s\ t$ equal to *twice* the tangential angle, and measure the chord $s\ t$; and so on at the other points $t\ u\ v$, &c., making each of the exterior angles $n\ t\ u$, $o\ u\ v$, equal to twice the tangential angle, and all the chords equal; then will the points B, s, t, u, v, &c., be in the circumference of a circle which is tangential to the line A D at the point B, as by the first method.

Fig. 2.



But if, at any of these points, as v, we wish to pass off to a tangent v L, employ at that point the *tangential* angle $z\ v$ L, equal to half the deflection angle $z\ v\ w$. (See Art. IV.)

These exterior angles, included between any *chord* and the extension of the preceding *chord*, are called *deflection angles*, or *angles of deflection*, or *angles of curvature*. In any given circle, the angle of deflection is always precisely double the tangential angle, supposing the chords to be equal. At page 160, we give tables of the angles corresponding to circles of different radii, embracing the limits of railroad practice; and calculated for chords 100 feet in length, that being the usual length for a measuring chain on public works.

N.B. The deflection angle of any curve is equal to the angle $t\ c\ u$, or $t\ c\ s$, &c., at the centre of the circle, subtended by one of the equal chords $t\ u$ or $t\ s$. This angle at the centre, so subtended, is called the *central* angle. The tangential angle, being always half the deflection angle, is, of course, always half the central angle.

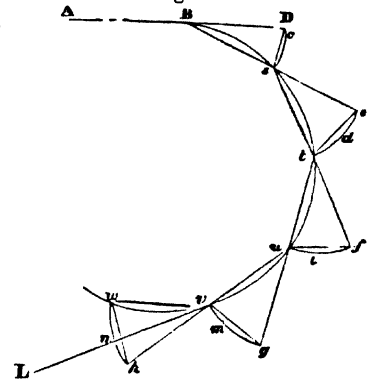
ARTICLE III.

METHOD 3.

To lay out a Curve by Eye.

The *deflection* angles, fig. 3, *e s t*, *f t u*, *g u v*, *h v w*, &c., being double the *tangential* angle D B *s*, the *arcs* *e d t*, *f i u*, *g m v*, *h n w*, &c., are double the *arc* D *c s*, since the arcs of circles are proportionate to the angles which they subtend; but the *chords* *e t*, *f u*, *g v*, *h w*, &c., are *not* double the *chord* D *s*, since the chords of arcs are not proportionate to the arcs or to the angles which they subtend.

Fig. 3.



The chords *e t*, *f u*, *g v*, *h w*, &c., which subtend the deflection angles, are called *deflection distances*; and the chord D *s*, which subtends the tangential angle, is called the *tangential distance*.

But although, in any given circle, the deflection distance is not *truly* twice the tangential distance, yet the difference is so trifling in large railroad curves, with chords of but 100 feet, that it may generally be neglected in curves of more than 300 feet radius.

In our tables the *precise* length of both will be found for different radii, and for chords of 100 feet.

Having these respective distances, we may frequently trace a curve on the ground by the eye only, with very tolerable accuracy, sufficient for guiding the excavations and embankments, especially on nearly level ground. Suppose, for instance, it be required to lay out in this manner a curve of 5730 feet radius.

First, find by the table, page 160, or by Art. XVI., the deflection distance *c t* or *f u*, &c., corresponding to a radius of 5730 feet for a chord of 100 feet—viz., 1·745 foot; and also the tangential distance *D s*, ·873 of a foot.

Then from the starting-point B, and in line with A B, measure B D, equal 100 feet, and put a pin at D. Also from B, measure the chord B *s*, equal 100 feet; at the same time measuring with a graduated rod, from the pin D, the *tangential* distance D *s*, equal to ·873 of a foot; and place a stake at *s*. The pin at D may then be removed.

Next, make *s e* equal to 100 feet, placing a pin at *e*, precisely in line with *s* B; also from *s* measure *s t*, equal 100 feet; at the same time measuring with the rod, from the pin *e*, the *deflection* distance *e t*,

equal to 1·745 foot. Place a stake at *t*, and remove the pin at *e*. In this manner proceed to find other points as far as the end of the curve at *v*.

In order to pass the curve, as at *v*, to a tangent *v* L, proceed as before, only using the tangential distance *h n*, instead of the deflection distance *h w*. (See Art. IV.)

This method is abundantly accurate for laying out curves on a canal or common road; and will occasionally answer very well, when carefully performed, for railroad curves, in the absence of an instrument. Thin straight rods, iron-pointed, and a plumb-line should be used for ranging the points in the latter case.

The transit instrument is the best for tracing curves, and running lines generally. I prefer the graduations to run from the same zero, right and left, to 180° each way. There should be two verniers, graduated to minutes; by their means half or even quarter minutes may generally be estimated with considerable certainty. The telescope, revolving in a vertical plane, greatly expedites the laying off of exterior angles, after having first sighted backward to the point behind.

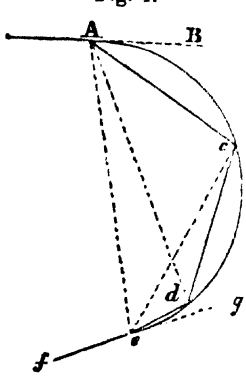
The verniers are sometimes graduated to hundredths of a degree; and this division is, in certain cases, the best; but for *general* purposes, the division into minutes is to be preferred, as all the printed tables of sines, tangents, &c., are calculated for that division.

ARTICLE IV.

On Sub-Chords.

We have hitherto spoken of curves as if they were composed of equal chords, each of 100 feet in length. It frequently happens, however, that at the end of a curve, as at *e*, fig. 4, we are obliged to use a shorter or sub-chord, *d e*, in order to unite properly with the tangent *e f*.

Fig. 4.



In that case, and *when using Method* 1, *Art.* I., *of laying out curves by means of tangential angles*, we must in order to fix the point *e*, lay off a *sub-tangential* angle, *d* A *c*, as much smaller than the entire tangential angle B A *c*, or *c* A *d*, &c., as the sub-chord *d e* is smaller than an entire 100 feet chord, *A c*, *c d*, &c. Thus, if the sub-chord be one-half, or one-fourth, &c., of the entire chord, the sub-tangential angle must be one-half, or one-fourth, &c., of the entire tangential angle.

This method is not mathematically exact, for the reason stated in Art. III. (viz., that the *chords* subtending different angles are not proportional to those angles); yet, for curves of 300 or more feet radius, and with chords not exceeding 100 feet in length, the error is not observable in practice.

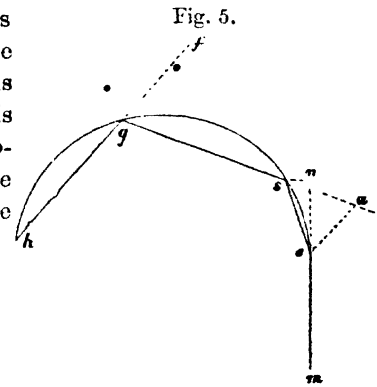
In like manner, when we pass off from a sub-chord, as at *e*, to a second tangent, *e f*, we must place the instrument at *e*, and lay off the same sub-tangential angle *d e g*; or, which is better, take sight from *e* to *c*, and lay off the angle *c e g*, equal to the *sum* of a tangential and the sub-tangential angle.

But *when using Method* 2, *Art.* II., *of deflection angles, or Method* 3, *Art.* III., *of deflection distances, we may calculate the sub-deflection angle* a s e, *fig.* 5, *and sub-deflection distance* a e, *formed between a sub-chord* s e, *and the extension* s a, *of an entire chord* g s, *with sufficient accuracy for curves of* 300 *or more feet radius, and chords of not more than* 100 *feet, thus*:

Rule.—Say, As an entire chord of 100 feet is to the sub-chord *s e*, so is the *deflection* angle of the curve to a certain angle. Add these two angles together and divide their sum by 2, for the sub-deflection angle *a s e* of the sub-chord.

Example.—The curve, fig. 5, has a radius of 319·6 feet, and an angle of deflection, *f g s*, of 18° for chords of 100 feet. The sub-chord *s e* is 25 feet in length: what is the sub-deflection *angle a s e*; and also the sub-deflection *distance a e*, for the sub-chord *s e*?

Fig. 5.



	Chord.	Sub-Chord.
Here, as	100	is to 25,
	Def. An. of 100 feet chord.	Certain Angle.
So is	18°	to 4° 30′.

The sum of these two angles, 18° and 4° 30′ = 22° 30′, the half of which is 11° 15′, the required sub-deflection angle *a s e*.

Again, to find the sub-deflection distance *a e* of the sub-chord *s e*; take from the table of sines the natural sine of *one-half* the sub-deflection angle *a s e*, just found. Multiply this natural sine by 2, and multiply that product by the length of the sub-chord.

Example.—The sub-deflection angle is 11° 15′; one half of it is 5° 37½′, the tabular natural sine of which is ·0979, which, multiplied by 2, gives ·1958; this, multiplied by the sub-chord, 25 feet, gives 4·895 feet, the required sub-deflection distance *a e*.

Finally, to find the sub-tangential distance $s\,n$, by means of which to pass from e to the tangent $e\,m$, say, As 10000 is to the square of the sub-chord in feet, so is the *tangential* distance for 100 feet chord to $s\,n$. In this instance, we have, As 10000 is to 625, so is 15·69 feet to ·980 foot, or $s\,n$.

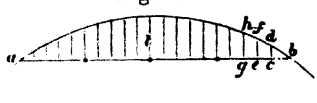
ARTICLE V.

Ordinates for Entire Chords.

It would be both tedious, and liable to inaccuracy, to attempt to fix all the necessary points in railroad curves by the foregoing means, which are employed only for entire chords, or for such sub-chords as may be required at the ends of curves.

The best method is to stretch a piece of twine, $a\,b$, fig. 6, 100 feet long, between two adjacent chord-stakes, and measure off as nearly as may be at right angles to it, with a graduated rod, the previously calculated ordinates, $c\,d$, $e\,f$, $g\,h$, &c., placing pegs at d, f, h, &c.* Our table of ordinates, page 162, is calculated for distances apart, $b\,c$, $c\,e$, $e\,g$, &c., of 5 feet; and for all curves likely to occur in practice. The 5 feet distances on the twine should be marked by knots or otherwise; and those at the centre, and half way between it and the ends, be further distinguished by tying on pieces of tape.

Fig. 6.



The 5 feet distances are only used (after the excavations and embankments are finished) for placing pegs to guide the laying of the rails, and then only for very sudden curves; for those of large radii, distances of 10 feet are sufficiently near, or even 25 feet for very easy curves. For guiding the curves of the cuttings and fillings, it is not necessary to place the stakes nearer than 50 feet apart; unless for those of less than about 1000 feet radius, when they may be placed 25 feet apart. Ordinates for radii intermediate to those in the table, may either be calculated by the rules given further on, or they may be taken proportionally intermediate of the tabular ones, with sufficient accuracy for practice.

Ordinates for Sub-Chords.

These may readily be calculated *approximately enough for railroad practice*, for curves of over 300 feet radius, and for chords not exceeding 100 feet, thus: In a circle of given radius, not less than about 300 feet, the ordinates of an entire 100 feet chord may be

* On the tops of these stakes small tacks are driven, to define the precise point in the curve.

assumed to be to those of a sub-chord as the square of the chord is to the square of the sub-chord.

In all our tables the chord is supposed to be 100 feet, the square of which is 10000; the rule therefore becomes, As 10000 feet : square of sub-chord in feet :: Ord. of Chord : Ord. of Sub-Chord *approximately*.

Example.—In a curve of 5730 feet radius, the middle ordinate of a 100 feet chord is ·218 of a foot; what will be the length of the middle ordinate of a sub-chord of 50 feet? Here,

Sq. of 100 ft. :	Sq. of 50 ft. ::	Mid. Ord. of Chord. :	Mid. Ord. Sub-Chord *approximately*.
10000 :	2500 ::	·218 ft. :	·0545 ft.

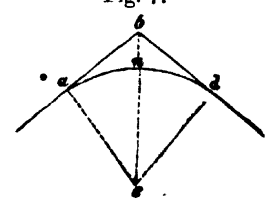
And so of any other ordinate, always supposing the chord and sub-chord to be divided into the *same number of parts*.

ARTICLE VI.

Having given the angle a b d, *fig.* 7, *it is required to find the point* a *or* d, *at which to commence a curve of given radius.*

Rule.—Subtract half the angle *a b d* from 90°; the remainder will be the angle *b c a* or *b c d*. From the table of tangents take the natural tangent of *b c a*, and multiply it by the given radius; the product will be *b a* or *b d*.

Fig. 7.



Example.—Let the angle *a b d* be 120°, how far from *b* must we begin, at *a* or *d*, to lay out a curve, *a n d*, of 2865 feet radius?

Here, half of the angle *a b d* = 60°, which taken from 90° leaves the angle *b c a* = 30°. The natural tangent of 30° = ·5773, which, multiplied by the radius of 2865 feet, gives 1653·96 feet for *b a* or *b d*. (See Art. XII.)

ARTICLE VII.

Having given the angle a b d, *fig.* 7, *and the distance from* b *to* a *or* d, *at one of which we wish to commence a curve, it is required to find what radius,* c a *or* c d, *the curve must have, in order to unite with* b a *and* b d *tangentially at* a *and* d.

Rule.—Subtract the angle *a b c*, which is half the angle *a b d*, from 90°; the remainder will be the angle *b c a* or *b c d*. Then as natural sine of *b c a** is to natural sine of *a b c*,† so is *a b* to *a c*, the radius required.

* The angle opposite the given side, *a b*.

† The angle opposite the required side, *a c*.

Example.—Let the angle *a b d* be 120°, and the distance *b a* or *b d* 1654 feet; what will be the radius *a c* or *c d* of a circle that shall touch *a* and *d* tangentially?

Here, the angle *a b c* = half the angle *a b d*, is 60°, which, taken from 90°, leaves the angle *b c a* or *b c d* = 30°. Then, as the natural sine of *b c a* (30°) = ·5000 is to natural sine of *a b c* 60°) = ·8660, so is *b a* (1654 feet) to *a c* (2865 feet) the radius required.

ARTICLE VIII.

Having given the radius a c, *fig.* 7, *of a curve, and the angle* a b d, *it is required to find the number of chords of* 100 *feet that will constitute the curve.*

Rule.—Subtract the angle *a b d* from 180°, and divide the remainder by the angle of curvature, or deflection of the curve. The quotient will be the required number of chords.

Example.—Let the angle *a b d* be 120°, and the radius *a c* 2865 feet.

Here, the angle *a b d*, 120°, subtracted from 180°, leaves a remainder of 60°; which, divided by 2°, the angle of deflection for a curve of 2865 feet, gives a quotient of 30; which is the required number of chords of 100 feet.

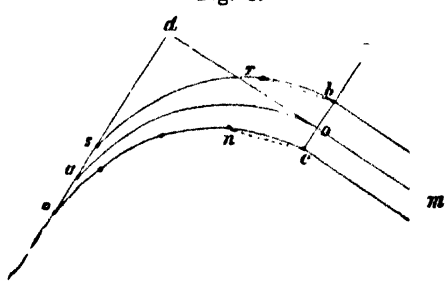
N.B.—Had the quotient contained a *fraction* of a chord, it would have indicated that we should have had to employ a sub-chord at the end of the curve; for instance, had the number of chords been 30½, a sub-chord of 50 feet (very approximately) would have been necessary.

ARTICLE IX.

How to proceed when the end of a curve does not correctly join the tangent.

We sometimes find, in running out a curve for the number of chords determined by the Rule in the preceding Article, that, instead of uniting as it should with the previously determined tan-

Fig. 8.



gent *d m*, fig. 8, at *o*, it ends tangentially to a line *parallel* to said tangent, either *within* it, as at *c*; or beyond it, as at *b*. Being first certain that no error has occurred in tracing out the curve, ascertain with the compass the bearing of the tangent *a d*, and, removing the compass to the end of the curve at *c* or *b* (as the case may be), run the line *b o* or *c o*, in the same course as *a d*, until it strikes the tangent *d o m*; which may be ascertained by ranging two stakes placed on the tangent.

Then measure *b o* or *c o* (as the case may be), and if the curve fall *within* the tangent *o m*, as at *c*, measure *forwards* from *t* towards *d* the distance *t a*, equal to *c o*; or if the curve fall *beyond* the tangent, as at *b*, measure *backwards* from *s* the distance *s a*, equal to *b o*. Then the curve retraced from *a* will terminate tangentially in *d m* at *o*.

N.B.—The direction of *c o* or *b o* may be ascertained without a compass, and better, thus: Multiply the *tangential* angle of the curve by *twice* the number of chords run, *less one*; subtract the product from 180°, and sighting back one chord to *n* or *r*, lay off the angle *n c b* or *r b v*, equal to the remainder. For example, if the tangential angle be 10°, and from *t* to *c* be 4 chords, then 7 times 10° taken from 180° leaves the angle *n c b* or *r b v* = 110°. When the product exceeds 180°, it must be subtracted from 360° for the angle *n c b* or *r b v*.*

This case occurs whenever an error has been made in measuring the distance from *d* to *a*. If *d a* be made too short, the curve *s b* is the result; and if too long, the curve *t c*.

If the error is small, it may be divided equally among the chords by measure without retracing the curve with an instrument. This method may be employed with perfect security so long as the error does not exceed 1 foot to every chord of 100 feet; and it will never be so great if moderate care be taken.

Thus, if the curve be 20 chords long, and the error 20 feet, the last stake may be moved 20 feet, the next 19, the next 18, &c., as nearly at right angles to the curve as can be judged by the eye.

The same ordinates that would have been used had the curve been correct will answer for the one so adjusted, without perceptible difference. For other cases, see Art. X.

ARTICLE X.

Again, it may happen that the error is not caused by a mismeasurement of the distance *a c*, figs. 9 and 10, as in the last case; but by mistake in obtaining the angle *a e f*.

* In both cases the angle is measured *outwardly* from the curve; but when the curve falls beyond the tangent, as at *b*, then *b v* must be continued inwardly, as *b o*.

If $a\ e\ f$, fig. 9, be measured in excess, as $a\ e\ g$, then the curve $a\ b\ c$,

Fig. 9.

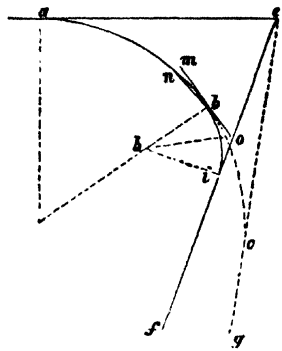
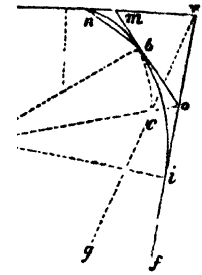


Fig. 10.



calculated for the incorrect angle $a\ e\ g$, will be found to fall *beyond* the true tangent $e\ f$, as at c; and the tangents $e\ g$ and $c\ f$ not being parallel, the curve cannot be adjusted by either of the methods given in the preceding Article, unless the error be within about 1 foot to each 100 feet length of curve; in which case (supposing no other error to exist), either of those methods may be employed with sufficient accuracy for practice.

Also, if $a\ e\ f$, fig. 10, be measured too small, as $a\ e\ g$, then the curve $a\ b\ c$, calculated for the incorrect angle $a\ e\ g$, will be found to fall *within* the true tangent $e\ f$, as at c; when so, the remarks contained in the preceding sentence are equally applicable here. If the error be within 1 foot to 100 feet length of curve, it may be equally divided among the chords. But if greater, we must either remeasure the angle $a\ e\ f$ correctly, and go over the whole work again, or resort to some other mode of obviating the difficulty. The angle $a\ e\ f$ may be difficult of access; or the curve may be so long that to retrace it would be a work of much labour. We may then adopt the method of *compound curves* (see Art. XIII.), by which much trouble will be avoided, and a considerable portion of the first part of the curve be allowed to remain as it is.

Thus, whether the curve $a\ b\ c$ fall beyond the true tangent $e\ f$, as in fig. 9, or inside of it, as in fig. 10, place the instrument at b, figs. 9 and 10 (the point at which the change of radius is to take place), and sighting back one chord to n, lay off the tangential angle $n\ b\ m$ of the curve $a\ b\ c$, and observe where the tangent $m\ b$ continued strikes $e\ f$, as at o. Measure both $b\ o$, and the angle $b\ o\ f$. Half the angle $b\ o\ f$ taken from 90° gives the angle $b\ h\ o$; then say,

As the { Nat. Sine of angle *b h o* opposite the given side *b o* } is to { Nat. Sine of angle *b o h* opposite the required side *b h*, }

So is The given side *b o*, to The required side or new radius *b h*.

Ascertain from the table, or by calculation, the angle of deflection and the tangential angle corresponding to this new radius *b h*; and the new curve commencing at *b* will terminate tangentially to *e f* at *i*, as far from *o* as *o* is from *b*.

For the mode of uniting two curves of different radii, so as to form a *compound* curve, see Art. XIII.

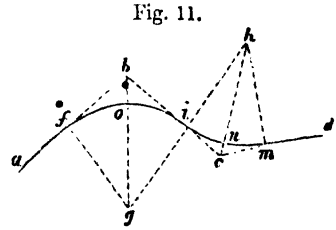
It will be observed, that when the first curve *a b c*, fig. 10, falls *inside* the tangent *e f*, the new curve must be of *greater* radius; and when *beyond*, fig. 9, of a *less* one.

ARTICLE XI.

Having given the angles a b c *and* b c d, *fig.* 11, *and the distance* b c, *it is required to find the greatest radius* g i *or* h i, *that can be employed in a* REVERSE *curve* (*see Art.* XIV.), f o i n m, *for uniting* a b *to* c d.

Rule.—Half the angle *a b c* taken from 90° leaves the angle *b g i*; and half the angle *b c d* taken from 90° leaves the angle *i h c*.

Fig. 11.



From the table of tangents take the natural tangent (*b i*) of the angle *b g i*; and that (*i c*) of the angle *i h c*; and add them together.

Then as the sum of these two natural tangents is to the natural tangent of *b g i*, so is *b c* to *b i*; and *b i* taken from *b c* gives *i c*.

Again, in the triangle *b g i*, as the natural sine of the angle *b g i*, opposite the given side *b i*, just found, is to the natural sine of the angle *g b i*, opposite the required side *g i*, so is *b i*, the given side, to *g i*, the required side or radius.

Example.—Let the angle *a b c* be 71° 40′, the angle *b c d* 129° 15′, and the distance *b c* 950 feet. What is the length of radius *h i* or *g i*, of the easiest reverse curve that can be traced for uniting *a b* to *c d*?

Here, half the angle *a b c* (35° 50′) taken from 90° leaves the angle *b g i* 54° 10′; and half the angle *b c d* (64° 37½′) taken from 90° leaves the angle *i h c* = 25° 22½′.

From the table of tangents, we have natural tangent of *b g i* (54° 10′) = 1·3848; and natural tangent of *i h c* (25° 22½′) = ·4743 their sum being 1·8591.

Then as

Sum of Tangts. 1·8591	is to	Tang. of 54° 10′ 1·3848,	so is	$b\,c$ 950 feet	to	$b\,i$ 707·63 feet,

and $b\,i$ 707·63 feet, taken from $b\,c$ 950 feet, leaves $i\,c$ 242·37 feet.

Again, as the

Nat. Sine of angle $b\,g\,i$ ·8107	is to	Nat. Sine of angle $g\,b\,i$ ·5854,	so is	$b\,i$ 707·63 feet	to	g or $h\,i$, the required radius, 510·97 feet.

ARTICLE XII.

To obtain the angle d b e, *formed by two tangents,* d b *and* b e, *when the point* b *is inaccessible.* Figs. 12, 13, 14, and 15.

This is of frequent occurrence.

Case 1. When the included figure, fig. 12, has but *three* sides.

Rule.—Subtract the angle $a\,d\,e$ from 180° for the angle $b\,d\,e$; and subtract the angle $d\,e\,c$ from 180° for the angle $d\,e\,b$. Add together $b\,d\,e$ and $d\,e\,b$, and subtract their sum from 180° for the angle $d\,b\,e$. Or, more briefly, subtract 180° from the sum of $a\,d\,e$ and $d\,e\,c$.

Fig. 12.



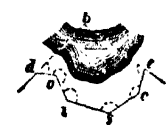
Fig. 13.



Fig. 14.



Fig. 15.



Case 2. When the included figure $d\,b\,e\,f$ (13, 14) has *four* sides.

Rule.—Subtract the sum of the three *internal* angles of the figure marked by dotted segments of circle, from 360° for the angle $d\,b\,e$.

Case 3. When the included figure, fig. 15, has *more than four sides.*

Rule.—Add together all the *internal* angles, marked by dotted segments of circles; and subtract their sum from twice as many right angles as the figure has sides, less four, for the angle $d\,b\,e$.

Example.—Let the angles denoted by the dotted segments at the different letters be as follows: That at d, 70°; at o, 220°; at i, 150°; at s, 110°; at c, 160°; at e, 100°. The sum of these is 810°. The figure has 7 sides; and twice 7 less 4 = 10; and 10 right angles = 900°; from which the sum of the designated internal angles (810°) being subtracted, leaves 90° for the angle $d\,b\,e$.

N.B.—When the angle $d\,b\,e$ has to be deduced from a figure of many sides, as fig. 15, the errors spoken of in Articles IX. and X. are apt to occur, unless the several sides and the angles $o\,i\,s$, &c., be measured with much care. For tracing curves with any accuracy and satisfaction, the instrument should be divided at least into minutes;

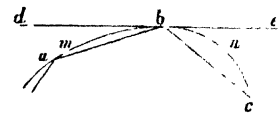
as before remarked, the transit intrument is the best for the purpose. With moderate care in the preparatory measurement of the sides and angles, errors will seldom occur that may not be adjusted with all the accuracy required in practice, by the very simple method of dividing them equally among the chords, as explained in Articles IX. and X.

ARTICLE XIII.

To pass from one curve, a m b, *fig.* 16, *to another,* b n c, *of different radius, but running in the same direction, constituting a* COMPOUND *curve.*

Rule.—Placing the instrument at *b*, sight back to the other end of the 100 feet chord at *a*; and lay off the *tangential* angle *a b d* of the curve *a m b*; then from the common tangent *d b e* lay off the *tangential* angle *e b c* of the curve *b n c*, making at the same time the chord *b c*, equal to 100 feet.

Fig. 16.



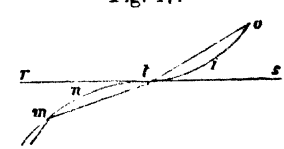
N.B.—If running the curve by eye, use the tangential *distances* instead of the angles.

ARTICLE XIV.

To pass from one curve, m n t, *fig.* 17, *to another,* t i o, *of either the same or of a different radius, but running in an opposite direction, constituting a* REVERSE *curve.*

Rule.—Placing the instrument at *t*, sight back to the other end of the 100 feet chord at *m*, and lay off the tangential angle *m t r* of the curve *m n t*; then from the common tangent *r t s* lay off the tangential angle *s t o* of the curve *t i o*, making at the same time the chord *t o*, equal to 100 feet.

Fig. 17.



N.B.—If running the curve by eye, use the tangential *distances* instead of the angles.

ARTICLE XV.

RADII.

To find the radius corresponding to any given angle of deflection, and to equal chords of any given length.

Rule 1.—Subtract the angle of deflection from 180°, then say, As natural sine of angle of deflection is to natural sine of *half* the remainder, so is the given chord to the radius required.

Example.—Let the angle of deflection be 2°, and the chord 100 feet; required the radius.

Here, 2° subtracted from 180° leaves 178°, the half of which is 89°; and as

Nat. Sine of 2°	:	Nat Sine of 89°	::	Chord	:	Radius
·034899		·999848		100 feet		2865 feet.

Rule 2.—The radius for 100 feet chords may be found *approximately*, by dividing 5730 by the deflection angle. This rule is very close for radii of not less than 500 feet. For 500 feet it gives eight-tenths of a foot too little, but is more approximate for larger radii.

Example.—What is the radius to a deflection angle of 2°, the chords being 100 feet long?

Here, 5730 divided by 2 gives 2865 feet, the radius required.

ARTICLE XVI.

TANGENTIAL AND DEFLECTION ANGLES.

To find either the Tangential or Deflection Angle corresponding to any given radius, and to equal chords of any given length.

Rule 1.—Divide *half* the chord by the radius; the quotient will be the natural sine of the *tangential* angle. Therefore the angle corresponding to this sine, in the Table of Natural Sines, will be the tangential angle required; and the tangential angle multiplied by 2 will give the deflection angle.

Example.—Let the radius be 2865 feet, and the chord 100 feet; what will be the tangential and deflection angles?

Here, half the chord (50 feet), divided by the radius (2865 feet), gives ·01745; and the tangential angle in the Table corresponding to the natural sine ·01745 is 1°, twice which is 2°, the deflection angle required.

Rule 2.—The deflection angle for 100 feet chords may be found approximately by dividing 5730 by the radius. This is very close for curves of over 500 feet radius. For 500 feet it gives about one minute too little.

Example.—What is the deflection angle for a radius of 2865 feet, the chords being 100 each?

Here, 5730 divided by the radius 2865 gives 2°, the deflection angle required.

ARTICLE XVII.

DEFLECTION DISTANCES.

To find the Deflection Distance (exactly) for any given radius, when the chords are 100 feet long.

Rule.—Divide the constant number 10000 by the radius in feet; the quotient will be the deflection angle required.*

Example.—What is the deflection distance to a radius of 5730 feet, the chords being 100 feet long?

Here, 10000 divided by 5730 radius gives 1·745 foot, the deflection distance required.

To find the Deflection Distance for any given radius, and for equal chords of any given length.

Rule.—Divide half the given chord by radius, the quotient will be the natural sine of one-*half* the deflection angle; and *double* this natural sine, multiplied by the chord, will give the deflection distance required. By this rule our Table was prepared.

Example.—As before, what is the deflection distance to a radius of 5730 feet, the chords being 100 feet long?

Here, half the chord (50 feet), divided by radius (5730 feet), gives ·008727, which is the natural sine of half the deflection angle. Now ·008727, multiplied by 2, gives ·017454, which, multiplied by the chord (100 feet), gives 1·745 foot, the required deflection distance, the same as in the preceding example.

ARTICLE XVIII.

TANGENTIAL DISTANCES.

To find the Tangential Distance corresponding to any given radius, and to equal chords of any given length.

Rule.—First find the tangential angle by Art. XVI., and take from the Table of Natural Sines that corresponding to one-*half* of the *tangential* angle. Then multiply *double* this sine by the given chord for the tangential distance. By this rule our Table was prepared.

* Because the deflection distance to a radius of 10000 feet, with chords of 100 feet, is 1 foot; and the deflection distances for other radii increase *inversely* as the radii.

Example.—Let the radius be 2865 feet, and the chords 100 feet each; what will be the tangential distance?

Here we find, by Art. XVI., the tangential angle 1° for a radius of 2865 feet.

The natural sine corresponding to 30 minutes, or one-half of this tangential angle, is, by the Table of Sines, ·008727; the double of which is ·017454, which, multiplied by the chord, or 100 feet, gives 1·745 foot for the tangential distance required.

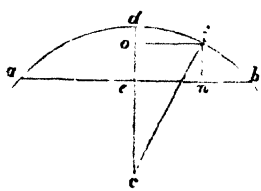
ARTICLE XIX.

ORDINATES.

To find the Middle Ordinate to any given radius, and to any given chord.

Rule 1.—From the square of the radius subtract the square of *half* the chord; and take the square root of the remainder from the radius, for the middle ordinate.

Fig. 18.



Example.—What is the length of the middle ordinate *d e*, fig. 18, the radius *c a* being 819 feet, and the chord *a b* 100 feet?

Here, the square of *c a* (819) is 670761, and the square of *a e* (50) is 2500; which, being subtracted from the former, leaves 668261, the square root of which is *e c*, 817·472; which, taken from the radius 819, leaves 1·528 foot, the required middle ordinate, *d e*.

Rule 2.—Subtract the tabular cosine of the *tangential* angle from 1, and multiply the remainder by the radius.

Example.—Same as foregoing; namely, radius 819 feet, angle of deflection 7°, to chords of 100 feet. What will be the length of the middle ordinate?

Here, tabular cosine of 3½° (the tangential angle) is ·998135; which, subtracted from 1, leaves ·001865; which, multiplied by 819, the radius, gives 1·527, the middle ordinate required.

ARTICLE XX.

Having given the Middle Ordinate d e, *fig.* 18, *it is required to find any other one, as* i n.

Rule 1.—Subtract the middle ordinate *d e* from the radius *d c*, the remainder will be *e c*: then from the square of the radius *c i* subtract the square of the distance *o i*, which the required ordinate *i n* is from the middle ordinate *d e*, and extract the square root of

the remainder. This square root will be *o c*. From this square root *o c* subtract *e c*; the remainder will be *o e*, which is equal to *i n*, the required ordinate.

Example.—The middle ordinate *d e*, of a 100 feet chord *b a*, to a radius of 819, being 1·528 foot, it is required to find the length of the ordinate *i n*, 20 feet from the middle one.

Here, the middle ordinate *d e*, 1·528, subtracted from the radius 819, leaves *e c*, 817·472. The square of the radius is 670761; and the square of 20 (the distance of the required ordinate from the middle one) is 400; which, taken from 670761, leaves 670361; the square root of which is 818·756, or *o c*; from which take *e c*, or 817·472, and the remainder, 1·284, will be *o e*, which is equal to *i n*, the required ordinate.

Rule 2.—Multiply the ordinates of a 1° curve by the deflection angle of the curve whose ordinates are required (chords being 100 feet). This is a sufficiently close approximation for curves of not less than 500 feet radius; and for placing ordinates *for guiding the excavations and embankments*, it is close enough for the smallest curves in our Table.

I.—Table of Radii, &c.—*Chord* 100 *feet.*

The Tangential Angle is always one-half of the Angle of Deflection.

Angle of Deflection.	Radius in feet.	Deflection distance in feet.	Tangential distance in feet.	Angle of Deflection.	Radius in feet.	Deflection distance in feet.	Tangential distance in feet.
° ′				° ′			
1	343800	·029	·014	51	6741	1·482	·741
2	171900	·058	·029	52	6611	1·511	·755
3	114600	·087	·043	53	6487	1·540	·770
4	85950	·116	·058	54	6367	1·569	·784
5	68760	·145	·072	55	6251	1·598	·799
6	57300	·174	·087	56	6139	1·627	·813
7	49116	·203	·101	57	6032	1·656	·828
8	42975	·232	·116	58	5928	1·685	·842
9	38200	·262	·131	59	5827	1·715	·857
10	34380	·291	·145	1 0	5730	1·745	·872
11	31256	·320	·160	2	5545	1·802	·901
12	28650	·349	·174	4	5372	1·860	·930
13	26446	·378	·189	6	5209	1·918	·959
14	24558	·407	·203	8	5056	1·976	·988
15	22920	·436	·218	10	4912	2·036	1·018
16	21487	·465	·232	12	4775	2·094	1·047
17	20224	·494	·247	14	4646	2·152	1·076
18	19100	·523	·261	16	4524	2·210	1·105
19	18094	·552	·276	18	4408	2·268	1·134
20	17190	·581	·290	20	4298	2·326	1·163
21	16372	·610	·305	22	4193	2·384	1·192
22	15628	·639	·319	24	4093	2·443	1·221
23	14948	·668	·334	26	3998	2·501	1·250
24	14325	·697	·348	28	3907	2·559	1·279
25	13752	·727	·363	30	3820	2·617	1·308
26	13223	·756	·378	32	3737	2·676	1·338
27	12733	·785	·392	34	3657	2·734	1·367
28	12279	·814	·407	36	3581	2·793	1·396
29	11856	·843	·421	38	3508	2·851	1·425
30	11460	·872	·436	40	3438	2·908	1·454
31	11090	·900	·450	42	3370	2·967	1·483
32	10744	·930	·465	44	3306	3·025	1·512
33	10419	·959	·479	46	3243	3·083	1·541
34	10112	·988	·494	48	3185	3·141	1·570
35	9823	1·017	·508	50	3126	3·199	1·599
36	9550	1·046	·523	52	3069	3·258	1·629
37	9292	1·075	·537	54	3016	3·316	1·658
38	9047	1·104	·552	56	2964	3·374	1·687
39	8815	1·133	·566	58	2914	3·432	1·716
40	8595	1·162	·581	2 0	2865	3·490	1·745
41	8385	1·191	·595	2	2818	3·548	1·774
42	8186	1·221	·610	4	2772	3·606	1·803
43	7995	1·250	·625	6	2729	3·665	1·832
44	7814	1·279	·639	8	2686	3·723	1·861
45	7640	1·308	·654	10	2644	3·781	1·890
46	7474	1·337	·668	12	2604	3·839	1·919
47	7315	1·366	·683	14	2566	3·897	1·948
48	7162	1·395	·697	16	2528	3·956	1·978
49	7016	1·424	·712	18	2491	4·014	2·007
50	6876	1·453	·726	20	2456	4·072	2·036

I.—Table of Radii, &c.—*continued.*

Angle of Deflection.	Radius in feet.	Deflection distance in feet.	Tangential distance in feet.	Angle of Deflection.	Radius in feet.	Deflection distance in feet.	Tangential distance in feet.
° ′				° ′			
2 22	2421	4·130	2·065	4 15	1348	7·416	3·708
24	2387	4·188	2·094	20	1322	7·563	3·781
26	2355	4·246	2·123	25	1298	7·708	3·854
28	2323	4·305	2·152	30	1274	7·853	3·927
30	2292	4·363	2·182	35	1251	7·998	3·999
32	2262	4·421	2·210	40	1228	8·143	4·071
34	2232	4·479	2·239	45	1207	8·289	4·145
36	2204	4·538	2·269	50	1185	8·432	4·216
38	2176	4·596	2·298	55	1166	8·577	4·288
40	2149	4·653	2·326	5 0	1146	8·722	4·361
42	2122	4·712	2·356	5	1127	8·869	4·434
44	2096	4·770	2·385	10	1109	9·014	4·507
46	2071	4·828	2·414	15	1092	9·159	4·579
48	2046	4·886	2·443	20	1074	9·304	4·652
50	2023	4·944	2·472	25	1058	9·449	4·724
52	1999	5·002	2·501	30	1042	9·595	4·798
54	1976	5·060	2·530	35	1026	9·740	4·870
56	1953	5·118	2·559	40	1011	9·885	4·942
58	1932	5·176	2·588	45	996·8	10·03	5·015
3 0	1910	5·235	2·618	50	982·7	10·18	5·090
2	1889	5·293	2·646	55	969·0	10·32	5·160
4	1868	5·351	2·675	6 0	955·4	10·47	5·235
6	1848	5·409	2·704	5	947·5	10·62	5·310
8	1828	5·468	2·734	10	939·7	10·76	5·380
10	1810	5·526	2·763	15	917·0	10·90	5·450
12	1790	5·584	2·792	20	905·0	11·04	5·520
14	1772	5·642	2·821	25	893·5	11·20	5·600
16	1754	5·700	2·850	30	882·0	11·34	5·670
18	1736	5·758	2·879	35	870·7	11·48	5·740
20	1719	5·817	2·908	40	859·5	11·63	5·815
22	1702	5·875	2·937	45	849·3	11·78	5·890
24	1685	5·933	2·966	50	838·9	11·92	5·960
26	1669	5·992	2·996	55	828·9	12·06	6·030
28	1653	6·050	3·025	7 0	819·0	12·21	6·105
30	1637	6·108	3·054	5	813·3	12·36	6·180
32	1621	6·166	3·083	10	807·4	12·50	6·250
34	1606	6·224	3·112	15	790·8	12·64	6·320
36	1591	6·282	3·141	20	781·9	12·79	6·395
38	1577	6·340	3·170	25	773·2	12·94	6·470
40	1563	6·398	3·199	30	764·5	13·08	6·540
42	1549	6·456	3·228	35	756·1	13·22	6·610
44	1534	6·515	3·257	40	748·0	13·37	6·685
46	1521	6·574	3·287	45	739·9	13·51	6·755
48	1508	6·632	3·316	50	732·0	13·66	6·830
50	1495	6·690	3·345	55	724·3	13·80	6·900
52	1482	6·748	3·374	8 0	716·8	13·95	6·975
54	1469	6·806	3·403	15	695·1	14·38	7·190
56	1457	6·864	3·432	30	674·6	14·81	7·405
58	1445	6·922	3·461	45	655·5	15·25	7·625
4 0	1433	6·980	3·490	9 0	637·3	15·68	7·840
5	1403	7·125	3·562	15	620·2	16·12	8·060
10	1375	7·270	3·635	30	603·8	16·55	8·275

I.—Table of Radii, &c.—*continued.*

Angle of Deflection.	Radius in feet.	Deflection distance in feet.	Tangential distance in feet.	Angle of Deflection.	Radius in feet.	Deflection distance in feet.	Tangential distance in feet.
° ′				° ′			
9 45	588·4	16·99	8·495	17 0	338·3	29·56	14·82
10 0	573·7	17·43	8·715	30	328·7	30·43	15·25
15	559·7	17·87	8·935	18 0	319·6	21·29	15·69
30	546·4	18·30	9·150	30	311·0	32·15	16·12
45	533·8	18·73	9·365	19 0	302·9	33·01	16·56
11 0	521·7	19·17	9·585	30	295·3	33·87	16·99
15	510·1	19·61	9·805	20 0	287·9	34·73	17·43
30	499·1	20·05	10·03	21 0	274·4	36·44	18·30
45	488·5	20·50	10·25	22 0	262·0	38·15	19·17
12 0	478·3	20·94	10·47	23 0	250·8	39·87	20·02
15	468·7	21·36	10·69	24 0	240·5	41·58	20·91
30	459·3	21·79	10·90	25 0	231·0	43·28	21·77
45	450·3	22·21	11·12	26 0	222·3	44·98	22·64
13 0	441·7	22·64	11·34	27 0	214·2	46·68	23·51
15	433·4	23·07	11·56	28 0	206·7	48·38	24·37
30	425·5	23·51	11·77	29 0	199·7	50·07	25·24
45	417·7	23·94	11·99	30 0	193·2	51·76	26·11
14 0	410·3	24·37	12·21	31 0	187·1	53·45	26·97
15	403·1	24·81	12·43	32 0	181·4	55·13	27·83
30	396·2	25·24	12·65	33 0	176·0	56·80	28·70
45	389·6	25·67	12·86	34 0	171·0	58·47	29·56
15 0	383·1	26·11	13·08	35 0	166·3	60·14	30·42
15	376·9	26·52	13·30	36 0	161·8	61·80	31·29
30	370·8	26·94	13·52	37 0	157·6	63·46	32·15
45	365·0	27·37	13·73	38 0	153·6	65·11	33·01
16 0	359·3	27·83	13·95	39 0	149·8	66·76	33·87
30	348·4	28·70	14·38	40 0	146·2	68·40	34·73

II.—Table of Ordinates.

Ordinates five feet apart.—Chord 100 *feet.*

Angle of Deflection.	Distances of the Ordinates from the end of the 100 feet Chord.									
	Middle, 50 feet.	45 feet.	40 feet.	35 feet.	30 feet.	25 feet.	20 feet.	15 feet.	10 feet.	5 feet.
° ′										
2	·007	·007	·007	·006	·006	·005	·003	·003	·002	·001
4	·014	·014	·014	·013	·012	·010	·008	·008	·005	·003
6	·021	·021	·021	·020	·019	·016	·013	·011	·008	·004
8	·029	·029	·028	·026	·024	·022	·018	·015	·010	·005
10	·036	·036	·035	·033	·031	·027	·023	·019	·013	·007
12	·043	·043	·041	·038	·037	·033	·028	·022	·015	·008
14	·050	·050	·048	·044	·043	·038	·032	·026	·017	·010
16	·058	·058	·056	·052	·049	·044	·037	·030	·020	·011
18	·065	·065	·063	·059	·055	·050	·042	·033	·023	·013
20	·073	·072	·070	·066	·061	·055	·047	·037	·026	·014
22	·080	·079	·076	·071	·067	·060	·051	·041	·029	·015

II.—TABLE OF ORDINATES—*continued.*

Angle of Deflection.	Distances of the Ordinates from the end of the 100 feet Chord.									
	Middle, 50 feet.	45 feet.	40 feet.	35 feet.	30 feet.	25 feet.	20 feet.	15 feet.	10 feet.	5 feet.
° ′										
24	·087	·086	·083	·077	·074	·066	·056	·045	·031	·017
26	·094	·093	·090	·084	·080	·071	·060	·048	·034	·018
28	·102	·101	·098	·092	·086	·077	·065	·052	·036	·019
30	·109	·108	·105	·099	·092	·082	·070	·055	·039	·020
32	·116	·115	·112	·106	·098	·088	·075	·058	·042	·022
34	·123	·122	·118	·111	·104	·094	·079	·062	·044	·023
36	·131	·130	·126	·119	·110	·099	·084	·066	·047	·024
38	·138	·137	·133	·126	·116	·105	·089	·070	·049	·025
40	·145	·144	·140	·133	·123	·110	·093	·074	·052	·027
42	·152	·150	·146	·138	·128	·115	·098	·077	·055	·028
44	·160	·158	·153	·145	·135	·121	·103	·081	·057	·030
46	·167	·165	·160	·152	·141	·126	·107	·085	·060	·032
48	·174	·172	·167	·158	·147	·132	·112	·088	·062	·033
50	·182	·180	·175	·166	·153	·138	·117	·092	·065	·034
52	·189	·187	·181	·171	·159	·143	·122	·095	·068	·035
54	·196	·194	·188	·178	·165	·148	·126	·099	·070	·036
56	·204	·202	·195	·185	·171	·154	·131	·103	·073	·038
58	·211	·209	·202	·192	·177	·159	·136	·107	·075	·039
1 0	·218	·216	·209	·198	·183	·164	·140	·111	·078	·041
2	·225	·223	·215	·204	·189	·169	·145	·114	·081	·042
4	·233	·231	·223	·211	·196	·175	·150	·118	·083	·043
6	·240	·238	·230	·217	·202	·180	·155	·121	·086	·045
8	·247	·245	·237	·224	·208	·186	·159	·125	·088	·046
10	·254	·252	·244	·231	·214	·191	·163	·130	·091	·048
12	·262	·260	·252	·237	·220	·196	·168	·133	·094	·049
14	·269	·267	·258	·244	·226	·202	·173	·136	·096	·050
16	·276	·274	·265	·251	·232	·207	·177	·140	·099	·052
18	·284	·282	·273	·257	·238	·213	·182	·144	·101	·053
20	·291	·288	·279	·264	·244	·218	·187	·148	·104	·055
22	·298	·295	·285	·270	·250	·224	·192	·151	·107	·056
24	·306	·303	·293	·277	·256	·229	·197	·155	·109	·057
26	·313	·310	·300	·284	·263	·235	·201	·159	·112	·059
28	·320	·317	·307	·291	·269	·240	·206	·163	·114	·060
30	·327	·324	·314	·297	·275	·246	·210	·167	·117	·062
32	·334	·331	·321	·304	·281	·251	·215	·171	·120	·063
34	·341	·338	·328	·310	·287	·257	·219	·174	·122	·065
36	·349	·345	·335	·317	·293	·262	·224	·178	·125	·066
38	·356	·353	·342	·323	·299	·268	·228	·182	·127	·068
40	·364	·360	·349	·330	·305	·273	·233	·185	·130	·069
42	·371	·367	·356	·337	·312	·278	·238	·189	·133	·070
44	·378	·374	·363	·343	·318	·284	·242	·192	·135	·072
46	·385	·382	·370	·350	·324	·289	·247	·196	·138	·073
48	·393	·389	·377	·356	·330	·295	·251	·200	·141	·075
50	·400	·396	·384	·364	·336	·300	·256	·204	·144	·076
52	·407	·403	·391	·370	·342	·305	·261	·208	·147	·077
54	·414	·410	·398	·376	·348	·311	·265	·211	·149	·079
56	·422	·418	·405	·383	·354	·316	·270	·215	·152	·080
58	·429	·425	·412	·389	·360	·322	·275	·219	·154	·082
2 0	·436	·432	·419	·397	·366	·327	·280	·222	·157	·083
2	·443	·439	·426	·402	·373	·332	·284	·226	·160	·084
4	·451	·446	·433	·409	·379	·338	·289	·230	·162	·086

II.—Table of Ordinates—*continued.*

Angle of Deflection.	Distances of the Ordinates from the end of the 100 feet Chord.									
	Middle, 50 feet.	45 feet.	40 feet.	35 feet.	30 feet.	25 feet.	20 feet.	15 feet.	10 feet.	5 feet.
° ′										
2 6	·458	·454	·440	·416	·385	·343	·293	·234	·165	·087
8	·465	·461	·447	·425	·391	·349	·298	237	·167	·088
10	·473	·468	·454	·430	·397	·355	·303	·241	·170	·089
12	·480	·475	·461	·437	·403	·360	·308	·245	·173	·090
14	·487	·482	·468	·443	·409	·366	·312	·248	·175	·092
16	·495	·490	·475	·450	·415	·371	·317	·252	·178	·093
18	·502	·497	·482	·456	·421	·377	·321	·256	·180	·095
20	·509	·504	·489	·463	·428	·382	·326	·260	·183	·096
22	·516	·511	·496	·470	·434	·387	·330	·264	·186	·097
24	·523	·518	·503	·476	·440	·393	·334	·267	·188	·099
26	·531	·526	·510	·483	·446	·398	·338	·271	·191	·100
28	·538	·533	·517	·489	·452	·404	·346	·275	·194	·102
30	·545	·540	·524	·496	·458	·409	·350	·278	·196	·103
32	·552	·547	·531	·503	·465	·415	·355	·282	·199	·104
34	·560	·554	·538	·509	·471	·420	·359	·285	·201	·106
36	·567	·562	·545	·516	·477	·425	·364	·289	·204	·107
38	·574	·569	·552	·522	·483	·431	·368	·293	·206	·109
40	·582	·576	·559	·529	·489	·436	·373	·297	·209	·110
42	·589	·583	·566	·536	·495	·441	·378	·301	·212	·111
44	·596	·590	·573	·542	·501	·447	·382	·304	·214	·113
46	·603	·598	·580	·549	·507	·452	·387	·308	·217	·114
48	·611	·605	·587	·555	·513	·458	·391	·312	·219	·116
50	·618	·612	·594	·562	·519	·464	·396	·315	·222	·117
52	·625	·619	·601	·569	·526	·469	·401	·319	·225	·118
54	·632	·626	·608	·575	·532	·474	·405	·322	·227	·119
56	·640	·634	·615	·582	·538	·480	·410	·326	·230	·121
58	·647	·641	·622	·588	·544	·485	·414	·330	·232	·123
3 0	·654	·648	·629	·595	·550	·491	·419	·334	·235	·124
2	·661	·655	·636	·602	·556	·497	·424	·338	·238	·125
4	·669	·662	·643	·608	·562	·502	·428	·341	·240	·127
6	·676	·670	·650	·615	·568	·507	·433	·345	·243	·128
8	·683	·677	·657	·621	·574	·512	·438	·349	·246	·130
10	·691	·684	·664	·629	·581	·518	·443	·353	·249	·131
12	·698	·691	·671	·635	·587	·523	·448	·357	·251	·132
14	·706	·698	·678	·642	·593	·529	·452	·360	·254	·134
16	·713	·705	·685	·649	·599	·534	·457	·364	·257	·135
18	·720	·713	·692	·655	·605	·540	·462	·368	·259	·137
20	·727	·720	·699	·662	·611	·545	·466	·371	·262	·138
22	·734	·727	·706	·668	·617	·550	·471	·375	·264	·139
24	·742	·734	·713	·675	·623	·556	·475	·378	·267	·141
26	·749	·742	·720	·682	·629	·561	·480	·382	·270	·142
28	·756	·749	·727	·688	·635	·567	·485	·386	·272	·144
30	·764	·756	·734	·695	·642	·573	·489	·390	·275	·145
32	·771	·763	·741	·702	·648	·578	·494	·394	·278	·146
34	·779	·770	·748	·708	·654	·584	·498	·397	·280	·148
36	·786	·777	·755	·715	·660	·589	·503	·401	·283	·149
38	·793	·785	·762	·721	·666	·594	·508	·405	·285	·151
40	·800	·792	·769	·728	·673	·600	·512	·408	·288	·152
42	·807	·799	·776	·734	·679	·605	·517	·412	·291	·153
44	·814	·806	·783	·741	·685	·611	·521	·415	·293	·155
46	·822	·814	·790	·748	·691	·616	·526	·419	·296	·156

II.—Table of Ordinates—*continued.*

Angle of Deflection.	Distances of the Ordinates from the end of the 100 feet Chord.									
	Middle, 50 feet.	45 feet.	40 feet.	35 feet.	30 feet.	25 feet.	20 feet.	15 feet.	10 feet.	5 feet.
° ′										
3 48	·829	·821	·797	·754	·697	.621	·531	·423	·298	·158
50	·836	·828	·804	·761	·703	·627	·536	·427	·301	·159
52	·843	·835	·811	·768	·709	·632	·541	·431	·304	·160
54	·850	·842	·818	·774	·715	·638	·545	·434	·306	·162
56	·858	·850	·825	·781	·721	·643	·550	·438	·309	·163
58	·865	·857	·832	·787	·728	·648	·555	·442	·311	·165
4 0	·873	·864	·839	·794	·734	·655	·559	·445	·314	·166
5	·891	·882	·856	·810	·749	·668	·571	·454	·320	·169
10	·909	·900	·874	·827	·764	·682	·582	·464	·327	·173
15	·927	·918	·891	·844	·780	·695	·594	·473	·334	·176
20	·945	·936	·909	·860	·795	·709	·606	·482	·340	·179
25	·963	·954	·926	·877	·810	·723	·617	·491	·347	·183
30	·981	·972	·944	·893	·825	·736	·629	·501	·354	·186
35	·999	·990	·961	·909	·840	·750	·640	·510	·360	·189
40	1·017	1·008	·979	·926	·855	·764	·652	·519	·367	·193
45	1·036	1·026	·996	·943	·871	·777	·664	·529	·373	·196
50	1·054	1·044	1·014	·959	·886	·791	·676	·538	·380	·199
55	1·072	1·062	1·031	·976	·901	·804	·687	·547	·386	·203
5 0	1·091	1·080	1·048	·993	·917	·818	·699	·557	·393	·207
5	1·109	1·098	1·065	1·009	·932	·831	·711	·566	·400	·210
10	1·127	1·116	1·083	1·026	·947	·845	·722	·576	·406	·214
15	1·146	1·134	1·000	1·042	·963	·859	·734	·585	·413	·217
20	1·164	1·152	1·118	1·058	·978	·872	·746	·594	·419	·220
25	1·182	1·170	1·135	1·075	·993	·886	·757	·603	·426	·224
30	1·200	1·188	1·153	1·092	1·009	·900	·769	·613	·432	·228
35	1·218	1·206	1·170	1·108	1·024	·913	·781	·622	·438	·231
40	1·236	1·224	1·188	1·124	1·039	·927	·792	·631	·445	·235
45	1·255	1·242	1·205	1·141	1·055	·941	·804	·640	·452	·238
50	1·273	1·260	1·223	1·157	1·070	·954	·816	·649	·458	·241
55	1·291	1·278	1·240	1·174	1·085	·967	·827	·658	·465	·245
6 0	1·309	1·296	1·258	1·191	1·100	·982	·839	·668	·472	·248
5	1·327	1·314	1·275	1·207	1·115	·995	·851	·677	·478	·251
10	1·345	1·332	1·293	1·224	1·130	1·009	·862	·686	·485	·255
15	1·364	1·350	1·310	1·240	1·146	1·023	·874	·696	·492	·259
20	1·382	1·368	1·328	1·256	1·161	1·036	·886	·705	·498	·262
25	1·400	1·386	1·345	1·273	1·176	1·050	·897	·714	·505	·266
30	1·419	1·404	1·362	1·290	1·192	1·064	·909	·724	·511	·269
35	1·437	1·422	1·379	1·306	1·207	1·077	·921	·733	·517	·272
40	1·455	1·440	1·397	1·323	1·222	1·091	·932	·742	·524	·276
45	1·473	1·458	1·415	1·339	1·238	1·105	·944	·752	·531	·280
50	1·491	1·476	1·432	1·355	1·253	1·118	·956	·761	·537	·283
55	1·509	1·494	1·450	1·372	1·268	1·132	·967	·770	·544	·287
7 0	1·528	1·512	1·467	1·389	1·284	1·146	·979	·779	·551	·290
5	1·546	1·530	1·484	1·405	1·299	1·159	·991	·788	·557	·293
10	1·564	1·548	1·502	1·422	1·314	1·173	1·002	·798	·564	·297
15	1·582	1·566	1·520	1·438	1·330	1·187	1·014	·807	·570	·301
20	1·600	1·584	1·537	1·454	1·345	1·200	1·026	·816	·576	·304
25	1·618	1·602	1·555	1·471	1·360	1·214	1·037	·825	·583	·308
30	1·637	1·620	1·572	1·488	1·375	1·228	1·048	·835	·590	·311
35	1·655	1·638	1·589	1·504	1·390	1·241	1·060	·844	·596	·314
40	1·673	1·656	1·607	1·521	1·405	1·255	1·071	·854	·603	·318

II.—Table of

Angle of Deflection.		Distances of the Ordinates from the end of the 100 feet Chord.									
		Middle, 50 feet.	45 feet.	40 feet.	35 feet.	30 feet.	25 feet.	20 feet.	15 feet.	10 feet.	5 feet.
°	′										
7	45	1·692	1·674	1·624	1·537	1·421	1·269	1·083	·863	·610	·321
	50	1·710	1·692	1·641	1·553	1·436	1·282	1·095	·872	·616	·324
	55	1·728	1·710	1·659	1·570	1·451	1·296	1·106	·881	·623	·328
8	0	1·746	1·728	1·677	1·587	1·467	1·310	1·118	·891	·629	·332
	15	1·801	1·782	1·729	1·637	1·513	1·351	1·153	·918	·649	·342
	30	1·855	1·836	1·782	1·687	1·559	1·392	1·188	·946	·669	·353
	45	1·910	1·890	1·834	1·737	1·605	1·433	1·223	·974	·689	·363
9	0	1·965	1·944	1·886	1·787	1·651	1·474	1·258	1·002	·708	·373
	15	2·019	1·998	1·939	1·837	1·696	1·515	1·293	1·030	·728	·384
	30	2·074	2·052	1·991	1·887	1·742	1·556	1·328	1·057	·748	·394
	45	2·128	2·106	2·044	1·937	1·788	1·597	1·363	1·085	·767	·405
10	0	2·183	2·161	2·096	1·987	1·834	1·637	1·398	1·114	·787	·415
	15	2·238	2·215	2·148	2·037	1·880	1·678	1·433	1·142	·807	·425
	30	2·292	2·269	2·201	2·087	1·926	1·719	1·468	1·170	·827	·436
	45	2·347	2·323	2·254	2·136	1·972	1·761	1·503	1·198	·846	·446
11	0	2·401	2·377	2·306	2·186	2·018	1·802	1·538	1·226	·866	·457
	15	2·456	2·432	2·359	2·236	2·064	1·843	1·574	1·254	·886	·467
	30	2·511	2·486	2·411	2·286	2·110	1·884	1·609	1·282	·906	·478
	45	2·566	2·540	2·464	2·336	2·156	1·926	1·644	1·310	·926	·488
12	0	2·620	2·594	2·516	2·386	2·203	1·967	1·680	1·339	·946	·499
	15	2·675	2·649	2·569	2·436	2·249	2·008	1·715	1·367	·966	·509
	30	2·730	2·703	2·621	2·485	2·295	2·049	1·750	1·395	·985	·520
	45	2·785	2·757	2·674	2·535	2·341	2·091	1·785	1·423	1·005	·530
13	0	2·839	2·811	2·726	2·585	2·387	2·132	1·820	1·451	1·025	·541
	15	2·894	2·865	2·779	2·635	2·433	2·173	1·855	1·479	1·045	·551
	30	2·949	2·920	2·832	2·685	2·479	2·214	1·891	1·507	1·065	·562
	45	3·000	2·974	2·884	2·735	2·525	2·256	1·926	1·535	1·085	·572
14	0	3·058	3·028	2·937	2·785	2·571	2·297	1·961	1·564	1·105	·583
	15	3·113	3·082	2·989	2·834	2·618	2·338	1·996	1·592	1·124	·593
	30	3·168	3·136	3·042	2·884	2·664	2·379	2·031	1·620	1·144	·604
	45	3·222	3·191	3·094	2·934	2·710	2·421	2·067	1·648	1·164	·614
15	0	3·277	3·245	3·147	2·984	2·756	2·462	2·102	1·676	1·184	·625
	15	3·332	3·299	3·200	3·034	2·802	2·503	2·137	1·704	1·204	·635
	30	3·387	3·354	3·252	3·084	2·848	2·544	2·172	1·732	1·224	·646
	45	3·442	3·408	3·305	3·134	2·895	2·586	2·208	1·760	1·244	·656
16	0	3·496	3·462	3·358	3·184	2·941	2·627	2·243	1·789	1·264	·667
	30	3·606	3·571	3·463	3·284	3·033	2·710	2·314	1·845	1·304	·688
17	0	3·716	3·680	3·569	3·384	3·125	2·792	2·384	1·902	1·344	·709
	30	3·826	3·788	3·674	3·484	3·218	2·875	2·455	1·958	1·384	·730
18	0	3·935	3·897	3·779	3·584	3·310	2·958	2·525	2·014	1·424	·751
	30	4·045	4·006	3·885	3·684	3·403	3·040	2·596	2·071	1·464	·772
19	0	4·155	4·115	3·990	3·784	3·495	3·123	2·666	2·127	1·504	·793
	30	4·265	4·223	4·096	3·884	3·588	3·205	2·737	2·184	1·544	·814
20	0	4·375	4·332	4·201	3·984	3·680	3·288	2·808	2·240	1·583	·836
21	0	4·595	4·549	4·412	4·184	3·864	3·454	2·950	2·353	1·663	·879
22	0	4·815	4·768	4·624	4·386	4·050	3·620	3·093	2·467	1·744	·922
23	0	5·035	4·986	4·836	4·587	4·237	3·786	3·236	2·581	1·824	·965
24	0	5·255	5·204	5·048	4·789	4·423	3·952	3·379	2·695	1·905	1·008
25	0	5·476	5·422	5·260	4·989	4·609	4·119	3·522	2·809	1·986	1·051
26	0	5·697	5·642	5·473	5·192	4·798	4·286	3·665	2·924	2·068	1·094
27	0	5·918	5·860	5·685	5·393	4·984	4·454	3·808	3·039	2·150	1·137

II.—TABLE OF ORDINATES—*continued.*

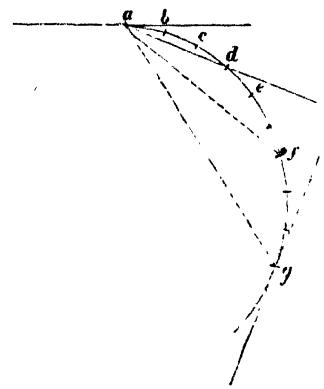
Angle of Deflection.	Distances of the Ordinates from the end of the 100 feet Chord.									
	Middle, 50 feet.	45 feet.	40 feet.	35 feet.	30 feet.	25 feet.	20 feet.	15 feet.	10 feet.	5 feet.
° ′										
28	6·139	6·079	5·898	5·595	5·171	4·622	3·952	3·154	2·232	1·181
29	6·361	6·298	6·110	5·796	5·357	4·790	4·095	3·269	2·314	1·224
30	6·582	6·517	6·323	5·999	5·544	4·958	4·239	3·385	2·396	1·268
31	6·804	6·737	6·537	6·202	5·733	5·127	4·384	3·502	2·481	1·312
32	7·027	6·957	6·751	6·406	5·922	5·297	4·530	3·619	2·565	1·356
33	7·249	7·178	6·965	6·609	6·111	5·467	4·676	3·737	2·649	1·401
34	7·472	7·398	7·179	6·813	6·300	5·637	4·822	3·854	2·733	1·445
35	7·694	7·619	7·393	7·017	6·489	5·807	4·968	3·972	2·817	1·490
36	7·918	7·841	7·609	7·222	6·679	5·978	5·115	4·090	2·901	1·535
37	8·143	8·063	7·825	7·427	6·870	6·149	5·262	4·209	2·985	1·581
38	8·367	8·286	8·041	7·633	7·060	6·320	5·410	4·327	3·069	1·626
39	8·592	8·508	8·257	7·838	7·251	6·491	5·557	4·446	3·153	1·672
40	8·816	8·731	8·474	8·044	7·442	6·663	5·705	4·565	3·238	1·718

ARTICLE XXI.

ON LONG CHORDS.

It is sometimes convenient, in preliminary locations, to lay off curves by chords longer than 100 feet. For instance, in fig. 19, instead of running from *a* by chords *a b*, *b c*, *c d*, &c., of but 100 feet, points *d*, *f*, *g*, &c., may be obtained with less trouble by using three times the tangential or deflection angles of the table (as the case may be), and employing chords *a d*, *d f*, *f g*, &c., *nearly* three times as long as the chords *a b*, *b c*, &c.; or if *a d*, *d f*, *f g*, be either 2 or 4 stations apart, then 2 or 4 times the tangential and deflection angles would be used; and chords nearly 2 or 4 times 100 feet in length.

Fig. 19.



The following table contains the precise length of chord required to subtend respectively 1, 2, 3, or 4 stations. It is seldom desirable to exceed the latter limit.

III.—Table of Long Chords.

Radius in feet.	Angle of Deflection.	Length of Chord in feet required to subtend. 1 Station.	2 Stations.	3 Stations.	4 Stations.
5730·0	1°	100	200·0	300·0	400·0
4584·0	¼	100	200·0	300·0	399·9
3820·0	½	100	200·0	300·0	399·9
3274·0	¾	100	200·0	300·0	399·8
2865·0	2°	100	200·0	299·9	399·7
2547·0	¼	100	200·0	299·9	399·6
2292·0	½	100	200·0	299·8	399·5
2084·0	¾	100	200·0	299·8	399·4
1910·0	3°	100	200·0	299·7	399·3
1763·0	¼	100	200·0	299·7	399·2
1637·0	½	100	200·0	299·6	399·1
1528·0	¾	100	200·0	299·6	399·0
1433·0	4°	100	199·9	299 6	398·9
1348·0	¼	100	199·9	299·5	398·7
1274·0	½	100	199·9	299·4	398·5
1207·0	¾	100	199·9	299·3	398·3
1146·0	5°	100	199·9	299·2	398·0
1092·0	¼	100	199·8	299·1	397·8
1042·0	½	100	199·8	299·0	397·6
996·8	¾	100	199·7	298·9	397·5
955·4	6°	100	199·7	298·8	397·3
917·0	¼	100	199·7	298·7	397·0
882·0	½	100	199·7	298·6	396·7
849·3	¾	100	199·6	298·5	396·5
819·0	7°	100	199·6	298·4	396·2
790·8	¼	100	199·6	298·3	396·0
764·5	½	100	199·6	298·2	395·7
739·9	¾	100	199·6	298·1	395·4
716·8	8°	100	199·6	298·0	395·1
695·1	¼	100	199·5	297·9	394·8
674·6	½	100	199 5	297·8	394·5
655·5	¾	100	199·4	297·7	394·3
637·3	9°	100	199·4	297·5	394·1
620·2	¼	100	199·4	297·4	393·7
603·8	½	100	199·3	297·3	393·2
588·4	¾	100	199·2	297·2	392·8
573·7	10°	100	199·2	297·0	392·4

For radii less than 573·7 feet, it is never required to use longer chords than 100 feet.

When this method of laying out curves by long chords is used, the instrument should be moved to each successive point after it is determined, in order to fix the next one, instead of attempting to obtain more than one point from one position of the instrument: because when the chords are longer than one chain, they cannot be measured in the right direction by eye, but must be guided by the instrument.

It must be especially borne in mind that, in any given curve, only the tangential and deflection *angles* increase in the same proportion

as the number of 100 feet stations subtended by the long chord. Therefore, *these* long chords cannot be used for laying out curves *by eye*, as their tangential and deflection *distances* are not known.

When it is required to use long chords for turning a curve *by eye*, they must be composed of a number of *whole chains*, being made say 200, 300, or 400, &c., feet in length. The tangential and deflection *distances* of curves of more than 500 feet radius may then be assumed, in practice, to increase as the *squares* of the number of chains in the length of the long chord. For instance, to lay off a 5° curve by chords of 200, 300, or 400 feet in length, the tangential and deflection distances of the table must be multiplied by 4, 9, or 16, as the case may be. In this case the tangential and deflection *angles* are unknown.

This is not mathematically correct, but will answer in practice for the curves of a canal or common road, where great nicety is not needed.

The only proper instrument for running lines of survey is the *transit*, furnished with a compass and with a revolving telescope. The deflections, being measured in *angles*, serve as a check to the numerous sources of error to which the compass is liable, arising from local attraction, electrical action in the glass cover, diurnal variation, &c. Besides, when the compass alone is used, it is necessary to test every course or bearing from each end of each station; and this involves loss of time.

The following is a good form of field-book for the transit and compass combined:

Station.	Distance.	Total Distance.	Course.	Deflection in Degrees.		The right-hand page is left blank for Remarks, and Sketches of Topography.
				Left.	Right.	

In every locating party there should be one person whose duty is to obtain and record the transverse slopes of the ground at each station. His observations will usually extend to from fifty feet to one hundred yards on each side of the centre stakes, depending on a variety of circumstances of locality which cannot be alluded to here. In preliminary locations these slopes need not be taken with very great nicety, as they will be used chiefly for ascertaining, approximately, the amount of excavation and embankment.

After the final location is made, the slopes should be taken again, with great care, to the nearest quarter of a degree; but need not extend beyond the width actually occupied by the road. Their use in this second operation will be for determining the cubic contents with more precision than before, for final estimates; and also for obtaining the positions of the *side-stakes*.

Should the duty of *recording* these slopes devolve upon the compassman (which it should not), it will be necessary to add another column to his field-book after that containing the deflections. In this column he will insert the slopes thus (fig. 20), the dot representing the centre stake. The degrees of slope are written above the lines, and the distance in feet to which they extend below.

Fig. 20.



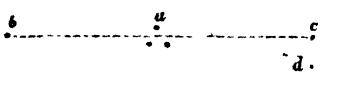
The slopes are taken by laying a long rod on the ground, at *right angles to the line of survey*, as nearly as may be judged by eye, and measuring the angles by means of a small *slope instrument* placed upon the rod. These are made by most of our instrument-makers.

ARTICLE XXII.

TO ADJUST A TRANSIT INSTRUMENT.

Having placed the transit firmly at *a*, fig. 21, and levelled it, clamp all fast, and direct the cross-hairs, by means of the tangent screw, to some convenient object, *b*. Then, revolving the telescope *vertically*, but without moving it in the least *horizontally*, let the cross-hairs fix upon a second object in the opposite direction, as *c*; or, if there be no such object, place one, as for instance a chain-pin, at any convenient distance. Then unclamp the *lower* clamp, and revolve *horizontally* the entire upper part of the instrument above the parallel plates. Clamp it again, and fix the cross-hairs upon *b*; then again revolve the *telescope* vertically. If the sight now strikes *c*, as before, it is in adjustment; but if not, place another object, *d*, where it does strike; and with the adjusting pin alter the vertical cross-hair so as to strike half-way between *d* and *c*. The instrument will then be in adjustment. Two or more trials will generally be needed before the adjustment is perfect.

Fig. 21.



With care, and on a firm floor, the operation may be performed in a long room, or by placing the instrument in a doorway communicating with two rooms of moderate size. Fine pins, or needles, should then be used as the objects to be sighted at. It is better, however, to adjust out of doors, with more distant objects. It is also a good precaution to hang up a long plumb-line, or select some vertical object, and see whether the vertical hair coincides with it, as the telescope is raised or lowered. If from any accident, or carelessness in its construction, it does not, the defect must be remedied by an instrument-maker.

IV.—Natural Sines and Tangents to a Radius 1.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0 Deg.						**0 Deg.**						**0 Deg.**					
0	·0000000	·000000	Infinite.	1·000000	60	21	·0061086	·006108	163·70010	·9999813	39	41	·0119261	·011927	83·84350	·9999289	19
1	·0002909	·000291	3437·7460	1·000000	59	22	·0063995	·006399	156·25900	·9999795	38	42	·0122170	·012217	81·84704	·9999254	18
2	·0005818	·000582	1718·8730	·9999998	58	23	·0066904	·006690	149·46500	·9999776	37	43	·0125079	·012508	79·94343	·9999218	17
3	·0008727	·000872	1145·9150	·9999996	57	24	·0069813	·006981	143·23710	·9999756	36	44	·0127987	·012799	78·12634	·9999181	16
4	·0011636	·001163	859·4363	·9999993	56	25	·0072721	·007272	137·50750	·9999736	35	45	·0130896	·013090	76·39000	·9999143	15
5	·0014544	·001454	687·4588	·9999989	55	26	·0075630	·007563	132·21850	·9999714	34	46	·0133805	·013381	74·72916	·9999105	14
6	·0017453	·001745	572·9572	·9999985	54	27	·0078539	·007854	127·32130	·9999692	33	47	·0136713	·013672	73·13899	·9999065	13
7	·0020362	·002036	491·1060	·9999979	53	28	·0081448	·008145	122·77390	·9999668	32	48	·0139622	·013963	71·61507	·9999025	12
8	·0023271	·002327	429·7175	·9999973	52	29	·0084357	·008436	118·54010	·9999644	31	49	·0142530	·014254	70·15334	·9998984	11
9	·0026180	·002618	381·9709	·9999966	51	30	·0087265	·008726	114·58860	·9999619	30	50	·0145439	·014545	68·75008	·9998942	10
10	·0029089	·002908	343·7737	·9999958	50	31	·0090174	·009017	110·89200	·9999593	29	51	·0148348	·014836	67·40185	·9998900	9
11	·0031998	·003199	312·5213	·9999949	49	32	·0093083	·009308	107·42640	·9999567	28	52	·0151256	·015127	66·10547	·9998856	8
12	·0034907	·003490	286·4777	·9999939	48	33	·0095992	·009599	104·17090	·9999539	27	53	·0154165	·015418	64·85800	·9998812	7
13	·0037815	·003781	264·4408	·9999928	47	34	·0098900	·009890	101·10690	·9999511	26	54	·0157073	·015709	63·65674	·9998766	6
14	·0040724	·004072	245·5519	·9999917	46	35	·0101809	·010181	98·21794	·9999482	25	55	·0159982	·016000	62·49915	·9998720	5
15	·0043633	·004363	229·1816	·9999905	45	36	·0104718	·010472	95·48947	·9999452	24	56	·0162890	·016291	61·38290	·9998673	4
16	·0046542	·004654	214·8576	·9999892	44	37	·0107627	·010763	92·90848	·9999421	23	57	·0165799	·016582	60·30582	·9998625	3
17	·0049451	·004945	202·2187	·9999878	43	38	·0110535	·011054	90·46333	·9999389	22	58	·0168707	·016873	59·26587	·9998577	2
18	·0052360	·005236	190·9841	·9999863	42	39	·0113444	·011345	88·14357	·9999357	21	59	·0171616	·017164	58·26117	·9998527	1
19	·0055268	·005526	180·9322	·9999847	41	40	·0116353	·011636	85·83979	·9999323	20	60	·0174524	·017455	57·28996	·9998477	0
20	·0058177	·005817	171·8854	·9999831	40												
	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 89.						Deg. 89.						Deg. 89.				

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

1 Deg.						1 Deg.						1 Deg.					
′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·0174524	·017455	57·28996	·9998477	60	21	·0235598	·023566	42·43346	·9997224	39	41	·0293755	·029388	34·02730	·9995684	19
1	·0177432	·017746	56·35059	·9998426	59	12	·0238506	·023857	41·91579	·9997156	38	42	·0296662	·029679	33·69350	·9995599	18
2	·0180341	·018037	55·44151	·9998374	58	23	·0241414	·024148	41·41058	·9997086	37	43	·0299570	·029970	33·36619	·9995512	17
3	·0183249	·018328	54·56130	·9998321	57	24	·0244322	·024439	40·91741	·9997015	36	44	·0302478	·030261	33·04517	·9995424	16
4	·0186158	·018619	53·70858	·9998267	56	25	·0247230	·024730	40·43583	·9996943	35	45	·0305385	·030552	32·73026	·9995336	15
5	·0189066	·018910	52·88211	·9998213	55	26	·0250138	·025021	39·96546	·9996871	34	46	·0308293	·030843	32·42129	·9995247	14
6	·0191974	·019201	52·08067	·9998157	54	27	·0253046	·025312	39·50589	·9996798	33	47	·0311200	·031135	32·11809	·9995157	13
7	·0194883	·019492	51·30315	·9998101	53	28	·0255954	·025603	39·05677	·9996724	32	48	·0314108	·031426	31·82051	·9995066	12
8	·0197791	·019783	50·54850	·9998044	52	29	·0258862	·025894	38·61773	·9996649	31	49	·0317015	·031717	31·52839	·9994974	11
9	·0200699	·020074	49·81572	·9997986	51	30	·0261769	·026185	38·18845	·9996573	30	50	·0319922	·032008	31·24157	·9994881	10
10	·0203608	·020365	49·10388	·9997927	50	31	·0264677	·026477	37·76861	·9996497	29	51	·0322830	·032299	30·95992	·9994788	9
11	·0206516	·020656	48·41208	·9997867	49	32	·0267585	·026768	37·35789	·9996419	28	52	·0325737	·032591	30·68330	·9994693	8
12	·0209424	·020947	47·73950	·9997807	48	33	·0270493	·027059	36·95600	·9996341	27	53	·0328644	·032882	30·41158	·9994598	7
13	·0212332	·021238	47·08534	·9997745	47	34	·0273401	·027350	36·56265	·9996262	26	54	·0331552	·033173	30·14461	·9994502	6
14	·0215241	·021529	46·44886	·9997683	46	35	·0276309	·027641	36·17759	·9996182	25	55	·0334459	·033464	29·88229	·9994405	5
15	·0218149	·021820	45·82935	·9997620	45	36	·0279216	·027932	35·80055	·9996101	24	56	·0337366	·033755	29·62449	·9994308	4
16	·0221057	·022111	45·22614	·9997556	44	37	·0282124	·028223	35·43128	·9996020	23	57	·0340274	·034047	29·37110	·9994209	3
17	·0223965	·022402	44·63859	·9997492	43	38	·0285032	·028514	35·06954	·9995937	22	58	·0343181	·034338	29·12200	·9994110	2
18	·0226873	·022693	44·06611	·9997426	42	39	·0287940	·028805	34·71511	·9995854	21	59	·0346088	·034629	28·87708	·9994009	1
19	·0229781	·022984	43·50812	·9997360	41	40	·0290847	·029097	34·36777	·9995770	20	60	·0348995	·034920	28·63625	·9993908	0
20	·0232690	·023275	42·96407	·9997292	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 88.						Deg. 88.						Deg. 88.				

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

2 Deg.						2 Deg.						2 Deg.					
	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·0348995	·034920	28·63625	·9993908	60	21	·0410037	·041038	24·36750	·9991590	39	41	·0468159	·046867	21·33685	·9989035	19
1	·0351902	·035212	28·39939	·9993806	59	22	·0412944	·041329	24·19571	·9991470	38	42	·0471065	·047158	21·20494	·9988899	18
2	·0354809	·035503	28·16642	·9993704	58	23	·0415850	·041621	24·02632	·9991350	37	43	·0473970	·047450	21·07466	·9988761	17
3	·0357716	·035794	27·93723	·9993600	57	24	·0418757	·041912	23·85927	·9991228	36	44	·0476876	·047741	20·94596	·9988623	16
4	·0360623	·036085	27·71174	·9993495	56	25	·0421663	·042203	23·69453	·9991106	35	45	·0479781	·048033	20·81182	·9988484	15
5	·0363530	·036377	27·48985	·9993390	55	26	·0424569	·042495	23·53205	·9990983	34	46	·0482687	·048325	20 69322	·9988344	14
6	·0366437	·036668	27·27148	·9993284	54	27	·0427475	·042786	23·37177	·9990859	33	47	·0485592	·048616	20·56911	·9988203	13
7	·0369344	·036959	27·05655	·9993177	53	28	·0430382	·043078	23·21366	·9990734	32	48	·0488498	·048908	20·44648	·9988061	12
8	·0372251	·037250	26·84498	·9993069	52	29	·0433288	·043369	23·05767	·9990609	31	49	·0491403	·049199	20·32530	·9987919	11
9	·0375158	·037542	26·63669	·9992960	51	30	·0436194	·043660	22·90376	·9990482	30	50	·0494308	·049491	20·20555	·9987775	10
10	·0378065	·037833	26·43160	·9992851	50	31	·0439100	·043952	22·75189	·9990355	29	51	·0497214	·049782	20·08719	·9987631	9
11	·0380971	·038124	26·22963	·9992740	49	32	·0442006	·044243	22·60201	·9990227	28	52	·0500119	050074	19·97021	·9987486	8
12	·0383878	·038416	26·03073	·9992629	48	33	·0444912	·044535	22·45409	·9990098	27	53	·0503024	·050366	19·85459	·9987340	7
13	·0386785	·038707	25·83482	·9992517	47	34	·0447818	·044826	22·30809	·9989968	26	54	·0505929	·050657	19·74029	·9987194	6
14	·0389692	·038998	25·64183	9992404	46	35	·0450724	·045118	22·16398	·9989837	25	55	·0508835	·050949	19·62729	·9987046	5
15	·0392598	·039290	25·45170	·9992290	55	36	·0453630	·045409	22·02171	·9989706	24	56	·0511740	·051241	19·51558	·9986898	4
16	·0395505	·039581	25·26436	·9992176	44	37	·0456536	·045701	21·88125	·9989573	23	57	·0514645	·051532	19·40513	·9986748	3
17	·0398411	·039872	25·07975	·9992060	43	38	·0459442	·045992	21·74256	·9989440	22	58	·0517550	·051824	19·29592	·9986598	2
18	·0401318	·040164	24·89782	·9991944	42	39	·0462347	·046284	21·60563	·9989306	21	59	·0520455	·052116	19·18793	·9986447	1
19	·0404224	·040455	24·71851	·9991827	41	40	·0465253	·046575	21·47040	·9989171	20	60	·0523360	·052407	19·08113	·9986295	0
20	·0407131	·040746	24·54175	·9991709	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 87.						Deg. 87.						Deg. 87.				

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

3 Deg. 3 Deg. 3 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·0523360	·052407	19·08113	·9986295	60	21	·0584352	·058535	17·08372	·9982912	39	41	·0642120	·064375	15·53398	·9979343	19
1	·0526264	·052699	18·97552	·9986143	59	22	·0587256	·058827	16·99895	·9982742	38	42	·0645323	·064667	15·46381	·9979156	18
2	·0529169	·052991	18·87106	·9985989	58	23	·0590160	·059119	16·91502	·9982570	37	43	·0648226	·064959	15·39427	·9978968	17
3	·0532074	·053282	18·76775	·9985835	57	24	·0593064	·059410	16·83191	·9982398	36	44	·0651129	·065251	15·32535	·9978779	16
4	·0534979	·053574	18·66556	·9985680	56	25	·0595967	·059702	16·74961	·9982225	35	45	·0654031	·065543	15·25705	·9978589	15
5	·0537883	·053866	18·56447	·9985524	55	26	·0598871	·059994	16·66811	·9982052	34	46	·0656934	·065835	15·18934	·9978399	14
6	·0540788	·054158	18·46447	·9985367	54	27	·0601775	·060286	16·58739	·9981877	33	47	·0659836	·066127	15·12224	·9978207	13
7	·0543693	·054449	18·36553	·9985209	53	28	·0604678	·060578	16·50745	·9981701	32	48	·0662739	·066419	15·05572	·9978015	12
8	·0546597	·054741	18·26765	·9985050	52	29	·0607582	·060870	16·42827	·9981525	31	49	·0665641	·666712	14·98978	·9977821	11
9	·0549502	·055033	18·17080	·9984891	51	30	·0610485	·061162	16·34985	·9981348	30	50	·0668544	·067004	14·92441	·9977627	10
10	·0552406	·055325	18·07497	·9984731	50	31	·0613389	·061454	16·27217	·9981170	29	51	·0671446	·067296	14·85961	·9977433	9
11	·0555311	·055616	17·98015	·9984570	49	32	·0616292	·061746	16·19522	·9980991	28	52	·0674349	·067588	14·79537	·9977237	8
12	·0558215	·055908	17·88631	·9984408	48	33	·0619196	·062038	16·11899	·9980811	27	53	·0677251	·067880	14·73167	·9977040	7
13	·0561119	·056200	17·79344	·9984245	47	34	·0622099	·062330	16·04348	·9980631	26	54	·0680153	·068173	14·66852	·9976843	6
14	·0564024	·056492	17·70152	·9984081	46	35	·0625002	·062622	15·96866	·9980450	25	55	·0683055	·068465	14·60591	·9976645	5
15	·0566928	·056784	17·61055	·9983917	45	36	·0627905	·062914	15·89454	·9980267	24	56	·0685957	·068757	14·54383	·9976445	4
16	·0569832	·057075	17·52051	·9983751	44	37	·0630808	·063206	15·82110	·9980084	23	57	·0688859	·069049	14·48227	·9976245	3
17	·0572736	·057367	17·43138	·9983585	43	38	·0633711	·063498	15·74833	·9979900	22	58	·0691761	·069342	14·42123	·9976045	2
18	·0575640	·057659	17·34315	·9983418	42	39	·0636614	·063790	15·67623	·9979716	21	59	·0694663	·069634	14·36069	·9975843	1
19	·0578544	·057951	17·25580	·9983250	41	40	·0639517	·064082	15·60478	·9979530	20	60	·0697565	·069926	14·30066	·9975641	0
20	·0581448	·058243	17·16933	·9983082	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 86. Deg. 86. Deg. 86

4 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
0	·0697565	·069926	14·30066	·9975641	60
1	·0700467	·070219	14·24113	·9975437	59
2	·0703368	·070511	14·18209	·9975233	58
3	·0706270	·070803	14·12353	·9975028	57
4	·0709171	·071096	14·06545	·9974822	56
5	·0712073	·071388	14·00785	·9974615	55
6	·0714974	·071680	13·95071	·9974408	54
7	·0717876	·071973	13·89404	·9974199	53
8	·0720777	·072265	13·83782	·9973990	52
9	·0723678	·072558	13·78206	·9973780	51
10	·0726580	·072850	13·72673	·9973569	50
11	·0729481	073143	13·67185	·9973357	49
12	·0732382	·073435	13·61740	·9973145	48
13	·0735283	·073727	13·56339	·9972931	47
14	·0738184	·074020	13·50979	·9972717	46
15	·0741085	·074312	13·45662	·9972502	45
16	·0743986	·074605	13·40386	·9972286	44
17	0746887	·074897	13·35151	·9972069	43
18	·0749787	075190	13·29957	·9971851	42
19	·0752688	·075482	13·24803	·9971633	41
20	·0755589	·075775	13·19688	·9971413	40
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 85.

4 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
21	·0758489	·076068	13·14612	·9971193	39
22	·0761390	·076360	13·09575	·9970972	38
23	·0764290	·076653	13·04576	·9970750	37
24	·0767190	·076945	12·99616	·9970528	36
25	0770091	·077238	12·94692	·9970304	35
26	0772991	·077531	12·89805	·9970080	34
27	·0775891	·077823	12·84955	·9969854	33
28	0778791	·078116	12·80141	·9969628	32
29	·0781691	·078409	12·75363	·9969401	31
30	·0784591	·078701	12·70620	·9969173	30
31	·0787491	·078994	12·65912	·9968945	29
32	·0790391	079287	12·61239	·9968715	28
33	·0793290	·079579	12 56599	·9968485	27
34	·0796190	·079872	12·51994	·9968254	26
35	·0799090	·080165	12·47422	·9968022	25
36	·0801989	·080458	12·42883	·9967789	24
37	·0804889	·080750	12·38376	·9967555	23
38	·0807788	·081043	12·33902	·9967321	22
39	·0810687	·081336	12·29460	·9967085	21
40	0813587	·081629	12·25050	·9966849	20
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 85.

4 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
41	·0816486	·081922	12·20671	·9966612	19
42	·0819385	·082215	12·16323	·9966374	18
43	·0822284	·082507	12·12006	·9966135	17
44	·0825183	·082800	12·07719	·9965895	16
45	·0828082	·083093	12·03462	·9965655	15
46	·0830981	·083386	11·99234	·9965414	14
47	·0833880	·083679	11·95037	·9965172	13
48	0836778	·083972	11 90868	·9964929	12
49	·0839677	·084265	11·86728	·9964685	11
50	·0842576	·084558	11·82616	·9964440	10
51	·0845474	·084851	11·78533	·9964195	9
52	·0848373	·085144	11·74477	·9963948	8
53	·0851271	·085437	11·70450	·9963701	7
54	·0854169	·085730	11·66449	·9963453	6
55	·0857067	·086023	11·62476	·9963204	5
56	·0859966	·086316	11·58529	·9962954	4
57	·0862864	·086609	11·54609	·9962704	3
58	·0865762	·086902	11·50715	·9962452	2
59	·0868660	·087195	11·46847	·9962200	1
60	·0871557	·087488	11·43005	·9961947	0
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 85.

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

5 Deg. 5 Deg. 5 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·0871557	·087488	11·43005	·9961947	60	21	·0932395	·093647	10·67834	·9956437	39	41	·0990303	·099519	10·048280	·9950844	19
1	·0874455	·087781	11·39188	·9961693	59	22	·0935291	·093940	10·64499	·9956165	38	42	·0993197	·099813	10·018710	·9950556	18
2	·0877353	·088074	11·35397	·9961438	58	23	·0938187	·094234	10·61184	·9955892	37	43	·0996092	·100107	9·989305	·9950266	17
3	·0880251	·088368	11·31630	·9961183	57	24	·0941083	·094527	10·57889	·9955620	36	44	·0998986	·100400	9·960072	·9949976	16
4	·0883148	·088661	11·27888	·9960926	56	25	·0943979	·094821	10·54615	·9955345	35	45	·1001881	·100694	9·931008	·9949685	15
5	·0886046	·088954	11·24171	·9960669	55	26	·0946875	·095114	10·51360	·9955070	34	46	·1004775	·100988	9·902112	·9949393	14
6	·0888943	·089247	11·20478	·9960411	54	27	·0949771	·095408	10·48126	·9954794	33	47	·1007669	·101282	9·873382	·9949101	13
7	·0891840	·089540	11·16808	·9960152	53	28	·0952666	·095701	10·44911	·9954517	32	48	·1010563	·101576	9·844816	·9948807	12
8	·0894738	·089834	11·13163	·9959892	52	29	·0955562	·095995	10·41715	·9954240	31	49	·1013457	·101870	9·816414	·9948513	11
9	·0897635	·090127	11·09541	·9959631	51	30	·0958458	·096289	10·38539	·9953962	30	50	·1016351	·102164	9·788173	·9948217	10
10	·0900532	·090420	11·05943	·9959370	50	31	·0961353	·096582	10·35382	·9953683	29	51	·1019245	·102458	9·760092	·9947921	9
11	·0903429	·090713	11·02367	·9959107	49	32	·0964248	·096876	10·32244	·9953403	28	52	·1022138	·102752	9·732171	·9947625	8
12	·0906326	·091007	10·98815	·9958844	48	33	·0967144	·097169	10·29125	·9953122	27	53	·1025032	·103046	9·704407	·9947327	7
13	·0909223	·091300	10·95285	·9958580	47	34	·0970039	·097463	10·26024	·9952840	26	54	·1027925	·103339	9·676800	·9947028	6
14	·0912119	·091593	10·91777	·9958315	46	35	·0972934	·097757	10·22942	·9952557	25	55	·1030819	·103634	9·649347	·9946729	5
15	·0915016	·091887	10·88292	·9958049	45	36	·0975829	·098050	10·19878	·9952274	24	56	·1033712	·103928	9·622048	·9946428	4
16	·0917913	·092180	10·84828	·9957783	44	37	·0978724	·098344	10·16833	·9951990	23	57	·1036605	·104222	9·594902	·9946127	3
17	·0920809	·092473	10·81387	·9957515	43	38	·0981619	·098638	10·13805	·9951705	22	58	·1039499	·104516	9·567906	·9945825	2
18	·0923706	·092767	10·77967	·9957247	42	39	·0984514	·098932	10·10795	·9951419	21	59	·1042392	·104810	9·541061	·9945523	1
19	·0926602	·093060	10·74568	·9956978	41	40	·0987408	·099225	10·07803	·9951132	20	60	·1045285	·105104	9·514364	·9945219	0
20	·0929499	·093354	10·71191	·9956708	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 84. Deg. 84. Deg. 84.

6 Deg.						6 Deg.						6 Deg.					
′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·1045285	·105104	9·514364	·9945219	60	21	·1106017	·111284	8·985984	·9938648	39	41	·1163818	·117178	8·534017	·9932045	19
1	·1048178	·105398	9·487814	·9944914	59	22	·1108908	·111578	8·962266	·9938326	38	42	·1166707	·117473	8·512594	·9931706	18
2	·1051070	·105692	9·461411	·9944609	58	23	·1111799	·111873	8·938672	·9938003	37	43	·1169596	·117767	8·491277	·9931367	17
3	·1053963	·105986	9·435153	·9944303	57	24	·1114689	·112168	8·915200	·9937679	36	44	·1172485	·118062	8·470065	·9931026	16
4	·1056856	·106280	9·409038	·9943996	56	25	·1117580	·112462	8·891850	·9937355	35	45	·1175374	·118357	8·448957	·9930685	15
5	·1059748	·106575	9·383066	·9943688	55	26	·1120471	·112757	8·868620	·9937029	34	46	·1178263	·118652	8·427953	·9930342	14
6	·1062641	·106869	9·357235	·9943379	54	27	·1123361	·113051	8·845510	·9936703	33	47	·1181151	·118947	8·407051	·9929999	13
7	·1065533	·107163	9·331545	·9943070	53	28	·1126252	·113346	8·822518	·9936375	32	48	·1184040	·119242	8·386251	·9929655	12
8	·1068425	·107457	9·305993	·9942760	52	29	·1129142	·113641	8·799644	·9936047	31	49	·1186928	·119537	8·365553	·9929310	11
9	·1071318	·107751	9·280580	·9942448	51	30	·1132032	·113935	8·776887	·9935719	30	50	·1189816	·119832	8·344955	·9928965	10
10	·1074210	·108046	9·255303	·9942136	50	31	·1134922	·114230	8·754246	·9935389	29	51	·1192704	·120127	8·324457	·9928618	9
11	·1077102	·108340	9·230162	·9941823	49	32	·1137812	·114525	8·731719	·9935058	28	52	·1195593	·120423	8·304058	·9928271	8
12	·1079994	·108634	9·205156	·9941510	48	33	·1140702	·114819	8·709307	·9934727	27	53	·1198481	·120718	8·283757	·9927922	7
13	·1082885	·108929	9·180283	·9941195	47	34	·1143592	·115114	8·687008	·9934395	26	54	·1201368	·121013	8·263554	·9927573	6
14	·1085777	·109223	9·155543	·9940880	46	35	·1146482	·115409	8·664822	·9934062	25	55	·1204256	·121308	8·243448	·9927224	5
15	·1088669	·109517	9·130934	·9940563	45	36	·1149372	·115703	8·642747	·9933728	24	56	·1207144	·121603	8·223438	·9926873	4
16	·1091560	·109812	9·106456	·9940246	44	37	·1152261	·115998	8·620783	·9933393	23	57	·1210031	·121898	8·203523	·9926521	3
17	·1094452	·110106	9·082107	·9939928	43	38	·1155151	·116293	8·598929	·9933057	22	58	·1212919	·122194	8·183704	·9926169	2
18	·1097343	·110401	9·057886	·9939610	42	39	·1158040	·116588	8·577183	·9932721	21	59	·1215806	·122489	8·163978	·9925816	1
19	·1100234	·110695	9·033793	·9939290	41	40	·1160929	·116883	8·555546	·9932384	20	60	·1218693	·122784	8·144346	·9925462	0
20	·1103126	·110989	9·009826	·9938969	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 83.						Deg. 83.						Deg. 83.				

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

′	Sine.	Tang.	Cotang.	Cosine.	′
0	·1218693	·122784	8·144346	·9925462	60
1	·1221581	·123079	8·124807	·9925107	59
2	·1224468	·123375	8·105359	·9924751	58
3	·1227355	·123670	8·086004	·9924394	57
4	·1230241	·123965	8·066739	·9924037	56
5	·1233128	·124261	8·047564	·9923679	55
6	·1236015	·124556	8·028479	·9923319	54
7	·1238901	·124852	8·009483	·9922959	53
8	·1241788	·125147	7·990575	·9922599	52
9	·1244674	·125442	7·971755	·9922237	51
10	·1247560	·125738	7·953022	·9921874	50
11	·1250446	·126033	7·934375	·9921511	49
12	·1253332	·126329	7·915815	·9921147	48
13	·1256218	·126624	7·897339	·9920782	47
14	·1259104	·126920	7·878948	·9920416	46
15	·1261990	·127216	7·860642	·9920049	45
16	·1264875	·127511	7·842419	·9919682	44
17	·1267761	·127807	7·824279	·9919314	43
18	·1270646	·128103	7·806221	·9918944	42
19	·1273531	·128398	7·788245	·9918574	41
20	·1276416	·128694	7·770350	·9918204	40
′	Cosine.	Cotan.	Tang.	Sine.	′

7 Deg.

Deg. 82.

′	Sine.	Tang.	Cotang.	Cosine.	′
21	·1279302	·128990	7·752536	·9917832	39
22	·1282186	·129885	7·734802	·9917459	38
23	·1285071	·129581	7·717148	·9917086	37
24	·1287956	·129877	7·699573	·9916712	36
25	·1290841	·130173	7·682076	·9916337	35
26	·1293725	·130469	7·664658	·9915961	34
27	·1296609	·130764	7·647317	·9915584	33
28	·1299494	·131060	7·630053	·9915206	32
29	·1302378	·131356	7·612865	·9914828	31
30	·1305262	·131652	7·595754	·9914449	30
31	·1308146	·131948	7·578717	·9914069	29
32	·1311030	·132244	7·561756	·9913688	28
33	·1313913	·132540	7·544869	·9913306	27
34	·1316797	·132836	7·528057	·9912923	26
35	·1319681	·133132	7·511317	·9912540	25
36	·1322564	·133428	7·494651	·9912155	24
37	·1325447	·133724	7·478057	·9911770	23
38	·1328330	·134020	7·461535	·9911384	22
39	·1331213	·134316	7·445085	·9910997	21
40	·1334096	·134612	7·428706	·9910610	20
′	Cosine.	Cotan.	Tang.	Sine.	′

7 Deg.

Deg. 82.

′	Sine.	Tang.	Cotang.	Cosine.	′
41	·1336979	·134909	7·412397	·9910221	19
42	·1339862	·135205	7·396159	·9909832	18
43	·1342744	·135501	7·379990	·9909442	17
44	·1345627	·135797	7·363891	·9909051	16
45	·1348509	·136094	7·347861	·9908659	15
46	·1351392	·136390	7·331898	·9908266	14
47	·1354274	·136686	7·316004	·9907873	13
48	·1357156	·136983	7·300178	·9907478	12
49	·1360038	·137279	7·284418	·9907083	11
50	·1362919	·137575	7·268725	·9906687	10
51	·1365801	·137872	7·253098	·9906290	9
52	·1368683	·138168	7·237537	·9905893	8
53	·1371564	·138465	7·222042	·9905494	7
54	·1374445	·138761	7·206611	·9905095	6
55	·1377327	·139058	7·191245	·9904694	5
56	·1380208	·139354	7·175943	·9904293	4
57	·1383089	·139651	7·160705	·9903891	3
58	·1385970	·139947	7·145530	·9903489	2
59	·1388850	·140244	7·130419	·9903085	1
60	·1391731	·140540	7·115369	·9902681	0
′	Cosine.	Cotan.	Tang.	Sine.	′

7 Deg.

Deg. 82.

8 Deg.						8 Deg.						8 Deg.					
′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·1391731	·140540	7·115369	·9902681	60	21	·1452197	·146775	6·813122	·9893994	39	41	·1509733	·152723	6·547767	·9885378	19
1	·1394612	·140837	7·100382	·9902275	59	22	·1455075	·147072	6·799356	·9893572	38	42	·1512608	·153021	6·535029	·9884939	18
2	·1397492	·141134	7·085457	·9901869	58	23	·1457953	·147369	6·785644	·9893148	37	43	·1515484	·153319	6·522339	·9884498	17
3	·1400372	·141430	7·070593	·9901462	57	24	·1460830	·147667	6·791986	·9892723	36	44	·1518359	·153617	6·509698	·9884057	16
4	·1403252	·141727	7·055790	·9901055	56	25	·1463708	·147964	6·758382	·9892298	35	45	·1521234	·153914	6·497104	·9883615	15
5	·1406132	·142024	7·041048	·9900646	55	26	·1466585	·148261	6·744831	·9891872	34	46	·1524109	·154212	6·484558	·9883172	14
6	·1409012	·142321	7·026366	·9900237	54	27	1469463	·148559	6·731334	·9891445	33	47	·1526984	·154510	6·472059	·9882728	13
7	·1411892	·142617	7·011744	·9899826	53	28	·1472340	·148856	6·717889	·9891017	32	48	·1529858	·154808	6·459607	·9882284	12
8	·1414772	·142914	6·997180	·9899415	52	29	·1475217	·149153	6·704496	·9890588	31	49	·1532733	·155106	6·447201	·9881838	11
9	·1417651	·143211	6·982678	·9899003	51	30	·1478094	·149451	6·691156	·9890159	30	50	·1535607	·155404	6·434842	·9881392	10
10	·1420531	·143508	6·968233	·9898590	50	31	·1480971	·149748	6·677867	·9889728	29	51	·1538482	·155701	6·422530	·9880945	9
11	·1423410	·143805	6·953847	·9898177	49	32	·1483848	·150045	6·664630	·9889297	28	52	·1541356	·155999	6·410263	·9880497	8
12	·1426289	·144102	6·939519	·9897762	48	33	·1486724	·150343	6·651444	·9888865	27	53	·1544230	·156297	6·398042	·9880048	7
13	·1429168	·144399	6·925248	·9897347	47	34	·1489601	·150640	6·638310	·9888432	26	54	·1547104	·156595	6·385866	·9879599	6
14	·1432047	·144696	6·911035	·9896931	46	35	·1492477	·150938	6·625225	·9887998	25	55	·1549978	·156893	6·373735	·9879148	5
15	·1434926	·144993	6·896879	·9896514	45	36	·1495353	·151235	6·612191	·9887564	24	56	·1552851	·157191	6·361650	·9878697	4
16	·1437805	·145290	6·882780	·9896096	44	37	·1498230	·151533	6·599208	·9887128	23	57	·1555725	·157490	6·349609	·9878245	3
17	·1440684	·145587	6·868737	·9895677	43	38	·1501106	·151830	6·586273	·9886692	22	58	·1558598	·157788	6·337612	·9877792	2
18	·1443562	·145884	6·854750	·9895258	42	39	·1503981	·152128	6·573389	·9886255	21	59	·1561472	·158086	6·325660	·9877338	1
19	·1446440	·146181	6·840819	·9894838	41	40	·1506857	·152426	6·560553	·9885817	20	60	·1564345	·158384	6·313751	·9876883	0
20	·1449319	·146478	6·826945	·9894416	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 81.						Deg. 81.						Deg. 81.				

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
	9 Deg.						9 Deg.						9 Deg.				
0	·1564345	·158384	6·313751	·9876883	60	21	·1624650	·164652	6·073397	·9867143	39	41	·1682026	·170633	5·860505	·9857524	19
1	·1567218	·158682	6·301886	·9876428	59	22	·1627520	·164951	6·062396	·9866670	38	42	·1684894	·170933	5·850241	·9857035	18
2	·1570091	·158980	6·290065	·9875972	58	23	·1630390	·165250	6·051434	·9866196	37	43	·1687761	·171232	5·840011	·9856544	17
3	·1572963	·159279	6·278286	·9875514	57	24	·1633260	·165548	6·040510	·9865722	36	44	·1690628	·171532	5·829817	·9856053	16
4	·1575836	·159577	6·266551	·9875057	56	25	·1636129	·165847	6·029624	·9865246	35	45	·1693495	·171831	5·819657	·9855561	15
5	·1578708	·159875	6·254858	·9874598	55	26	·1638999	·166146	6·018777	·9864770	34	46	·1696362	·172130	5·809531	·9855068	14
6	·1581581	·160174	6·243208	·9874138	54	27	·1641868	·166445	6·007967	·9864293	33	47	·1699228	·172430	5·799440	·9854574	13
7	·1584453	·160472	6·231600	·9873678	53	28	·1644738	·166744	5·997195	·9863815	32	48	·1702095	·172730	5·789382	·9854079	12
8	·1587325	·160770	6·220034	·9873216	52	29	·1647607	·167043	5·986461	·9863336	31	49	·1704961	·173029	5·779358	·9853583	11
9	·1590197	·161069	6·208510	·9872751	51	30	·1650476	·167342	5·975764	·9862856	30	50	·1707828	·173329	5·769368	·9853087	10
10	·1593069	·161367	6·197027	·9872291	50	31	·1653345	·167641	5·965104	·9862375	29	51	·1710694	·173628	5·759412	·9852590	9
11	·1595940	·161666	6·185586	·9871827	49	32	·1656214	·167940	5·954481	·9861894	28	52	·1713560	·173928	5·749488	·9852092	8
12	·1598812	·161964	6·174186	·9871363	48	33	·1659082	·168239	5·943895	·9861412	27	53	·1716425	·174228	5·739598	·9851593	7
13	·1601683	·162263	6·162827	·9870897	47	34	·1661951	·168539	5·933345	·9860929	26	54	·1719291	·174527	5·729741	·9851093	6
14	·1604555	·162561	6·151508	·9870431	46	35	·1664819	·168838	5·922832	·9860445	25	55	·1722156	·174827	5·719917	·9850593	5
15	·1607426	·162860	6·140230	·9869964	45	36	·1667687	·169137	5·912355	·9859960	24	56	·1725022	·175127	5·710125	·9850091	4
16	·1610297	·163159	6·128992	·9869496	44	37	·1670556	·169436	5·901913	·9859475	23	57	·1727887	·175427	5·700366	·9849589	3
17	·1613167	·163457	6·117794	·9869027	43	38	·1673423	·169735	5·891508	·9858988	22	58	·1730752	·175727	5·690639	·9849086	2
18	·1616038	·163756	6·106636	·9868557	42	39	·1676291	·170035	5·881138	·9858501	21	59	·1733617	·176027	5·680944	·9848582	1
19	·1618909	·164055	6·095517	·9868087	41	40	·1679159	·170334	5·870804	·9858013	20	60	·1736482	·176327	5·671281	·9848078	0
20	·1621779	·164353	6·084438	·9867615	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 80.						Deg. 80.						Deg. 80.				

10 Deg.						10 Deg.					10 Deg.					
′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·1736482	·176327	5·671281	·9848078	60	21	·1796607	·182632	5·475478	·9837286	39	41	·1853808	·188650	5·300801	·9826668	19
1	·1739346	·176626	5·661650	·9847572	59	22	·1799469	·182933	5·466481	·9836763	38	42	·1856666	·188952	5·292350	·9826128	18
2	·1742211	·176926	5·652051	·9847066	58	23	·1802330	·183233	5.457512	·9836239	37	43	·1859524	·189253	5·283925	·9825587	17
3	·1745075	·177226	5·642483	·9846558	57	24	·1805191	·183534	5·448571	·9835715	36	44	·1862382	·189554	5·275525	·9825046	16
4	·1747939	·177527	5·632947	·9846050	56	25	·1808052	·183835	5·439659	·9835189	35	45	·1865240	·189855	5·267151	·9824504	15
5	·1750803	·177827	5·623442	·9845542	55	26	·1810913	·184135	5·430775	·9834663	34	46	·1868098	·190157	5·258803	·9823961	14
6	·1753667	·178127	5·613968	·9845032	54	27	·1813774	·184436	5·421918	·9834136	33	47	·1870956	·190458	5·250480	·9823417	13
7	·1756531	·178427	5·604524	·9844521	53	28	·1816635	·184737	5·413090	·9833608	32	48	·1873813	·190760	5·242183	·9822873	12
8	·1759395	·178727	5·595112	·9844010	52	29	·1819495	·185038	5·404290	·9833079	31	49	·1876670	·191061	5·233911	·9822327	11
9	·1762258	·179027	5·585730	·9843498	51	30	·1822355	·185339	5·395517	·9832549	30	50	·1879528	·191363	5·225664	·9821781	10
10	·1765121	·179327	5·576378	·9842985	50	31	·1825215	·185639	5·386771	·9832019	29	51	·1882385	·191664	5·217442	·9821234	9
11	·1767984	·179628	5·567057	·9842471	49	32	·1828075	·185940	5·378053	·9831487	28	52	·1885241	·191966	5·209245	·9820686	8
12	·1770847	·179928	5·557766	·9841956	48	33	·1830935	·186241	5·369363	·9830955	27	53	·1888098	·192268	2·201073	·9820137	7
13	·1773710	·180228	5·548505	·9841441	47	34	·1833795	·186542	5·369699	·9830422	26	54	·1890954	·192569	5·192926	·9819587	6
14	·1776573	·180529	5·539274	·9840924	46	35	·1836654	·186843	5·352062	·9829888	25	55	·1893811	·192871	5·184803	·9819037	5
15	·1779435	·180829	5·530072	·9840407	45	36	·1839514	·187144	5·343452	·9829353	24	56	·1896667	·193173	5·176705	·9818485	4
16	·1782298	·181129	5·520900	·9839889	44	37	·1842373	·187446	5·334869	·9828818	23	57	·1899523	·193474	5·168631	·9817933	3
17	·1785160	·181430	5·511757	·9839370	43	38	·1845232	·187747	5·326313	·9828282	22	58	·1902379	·193776	5·160581	·9817380	2
18	·1788022	·181730	5·502644	·9838850	42	39	·1848091	·188048	5·317783	·9827744	21	59	·1905234	·194078	5·152555	·9816826	1
19	·1790884	·182031	5·493560	·9838330	41	40	·1850949	·188349	5·309279	·9827206	20	60	·1908090	·194380	5·144554	·9816272	0
20	·1793746	·182331	5·484505	·9837808	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 79.						Deg. 79.						Deg. 79.				

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
	11 Deg.						11 Deg.						11 Deg				
0	·1908090	·194380	5·144554	·9816272	60	21	·1968018	·200727	4·981881	·9804433	39	41	·2025024	·206786	4·835901	·9792818	19
1	·1910945	·194682	5·136576	·9815716	59	22	·1970870	·201030	4·974381	·9803860	38	42	·2027873	·207090	4·828817	·9792228	18
2	·1913801	·194984	5·128622	·9815160	58	23	·1973722	·201332	4·966903	·9803286	37	43	·2030721	·207393	4·821753	·9791638	17
3	·1916656	·195286	5·120692	·9814603	57	24	·1976573	·201635	4·959447	·9802712	36	44	·2033569	·207696	4·814709	·9791047	16
4	·1919510	·195588	5·112785	·9814045	56	25	·1979425	·201938	4·952012	·9802136	35	45	·2036418	·208000	4·807685	·9790455	15
5	·1922365	·195890	5·104902	·9813486	55	26	·1982276	·202240	4·944599	·9801560	34	46	·2039265	·208303	4·800680	·9789862	14
6	·1925220	·196192	5·097042	·9812927	54	27	·1985127	·202543	4·937206	·9800983	33	47	·2042113	·208607	4·793695	·9789268	13
7	·1928074	·196494	5·089206	·9812366	53	28	·1987978	·202846	4·929835	·9800405	32	48	·2044961	·208910	4·786730	·9788674	12
8	·1930928	·196796	5·081392	·9811805	52	29	·1990829	·203149	4·922485	·9799827	31	49	·2047808	·209214	4·779783	·9788079	11
9	·1933782	·197098	5·073602	·9811243	51	30	·1993679	·203452	4·915157	·9799247	30	50	·2050655	·209518	4·772856	·9787483	10
10	·1936636	·197400	5·065835	·9810680	50	31	·1996530	·203755	4·907849	·9798667	29	51	·2053502	·209821	4·765949	·9786886	9
11	·1939490	·197703	5·058090	·9810116	49	32	·1999380	·204058	4·900562	·9798086	28	52	·2056349	·210125	4·759060	·9786288	8
12	·1942344	·198005	5·050369	·9809552	48	33	·2002230	·204361	4·893295	·9797504	27	53	·2059195	·210429	4·752190	·9785689	7
13	·1945197	·198307	5·042670	·9808986	47	34	·2005080	·204664	4·886049	·9796921	26	54	·2062042	·210733	4·745340	·9785090	6
14	·1948050	·198610	5·034993	·9808420	46	35	·2007930	·204967	4·878824	·9796337	25	55	·2064888	·211036	4·738508	·9784490	5
15	·1950903	·198912	5·027339	·9807853	45	36	·2010779	·205270	4·871620	·9795752	24	56	·2067734	·211340	4·731695	·9783889	4
16	·1953756	·199214	5·019707	·9807285	44	37	·2013629	·205573	4·864435	·9795167	23	57	·2070580	·211644	4·714901	·9783287	3
17	·1956609	·199517	5·012098	·9806716	43	38	·2016478	·205876	4·857271	·9794581	22	58	·2073426	·211948	4·718125	·9782684	2
18	·1959461	·199819	5·004511	·9806147	42	39	·2019327	·206180	4·850128	·9793994	21	59	·2076272	·212252	4·711368	·9782080	1
19	·1962314	·200122	4·996945	·9805576	41	40	·2022176	·206483	4·843004	·9793406	20	60	·2079117	·212556	4·704630	·9781476	0
20	·1965166	·200424	4·989402	·9805005	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 78.						Deg. 78.						Deg. 78.				

12 Deg.						12 Deg.						12 Deg.					
′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·2079117	·212556	4·704630	·9781476	60	21	·2138829	·218949	4·567261	·9768593	39	41	·2195624	·225054	4·443376	·9755985	19
1	·2081962	·212860	4·697910	·9780871	59	22	·2141671	·219254	4·560911	·9767970	38	42	·2198462	·225359	4·437350	·9755345	18
2	·2084807	·213164	4·691208	·9780265	58	23	·2144512	·219559	4·554577	·9767347	37	43	·2201300	·225665	4·431339	·9754706	17
3	·2087652	·213468	4·684524	·9779658	57	24	·2147353	·219864	4·548260	·9766723	36	44	·2204137	·225971	4·425343	·9754065	16
4	·2090497	·213773	4·677859	·9779050	56	25	·2150194	·220169	4·541960	·9766098	35	45	·2206974	·226276	4·419364	·9753423	15
5	·2093341	·214077	4·671212	·9778441	55	26	·2153035	·220474	4·535677	·9765472	34	46	·2209811	·226582	4·413399	·9752781	14
6	·2096186	·214381	4·664583	·9777832	54	27	·2155876	·220779	4·529410	·9764845	33	47	·2212648	·226888	4·407450	·9752138	13
7	·2099030	·214685	4·657972	·9777222	53	28	·2158716	·221084	4·523160	·9764217	32	48	·2215485	·227194	4·401516	·9751494	12
8	·2101874	·214990	4·651378	·9776611	52	29	·2161556	·221389	4·516926	·9763589	31	49	·2218321	·227500	4·395597	·9750849	11
9	·2104718	·215294	4·644803	·9775999	51	30	·2164396	·221694	4·510708	·9762960	30	50	·2221158	·227806	4·389694	·9750203	10
10	·2107561	·215589	4·638245	·9775386	50	31	·2167236	·221999	4·504507	·9762330	29	51	·2223994	·228112	4·383805	·9749556	9
11	·2110405	·215903	4·631705	·9774773	49	32	·2170076	·222305	4·498322	·9761699	28	52	·2226830	·228418	4·377931	·9748909	8
12	·2113248	·216207	4·625183	·9774159	48	33	·2172915	·222610	4·492153	·9761067	27	53	·2229666	·228724	4·372073	·9748261	7
13	·2116091	·216512	4·618678	·9773544	47	34	·2175754	·222915	4·486000	·9760435	26	54	·2232501	·229030	4·366229	·9747612	6
14	·2118934	·216816	4·612190	·9772928	46	35	·2178593	·223221	4·479863	·9759802	25	55	·2235337	·229336	4·360400	·9746962	5
15	·2121777	·217121	4·605720	·9772311	45	36	·2181432	·223526	4·473742	·9759168	24	56	·2238172	·229642	4·354586	·9746311	4
16	·2124619	·217425	4·599268	·9771693	44	37	·2184271	·223831	4·467637	·9758533	23	57	·2241007	·229949	4·348786	·9745660	3
17	·2127462	·217730	4·592832	·9771075	43	38	·2187110	·224137	4·461548	·9757897	22	58	·2243842	·230255	4·343001	·9745008	2
18	·2130304	·218035	4·586414	·9770456	42	39	·2189948	·224442	4·455475	·9757260	21	59	·2246676	·230561	4·337231	·9744355	1
19	·2133146	·218340	4·580012	·9769836	41	40	·2192786	·224748	4·449418	·9756623	20	60	·2249511	·230868	4·331475	·9743701	0
20	·2135988	·218644	4·573628	·9769215	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 77.						Deg. 77.						Deg. 77.				

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

13 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
0	·2249511	·230868	4·331475	·9743701	60
1	·2252345	·231174	4·325734	·9743046	59
2	·2255179	·231481	4·320007	·9742390	58
3	·2258013	·231787	4·314295	·9741734	57
4	·2260846	·232094	4·308597	·9741077	56
5	·2263680	·232400	4·302913	·9740419	55
6	·2266513	·232707	4·297244	9739760	54
7	·2269346	·233014	4·291588	·9739100	53
8	·2272179	·233320	4·285947	·9738439	52
9	·2275012	·233627	4·280319	·9737778	51
10	·2277844	·233934	4·274706	·9737116	50
11	·2280677	·234241	4·269107	·9736453	49
12	·2283509	·234547	4·263521	·9735789	48
13	·2286341	·234854	4·257950	·9735124	47
14	·2289172	·235161	4·252392	·9734458	46
15	·2292004	·235468	4·246848	·9733792	45
16	·2294835	·235775	4·241317	·9733125	44
17	·2297666	·236082	4·235800	·9732457	43
18	·2300497	·236390	4·230297	·9731789	42
19	·2303328	·236697	4·224808	·9731119	41
20	·2306159	·237004	4·219331	·9730449	40
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 76.

13 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
21	·2308989	·237311	4·213869	·9729777	39
22	·2311819	·237618	4·208419	·9729105	38
23	·2314649	·237926	4·202983	·9728432	37
24	·2317479	·238233	4·197560	·9727759	36
25	·2320309	·238541	4·192151	·9727084	35
26	·2323138	·238848	4·186754	·9726409	34
27	·2325967	·239156	4·181371	·9725733	33
28	·2328796	·239463	4·176001	·9725056	32
29	·2331625	·239771	4·170644	·9724378	31
30	·2334454	·240078	4·165299	·9723699	30
31	·2337282	·240386	4·159968	·9723020	29
32	·2340110	·240694	4·154650	·9722339	28
33	·2342938	·241001	4·149344	·9721658	27
34	·2345766	·241309	4·144051	·9720976	26
35	·2348594	·241617	4·138771	·9720294	25
36	·2351421	·241925	4·133504	·9719610	24
37	·2354248	·242233	4·128249	·9718926	23
38	·2357075	·242541	4·123007	·9718240	22
39	·2359902	·242849	4·117778	·9717554	21
40	·2362729	·243157	4·112561	·9716867	20
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 76.

13 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
41	·2365555	·243465	4·107356	·9716180	19
42	·2368381	·243773	4·102164	·9715491	18
43	·2371207	·244081	4·096985	·9714802	17
44	·2374033	·244390	4·091817	·9714112	16
45	·2376859	·244698	4·086662	·9713421	15
46	·2379684	·245006	4·081519	·9712729	14
47	·2382510	·245315	4·076389	·9712036	13
48	·2385335	·245623	4·071270	·9711343	12
49	·2388159	·245932	4·066164	·9710649	11
50	·2390984	·246240	4·061070	·9709953	10
51	·2393808	·246549	4·055987	·9709258	9
52	·2396633	·246857	4·050917	·9708561	8
53	·2399457	·247166	4·045859	·9707863	7
54	·2402280	·247475	4·040812	·9707165	6
55	·2405104	·247783	4·035777	·9706466	5
56	·2407927	·248092	4·030755	·9705766	4
57	·2410751	·248401	4·025744	·9705065	3
58	·2413574	·248710	4·020744	·9704363	2
59	·2416396	·249019	4·015757	·9703660	1
60	·2419219	·249328	4·010780	·9702957	0
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 76.

14 Deg.						14 Deg.						14 Deg.					
′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·2419219	·249328	4·010780	·9702957	60	21	·2478445	·255826	3·908901	·9687998	39	41	·2534766	·262034	3·816295	·9673415	19
1	·2422041	·249637	4·005816	·9702253	59	22	·2481263	·256136	3·904171	·9687277	38	42	·2537579	·262345	3·811773	·9672678	18
2	·2424863	·249946	4·000863	·9701548	58	23	·2484081	·256446	3·899451	·9686555	37	43	·2540393	·262656	3·807260	·9671939	17
3	·2427685	·250255	3·995922	·9700842	57	24	·2486899	·256756	3·894742	·9685832	36	44	·2543206	·262967	3·802758	·9671200	16
4	·2430507	·250564	3·990992	·9700135	56	25	·2489716	·257066	3·890044	·9685108	35	45	·2546019	·263278	3·798266	·9670459	15
5	·2433329	·250873	3·986073	·9699428	55	26	·2492533	·257376	3·885357	·9684383	34	46	·2548832	·263589	3·793783	·9669718	14
6	·2436150	·251182	3·981166	·9698720	54	27	·2495350	·257686	3·880680	·9683658	33	47	·2551645	·263900	3·789310	·9668977	13
7	·2438971	·251491	3·976271	·9698011	53	28	·2498167	·257997	3·876014	·9682931	32	48	·2554458	·264211	3·784848	·9668234	12
8	·2441792	·251801	3·971386	·9697301	52	29	·2500984	·258307	3·871358	·9682204	31	49	·2557270	·264522	3·780395	·9667490	11
9	·2444613	·252110	3·966513	·9696591	51	30	·2503800	·258617	3·866713	·9681476	30	50	·2560082	·264833	3·775951	·9666746	10
10	·2447433	·252420	3·961651	·9695879	50	31	·2506616	·258928	3·862078	·9680748	29	51	·2562894	·265145	3·771518	·9666001	9
11	·2450254	·252729	3·956801	·9695167	49	32	·2509432	·259238	3·857453	·9680018	28	52	·2565705	·265456	3·767094	·9665255	8
12	·2453074	·253038	3·951961	·9694453	48	33	·2512248	·259548	3·852839	·9679288	27	53	·2568517	·265768	3·762680	·9664508	7
13	·2455894	·253348	3·947133	·9693740	47	34	·2515063	·259859	3·848235	·9678557	26	54	·2571328	·266079	3·758276	·9663761	6
14	·2458713	·253658	3·942315	·9693025	46	35	·2517879	·260169	3·843642	·9677825	25	55	·2574139	·266390	3·753881	·9663012	5
15	·2461533	·253967	3·937509	·9692309	45	36	·2520694	·260480	3·839059	·9677092	24	56	·2576950	·266702	3·749496	·9662263	4
16	·2464352	·254277	3·932714	·9691593	44	37	·2523508	·260791	3·834486	·9676358	23	57	·2579760	·267014	3·745120	·9661513	3
17	·2467171	·254587	3·927929	·9690875	43	38	·2526323	·261101	3·829923	·9675624	22	58	·2582570	·267325	3·740754	·9660762	2
18	·2469990	·254896	3·923156	·9690157	42	39	·2529137	·261412	3·825370	·9674888	21	59	·2585381	·267637	3·736398	·9660011	1
19	·2472809	·255206	3·918393	·9689438	41	40	·2531952	·261723	3·820828	·9674152	20	60	·2588190	·267949	3·732050	·9659258	0
20	·2475627	·255516	3·913642	·9688719	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 75.						Deg. 75.						Deg. 75.				

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

15 Deg. 15 Deg. 15 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·2588190	·267949	3·732050	·9659258	60	21	·2647147	·274507	3·642891	·9643268	39	41	·2703204	·280773	3·561590	·9627704	19
1	·2591000	·268261	3·727713	·9658505	59	22	·2649952	·274820	3·638744	·9642497	38	42	·2706004	·281087	3·557613	·9626917	18
2	·2593810	·268572	3·723384	·9657751	58	23	·2652757	·275133	3·634606	·9641726	37	43	·2708805	·281401	3·553644	·9626130	17
3	·2596619	·268884	3·719065	·9656996	57	24	·2655561	·275445	3·630477	·9640954	36	44	·2711605	·281715	3·549684	·9625342	16
4	·2599428	·269196	3·714756	·9656240	56	25	2658366	·275758	3·626356	·9640181	35	45	·2714404	·282029	3·545732	·9624552	15
5	·2602237	·269508	3·710455	·9655484	55	26	2661170	·276071	3 622244	·9639407	34	46	·2717204	·282343	3·541788	·9623762	14
6	·2605045	·269820	3·706164	·9654726	54	27	·2663973	·276385	3·618141	·9638633	33	47	·2720003	·282657	3·537852	·9622972	13
7	·2607853	·270132	3·701883	·9653968	53	28	·2666777	·276698	3·614046	·9637858	32	48	2722802	·282971	3·533925	·9622180	12
8	·2610662	·270444	3·697610	·9653209	52	29	·2669581	·277011	3·609960	9637081	31	49	·2725601	·283285	3·530005	·9621387	11
9	·2613469	·270757	3·693346	·9652449	51	30	·2672384	·277324	3·605883	·9636305	30	50	·2728400	·283599	3·526093	·9620594	10
10	·2616277	·271069	3·689092	·9651689	50	31	·2675187	·277637	3·601814	·9635527	29	51	·2731198	·283914	3·522190	·9619800	9
11	·2619085	271381	3·684847	·9650927	49	32	·2677989	277951	3·597754	9634748	28	52	·2733997	·284228	3·518294	·9619005	8
12	·2621892	271694	3·680611	·9650165	48	33	·2680792	·278264	3·593702	·9633969	27	53	·2736794	·284543	3·514407	·9618210	7
13	·2624699	·272006	3·676384	·9649402	47	34	·2683594	·278578	3·589659	·9633189	26	54	·2739592	·284857	3·510527	·9617413	6
14	·2627506	·272318	3·672166	·9648638	46	35	·2686396	·278891	3·585624	·9632408	25	55	·2742390	·285172	3·506655	·9616616	5
15	2630312	·272631	3 667957	·9647873	45	36	·2689198	·279205	3·581597	·9631626	24	56	·2745187	·285486	3·502791	·9615818	4
16	2633118	·272943	3 663757	·9647108	44	37	·2692000	·279518	3·577579	·9630843	23	57	·2747984	·285801	3·498935	·9615019	3
17	2635925	·273256	3·659566	·9646341	43	38	·2694801	·279832	3·573569	·9630060	22	58	·2750781	·286115	3·495087	·9614219	2
18	2638730	·273569	3·655384	·9645574	42	39	·2697602	·280145	3·569568	·9629275	21	59	·2753577	·286430	3·491247	·9613418	1
19	2641536	·273881	3·651211	·9644806	41	40	·2700403	·280459	3·565574	·9628490	20	60	·2756374	·286745	3·487414	·9612617	0
20	2644342	·274194	3·547046	·9644037	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 74. Deg. 74. Deg. 74.

16 Deg.						16 Deg.						16 Deg.					
′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·2756374	·286745	3·487414	·9612617	60	21	·2815042	·293368	3·408688	·9595600	39	41	·2870819	·299697	3·336699	·9579060	19
1	·2759170	·287060	3·483589	·9611815	59	22	·2817833	·293683	3·405021	·9594781	38	42	·2873605	·300014	3·333173	·9578225	18
2	·2761965	·287375	3·479772	·9611012	58	23	·2820624	·293999	3·401361	·9593961	37	43	·2876391	·300331	3·329654	·9577389	17
3	·2764761	·287690	3·475963	·9610208	57	24	·2823415	·294316	3·397708	9593140	36	44	·2879177	·300648	3·326141	·9576552	16
4	·2767556	·288005	3·472161	·9609403	56	25	·2826205	·294632	3·394063	·9592318	35	45	·2881963	·300965	3·322636	·9575714	15
5	·2770352	·288320	3·468367	·9608598	55	26	·2828995	·294948	3·390424	·9591496	34	46	·2884748	·301283	3·319137	·9574875	14
6	·2773147	·288635	3·464581	·9607792	54	27	·2831785	·295264	3·386793	·9590672	33	47	·2887533	·301600	3·315645	·9574035	13
7	·2775941	·288950	3·460802	·9606984	53	28	·2834575	·295580	3·383169	·9589848	32	48	·2890318	·301917	3·312159	·9573195	12
8	·2778736	·289265	3·457031	·9606177	52	29	·2837364	·295897	3·379553	·9589023	31	49	·2893103	·302235	3·308681	·9572354	11
9	·2781530	·289580	3·453267	·9605368	51	30	·2840153	·296213	3·375943	·9588197	30	50	·2895887	·302552	3·305209	·9571512	10
10	·2784324	·289896	3·449512	·9604558	50	31	·2842942	·296529	3·372340	9587371	29	51	·2898671	·302870	3·301743	·9570669	9
11	·2787118	·290211	3·445763	·9603748	49	32	·2845731	·296846	3·368745	·9586543	28	52	·2901455	·303187	3·298285	·9569825	8
12	·2789911	·290526	3·442022	·9602937	48	33	·2848520	·297163	3·365156	·9585715	27	53	·2904239	·303505	3·294833	·9568981	7
13	·2792704	·290842	3·438289	·9602125	47	34	·2851308	·297479	3·361575	·9584886	26	54	·2907022	·303823	3·291387	·9568136	6
14	·2795497	·291157	3·434563	·9601312	46	35	·2854096	·297796	3·358000	·9584056	25	55	·2909805	·304141	3·287948	·9567290	5
15	·2798290	·291473	3·430844	·9600499	45	36	·2856884	·298112	3·354433	·9583226	24	56	·2912588	·304458	3·284516	·9566443	4
16	·2801083	·291789	3·427133	·9599684	44	37	·2859671	·298429	3·350872	·9582394	23	57	·2915371	·304776	3·281090	·9565595	3
17	·2803875	·292104	3·423429	·9598869	43	38	·2862458	·298746	3·347319	·9581562	22	58	·2918153	·305094	3·277671	·9564747	2
18	·2806667	·292420	3·419733	·9598053	42	39	·2865246	·299063	3·343772	·9580729	21	59	·2920935	·305412	3·274258	·9563898	1
19	·2809459	·292736	3·416044	·9597236	41	40	·2868032	·299380	3·340232	·9579895	20	60	·2923717	·305730	3·270852	·9563048	0
20	·2812251	·293052	3·412362	·9596418	40												
	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 73.						Deg. 73.						Deg. 73.				

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
	17 Deg.						17 Deg.						17 Deg.				
0	·2923717	·305730	3·270852	·9563048	60	21	·2982079	·312422	3·200789	·9545009	39	41	·3037559	·318820	3·136563	·9527499	19
1	·2926499	·306048	3·267452	·9562197	59	22	·2984856	·312742	3·197521	·9544141	38	42	·3040331	·319140	3·133414	·9526615	18
2	·2929280	·306367	3·264059	·9561345	58	23	·2987632	·313061	3·194259	·9543273	37	43	·3043102	·319461	3·130270	·9525730	17
3	·2932061	·306685	3·260672	·9560492	57	24	·2990408	·313381	3·191003	·9542403	36	44	·3045872	·319781	3·127131	·9524844	16
4	·2934842	·307003	3·257292	·9559639	56	25	·2993184	·313700	3·187754	·9541533	35	45	·3048643	·320102	3·123999	·9523958	15
5	·2937623	·307321	3·253918	·9558785	55	26	·2995959	·314020	3·184510	·9540662	34	46	·3051413	·320423	3·120872	·9523071	14
6	·2940403	·307640	3·250550	·9557930	54	27	·2998734	·314339	3·181272	·9539790	33	47	·3054183	·320744	3·117750	·9522183	13
7	·2943183	·307958	3·247189	·9557074	53	28	·3001509	·314659	3·178040	·9538917	32	48	·3056953	·321064	3·114635	·9521294	12
8	·2945963	·308277	3·243834	·9556218	52	29	·3004284	·314979	3·174814	·9538044	31	49	·3059723	·321385	3·111525	·9520404	11
9	·2948743	·308595	3·240486	·9555361	51	30	·3007058	·315298	3·171594	·9537170	30	50	·3062492	·321706	3·108421	·9519514	10
10	·2951522	·308914	3·237143	·9554502	50	31	·3009832	·315618	3·168380	·9536294	29	51	·3065261	·322027	3·105322	·9518623	9
11	·2954302	·309233	3·233807	·9553643	49	32	·3012606	·315938	3·165172	·9535418	28	52	·3068030	·322348	3·102229	·9517731	8
12	·2957081	·309551	3·230478	·9552784	48	33	·3015380	·316258	3·161970	·9534542	27	53	·3070798	·322670	3·099141	·9516838	7
13	·2959859	·309870	3·227154	·9551923	47	34	·3018153	·316578	3·158774	·9533664	26	54	·3073566	·322991	3·096059	·9515944	6
14	·2962638	·310189	3·223837	·9551062	46	35	·3020926	·316898	3·155584	·9532786	25	55	·3076334	·323312	3·092983	·9515050	5
15	·2965416	·310508	3·220526	·9550199	45	36	·3023699	·317218	3·152399	·9531907	24	56	·3079102	·323633	3·089912	·9514154	4
16	·2968194	·310827	3·217221	·9549336	44	37	·3026471	·317538	3·149220	·9531027	23	57	·3081869	·323955	3·086846	·9513258	3
17	·2970971	·311146	3·213922	·9548473	43	38	·3029244	·317859	3·146047	·9530146	22	58	·3084636	·324276	3·083786	·9512361	2
18	·2973749	·311465	3·210630	·9547608	42	39	·3032016	·318179	3·142880	·9529264	21	59	·3087403	·324598	3·080732	·9511464	1
19	·2976526	·311784	3·207344	·9546743	41	40	·3034788	·318499	3·139719	·9528382	20	60	·3090170	·324919	3·077683	·9510565	0
20	·2979303	·312103	3·204063	·9545876	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 72.						Deg. 72.						Deg. 72.				

18 Deg.						18 Deg.					18 Deg.				
′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·3090170	·324919	3·077683	·9500565	60	21	·3148209	·331686	3·014892	·9491511	39	41	·3203374	·338157	2·957205	·9473035	19
1	·3092936	·325241	3·074640	·9509666	59	22	·3150969	·332009	3·011960	·9490595	38	42	·3206130	·338481	2·954372	·9472103	18
2	·3095702	·325563	3·071602	·9508766	58	23	·3153730	·332332	3·009033	·9489678	37	43	·3208885	·338805	2·951545	·9471170	17
3	·3098468	·325884	3·068569	·9507865	57	24	·3156490	·332655	3·006110	·9488760	36	44	·3211640	·339129	2·948722	·9470236	16
4	·3101234	·326206	3·065542	·9506963	56	25	·3159250	·332978	3·003193	·9487842	35	45	·3214395	·339454	2·945905	·9469301	15
5	·3103999	·326528	3·062520	·9506061	55	26	·3162010	·333302	3·000282	·9486922	34	46	·3217149	·339778	2·943092	·9468366	14
6	·3106764	·326850	3·059503	·9505157	54	27	·3164770	·333625	2·997375	·9486002	33	47	·3219903	·340103	2·940284	·9467430	13
7	·3109529	·327172	3·056492	·9504253	53	28	·3167529	·333948	2·994473	·9485081	32	48	·3222657	·340427	2·937480	·9466493	12
8	·3112294	·327494	3·053487	·9503348	52	29	·3170288	·334271	2·991576	·9484159	31	49	·3225411	·340752	2·934682	·9465555	11
9	·3115058	·327816	3·050486	·9502443	51	30	·3173047	·334595	2·988685	·9483237	30	50	·3228164	·341077	2·931888	·9464616	10
10	·3117822	·328138	3·047491	·9501536	50	31	·3175805	·334918	2·985798	·9482313	29	51	·3230917	·341401	2·929099	·9463677	9
11	·3120586	·328461	3·044501	·9500629	49	32	·3178563	·335242	2·982916	·9481389	28	52	·3233670	·341726	2·926315	·9462736	8
12	·3123349	·328783	3·041517	·9499721	48	33	·3181321	·335566	2·980040	·9480464	27	53	·3236422	·342051	2·923535	·9461795	7
13	·3126112	·329105	3·038538	·9498812	47	34	·3184079	·335889	2·977168	·9479538	26	54	·3239174	·342376	2·920761	·9460854	6
14	·3128875	·329428	3·035564	·9497902	46	35	·3186836	·336213	2·974301	·9478612	25	55	·3241926	·342701	2·917990	·9459911	5
15	·3131638	·329750	3·032595	·9496991	45	36	·3189593	·336537	2·971439	·9477684	24	56	·3244678	·343026	2·915225	·9458968	4
16	·3134400	·330073	3·029632	·9496080	44	37	·3192350	·336861	2·968583	·9476756	23	57	·3247429	·343351	2·912464	·9458023	3
17	·3137163	·330395	3·026673	·9495168	43	38	·3195106	·337185	2·965731	·9475827	22	58	·3250180	·343677	2·909708	·9457078	2
18	·3139925	·330718	3·023720	·9494255	42	39	·3197863	·337509	2·962884	·9474897	21	59	·3252931	·344002	2·906957	·9456132	1
19	·3142686	·331041	3·020772	·9493341	41	40	·3200619	·337833	2·960042	·9473966	20	60	·3255682	·344327	2·904211	·9455186	0
20	·3145448	·331363	3·017830	9492426	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 71.						Deg. 71.						Deg. 71.				

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

19 Deg. 19 Deg. 19 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·3255682	·344327	2·904210	·9455186	60	21	·3313379	·351175	2·847583	·9435122	39	41	·3368214	·357723	2·795453	·9415686	19
1	·3258432	·344653	2·901468	·9454238	59	22	·3316123	·351501	2·844935	·9434157	38	42	·3370953	·358051	2·792891	·9414705	18
2	·3261182	·344978	2·898731	·9453290	58	23	·3318867	·351828	2·842292	·9433192	37	43	·3373691	·358380	2·790333	·9413724	17
3	·3263932	·345304	2·895998	·9452341	57	24	·3321611	·352155	2·839653	·9432227	36	44	·3376429	·358708	2·787780	·9412743	16
4	·3266681	·345629	2·893270	·9451391	56	25	·3324355	·352482	2·837019	·9431260	35	45	·3379167	·359036	2·785230	·9411760	15
5	·3269430	·345955	2·890546	·9450441	55	26	·3327098	·352809	2·834389	·9430293	34	46	·3381905	·359365	2·782685	·9410777	14
6	·3272179	·346281	2·887827	·9449489	54	27	·3329841	·353136	2·831763	·9429324	33	47	·3384642	·359693	2·780144	·9409793	13
7	·3274928	·346606	2·885113	·9448537	53	28	·3332584	·353464	2·829142	·9428355	32	48	·3387379	·360022	2·777606	·9408808	12
8	·3277676	·346932	2·882403	·9447584	52	29	·3335326	·353791	2·826525	·9427386	31	49	·3390116	·360350	2·775073	·9407822	11
9	·3280424	·347258	2·879697	·9446630	51	30	·3338069	·354118	2·823912	·9426415	30	50	·3392852	·360679	2·772544	·9406835	10
10	·3283172	·347584	2·876997	·9445675	50	31	·3340810	·354446	2·821304	·9425444	29	51	·3395589	·361008	2·770019	·9405848	9
11	·3285919	·347910	2·874300	·9444720	49	32	·3343552	·354773	2·818700	·9424471	28	52	·3398325	·361337	2·767499	·9404860	8
12	·3288666	·348236	2·871608	·9443764	48	33	·3346293	·355101	2·816100	·9423498	27	53	·3401060	·361666	2·764982	·9403871	7
13	·3291413	·348563	2·868921	·9442807	47	34	·3349034	·355428	2·813504	·9422525	26	54	·3403796	·361994	2·762469	·9402881	6
14	·3294160	·348889	2·866238	·9441849	46	35	·3351775	·355756	2·810913	·9421550	25	55	·3406531	·362324	2·759960	·9401891	5
15	·3296906	·349215	2·863560	·9440890	45	36	·3354516	·356084	2·808326	·9420575	24	56	·3409265	·362653	2·757456	·9400899	4
16	·3299653	·349542	2·860886	·9439931	44	37	·3357256	·356411	2·805743	·9419598	23	57	·3412000	·362982	2·754955	·9399907	3
17	·3302398	·349868	2·858216	·9438971	43	38	·3359996	·356739	2·803164	·9418621	22	58	·3414734	·363311	2·752458	·9398914	2
18	·3305144	·350195	2·855551	·9438010	42	39	·3362735	·357067	2·800590	·9417644	21	59	·3417468	·363640	2·749966	·9397921	1
19	·3307889	·350521	2·852891	·9437048	41	40	·3365475	·357395	2·798019	·9416665	20	60	·3420201	·363970	2·747477	·9396926	0
20	·3310634	·350848	2·850234	·9436085	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 70. Deg. 70. Deg. 70.

20 Deg. 20 Deg. 20 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·3420201	·363970	2·747477	·9396926	60	21	·3477540	·370903	2·696118	·9375858	39	41	·3532027	·377536	2·648753	·9355468	19
1	·3422935	·364299	2·744992	·9395931	59	22	·3480267	·371234	2·693714	·9374846	38	42	·3534748	·377868	2·646423	·9354440	18
2	·3425668	·364629	2·742512	·9394935	58	23	·3482994	·371565	2·691314	·9373833	37	43	·3537469	·378201	2·644096	·9353412	17
3	·3428400	·364958	2·740035	·9393938	57	24	·3485720	·371896	2·688919	·9372820	36	44	·3540190	·378533	2·641774	·9352382	16
4	·3431133	·365288	2·737562	·9392940	56	25	·3488447	·372227	2·686526	·9371806	35	45	·3542910	·378866	2·639454	·9351352	15
5	·3433865	·365618	2·735093	·9391942	55	26	·3491173	·372559	2·684138	·9370790	34	46	·3545630	·379198	2·637139	·9350321	14
6	·3436597	·365948	2·732628	·9390943	54	27	·3493898	·372890	2·681753	·9369774	33	47	·3548350	·379531	2·634827	·9349289	13
7	·3439329	·366277	2·730167	·9389943	53	28	·3496624	·373221	2·679372	·9368758	32	48	·3551070	·379864	2·632518	·9348257	12
8	·3442060	·366607	2·727710	·9388942	52	29	·3499349	·373553	2·676995	·9367740	31	49	·3553789	·380197	2·630213	·9347223	11
9	·3444791	·366937	2·725256	·9387940	51	30	·3502074	·373884	2·674621	·9366722	30	50	·3556508	·380530	2·627912	·9346189	10
10	·3447521	·367268	2·722807	·9386938	50	31	·3504798	·374216	2·672251	·9365703	29	51	·3559226	·380863	2·625614	·9345154	9
11	·3450252	·367598	2·720362	·9385934	49	32	·3507523	·374547	2·669885	·9364683	28	52	·3561944	·381196	2·623319	·9344119	8
12	·3452982	·367928	2·717920	·9384930	48	33	·3510246	·374879	2·667522	·9363662	27	53	·3564662	·381529	2·621028	·9343082	7
13	·3455712	·368258	2·715482	·9383925	47	34	·3512970	·375211	2·665163	·9362641	26	54	·3567380	·381862	2·618741	·9342045	6
14	·3458441	·368589	2·713048	·9382920	46	35	·3515693	·375543	2·662808	·9361618	25	55	·3570097	·382196	2·616457	·9341007	5
15	·3461171	·368919	2·710618	·9381913	45	36	·3518416	·375875	2·660456	·9360595	24	56	·3572814	·382529	2·614176	·9339968	4
16	·3463900	·369250	2·708192	·9380906	44	37	·3521139	·376207	2·658108	·9359571	23	57	·3575531	·382863	2·611899	·9338928	3
17	·3466628	·369580	2·705769	·9379898	43	38	·3523862	·376539	2·655764	·9358547	22	58	·3578248	·383196	2·609625	·9337888	2
18	·3469357	·369911	2·703351	·9378889	42	39	·3526584	·376871	2·653423	·9357521	21	59	·3580964	·383530	2·607355	·9336846	1
19	·3472085	·370242	2·700936	·9377880	41	40	·3529306	·377203	2·651086	·9356495	20	60	·3583679	·383864	2·605089	·9335804	0
20	·3474812	·370572	2·698525	·9376869	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 69. Deg. 69. Deg. 69.

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

′	Sine.	Tang.	Cotang.	Cosine.	′
0	·3583679	·383864	2·605089	·9335804	60
1	·3586395	·384197	2·602825	·9334761	59
2	·3589110	·384531	2·600565	·9333718	58
3	·3591825	·384865	2·598309	·9332673	57
4	·3594540	·385199	2·596056	·9331628	56
5	·3597254	·385533	2·593806	·9330582	55
6	·3599968	·385867	2·591560	·9329535	54
7	·3602682	·386202	2·589317	·9328488	53
8	·3605395	·386536	2·587078	·9327439	52
9	·3608108	·386870	2·584842	·9326390	51
10	·3610821	·387205	2·582609	·9325340	50
11	·3613534	·387539	2·580380	·9324290	49
12	·3616246	·387874	2·578153	·9323238	48
13	·3618958	·388209	2·575931	·9322186	47
14	·3621669	·388543	2·573711	·9321133	46
15	·3624380	·388878	2·571495	·9320079	45
16	·3627091	·389213	2·569283	·9319024	44
17	·3629802	·389548	2·567073	·9317969	43
18	·3632512	·389883	2·564867	·9316912	42
19	·3635222	·390218	2·562664	·9315855	41
20	·3637932	·390554	2·560464	·9314797	40
′	Cosine.	Cotan.	Tang.	Sine.	′

21 Deg. — Deg. 68.

′	Sine.	Tang.	Cotang.	Cosine.	′
21	·3640641	·390889	2·558268	·9313739	39
22	·3643351	·391224	2·556075	·9312679	38
23	·3646059	·391560	2·553885	·9311619	37
24	·3648768	·391895	2·551699	·9310558	36
25	·3651476	·392231	2·549516	·9309496	35
26	·3654184	·392567	2·547335	·9308434	34
27	·3656891	·392902	2·545159	·9307370	33
28	·3659599	·393238	2·542985	·9306306	32
29	·3662306	·393574	2·540815	·9305241	31
30	·3665012	·393910	2·538647	·9304176	30
31	·3667719	·394246	2·536483	·9303109	29
32	·3670425	·394582	2·534323	·9302042	28
33	·3673130	·394918	2·532165	·9300974	27
34	·3675836	·395255	2·530011	·9299905	26
35	·3678541	·395591	2·527859	·9298835	25
36	·3681246	·395928	2·525711	·9297765	24
37	·3683950	·396264	2·523566	·9296694	23
38	·3686654	·396601	2·521424	·9295622	22
39	·3689358	·396937	2·519286	·9294549	21
40	·3692061	·397274	2·517150	·9293475	20
′	Cosine.	Cotan.	Tang.	Sine.	′

21 Deg. — Deg. 68.

′	Sine.	Tang.	Cotang.	Cosine.	′
41	·3694765	·397611	2·515018	·9291401	19
42	·3697468	·397948	2·512889	·9291326	18
43	·3700170	·398285	2·510762	·9290250	17
44	·3702872	·398622	2·508639	·9289173	16
45	·3705574	·398959	2·506519	·9288096	15
46	·3708276	·399296	2·504402	·9287017	14
47	·3710977	·399634	2·502289	·9285938	13
48	·3713678	·399971	2·500178	·9284858	12
49	·3716379	·400308	2·498070	·9283778	11
50	·3719079	·400646	2·495966	·9282696	10
51	·3721780	·400984	2·493864	·9281614	9
52	·3724479	·401321	2·491766	·9280531	8
53	·3727179	·401659	2·489670	·9279447	7
54	·3729878	·401997	2·487578	·9278363	6
55	·3732577	·402335	2·485488	·9277277	5
56	·3135275	·402673	2·483402	·9276191	4
57	·3737973	·403011	2·481319	·9275104	3
58	·3740671	·403349	2·479238	·9274016	2
59	·3743369	·403687	2·477161	·9272928	1
60	·3746066	·404026	2·475086	·9271839	0
′	Cosine.	Cotan.	Tang.	Sine.	′

21 Deg. — Deg. 68.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·3746066	·404026	2·475086	·9271839	60	21	·3802634	·411149	2·432204	·9248782	39	41	·3856377	·417967	2·392531	·9226503	19
1	·3748763	·404364	2·473015	·9270748	59	22	·3805324	·411489	2·430193	·9247676	38	42	·3859060	·418309	2·390576	·9225381	18
2	·3751459	·404703	2·470947	·9269658	58	23	·3808014	·411830	2·428186	·9246568	37	43	·3861744	·418650	2·388625	·9224258	17
3	·3754156	·405041	2·468881	·9268566	57	24	·3810704	·412170	2·426181	·9245460	36	44	·3864427	·418992	2·386675	·9223134	16
4	·3756852	·405380	2·466819	·9267474	56	25	·3813393	·412510	2·424180	·9244351	35	45	·3867110	·419334	2·384729	·9222010	15
5	·3759547	·405719	2·464759	·9266380	55	26	·3816082	·412851	2·422181	·9243242	34	46	·3869792	·419676	2·382785	·9220884	14
6	·3762243	·406057	2·462703	·9265286	54	27	·3818770	·413191	2·420185	·9242131	33	47	·3872474	·420019	2·380844	·9219758	13
7	·3764938	·406396	2·460649	·9264192	53	28	·3821459	·413532	2·418191	·9241020	32	48	·3875156	·420361	2·378906	·9218632	12
8	·3767632	·406735	2·458598	·9263096	52	29	·3824147	·413872	2·416201	·9239908	31	49	·3877837	·420703	2·376970	·9217504	11
9	·3770327	·407074	2·456551	·9262000	51	30	·3826834	·414213	2·414213	·9238795	30	50	·3880518	·421046	2·375037	·9216375	10
10	·3773021	·407413	2·454506	·9260902	50	31	·3829522	·414554	2·412228	·9237682	29	51	·3883199	·421388	2·373106	·9215246	9
11	·3775714	·407753	2·452464	·9259805	49	32	3832209	·414895	2·410246	·9236567	28	52	·3885880	·421731	2·371179	·9214116	8
12	·3778408	·408092	2·450425	·9258706	48	33	·3834895	·415236	2·408267	·9235452	27	53	·3888560	·422073	2·369254	·9212986	7
13	·3781101	·408431	2·448389	·9257606	47	34	·3837582	·415577	2·406290	·9234336	26	54	·3891240	·422416	2·367331	·9211854	6
14	·3783794	·408771	2·446355	·9256506	46	35	·3840268	·415918	2·404316	·9233220	25	55	·3893919	·422759	2·365411	·9210722	5
15	·3786486	·409110	2·444325	·9255405	45	36	·3842953	·416259	2·402345	·9232102	24	56	·3896598	·423102	2·363494	·9209589	4
16	·3789178	·409450	2·442298	·9254303	44	37	·3845639	·416601	2·400377	·9230984	23	57	·3899277	·423445	2·361580	·9208455	3
17	·3791870	·409790	2·440273	·9253201	43	38	·3848324	·416942	2·398411	·9229865	22	58	·3901955	·423788	2·359668	·9207320	2
18	·3794562	·410129	2·438251	·9252097	42	39	·3851008	·417284	2·396449	·9228745	21	59	·3904633	·424131	2·357759	·9206185	1
19	·3797253	·410469	2·436233	·9250993	41	40	·3853693	·417625	2·394488	·9227624	20	60	·3907311	·424474	2·355852	·9205049	0
20	·3799944	·410809	2·434217	·9249888	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

23 Deg.					23 Deg.					23 Deg					
′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·3907311	·424474	2·355852	·9205049	60	21	·3963468	·431703	2·316407	·9181009	39	41	·4016814	·438622	2·279865	·9157795	19
1	·3909989	·424818	2·353948	·9203912	59	22	·3966139	·432048	2·314557	·9179855	38	42	·4019478	·438969	2·278063	·9156626	18
2	·3912666	·425161	2·352046	·9202774	58	23	·3968809	·432393	2·312709	·9178701	37	43	·4022141	·439316	2·276264	·9155456	17
3	·3915343	·425505	2·350148	·9201635	57	24	·3971479	·432738	2·310863	·9177546	36	44	·4024804	·439663	2·274467	·9154286	16
4	·3918019	·425848	2·348251	·9200496	56	25	·3974148	·433084	2·309020	·9176391	35	45	·4027467	·440010	2·272672	·9153115	15
5	·3920695	·426192	2·346358	·9199356	55	26	·3976818	·433429	2·307180	·9175234	34	46	·4030129	·440357	2·270880	·9151943	14
6	·3923371	·426536	2·344467	·9198215	54	27	·3979486	·433775	2·305342	·9174077	33	47	·4032791	·440705	2·269090	·9150770	13
7	·3926047	·426880	2·342578	·9197073	53	28	·3982155	·434120	2·303506	·9172919	32	48	·4035453	·441052	2·267303	·9149597	12
8	·3928722	·427223	2·340692	·9195931	52	29	·3984823	·434466	2·301673	·9171760	31	49	·4038114	·441400	2·265518	·9148422	11
9	·3931397	·427568	2·338809	·9194788	51	30	·3987491	·434812	2·299842	·9170601	30	50	·4040775	·441747	2·263735	·9147247	10
10	·3934071	·427912	2·336928	·9193644	50	31	·3990158	·435158	2·298014	·9169440	29	51	·4043436	·442095	2·261955	·9146072	9
11	·3936745	·428256	2·335050	·9192499	49	32	·3992825	·435504	2·296188	·9168279	28	52	·4046096	·442443	2·260177	·9144895	8
12	·3939419	·428600	2·333174	·9191353	48	33	·3995492	·435850	2·294365	·9167118	27	53	·4048756	·442791	2·258401	·9143718	7
13	·3942093	·428944	2·331301	·9190207	47	34	·3998158	·436196	2·292544	·9165955	26	54	·4051416	·443139	2·256628	·9142540	6
14	·3944766	·429289	2·329431	·9189060	46	35	·4000825	·436542	2·290725	·9164791	25	55	·4054075	·443487	2·254857	·9141361	5
15	·3947439	·429633	2·327563	·9187912	45	36	·4003490	·436889	2·288909	·9163627	24	56	·4056734	·443835	2·253088	·9140181	4
16	·3950111	·429978	2·325697	·9186763	44	37	·4006156	·437235	2·287095	·9162462	23	57	·4059393	·444183	2·251322	·9139001	3
17	·3952783	·430323	2·323834	·9185614	43	38	·4008821	·437582	2·285284	·9161297	22	58	·4062051	·444531	2·249558	·9137819	2
18	·3955455	·430668	2·321974	·9184464	42	39	·4011486	·437928	2·283475	·9160130	21	59	·4064709	·444880	2·247796	·9136637	1
19	·3958127	·431012	2·320116	·9183313	41	40	·4014150	·438275	2·281669	·9158963	20	60	·4067366	·445228	2·246036	·9135455	0
20	·3960798	·431357	2·318260	·9182161	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 66.						Deg. 66.						Deg. 66.				

24 Deg.						24 Deg.						24 Deg.					
′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·4067366	·445228	2·246036	·9135455	60	21	·4123096	·452568	2·209611	·9110438	39	41	·4176028	·459596	2·175822	·9086297	19
1	·4070024	·445577	2·244279	·9134271	59	22	·4125745	·452918	2·207901	·9109238	38	42	·4178671	·459948	2·174155	·9085082	18
2	·4072681	·445926	2·242524	·9133087	58	23	·4128395	·453269	2·206193	·9108038	37	43	·4181313	·460301	2·172491	·9083866	17
3	·4075337	·446274	2·240772	·9131902	57	24	·4131044	·453620	2·204487	·9106837	36	44	·4183956	·460653	2·170828	·9082649	16
4	·4077993	·446623	2·239021	·9130716	56	25	·4133693	·453970	2·202784	·9105635	35	45	·4186597	·461006	2·169167	·9081432	15
5	·4080649	·446972	2·237273	·9129529	55	26	·4136342	·454321	2·201083	·9104432	34	46	·4189239	·461359	2·167509	·9080214	14
6	·4083305	·447321	2·235528	·9128342	54	27	·4138990	·454672	2·199384	·9103228	33	47	·4191880	·461711	2·165852	·9078995	13
7	·4085960	·447670	2·233784	·9127154	53	28	·4141638	·455023	2·197687	·9102024	32	48	·4194521	·462064	2·164198	·9077775	12
8	·4088615	·448020	2·232043	·9125965	52	29	·4144285	·455375	2·195992	·9100819	31	49	·4197161	·462417	2·162546	·9076554	11
9	·4091269	·448369	2·230304	·9124775	51	30	·4146932	·455726	2·194299	·9099613	30	50	·4199801	·462771	2·160895	·9075333	10
10	·4093923	·448718	2·228567	·9123584	50	31	·4149579	·456077	2·192609	·9098406	29	51	·4202441	·463124	2·159247	·9074111	9
11	·4096577	·449068	2·226833	·9122393	49	32	·4152226	·456429	2·190921	·9097199	28	52	·4205080	·463477	2·157601	·9072888	8
12	·4099230	·449417	2·225100	·9121201	48	33	·4154872	·456780	2·189234	·9095990	27	53	·4207719	·463831	2·155957	·9071665	7
13	·4101883	·449767	2·223370	·9120008	47	34	·4157517	·457132	2·187551	·9094781	26	54	·4210358	·464184	2·154315	·9070440	6
14	·4104536	·450117	2·221643	·9118815	46	35	·4160163	·457483	2·185869	·9093572	25	55	·4212966	·464538	2·152675	·9069215	5
15	·4107189	·450467	2·219917	·9117620	45	36	·4162808	·457835	2·184189	·9092361	24	56	·4215634	·464891	2·151037	·9067989	4
16	·4109841	·450817	2·218194	·9116425	44	37	·4165453	·458187	2·182511	·9091150	23	57	·4218272	·465245	2·149402	·9066762	3
17	·4112492	·451167	2·216473	·9115229	43	38	·4168097	·458539	2·180836	·9089938	22	58	·4220909	·465599	2·147768	·9065535	2
18	·4115144	·451517	2·214754	·9114033	42	39	·4170741	·458891	2.179163	·9088725	21	59	·4223546	·465953	2·146136	·9064307	1
19	·4117795	·451867	2·213037	·9112835	41	40	·4173385	·459243	2·177492	·9087511	20	60	·4226183	·466307	2·144506	·9063078	0
20	·4120445	·452217	2·211323	·9111637	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 65.						Deg. 65.						Deg. 65.				

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

25 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
0	·4226183	·466307	2·144506	·9063078	60
1	·4228819	·466661	2·142879	·9061848	59
2	·4231455	·467016	2·141253	9060618	58
3	·4234090	·467370	2·139630	·9059386	57
4	·4236725	·467725	2·138008	·9058154	56
5	·4239360	·468079	2·136389	·9056922	55
6	·4241994	·468434	2·134771	·9055688	54
7	·4244628	·468789	2·133155	·9054454	53
8	·4247262	·469143	2·131542	·9053219	52
9	·4249895	·469498	2·129930	·9051983	51
10	·4252528	·469853	2·128321	·9050746	50
11	·4255161	·470209	2·126713	·9049509	49
12	·4257793	·470564	2·125108	·9048271	48
13	·4260425	·470919	2·123504	·9047032	47
14	·4263056	·471275	2·121903	·9045792	46
15	·4265687	·471630	2·120303	·9044551	45
16	·4268318	·471986	2·118705	·9043310	44
17	·4270949	·472342	2·117110	·9042068	43
18	·4273579	·472697	2·115516	·9040825	42
19	·4276208	·473053	2·113924	·9039582	41
20	·4278838	·473409	2·112334	·9038338	40
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 64.

25 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
21	·4281467	·473765	2·110747	·9037093	39
22	·4284095	·474122	2·109161	·9035847	38
23	·4286723	·474478	2·107577	·9034600	37
24	·4289351	·474834	2·105995	·9033353	36
25	·4291979	·475191	2·104415	·9032105	35
26	·4294606	·475548	2·102836	·9030856	34
27	·4297233	·475904	2·101260	·9029606	33
28	·4299859	·476261	2·099686	·9028356	32
29	·4302485	·476618	2·098114	·9027105	31
30	·4305111	·476975	2·096543	·9025853	30
31	·4307736	·477332	2·094975	·9024600	29
32	·4310361	·477689	2·093408	·9023347	28
33	·4312986	·478047	2·091843	·9022092	27
34	·4315610	·478404	2·090280	·9020838	26
35	·4318234	·478762	2·088720	·9019582	25
36	·4320857	·479119	2·087161	·9018325	24
37	·4323481	·479477	2·085603	·9017068	23
38	·4326103	·479835	2·084048	·9015810	22
39	·4328726	·480193	2·082495	·9014551	21
40	·4331348	·480551	2·080943	·9013292	20
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 64.

25 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
41	·4333970	·480909	2·079394	·9012031	19
42	·4336591	·481267	2·077846	·9010770	18
43	·4339212	·481625	2·076300	·9009508	17
44	·4341832	·481984	2·074756	·9008246	16
45	·4344453	·482342	2·073214	·9006982	15
46	·4347072	·482701	2·071674	·9005718	14
47	·4349692	·483060	2·070135	·9004453	13
48	·4352311	·483418	2·068599	·9003188	12
49	·4354930	·483777	2·067064	·9001921	11
50	·4357548	·484136	2·065531	·9000654	10
51	·4360166	·484495	2·064000	·8999386	9
52	·4362784	·484855	2·062471	·8998117	8
53	·4365401	·485214	2·060944	·8996848	7
54	·4368018	·485573	2·059418	·8995578	6
55	·4370634	·485933	2·057895	·8994307	5
56	·4373251	·486293	2·056373	·8993035	4
57	·4375866	·486652	2·054853	·8991763	3
58	·4378482	·487012	2·053334	·8990489	2
59	·4381097	·487372	2·051818	·8989215	1
60	·4383711	·487732	2·050303	·8987940	0
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 64.

26 Deg.						26 Deg.						26 Deg.					
′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·4383711	·487732	2·050303	·8987940	60	21	·4438534	·495317	2·018908	·8960994	39	41	·4490591	·502583	1·989720	·8935021	19
1	·4386326	·488092	2·048791	·8986665	59	22	·4441140	·495679	2·017433	·8959703	38	42	·4493190	·502947	1·988278	·8933714	18
2	·4388940	·488453	2·047280	·8985389	58	23	·4443746	·496041	2·015959	·8958411	37	43	·4495789	·503312	1·986838	·8932406	17
3	·4391553	·488813	2·045770	·8984112	57	24	·4446352	·496404	2·014486	·8957118	36	44	·4498387	·503676	1·985400	·8931098	16
4	·4394166	·489173	2·044263	·8982834	56	25	·4448957	·496766	2·013016	·8955824	35	45	·4500984	·504041	1·983963	·8929789	15
5	·4396779	·489534	2·042757	·8981555	55	26	·4451562	·497129	2·011547	·8954529	34	46	·4503582	·504406	1·982528	·8928480	14
6	·4399392	·489894	2·041254	·8980276	54	27	·4454167	·497492	2·010080	·8953234	33	47	·4506179	·504771	1·981095	·8927169	13
7	·4402004	·490255	2·039751	·8978996	53	28	·4456771	·497855	2·008615	·8951938	32	48	·4508775	·505136	1·979663	·8925858	12
8	·4404615	·490616	2·038251	·8977715	52	29	·4459375	·498218	2·007151	·8950641	31	49	·4511372	·505501	1·978233	·8924546	11
9	·4407227	·490977	2·036753	·8976433	51	30	·4461978	·498581	2·005689	·8949344	30	50	·4513967	·505866	1·976805	·8923234	10
10	·4409838	·491338	2·035256	·8975151	50	31	·4464581	·498944	2·004229	·8948045	29	51	·4516563	·506232	1·975378	·8921920	9
11	·4412448	·491699	2·033761	·8973868	49	32	·4467184	·499308	2·002771	·8946746	28	52	·4519158	·506597	1·973953	·8920606	8
12	·4415059	·492061	2·032268	·8972584	48	33	·4469786	·499671	2·001314	·8945446	27	53	·4521753	·506963	1·972529	·8919291	7
13	·4417668	·492422	2·030776	·8971299	47	34	·4472388	·500035	1·999859	·8944146	26	54	·4524347	·507329	1·971107	·8917975	6
14	·4420278	·492783	2·029287	·8970014	46	35	·4474990	·500398	1·998405	·8942844	25	55	·4526941	·507694	1·969687	·8916659	5
15	·4422887	·493145	2·027799	·8968727	45	36	·4477591	·500762	1·996953	·8941542	24	56	·4529535	·508060	1·968268	·8915342	4
16	·4425496	·493507	2·026313	·8967440	44	37	·4480192	·501126	1·995503	·8940240	23	57	·4532128	·508426	1·966851	·8914024	3
17	·4428104	·493868	2·024828	·8966153	43	38	·4482792	·501490	1·994055	·8938936	22	58	·4534721	·508792	1·965436	·8912705	2
18	·4430712	·494230	2·023346	·8964864	42	39	·4485392	·501854	1·992608	·8937632	21	59	·4537313	·509159	1·964022	·8911385	1
19	·4433319	·494592	2·021865	·8963575	41	40	·4487992	·502218	1·991163	·8936326	20	60	·4539905	·509525	1·962610	·8910065	0
20	·4435927	·494954	2·020386	·8962285	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 63.						Deg. 63.						Deg. 63.				

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

27 Deg.						27 Deg.						27 Deg.					
′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·4539905	·509525	1·962610	·8910065	60	21	·4594248	·517244	1·933323	·8882166	39	41	·4645845	·524640	1·906066	·8855288	19
1	·4542497	·509891	1·961200	·8908744	59	22	·4596832	·517612	1·931945	·8880830	38	42	·4648420	·525011	1·904719	·8853936	18
2	·4545088	·510258	1·959791	·8907423	58	23	·4599415	·517981	1·930569	·8878492	37	43	·4650996	·525382	1·903373	·8852584	17
3	·4547679	·510625	1·958383	·8906100	57	24	·4601998	·518350	1·929195	·8879154	36	44	·4653571	·525754	1·902029	·8851230	16
4	·4550269	·510991	1·956978	·8904777	56	25	·4604580	·518719	1·927822	·8876815	35	45	·4656145	·526125	1·900687	·8849876	15
5	·4552859	·511358	1·955573	·8903453	55	26	·4607162	·519089	1·926451	·8875475	34	46	·4658719	·526496	1·899346	·8848522	14
6	·4555449	·511725	1·954171	·8902128	54	27	·4609744	·519458	1·925081	·8874134	33	47	·4661293	·526868	1·898006	·8847166	13
7	·4558038	·512093	1·952770	·8900803	53	28	·4612325	·519827	1·923713	·8872793	32	48	·4663866	·527240	1·896668	·8845810	12
8	·4560627	·512460	1·951371	·8899476	52	29	·4614906	·520197	1·922347	·8871451	31	49	·4666439	·527612	1·895332	·8844453	11
9	·4563216	·512827	1·949973	·8898149	51	30	·4617486	·520567	1·920982	·8870108	30	50	·4669012	·527983	1·893997	·8843095	10
10	·4565804	·513195	1·948577	·8896822	50	31	·4620066	·520936	1·919618	·8868765	29	51	·4671584	·528356	1·892663	·8841736	9
11	·4568392	·513562	1·947182	·8895493	49	32	·4622646	·521306	1·918256	·8867420	28	52	·4674156	·528728	1·891331	·8840377	8
12	·4570979	·513930	1·945789	·8894164	48	33	·4625225	·521676	1·916896	·8866075	27	53	·4676727	·529100	1·890000	·8839017	7
13	·4573566	·514298	1·944398	·8892834	47	34	·4627804	·522046	1·915537	·8864730	26	54	·4679298	·529472	1·888671	·8837656	6
14	·4576153	·514666	1·943008	·8891503	46	35	·4630382	·522417	1·914179	·8863383	25	55	·4681869	·529845	1·887343	·8836295	5
15	·4578739	·515033	1·941620	·8890171	45	36	·4632960	·522787	1·912823	·8862036	24	56	·4684439	·530217	1·886017	·8834933	4
16	·4581325	·515401	1·940233	·8888839	44	37	·4635538	·523157	1·911469	·8860688	23	57	·4687009	·530590	1·884692	·8833569	3
17	·4583910	·515770	1·938848	·8887506	43	38	·4638115	·523528	1·910116	·8859339	22	58	·4689578	·530963	1·883369	·8832206	2
18	·4586496	·516138	1·937464	·8886172	42	39	·4640692	·523899	1·908764	·8857989	21	59	·4692147	·531336	1·882047	·8830841	1
19	·4589080	·516506	1·936082	·8884838	41	40	·4643269	·524269	1·907414	·8856639	20	60	·4694716	·531709	1·880726	·8829476	0
20	·4591665	·516875	1·934702	·8883503	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 62.						Deg. 62.						Deg. 62.				

28 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
0	·4694716	·531709	1·880726	·8829476	60
1	·4697284	·532082	1·879407	·8828110	59
2	·4699852	·532455	1·878089	·8826743	58
3	·4702419	·532829	1·876773	·8825376	57
4	·4704986	·533202	1·875458	·8824007	56
5	·4707553	·533576	1·874145	·8822638	55
6	·4710119	·533950	1·872833	·8821269	54
7	·4712685	·534324	1·871523	·8819898	53
8	·4715250	·534698	1·870214	·8818527	52
9	·4717815	·535072	1·868906	·8817155	51
10	·4720380	·535446	1·867600	·8815782	50
11	·4722944	·535820	1·866295	·8814409	49
12	·4725508	·536195	1·864992	·8813035	48
13	·4728071	·536569	1·863690	·8811660	47
14	·4730634	·536944	1·862389	·8810284	46
15	·4733197	·537319	1·861090	·8808907	45
16	·4735759	·537694	1·859792	·8807530	44
17	·4738321	·538069	1·858496	·8806152	43
18	·4740882	·538444	1·857201	·8804774	42
19	·4743443	·538819	1·855908	·8803394	41
20	·4746004	·539195	1·854615	·8802014	40
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 61.

28 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
21	·4748564	·539570	·1853325	·8800633	39
22	·4751124	·539946	·1852035	·8799251	38
23	·4753683	·540322	·1850747	·8797869	37
24	·4756242	·540698	·1849461	·8796486	36
25	·4758801	·541074	·1848176	·8795102	35
26	·4761359	·541450	·1846892	·8793717	34
27	·4763917	·541826	·1845609	·8792332	33
28	·4766474	·542202	·1844328	·8790946	32
29	·4769031	·542579	·1843049	·8789559	31
30	·4771588	·542955	·1841770	·8788171	30
31	·4774144	·543332	·1840494	·8786783	29
32	·4776700	·543709	·1839218	·8785394	28
33	·4779255	·544086	·1837944	·8784004	27
34	·4781810	·544463	·1836671	·8782613	26
35	·4784364	·544840	·1835399	·8781222	25
36	·4786919	·545217	·1834129	·8779830	24
37	·4789472	·545595	·1832861	·8778437	23
38	·4792026	·545972	·1831593	·8777043	22
39	·4794579	·546350	·1830327	·8775649	21
40	·4797131	·546728	·1829062	·8774254	20
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 61.

28 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
41	·4799683	·547106	1·827799	·8772858	19
42	·4802235	·547484	1·826537	·8771462	18
43	·4804786	·547862	1·825276	·8770064	17
44	·4807337	·548240	1·824017	·8768666	16
45	·4809888	·548618	1·822759	·8767268	15
46	·4812438	·548997	1·821502	·8765868	14
47	·4814987	·549375	1·820247	·8764468	13
48	·4817537	·549754	1·818993	·8763067	12
49	·4820086	·550133	1·817740	·8761665	11
50	·4822634	·550512	1·816489	·8760263	10
51	·4825182	·550891	1·815239	·8758859	9
52	·4827730	·551270	1·813990	·8757455	8
53	·4830277	·551650	1·812743	·8756051	7
54	·4832824	·552029	1·811496	·8754645	6
55	·4835370	·552409	1·810252	·8753239	5
56	·4837916	·552789	1·809008	·8751832	4
57	·4840462	·553168	1·807766	·8750425	3
58	·4843007	·553548	1·806525	·8749016	2
59	·4845552	·553928	1·805286	·8747607	1
60	·4848096	·554309	1·804047	·8746197	0
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 61.

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
29 Deg.						**29 Deg.**						**29 Deg.**					
0	·4848096	·554309	1·804047	·8746197	60	21	·4901433	·562321	1·778340	·8716419	39	41	·4952060	·570004	1·754372	·8687756	19
1	·4850640	·554689	1·802810	·8744786	59	22	·4903968	·562704	1·777130	·8714993	38	42	·4954587	·570389	1·753186	·8686315	18
2	·4853184	·555069	1·801575	·8743375	58	23	·4906503	·563087	1·775921	·8713566	37	43	·4957113	·570775	1·752002	·8684874	17
3	·4855727	·555450	1·800340	·8741963	57	24	·4909038	·563471	1·774714	·8712138	36	44	·4959639	·571161	1·750819	·8683431	16
4	·4858270	·555831	1·799107	·8740550	56	25	·4911572	·563854	1·773507	·8710710	35	45	·4962165	·571547	1·749637	·8681988	15
5	·4860812	·556211	1·797875	·8739137	55	26	·4914105	·564237	1·772302	·8709281	34	46	·4964690	·571933	1·748456	·8680544	14
6	·4863354	·556592	1·796645	·8737722	54	27	·4916638	·564621	1·771098	·8707851	33	47	·4967215	·572319	1·747276	·8679100	13
7	·4865895	·556973	1·795416	·8736307	53	28	·4919171	·565005	1·769895	·8706420	32	48	·4969740	·572705	1·746098	·8677655	12
8	·4868436	·557355	1·794188	·8734891	52	29	·4921704	·565388	1·768694	·8704989	31	49	·4972264	·573091	1·744921	·8676209	11
9	·4870977	·557736	1·792961	·8733475	51	30	·4924236	·565772	1·767494	·8703557	30	50	·4974787	·573478	1·743745	·8674762	10
10	·4873517	·558117	1·791736	·8732058	50	31	·4926767	·566156	1·766295	·8702124	29	51	·4977310	·573864	1·742570	·8673314	9
11	·4876057	·558499	1·790512	·8730640	49	32	·4929298	·566541	1·765097	·8700691	28	52	·4979833	·574251	1·741396	·8671866	8
12	·4878597	·558881	1·789289	·8729221	48	33	·4931829	·566925	1·763900	·8699256	27	53	·4982355	·574638	1·740224	·8670417	7
13	·4881136	·559262	1·788067	·8727801	47	34	·4934359	·567309	1·762705	·8697821	26	54	·4984877	·575025	1·739053	·8668967	6
14	·4883674	·559644	1·786847	·8726381	46	35	·4936889	·567694	1·761511	·8696386	25	55	·4987399	·575412	1·737883	·8667517	5
15	·4886212	·560026	1·785628	·8724960	45	36	·4939419	·568079	1·760318	·8694949	24	56	·4989920	·575799	1·736714	·8666066	4
16	·4888750	·560409	1·784410	·8723538	44	37	·4941948	·568463	1·759126	·8693512	23	57	·4992441	·576187	1·735546	·8664614	3
17	·4891288	·560791	1·783194	·8722116	43	38	·4944476	·568848	1·757936	·8692074	22	58	·4994961	·576574	1·734380	·8663161	2
18	·4893825	·561173	1·781979	·8720693	42	39	·4947005	·569233	1·756747	·8690636	21	59	·4997481	·576962	1·733214	·8661708	1
19	·4896361	·561556	1·780765	·8719269	41	40	·4949532	·569619	1·755559	·8689196	20	60	·5000000	·577350	1·732050	·8660254	0
20	·4898897	·561939	1·779552	·8717844	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 60.						**Deg. 60.**						**Deg. 60.**				

30 Deg.						30 Deg.					30 Deg.				
′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·5000000	·577350	1·732050	·8660254	60	21	·5052809	·585524	1·707871	·8629549	39	41	5102928	·593363	1·685308	·8600007	19
1	·5002519	·577738	1·730887	·8658799	59	22	·5055319	·585914	1·706732	·8628079	38	42	·5105429	·593756	1·684191	·8598523	18
2	·5005037	578126	1·729726	·8657344	58	23	·5057828	·586305	1·705595	·8626608	37	43	·5107930	·594150	1·683076	·8597037	17
3	·5007556	·578514	1·728565	·8655887	57	24	·5060338	·586696	1·704458	·8625137	36	44	·5110431	·594543	1·681962	·8595551	16
4	·5010073	·578902	1·727406	·8654430	56	25	·5062846	·587087	1·703323	·8623664	35	45	·5112931	·594937	1·680848	·8594064	15
5	·5012591	·579291	1·726247	·8652973	55	26	·5065355	·587478	1·702189	·8622191	34	46	·5115431	·595331	1·679736	·8592576	14
6	·5015107	·579679	1·725090	·8651514	54	27	·5067863	·587870	1·701055	·8620717	33	47	·5117930	·595725	1·678625	·8591088	13
7	·5017624	·580068	1·723934	·8650055	53	28	·5070370	·588261	1·699923	·8619243	32	48	·5120429	·596119	1·677515	·8589599	12
8	·5020140	580457	1·722779	·8648595	52	29	·5072877	·588653	1·698792	·8617768	31	49	·5122927	·596514	1·676406	·8588109	11
9	·5022655	·580846	1·721626	·8647134	51	30	·5075384	·589045	1·697663	·8616292	30	50	·5125425	·596908	1·675298	·8586619	10
10	·5025170	·581235	1·720473	·8645673	50	31	·5077890	·589436	1·696534	·8614815	29	51	·5127923	·597303	1 674192	·8585127	9
11	·5027685	581624	1·719322	·8644211	49	32	5080396	·589828	1·695406	·8613337	28	52	·5130420	·597697	1·673086	·8583635	8
12	5030199	·582013	1·718172	·8642748	48	33	·5082901	·590221	1·694280	·8611859	27	53	·5132916	·598092	1·671981	·8582143	7
13	·5032713	·582403	1·717023	·8641284	47	34	5085406	·590613	1·693155	·8610380	26	54	·5135413	·598487	1·670878	·8580649	6
14	·5035227	·582793	1·715875	·8639820	46	35	·5087910	·591005	1·692030	·8608901	25	55	·5137908	·598882	1·669775	·8579155	5
15	·5037740	·583182	1·714728	·8638355	45	36	·5090414	·591398	1·690907	·8607420	24	56	·5140404	·599278	1·668674	·8577660	4
16	·5040252	583572	1·713582	·8636889	44	37	·5092918	·591791	1·689785	·8605939	23	57	·5142899	·599673	1·667574	·8576164	3
17	·5042765	·583962	1·712438	·8635423	43	38	·5095421	·592183	1·688664	·8604457	22	58	·5145393	·600069	1·666474	·8574668	2
18	·5045276	·584352	1·711294	·8633956	42	39	·5097924	·592576	1·687544	·8602975	21	59	·5147887	·600464	1·665376	·8573171	1
19	·5047788	·584743	1·710152	·8632488	41	40	·5100426	·592969	1·686426	·8601491	20	60	·5150381	·600860	1·664279	·8571673	0
20	·5050298	·585133	1·709011	·8631019	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 59.						Deg. 59.						Deg. 59.				

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

31 Deg.						31 Deg.						31 Deg.					
′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·5150381	·600860	1·664279	·8571673	60	21	·5202646	·609205	1·641482	·8540051	39	41	·5252241	·617210	1·620192	·8509639	19
1	·5152874	·601256	1·663183	·8570174	59	22	·5205130	·609604	1·640408	·8538538	38	42	·5254717	·617612	1·619138	·8508111	18
2	·5155367	·601652	1·662088	·8568675	58	23	·5207613	·610003	1·639335	·8537023	37	43	·5257191	·618014	1·618085	·8506582	17
3	·5157859	·602049	1·660994	·8567175	57	24	·5210096	·610402	1·638263	·8535508	36	44	·5259665	·618416	1·617033	·8505053	16
4	·5160351	·602445	1·659901	·8565674	56	25	·5212579	·610801	1·637191	·8533992	35	45	·5262139	·618818	1·615982	·8503522	15
5	·5162842	·602841	1·658809	·8564173	55	26	·5215061	·671201	1·636121	·8532475	34	46	·5264613	·619221	1·614932	·8501991	14
6	·5165333	·603238	1·657718	·8562671	54	27	·5217543	·611601	1·635052	·8530958	33	47	·5267085	·619623	1·613882	·8500459	13
7	·5167824	·603635	1·656629	·8561168	53	28	·5220024	·612000	1·633984	·8529440	32	48	·5269558	·620026	1·612834	·8498927	12
8	·5170314	·604032	1·655540	·8559664	52	29	·5222505	·612400	1·632917	·8527921	31	49	·5272030	·620429	1·611787	·8497394	11
9	·5172804	·604429	1·654452	·8558160	51	30	·5224986	·612800	1·631851	·8526402	30	50	·5274502	·620832	1·610741	·8495860	10
10	·5175293	·604826	1·653366	·8556655	50	31	·5227466	·613201	1·630786	8524881	29	51	·5276973	·621235	1·609696	·8494325	9
11	·5177782	·605224	1·652280	8555149	49	32	·5229945	·613601	1·629722	·8523360	28	52	·5279443	·621638	1·608652	·8492790	8
12	·5180270	·605621	1·651196	·8553643	48	33	·5232424	·614001	1·628659	·8521839	27	53	·5281914	·622041	1·607609	·8491254	7
13	·5182758	·606019	1·650112	·8552135	47	34	·5234903	·614402	1·627597	·8520316	26	54	·5284383	·622445	1·606567	·8489717	6
14	·5185246	·606417	1·649030	·8550627	46	35	·5237381	·614803	1·626536	·8518793	25	55	·5286853	·622848	1·605526	·8488179	5
15	·5187733	·606814	1·647949	·8549119	45	36	·5239859	·615204	1·625476	·8517269	24	56	·5289322	·623252	1·604485	·8486641	4
16	·5190219	·607213	1·646868	·8547609	44	37	·5242336	·615605	1·624417	·8515745	23	57	·5291790	·623656	1·603446	·8485102	3
17	·5192705	·607611	1·645789	·8546099	43	38	·5244813	·616006	1·623359	·8514219	22	58	·5294258	·624060	1·602408	·8483562	2
18	·5195191	·608009	1·644711	·8544588	42	39	·5247290	·616407	1·622302	·8512693	21	59	·5296726	·624465	1·601370	·8482022	1
19	·5197676	·608408	1·643633	·8543077	41	40	·5249766	·616809	1·621246	·8511167	20	60	·5299193	·624869	1·600334	·8480481	0
20	·5200161	·608806	1·642557	·8541564	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 58.						Deg. 58						Deg. 58.				

32 Deg.					32 Deg.						32 Deg.					
′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·5299193	·624869	1·600334	·8480481	60	21	·5350898	·633395	1·578791	·8447952	39	41	·5399955	·641577	1·558657	·8416679	19
1	·5301659	·625273	1·599299	·8478939	59	22	·5353355	·633803	1·577776	·8446395	38	42	·5402403	·641988	1·557660	·8415108	18
2	·5304125	·625678	1·598264	·8477397	58	23	·5355812	·634211	1·576761	·8444838	37	43	·5404851	·642399	1·556663	·8413536	17
3	·5306591	·626083	1·597231	·8475853	57	24	·5358268	·634619	1·575747	·8443279	36	44	·5407298	·642810	1·555668	·8411963	16
4	·5309057	·626488	1·596198	·8474309	56	25	·5360724	·635027	1·574735	·8441720	35	45	·5409745	·643221	1·554674	·8410390	15
5	·5311521	·626893	1·595167	·8472765	55	26	·5363179	·635435	1·573723	·8440161	34	46	·5412191	·643632	1·553680	·8408816	14
6	·5313986	·627298	1·594136	·8471219	54	27	·5365634	·635844	1·572712	·8438600	33	47	·5414637	·644044	1·552688	·8407241	13
7	·5316450	·627704	1·593107	·8469673	53	28	·5368089	·636252	1·571702	·8437039	32	48	·5417082	·644456	1·551696	·8405666	12
8	·5318913	·628109	1·592078	·8468126	52	29	·5370543	·636661	1·570693	·8435477	31	49	·5419527	·644867	1·550705	·8404090	11
9	·5321376	·628515	1·591050	·8466579	51	30	·5372996	·637070	1·569685	·8433914	30	50	·5421971	·645279	1·549715	·8402513	10
10	·5323839	·628921	1·590023	·8465030	50	31	·5375449	·637479	1·568678	·8432351	29	51	·5424415	·645691	1·548726	·8400936	9
11	·5326301	·629327	1·588997	·8463481	49	32	·5377902	·637888	1·567672	·8430787	28	52	·5426859	·646104	1·547738	·8399357	8
12	·5328763	·629733	1·587973	·8461932	48	33	·5380354	·638297	1·566666	·8429222	27	53	·5429302	·646516	1·546751	·8397778	7
13	·5331224	·630139	1·586949	·8460381	47	34	·5382806	·638707	1·565662	·8427657	26	54	·5431744	·646929	1·545764	·8396199	6
14	·5333685	·630546	1·585926	·8458830	46	35	·5385257	·639116	1·564659	·8426091	25	55	·5434187	·647341	1·544779	·8394618	5
15	·5336145	·630953	1·584904	·8457278	45	36	·5387708	·639526	1·563656	·8424524	24	56	·5436628	·647754	1·543794	·8393037	4
16	·5338605	·631359	1·583883	·8455726	44	37	·5390158	·639936	1·562654	·8422956	23	57	·5439069	·648167	1·542810	·8391455	3
17	·5341065	·631766	1·582862	·8454172	43	38	·5392608	·640346	1·561654	·8421388	22	58	·5441510	·648580	1·541828	·8389873	2
18	·5343523	·632173	1·581843	·8452618	42	39	·5395058	·640756	1·560654	·8419819	21	59	·5443951	·648994	1·540846	·8388290	1
19	·5345982	·632581	1·580825	·8451064	41	40	·5397507	·641167	1·559655	·8418249	20	60	·5446390	·649407	1·539865	·8386706	0
20	·5348440	·632988	1·579807	·8449508	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 57.						Deg. 57.						Deg. 57.				

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

33 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
0	·5446390	·649407	1·539865	·8386706	60
1	·5448830	·649821	1·538884	·8385121	59
2	·5451269	·650235	1·537905	·8383536	58
3	·5453707	·650649	1·536927	·8381950	57
4	·5456145	·651063	1·535949	·8380363	56
5	·5458583	·651477	1·534972	·8378775	55
6	·5461020	·651891	1·533996	·8377187	54
7	·5463456	·652306	1·533021	·8375598	53
8	·5465892	·652721	1·532047	·8374009	52
9	·5468328	·653136	1·531074	·8372418	51
10	·5470763	·653551	1·530102	·8370827	50
11	·5473198	·653966	1·529130	·8369236	49
12	·5475632	·654381	1·528160	·8367643	48
13	·5478066	·654797	1·527190	·8366050	47
14	·5480499	·655212	1·526221	·8364456	46
15	·5482932	·655628	1·525253	·8362862	45
16	·5485365	·656044	1·524286	·8361266	44
17	·5487797	·656460	1·523320	·8359670	43
18	·5490228	·656877	1·522354	·8358074	42
19	·5492659	·657293	1·521389	·8356476	41
20	·5495090	·657710	1·520426	·8354878	40
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 56.

33 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
21	·5497520	·658127	1·519463	·8353279	39
22	·5499950	·658544	1·518501	·8351680	38
23	·5502379	·658961	1·517540	·8350080	37
24	·5504807	·659378	1·516579	·8348479	36
25	·5507236	·659796	1·515620	·8346877	35
26	·5509663	·660213	1·514661	·8345275	34
27	·5512091	·660631	1·513703	·8343672	33
28	·5514518	·661049	1·512746	·8342068	32
29	·5516944	·661467	1·511790	·8340463	31
30	·5519370	·661885	1·510835	·8338858	30
31	·5521795	·662304	1·509880	·8337252	29
32	·5524220	·662722	1·508927	·8335646	28
33	·5526645	·663141	1·507974	·8334038	27
34	·5529069	·663560	1·507022	·8332430	26
35	·5531492	·663979	1·506071	·8330822	25
36	·5533915	·664398	1·505121	·8329212	24
37	·5536338	·664817	1·504171	·8327602	23
38	·5538760	·665237	1·503222	·8325991	22
39	·5541182	·665657	1·502275	·8324380	21
40	·5543603	·666076	1·501328	·8322768	20
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 56.

33 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
41	·5546024	·666496	1·500382	·8321155	19
42	·5548444	·666917	1·499436	·8319541	18
43	·5550864	·667337	1·498492	·8317927	17
44	·5553283	·667758	1·497548	·8316312	16
45	·5555702	·668178	1·496605	·8314696	15
46	·5558121	·668599	1·495663	·8313080	14
47	·5560539	·669020	1·494722	·8311463	13
48	·5562956	·669441	1·493782	·8309845	12
49	·5565373	·669863	1·492842	·8308226	11
50	·5567790	·670284	1·491903	·8306607	10
51	·5570206	·670706	1·490965	·8304987	9
52	·5572621	·671128	1·490028	·8303366	8
53	·5575036	·671550	1·489092	·8301745	7
54	·5577451	·671972	1·488157	·8300123	6
55	·5579865	·672394	1·487222	·8298500	5
56	·5582279	·672816	1·486288	·8296877	4
57	·5584692	·673239	1·485355	·8295252	3
58	·5587105	·673662	1·484423	·8293628	2
59	·5589517	·674085	1·483491	·8292002	1
60	·5591929	·674508	1·482561	·8290376	0
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 56.

34 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
0	·5591929	·674508	1·482561	·8290376	60
1	·5594340	·674931	1·481631	·2288749	59
2	·5596751	·675355	1·480702	·8287121	58
3	·5599162	·675779	1·479773	·8285493	57
4	·5601572	·676202	1·478846	·8283864	56
5	·5603981	·676626	1·477919	8282234	55
6	·5606390	·677050	1·476993	·8280603	54
7	·5608798	·677475	1·476068	·8278972	53
8	·5611206	·677899	1·475144	·8277340	52
9	·5613614	·678324	1·474221	·8275708	51
10	·5616021	·678749	1·473298	·8274074	50
11	·5618428	·679174	1·472376	·8272440	49
12	·5620834	·679599	1·471455	·8270806	48
13	·5623239	·680024	1·470535	·8269170	47
14	·5625645	·680450	1·469615	·8267534	46
15	·5628049	·680875	1·468696	·8265897	45
16	·5630453	·681301	1·467778	·8264260	44
17	·5632857	·681727	1·466861	·8262622	43
18	·5635260	·682153	1·465945	·8260983	42
19	·5637663	·682580	1·465029	·8259343	41
20	·5640066	·683006	1·464114	·8257703	40
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 55.

34 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
21	·5642467	·683433	1·463200	·8256062	39
22	·5644869	·683860	1·462287	·8254420	38
23	·5647270	·684287	1·461374	·8252778	37
24	·5649670	·684714	1·460463	·8251135	36
25	·5652070	·685141	1·459552	·8249491	35
26	·5654469	·685569	1·458642	·8247847	34
27	·5656868	·685996	1·457732	·8246202	33
28	·5659267	·686424	1·456824	·8244556	32
29	·5661665	·686852	1·455916	·8242909	31
30	·5664062	·687281	1·455009	·8241262	30
31	·5666459	·687709	1·454102	·8239614	29
32	·5668856	·688137	1·453197	·8237965	28
33	·5671252	·688566	1·452292	·8236316	27
34	·5673648	·688995	1·451388	·8234666	26
35	·5676043	·689424	1·450485	·8233015	25
36	·5678437	·689853	1·449582	·8231364	24
37	·5680832	·690283	1·448680	·8229712	23
38	·5683225	·690712	1·447779	·8228059	22
39	·5685619	·691142	1·446879	·8226405	21
40	·5688011	·691572	1·445980	·8224751	20
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 55.

34 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
41	·5690403	·692002	1·445081	·8223096	19
42	·5692795	·692432	1·444183	·8221440	18
43	·5695187	·692863	1·443286	·8219784	17
44	·5697577	·693293	1·442389	·8218127	16
45	·5699968	·693724	1·441494	·8216469	15
46	·5702357	·694155	1·440599	·8214811	14
47	·5704747	·694586	1·439704	·8213152	13
48	·5707136	·695018	1·438811	·8211492	12
49	·5709524	·695449	1·437918	·8209832	11
50	·5711912	·695881	1·437026	·8208170	10
51	·5714299	·696313	1·436135	·8206509	9
52	·5716686	·696745	1·435245	·8204846	8
53	·5719073	·697177	1·434355	·8203183	7
54	·5721459	·697609	1·433466	·8201519	6
55	·5723844	·698042	1·432578	·8199854	5
56	·5726229	·698474	1·431690	·8198189	4
57	·5728614	·698907	1·430803	·8196523	3
58	·5730998	·699340	1·429917	·8194856	2
59	·5733381	·699774	1·429032	·8193189	1
60	·5735764	·700207	1·428148	·8191520	0
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 55.

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
	35 Deg.						35 Deg.						35 Deg.				
0	·5735764	·700207	1·428148	·8191520	60	21	·5785696	·709350	1·409740	·8156330	39	41	·5833050	·718131	1·392501	·8122532	19
1	·5738147	·700641	1·427264	·8189852	59	22	·5788069	·709787	1·408871	·8154647	38	42	·5835412	·718572	1·391647	·8120835	18
2	·5740529	·701074	1·426381	·8188182	58	23	·5790440	·710225	1·408003	·8152963	37	43	·5837774	·719014	1·390793	·8119137	17
3	·5742911	·701508	1·425498	8186512	57	24	·5792812	·710663	1·407136	·8151278	36	44	·5840136	·719455	1·389940	·8117439	16
4	·5745292	·701943	1·424617	·8184841	56	25	·5795183	·711100	1·406270	·8149593	35	45	·5842497	·719897	1·389087	·8115740	15
5	·5747672	·702377	1·423736	·8183169	55	26	·5797553	·711539	1·405404	·8147906	34	46	·5844857	·720338	1·388235	·8114040	14
6	·5750053	·702811	1·422856	·8181497	54	27	·5799923	·711977	1·404539	·8146220	33	47	·5847217	·720780	1·387384	·8112339	13
7	·5752432	·703246	1·421976	·8179824	53	28	·5802292	·712415	1·403674	·8144532	32	48	·5849577	·721222	1·386534	·8110638	12
8	·5154811	·703681	1·421097	·8178151	52	29	·5804661	·712854	1·402811	·8142844	31	49	·5851936	·721665	1·385684	·8108936	11
9	·5757190	·704116	1·420220	·8176476	51	30	·5807030	·713293	1·401948	·8141155	30	50	·5854294	·722107	1·384835	·8107234	10
10	·5759568	·704551	1·419342	·8174801	50	31	·5809397	·713732	1·401086	·8139466	29	51	·5856652	·722550	1·383986	·8105530	9
11	·5761946	·704986	1·418466	·8173125	49	32	·5811765	·714171	1·400224	·8137775	28	52	·5859010	·722993	1·383139	·8103826	8
12	·5764323	·705422	1·417590	·8171449	48	33	·5814132	·714610	1·399363	·8136084	27	53	·5861367	·723436	1·382292	·8102122	7
13	·5766700	·705858	1·416715	·8169772	47	34	·5816498	·715050	1·398503	·8134393	26	54	·5863724	·723879	1·381445	·8100416	6
14	·5769076	·706294	1·415840	·8168094	46	35	·5818864	·715489	1·397644	·8132701	25	55	·5866080	·724322	1·380600	·8098710	5
15	·5771452	·706730	1·414967	·8166416	45	36	·5821230	·715929	1·396785	·8131008	24	56	·5868435	·724766	1·379755	·8097004	4
16	·5773827	·707166	1·414094	·8164736	44	37	·5823595	·716369	1·395927	·8129314	23	57	·5870790	·725210	1·378910	·8095296	3
17	·5776202	·707602	1·413222	·8163056	43	38	·5825959	·716810	1·395069	·8127620	22	58	·5873145	·725654	1·378067	·8093588	2
18	·5778576	·708039	1·412350	·8161376	42	39	·5828323	·717250	1·394213	·8125925	21	59	·5875499	·726098	1·377224	·8091879	1
19	·5780950	·708476	1·411479	·8159695	41	40	·5830687	·717691	1·393357	·8124229	20	60	·5877853	·726542	1·376381	·8090170	0
20	·5783323	·708913	1·410609	·8158013	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 54.						Deg. 54.						Deg. 54.				

36 Deg. 36 Deg. 36 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·5877853	·726542	1·376381	·8090170	60	21	·5927163	·735917	1·358848	·8054113	39	41	·5973919	·744924	1·342417	·8019495	19
1	·5880206	·726987	1·375540	·8088460	59	22	·5929505	·736366	1·358020	·8052389	38	42	·5976251	·745377	1·341602	·8017756	18
2	·5882558	·727431	1·374699	·8086749	58	23	·5931847	·736814	1·357193	·8050664	37	43	·5978583	·745829	1·340788	·8016018	17
3	·5884910	·727876	1·373859	·8085037	57	24	·5934189	·737263	1·356367	·8048938	36	44	·5980915	·746282	1·339975	·8014278	16
4	·5887262	·728321	1·373019	·8083325	56	25	·5936530	·737712	1·355541	·8047211	35	45	·5983246	·746735	1·339162	·8012538	15
5	·5889613	·728767	1·372180	·8081612	55	26	·5938871	·738162	1·354716	·8045484	34	46	·5985577	·747188	1·338350	·8010797	14
6	·5891964	·729212	1·371342	·8079899	54	27	·5941211	·738611	1·353891	·8043756	33	47	·5987906	·747642	1·337538	·8009056	13
7	·5894314	·729658	1·370504	·8078185	53	28	·5943550	·739061	1·353068	·8042028	32	48	·5990236	·748095	1·336727	·8007314	12
8	·5896663	·730104	1·369667	·8076470	52	29	·5945889	·739511	1·352244	·8040299	31	49	·5992565	·748549	1·335917	·8005571	11
9	·5899012	·730550	1·368831	·8074754	51	30	·5948228	·739961	1·351422	·8038569	30	50	·5994893	·749003	1·335107	·8003827	10
10	·5901361	·730996	1·367995	·8073038	50	31	·5950566	·740411	1·350600	·8036838	29	51	·5997221	·749457	1·334298	·8002083	9
11	·5903709	·731442	1·367161	·8071321	49	32	·5952904	·740861	1·349779	·8035107	28	52	·5999549	·749911	1·333490	·8000338	8
12	·5906057	·731889	1·366326	·8069603	48	33	·5955241	·741312	1·348958	·8033375	27	53	·6001876	·750366	1·332682	·7998593	7
13	·5908404	·732336	1·365493	·8067885	47	34	·5957577	·741763	1·348139	·8031642	26	54	·6004202	·750821	1·331875	·7996847	6
14	·5910750	·732783	1·364660	·8066166	46	35	·5959913	·742214	1·347319	·8029909	25	55	·6006528	·751276	1·331068	·7995100	5
15	·5913096	·733230	1·363827	·8064446	45	36	·5962249	·742665	1·346501	·8028175	24	56	·6008854	·751731	1·330262	·7993352	4
16	·5915442	·733677	1·362996	·8062726	44	37	·5964584	·743117	1·345683	·8026440	23	57	·6011179	·752186	1·329457	·7991604	3
17	·5917787	·734125	1·362165	·8061005	43	38	·5966918	·743568	1·344865	·8024705	22	58	·6013503	·752642	1·328652	·7989855	2
18	·5920132	·734573	1·361335	·8059283	42	39	·5969252	·744020	1·344049	·8022969	21	59	·6015827	·753098	1·327848	·7988105	1
19	·5922476	·735021	1·360505	·8057560	41	40	·5971586	·744472	1·343233	·8021232	20	60	·6018150	·753554	1·327044	·7986355	0
20	·5924819	·735469	1·359676	·8055837	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 53. Deg. 53.

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

37 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
0	·6018150	·753554	1·327044	·7986355	60
1	·6020473	·754010	1·326242	·7984604	59
2	·6022795	·754466	1·325439	·7982853	58
3	·6025117	754923	1·324638	·7981100	57
4	6027439	·755379	1·323837	·7979347	56
5	·6029760	·755836	1·323036	·7977594	55
6	·6032080	·756294	1·322237	·7975839	54
7	6034400	·756751	1·321437	·7974084	53
8	·6036719	·757209	1·320639	·7972329	52
9	·6039038	·757666	1·319841	·7970572	51
10	·6041356	·758124	1·319044	·7968815	50
11	·6043674	·758582	1·318247	·7967058	49
12	·6045991	·759041	1·317451	·7965299	48
13	·6048308	·759499	1·316655	·7963540	47
14	·6050624	·759958	1·315861	·7961780	46
15	·6052940	·760417	1·315066	·7960020	45
16	·6055255	·760876	1·314273	·7958259	44
17	·6057570	·761336	1·313480	·7956497	43
18	·6059884	·761795	1·312687	·7954735	42
19	·6062198	·762255	1·311895	·7952972	41
20	·6064511	·762715	1·311104	·7951208	40
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 52.

37 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
21	·6066824	·763175	1·310314	·7949444	39
22	·6069136	·763636	1·309523	·7947678	38
23	·6071447	·764096	1 308734	·7945913	37
24	·6073758	·764557	1·307945	·7944146	36
25	·6076069	·765018	1·307157	·7942379	35
26	6078379	·765480	1·306369	·7940611	34
27	·6080689	·765941	1·305582	·7938843	33
28	·6082998	·766403	1·304796	·7937074	32
29	·6085306	·766864	1·304010	·7935304	31
30	·6087614	·767327	1·303225	·7933533	30
31	·6089922	·767789	1·302440	·7931762	29
32	·6092229	·768251	1·301656	·7929990	28
33	·6094535	·768714	1·300873	·7928218	27
34	·6096841	·769177	1·300090	·7926445	26
35	·6099147	·769640	1·299308	·7924671	25
36	·6101452	·770103	1·298526	·7922896	24
37	·6103756	·770567	1·297745	·7921121	23
38	·6106060	·771030	1·296964	·7919345	22
39	·6108363	·771494	1·296185	·7917569	21
40	·6110666	·771958	1·295405	·7915792	20
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 52.

37 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
41	·6112969	·772423	1·294627	·7914014	19
42	·6115270	·772887	1·293848	·7912235	18
43	·6117572	·773352	1·293071	·7910456	17
44	·6119873	·773817	1·292294	·7908676	16
45	·6122173	·774282	1·291517	·7906896	15
46	·6124473	·774748	1·290742	·7905115	14
47	·6126772	·775213	1·289966	·7903333	13
48	·6129071	·776679	1·289192	·7901550	12
49	·6131369	·776145	1·288418	·7899767	11
50	·6133666	·776611	1·287644	·7897983	10
51	·6135964	·777078	1·286871	·7896198	9
52	·6138260	·777544	1·286099	·7894413	8
53	·6140556	·778011	1·285327	·7892627	7
54	·6142852	·778478	1·284556	·7890841	6
55	·6145147	·778946	1·283786	·7889054	5
56	·6147442	·779413	1·283016	·7887266	4
57	·6149736	·779881	1·282246	·7885477	3
58	·6152029	·780349	1·281477	·7883688	2
59	·6154322	·780817	1·280709	·7881898	1
60	·6156615	·781285	1·279941	·7880108	0
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 52.

38 Deg.						38 Deg.						38 Deg.					
′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·6156615	·781285	1·279941	·7880108	60	21	·6204636	·791170	1·263950	·7842352	39	41	·6250156	·800673	1·248948	·7806123	19
1	·6158907	·781754	1·279174	·7878316	59	22	·6206917	·791643	1·263195	·7840547	38	42	·6252427	·801151	1·248204	·7804304	18
2	·6161198	·782222	1·278407	·7876524	58	23	·6209198	·792116	1·262440	·7838741	37	43	·6254696	·801628	1·247460	·7802485	17
3	·6163489	·782691	1·277641	·7874732	57	24	·6211478	·792590	1·261686	·7836935	36	44	·6256966	·802106	1·246716	·7800665	16
4	·6165780	·783161	1·276876	·7872939	56	25	·6213757	·793064	1·260932	·7835127	35	45	·6259235	·802584	1·245974	·7798845	15
5	·6168069	·783630	1·276111	·7871145	55	26	·6216036	·793537	1·260179	·7833320	34	46	·6261503	·803063	1·245232	·7797024	14
6	·6170359	·784100	1·275347	·7869350	54	27	·6218314	·794012	1·259426	·7831511	33	47	·6263771	·803541	1·244490	·7795202	13
7	·6172648	·784570	1·274583	·7867555	53	28	·6220592	·794486	1·258674	·7829702	32	48	·6266038	·804020	1·243749	·7793380	12
8	·6174936	·785040	1·273820	·7865759	52	29	·6222870	·794961	1·257923	·7827892	31	49	·6268305	·804499	1·243008	·7791557	11
9	·6177224	·785510	1·273057	·7863963	51	30	·6225146	·795435	1·257172	·7826082	30	50	·6270571	·804979	1·242268	·7789733	10
10	·6179511	·785980	1·272295	·7862165	50	31	·6227423	·795911	1·256421	·7824270	29	51	·6272837	·805458	1·241529	·7787909	9
11	·6181798	·786451	1·271534	·7860367	49	32	·6229698	·796386	1·255672	·7822459	28	52	·6275102	·805938	1·240790	·7786084	8
12	·6184084	·786922	1·270773	·7858569	48	33	·6231974	·796861	1·254922	·7820646	27	53	·6277366	·806418	1·240051	·7784258	7
13	·6186370	·787393	1·270013	·7856770	47	34	·6234248	·797337	1·254174	·7818833	26	54	·6279631	·806898	1·239313	·7782431	6
14	·6188655	·787864	1·269253	·7854970	46	35	·6236522	·797813	1·253426	·7817019	25	55	·6281894	·807378	1·238576	·7780604	5
15	·6190939	·788336	1·268494	·7853169	45	36	·6238796	·798289	1·252678	·7815205	24	56	·6284157	·807859	1·237839	·7778777	4
16	·6193224	·788808	1·267735	·7851368	44	37	·6241069	·798765	1·251931	·7813390	23	57	·6286420	·808340	1·237103	·7776949	3
17	·6195507	·789280	1·266977	·7849566	43	38	·6243342	·799242	1·251184	·7811574	22	58	·6288682	·808821	1·236367	·7775120	2
18	·6197790	·789752	1·266219	·7847764	42	39	·6245614	·799719	1·250438	·7809757	21	59	·6290943	·809302	1·235631	·7773290	1
19	·6200073	·790224	1·265462	·7845961	41	40	·6247885	·800196	1·249693	·7807940	20	60	·6293204	·809784	1·234897	·7771460	0
20	·6202355	·790697	1·264706	·7844157	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 51.						Deg. 51.						Deg. 51.				

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

′	Sine.	Tang.	Cotang.	Cosine.		′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·6293204	·809784	1·234897	·7771460	60	21	·6340559	·819948	1·219588	·7732872	39	41	·6385440	·829724	1·205219	·7695853	19
1	·6295464	·810265	1·234162	·7769629	59	22	·6342808	·820435	1·218865	·7731027	38	42	·6387678	·830216	1·204505	·7693996	18
2	·6297724	·810747	1·233429	·7767797	58	23	·6345057	·820922	1·218142	·7729182	37	43	·6389916	·830707	1·203793	·7692137	17
3	·6299983	·811230	1·232696	·7765965	57	24	·6347305	·821409	1·217419	·7727336	36	44	·6392153	·831199	1·203081	·7690278	16
4	·6302242	·811712	1·231963	·7764132	56	25	·6349553	·821896	1·216698	·7725489	35	45	·6394390	·831691	1·202369	·7688418	15
5	·6304500	·812195	1·231231	·7762298	55	26	·6351800	·822384	1·215976	·7723642	34	46	·6396626	·832183	1·201658	·7686558	14
6	·6306758	·812678	1·230499	·7760464	54	27	·6354046	·822871	1·215256	·7721794	33	47	·6398862	·832675	1·200947	·7684697	13
7	·6309015	·813161	1·229768	·7758629	53	28	·6356292	·823359	1·214535	·7719945	32	48	·6401097	·833168	1·200237	·7682835	12
8	·6311272	·813644	1·229038	·7756794	52	29	·6358537	·823847	1·213816	·7718096	31	49	·6403332	·833661	1·199527	·7680973	11
9	·6313528	·814128	1·228308	·7754957	51	30	·6360782	·824336	1·213097	·7716246	30	50	·6405566	·834154	1·198818	·7679110	10
10	·6315784	·814611	1·227578	·7753121	50	31	·6363026	·824825	1·212378	·7714395	29	51	·6407799	·834648	1·198109	·7677246	9
11	·6318039	·815095	1·226849	·7751283	49	32	·6365270	·825314	1·211660	·7712544	28	52	·6410032	·835141	1·197401	·7675382	8
12	·6320293	·815580	1·226121	·7749445	48	33	·6367513	·825803	1·210942	·7710692	27	53	·6412264	·835635	1·196693	·7673517	7
13	·6322547	·816064	1·225393	·7747606	47	34	·6369756	·826292	1·210225	·7708840	26	54	·6414496	·836129	1·195986	·7671652	6
14	·6324800	·816549	1·224665	·7745767	46	35	·6371998	·826782	1·209508	·7706986	25	55	·6416728	·836624	1·195279	·7669785	5
15	·6327053	·817034	1·223938	·7743926	45	36	·6374240	·827271	1·208792	·7705132	24	56	·6418958	·837118	1·194573	·7667918	4
16	·6329306	·817519	1·223212	·7742086	44	37	·6376481	·827762	1·208076	·7703278	23	57	·6421189	·837613	1·193867	·7666051	3
17	·6331557	818004	1·222486	·7740244	43	38	·6378721	·828252	1·207361	·7701423	22	58	·6423418	·838108	1·193162	·7664183	2
18	·6333809	·818490	1·221761	·7738402	42	39	·6380961	·828742	1·206646	·7699567	21	59	6425647	·838604	1·192457	·7662314	1
19	·6336059	·818976	1·221036	·7736559	41	40	·6383201	·829233	1·205932	·7697710	20	60	·6427876	·839099	1·191753	·7660444	0
20	·6338310	·819462	1·220312	·7734716	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

39 Deg. 39 Deg. 39 Deg.

Deg. 50. Deg. 50. Deg. 50.

40 Deg.

	Sine.	Tang.	Cotang.	Cosine.	′
0	·6427876	·839099	1·191753	·7660444	60
1	·6430104	·839595	1·191049	·7658574	59
2	·6432332	·840091	1·190346	·7656704	58
3	·6434559	·840587	1·189643	·7654832	57
4	·6436785	·841084	1·188941	·7652960	56
5	·6439011	·841581	1·188239	·7651087	55
6	·6441236	·842078	1·187538	·7649214	54
7	·6443461	·842575	1·186837	·7647340	53
8	·6445685	·843073	1·186136	·7645465	52
9	·6447909	·843570	1·185437	·7643590	51
10	·6450132	·844068	1·184737	·7641714	50
11	·6452355	·844567	1·184038	·7639838	49
12	·6454577	·845065	1·183340	·7637960	48
13	·6456798	·845564	1·182642	·7636082	47
14	·6459019	·846063	1·181944	·7634204	46
15	·6461240	·846562	1·181247	·7632325	45
16	·6463460	·847062	1·180551	·7630445	44
17	·6465679	·847561	1·179855	·7628564	43
18	·6467898	·848061	1·179159	·7626683	42
19	·6470116	·848561	1·178464	·7624802	41
20	·6472334	·849062	1·177769	·7622919	40
	Cosine.	Cotan.	Tang.	Sine.	′

40 Deg.

	Sine.	Tang.	Cotang.	Cosine.	′
21	·6474551	·849563	1·177075	·7621036	39
22	·6476767	·850064	1·176382	·7619152	38
23	·6478984	·850565	1·175688	·7617268	37
24	·6481199	·851066	1·174996	·7615383	36
25	·6483414	·851568	1·174303	·7613497	35
26	·6485628	·852070	1·173612	·7611611	34
27	·6487842	·852572	1·172920	·7609724	33
28	·6490056	·853075	1·172229	·7607837	32
29	·6492268	·853577	1·171539	·7605949	31
30	·6494480	·854080	1·170849	·7604060	30
31	·6496692	·854583	1·170160	·7602170	29
32	·6498903	·855087	1·169471	·7600280	28
33	·6501114	·855591	1·168782	·7598389	27
34	·6503324	·856095	1·168094	·7596498	26
35	·6505533	·856599	1·167407	·7594606	25
36	·6507742	·857103	1·166720	·7592713	24
37	·6509951	·857608	1·166033	·7590820	23
38	·6512158	·858113	1·165347	·7588926	22
39	·6514366	·858618	1·164661	·7587031	21
40	·6516572	·859124	1·163976	·7585136	20
	Cosine.	Cotan.	Tang.	Sine.	′

40 Deg.

	Sine.	Tang.	Cotang.	Cosine.	′
41	·6518778	·859629	1·163291	·7583240	19
42	·6520984	·860135	1·162607	·7581343	18
43	·6523189	·860641	1·161923	·7579446	17
44	·6525394	·861148	1·161240	·7577548	16
45	·6527598	·861655	1·160557	·7575650	15
46	·6529801	·862162	1·159874	·7573751	14
47	·6532004	·862669	1·159192	·7571851	13
48	·6534206	·863176	1·158511	·7569951	12
49	·6536408	·863684	1·157830	·7568050	11
50	·6538609	·864192	1·157149	·7566148	10
51	·6540810	·864700	1·156469	·7564246	9
52	·6543010	·865209	1·155789	·7562343	8
53	·6545209	·865718	1·155110	·7560439	7
54	·6547408	·866227	1·154431	·7558535	6
55	·6549607	·866736	1·153753	·7556630	5
56	·6551804	·867246	1·153075	·7554724	4
57	·6554002	·867755	1·152397	·7552818	3
58	·6556198	·868265	1·151721	·7550911	2
59	·6558395	·868776	1·151044	·7549004	1
60	·6560590	·869286	1·150368	·7547096	0
	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 49. Deg. 49. Deg. 49.

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

41 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
0	·6560590	·869286	1·150368	·3547096	60
1	·6562785	·869797	1·149692	·7545187	59
2	·6564980	·870308	1·149017	·7543278	58
3	·6567174	·870820	1·148342	·7541368	57
4	·6569367	·871331	1·147668	·7539457	56
5	·6571560	·871843	1·146994	·7537546	55
6	·6573752	·872355	1·146321	·7535634	54
7	·6575944	·872868	1·145648	·7533721	53
8	·6578135	·873380	1·144976	·7531808	52
9	·6580326	·873893	1·144304	·7529894	51
10	·6582516	·874406	1·143632	·7527980	50
11	·6584706	·874920	1·142961	·7526065	49
12	·6586895	·875433	1·142290	·7524149	48
13	·6589083	·875947	1·141620	·7522233	47
14	·6591271	·876462	1·140950	·7520316	46
15	·6593458	·876976	1·140281	·7518398	45
16	·6595645	·877491	1·139612	·7516480	44
17	·6597831	·878006	1·138944	·7514561	43
18	·6600017	·878521	1·138276	·7512641	42
19	·6602202	·879037	1·137608	·7510721	41
20	·6604386	·879552	1·136941	·7508800	40
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 48.

41 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
21	·6606570	·880068	1·136274	·7506879	39
22	·6608754	·880585	1·135608	·7504957	38
23	·6610936	·881101	1·134942	·7503034	37
24	·6613119	·881618	1·134277	·7501111	36
25	·6615300	·882135	1·133612	·7499187	35
26	·6617482	·882653	1·132947	·7497262	34
27	·6619662	·883170	1·132283	·7495337	33
28	·6621842	·883688	1·131620	·7493411	32
29	·6624022	·884206	1·130957	·7491484	31
30	·6626200	·884725	1·130294	·7489557	30
31	·6628379	·885244	1·129632	·7487629	29
32	·6630557	·885763	1·128970	·7485701	28
33	·6632734	·886282	1·128308	·7483772	27
34	·6634910	·886801	1·127647	·7481842	26
35	·6637087	·887321	1·126987	·7479912	25
36	·6639262	·887841	1·126327	·7477981	24
37	·6641437	·888361	1·125667	·7476049	23
38	·6643612	·888882	1·125008	·7474117	22
39	·6645785	·889403	1·124349	·7472184	21
40	·6647959	·889924	1·126690	·7470251	20
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 48.

41 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
41	·6650131	·890445	1·123032	·7468317	19
42	·6652304	·890967	1·122375	·7466382	18
43	·6654475	·891489	1·121718	·7464446	17
44	·6656646	·892011	1·121061	·7462510	16
45	·6658817	·892534	1·120405	·7460574	15
46	·6660987	·893056	1·119749	·7458636	14
47	·6663156	·893579	1·119094	·7456699	13
48	·6665325	·894103	1·118439	·7454760	12
49	·6667493	·894626	1·117784	·7452821	11
50	·6669661	·895150	1·117130	·7450881	10
51	·6671828	·895674	1·116476	·7448941	9
52	·6673994	·896199	1·115823	·7446999	8
53	·6676160	·896723	1·115170	·7445058	7
54	·6678326	·897248	1·114518	·7443115	6
55	·6680490	·897773	1·113866	·7441173	5
56	·6683655	·898299	1·113214	·7439229	4
57	·6684818	·898825	1·112563	·7437285	3
58	·6686981	·899351	1·111912	·7435340	2
59	·6689144	·899877	1·111262	·7433394	1
60	·6691306	·900404	1·110612	·7431448	0
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 48.

42 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
0	·6691306	·900404	1·110612	·7431448	60
1	·6693468	·900930	1·109963	·7429502	59
2	·6695628	·901458	1·109314	·7427554	58
3	·6697789	·901985	1·108665	·7425606	57
4	·6699948	·902513	1·108017	·7423658	56
5	·6702108	·903041	1·107369	·7421708	55
6	·6704266	·903569	1·106721	·7419758	54
7	·6706424	·904097	1·106075	·7417808	53
8	·6708582	·904626	1·105428	·7415857	52
9	·6710739	·905155	1·104782	·7413905	51
10	·6712895	·905685	1·104136	·7411953	50
11	·8715051	·906214	1·103491	·7410000	49
12	·6717206	·906744	1·102846	·7408046	48
13	·6719361	·907274	1·102201	·7406092	47
14	·6721515	·907805	1·101557	·7404137	46
15	·6723668	·908336	1·100914	·7402181	45
16	·6725821	·908867	1·100270	·7400225	44
17	·6727973	·909398	1·199628	·7398268	43
18	·6730125	·909930	1·198985	·7396311	42
19	·6732276	·910461	1·198343	·7394353	41
20	·6734427	·910994	1·197702	·7392394	40
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 47.

42 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
21	·6736577	·911526	1·097060	·7390435	39
22	·6738727	·912059	1·096420	·7388475	38
23	·6740876	·912592	1·095779	·7386515	37
24	·6743024	·913125	1·095139	·7384553	36
25	·6745172	·913659	1·094500	·7382592	35
26	·6747319	·914192	1·093861	·7380629	34
27	·6749466	·914727	1·093222	·7378666	33
28	·6751612	·915261	1·092584	·7376703	32
29	·6753757	·915796	1·091946	·7374738	31
30	·6755902	·916331	1·091308	·7372773	30
31	·6758046	·916866	1·090671	·7370808	29
32	·6760190	·917402	1·090034	·7368842	28
33	·6762333	·917937	1·089398	·7366875	27
34	·6764476	·918474	1·088762	·7364908	26
35	·6766618	·919010	1·088126	·7362940	25
36	·6768760	·919547	1·087491	·7360971	24
37	·6770901	·920084	1·086857	·7359002	23
38	·6773041	·920621	1·086222	·7357032	22
39	·6775181	·921159	1·085588	·7355061	21
40	·6777320	·921696	1·084955	·7353090	20
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 47.

42 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
41	·6779459	·922235	1·084322	·7351118	19
42	·6781597	·922773	1·083689	·7349146	18
43	·6783734	·923312	1·083057	·7347173	17
44	·6785871	·923851	1·082425	·7345199	16
45	·6788007	·924390	1·081793	·7343225	15
46	·6790143	·924930	1·081162	·7341250	14
47	·6792278	·925470	1·080532	·7339275	13
48	·6794413	·926010	1·079901	·7337299	12
49	·6796547	·926550	1·079271	·7335322	11
50	·6798681	·927091	1·078642	·7333345	10
51	·6800813	·927632	1·078013	·7331367	9
52	·6802946	·928173	1·077384	·7329388	8
53	·6805078	·928715	1·076756	·7327409	7
54	·6807209	·929257	1·076128	·7325429	6
55	·6809339	·929799	1·075500	·7323449	5
56	·6811469	·930342	1·074873	·7321467	4
57	·6813599	·930884	1·074246	·7319486	3
58	·6815728	·931428	1·073620	·7317503	2
59	·6817856	·931971	1·072994	·7315521	1
60	·6819984	·932515	1·072368	·7313537	0
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 47.

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
43 Deg						**43 Deg.**						**43 Deg.**					
0	·6819984	·932515	1·072368	·7313537	60	21	·6864532	·944001	1·059320	·7271740	39	41	·6906721	·955064	1·047049	·7231681	19
1	·6822111	·933059	1·071743	·7311553	59	22	·6866647	·944551	1·058703	·7269743	38	42	·6908824	·955620	1·046440	·7229671	18
2	·6824237	·933603	1·071118	·7309568	58	23	·6868761	·945102	1·058086	·7267745	37	43	·6910927	·956177	1·045831	·7227661	17
3	·6826363	·934147	1·070494	·7307583	57	24	·6870875	·945653	1·057470	·7265747	36	44	·6913029	·956734	1·045222	·7225651	16
4	·6828489	·934692	1·069870	·7305597	56	25	·6872988	·946204	1·056854	·7263748	35	45	·6915131	·957291	1·044613	·7223640	15
5	·6830613	·935238	1·069246	·7303610	55	26	·6875101	·946755	1·056238	·7261748	34	46	·6917232	·957849	1·044005	·7221628	14
6	·6832738	·935783	1·068623	·7301623	54	27	·6877213	·947307	1·855623	·7259748	33	47	·6919332	·958407	1·043397	·7219615	13
7	·6834861	·936329	1·068000	·7299635	53	28	·6879325	·947859	1·055008	·7257747	32	48	·6921432	·958965	1·042790	·7217602	12
8	·6836984	·936875	1·067377	·7297646	52	29	·6881435	·948411	1·054394	·7255746	31	49	·6923531	·959524	1·042183	·7215589	11
9	·6839107	·937421	1·066755	·7295657	51	30	·6883546	·948964	1·053780	·7253744	30	50	·6925630	·960082	1·041576	·7213574	10
10	·6841229	·937968	1·066134	·7293668	50	31	·6885655	·949517	1·053166	·7251741	29	51	·6927728	·960642	1·040970	·7211559	9
11	·6843350	·938515	1·065512	·7291677	49	32	·6887765	·950070	1·052553	·7249738	28	52	·6929825	·961201	1·040364	·7209544	8
12	·6845471	·939062	1·064891	·7289686	48	33	·6889873	·950624	1·051940	·7247734	27	53	·6931922	·961761	1·039758	·7207528	7
13	·6847591	·939610	1·064271	·7287695	47	34	·6891981	·951178	1·051327	·7245729	26	54	·6934018	·962321	1·039153	·7205511	6
14	·6849711	·940157	1·063651	·7285703	46	35	·6894089	·951732	1·050715	·7243724	25	55	·6936114	·962881	1·038548	·7203494	5
15	·6851830	·940706	1·063031	·7283710	45	36	·6896195	·952287	1·050103	·7241719	24	56	·6938209	·963442	1·037944	·7201476	4
16	·6853948	·941254	1·062411	·7281716	44	37	·6898302	·952842	1·049492	·7239712	23	57	·6940304	·964003	1·037340	·7199457	3
17	·6856066	·941803	1·061792	·7279722	43	38	·6900407	·953397	1·048880	·7237705	22	58	·6942398	·964565	1·036736	·7197438	2
18	·6858184	·942352	1·061174	·7277728	42	39	·6902512	·953952	1·048270	·7235698	21	59	·6944491	·965126	1·036133	·7195418	1
19	·6860300	·942901	1·060556	·7275732	41	40	·6904617	·954508	1·047659	·7233690	20	60	·6946584	·965688	1·035530	·7193398	0
20	·8662416	·943451	1·059938	·7273736	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
	Deg. 46.								**Deg. 46.**							**Deg. 46.**	

′	Sine.	Tang.	Cotang.	Cosine.	′
44 Deg.					
0	·6946584	·965688	1·035530	·7193398	60
1	·6948676	·966251	1·034927	·7191377	59
2	·6950767	·966813	1·034325	·7189355	58
3	·6952858	·967376	1·033723	·7187333	57
4	·6954949	·967939	1·033122	·7185310	56
5	·6957039	·968503	1·032520	·7183287	55
6	·6959128	·969067	1·031919	·7181263	54
7	·6961217	·969631	1·031319	·7179238	53
8	·6963305	·970196	1·030719	·7177213	52
9	·6965392	·970761	1·030119	·7175187	51
10	·6967479	·971326	1·029520	·7173161	50
11	·6969565	·971891	1·028921	·7171134	49
12	·6971651	·972457	1·028322	·7169106	48
13	·6973736	·973023	1·027724	·7167078	47
14	·6975821	·973590	1·027126	·7165049	46
15	·6977905	·974156	1·026528	·7163019	45
16	·6979988	·974724	1·025931	·7160989	44
17	·6982071	·975291	1·025334	·7158959	43
18	·6984153	·975859	1·024738	·7156927	42
19	·6986234	·976427	1·024141	·7154895	41
20	·6988315	·976995	1·023546	·7152863	40
′	Cosine.	Cotan.	Tang.	Sine.	′
			Deg. 45.		

′	Sine.	Tang.	Cotang.	Cosine.	′
44 Deg.					
21	·6990396	·977564	1·022950	·7150830	39
22	·6992476	·978133	1·022355	·7148796	38
23	·6994555	·978702	1·021760	·7146762	37
24	·6996633	·979272	1·021166	·7144727	36
25	·6998711	·979842	1·020572	·7142691	35
26	·7000789	·980412	1·019978	·7140655	34
27	·7002866	·980983	1·019385	·7138618	33
28	·7004942	·981554	1·018792	·7136581	32
29	·7007018	·982125	1·018199	·7134543	31
30	·7009093	·982697	1·017607	·7132504	30
31	·7011167	·983269	1·017015	·7130465	29
32	·7013241	·983841	1·016423	·7128426	28
33	·7015314	·984414	1·015832	·7126385	27
34	·7017387	·984987	1·015241	·7124344	26
35	·7019459	·985560	1·014651	·7122303	25
36	·7021531	·986133	1·014061	·7120260	24
37	·7023601	·986707	1·013471	·7118218	23
38	·7025672	·987282	1·012881	·7116174	22
39	·7027741	·987856	1·012292	·7114130	21
40	·7029811	·988431	1·011703	·7112086	20
′	Cosine.	Cotan.	Tang.	Sine.	′
			Deg. 45.		

′	Sine.	Tang.	Cotang.	Cosine.	′
44 Deg.					
41	·7031879	·989006	1·011115	·7110041	19
42	·7033947	·989582	1·010527	·7107995	18
43	·7036014	·990158	1·009939	·7105948	17
44	·7038081	·990734	1·009352	·7103901	16
45	·7040147	·991311	1·008764	·7101854	15
46	·7042213	·991888	1·008178	·7099806	14
47	·7044278	·992465	1·007591	·7097757	13
48	·7046342	·993042	1·007005	·7095707	12
49	·7048406	·993620	1·006420	·7093657	11
50	·7050469	·994199	1·005834	·7091607	10
51	·7052532	·994777	1·005249	·7089556	9
52	·7054594	·995356	1·004665	·7087504	8
53	·7056655	·995935	1·004080	·7085451	7
54	·7058716	·996515	1·003496	·7083398	6
55	·7060776	·997095	1·002913	·7081345	5
56	·7062835	·997675	1·002329	·7079291	4
57	·7064894	·998256	1·001746	·7077236	3
58	·7066953	·998837	1·001164	·7075180	2
59	·7069011	·999418	1·000581	·7073124	1
60	·7071068	1·00000	1·000000	·7071068	0
′	Cosine.	Cotan.	Tang.	Sine.	′
			Deg. 45.		

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