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Light, at the entrance to Racine Harbor, Michigan, in winter.

THE UNITED STATES LIGHT HOUSE SERVICE.—[See page 344.]

The Organism as a Thermodynamic Mechanism*

A Review and Criticism of Some of the Literature Relating to the Doctrine

By Hugh Elliot

An interesting feature, which constantly recurs in the history of science, is the gradual progress of unpopular doctrines against a solid body of hostile superstition and ignorance. Science is unpopular, partly because it demands severe mental concentration, and partly because its conclusions and principles are often at variance with those which the public desire to believe, and which, therefore, they intend to go on believing, notwithstanding any evidence that may be presented to them in a contrary sense. Among the doctrines which are thus exposed to public animosity is the theory that an organism—animal or plant—is a machine, all the processes of which are controlled and determined by physical and chemical forces identical with those found in the inorganic world. The public prefer to believe that an animal, or at all events a human being, is inspired by a spiritual element which is entirely beyond the control of any gross material laws; they prefer to believe it, and they therefore do believe it. It is true that they have not inquired into the evidence; it is even true that they resent being offered any evidence which might disturb their existing predilections—though in truth the danger of so untoward a result would scarcely be very imminent.

There are a certain number of people, however, who take upon themselves the task of defending unpopular doctrines which have been established by science. They do not embark upon this course in order to convert the public, for such a project would be comparable to trying to sink a dreadnought by pricking it with a needle. There are at all times, moreover, a certain number of writers who *do* examine the evidence, who *do* genuinely desire to find the truth, and who yet come to results which happen to be in harmony with those demanded by the public. Such are some of the writers whose works I am about to criticise. They are all careful thinkers and able writers; and, although a critic may differ profoundly from the views they express, he cannot but recognize the labor and honesty of purpose which inspire them.

I propose to deal first with Dr. James Johnstone, whose work on the "Philosophy of Biology" constitutes one of the best defences of the popular view with which I am acquainted. Not that his treatment itself is in any way popular. He is filled with the philosophies of Bergson and Driesch, two writers who have obtained much vogue with the public, no doubt because the public feels that, if it could understand their doctrines, it would certainly approve of them. Dr. Johnstone does not intrude Bergsonism overtly upon us; but he writes under Bergsonian influence, which makes him quick to see and collect any biological events which harmonize with that philosophy, while slow to observe or record other events which do not harmonize with it. I wish in particular to comment on the special point raised by Dr. Johnstone in the last number of this review. The writer, it may be remembered, starts with a paradox of physics; and then sets forth a vitalistic theory of life which he regards as the only possible mode of escape from that paradox. The paradox is as follows: Under the second law of thermodynamics, there is a universal and unceasing tendency toward the degradation of energy in the form of dissipated heat. The universe, as we see it, is passing from a state in which energy is concentrated at certain places at high potential, to a state in which all the energy will have become dissipated equally everywhere; and the universe will then be a dead, inert, motionless existence, possessing a uniform temperature, representing the degraded sum total of all the various forms of energy previously concentrated in particular regions. But the universe has existed throughout infinite time: therefore the state of final equilibrium must already have been reached, unless there were somewhere a source of "restoration of available energy"—that is to say, a phenomenon which *reverses* the degradation of energy, and sets up contrary processes leading once more to concentration at high potential. And we are then introduced to the suggestion (already made by Dr. Johnstone in his "Philosophy of Biology") that Life is the source of this reversal of physical processes.

Now I propose, in the first place, to deny that we are called upon to believe in any such reversal of the second law of thermodynamics; and in the second place to deny that, if there were any such reversal, it could have any possible connection with Life. Had I more space available, I should have begun by criticising Dr. Johnstone's statement of the law itself, which appears to me imperfect in certain particulars. But in order to limit the discussion to the truly essential points, I am prepared to accept his statement of the law as true and accurate.

I may begin then by pointing out that the whole argument is purely deductive in character. Energy is continually being degraded: the past duration of the universe is infinite: therefore, unless there be some source of restoration, the degradation must long ago have been complete; but it is far from complete: hence there must be some source of restoration. Now we may gravely doubt the value of any chain of deduction which leads you by two or three simple steps from the infinity of time to a theory of vitalism. The infinity of time is too vague, too metaphysical, and too incomprehensible a doctrine to be suitable for use as a major premise for the deduction of physical and biological facts. It may, indeed, be questioned whether *any* deduction should suffice to convince us of the reversibility of a law of thermodynamics, which is based (like the law of conservation of energy) on the uniform and unbroken experience of mankind. But if any deduction of this kind could be valid, it surely is not one which is based upon the infinity of time—a theory which we cannot genuinely bring before consciousness and which staggers every attempt to realize it. Let me pass, however, from Dr. Johnstone's logic to his physics.

In order that the second law of thermodynamics may be reversed, he tells us, we must assume that at a given moment in some portion of gas every molecule should happen to collide with another molecule moving at the same velocity and in the same straight line. In that case the direction of motion of every molecule would be instantaneously reversed, while its velocity would remain unaltered; there would then occur a reversal of sign in the second law of thermodynamics: entropy would be diminished, instead of being increased. The chance against such an event occurring is, as Dr. Johnstone rightly observes, immeasurably great; but, as he continues, time and space are also immeasurably great, and we may therefore suppose that the thing can actually happen.[1] Yet he does not adequately realize the infinite improbability of the occurrence. He says: "At any instant many of the molecules in a deciliter of gas must be approaching each other in the same straight line and with the same velocity." On the contrary, the odds against two molecules approaching each other in the same mathematical straight line is infinity to 1. The odds against their moving with a mathematically equal velocity is also infinity to 1; and the odds against a combination of these two events is the square of infinity to 1. Further, the chance that all the molecules in a deciliter of gas should fulfil these conditions at the same moment is represented by a fraction of which the numerator is 1, and the denominator is infinity raised to a power equal to twice the number of molecules in the gas; and that we may call for practical purposes infinity to the power of infinity.

Seeing that it is Dr. Johnstone's object to throw doubt upon the universal validity of the second law of thermodynamics, it is not apparent why he should have selected a mode of argument which represents the odds against its being "violated" as infinity to the power of infinity. No one has ever claimed for it on inductive grounds the overwhelming certainty which Dr. Johnstone confers upon it by means of deduction. To most physicists the validity of the law is based upon the unbroken experience of mankind; and that experience, though it may bestow a very high degree of probability, does not rise to the attenuated regions of $\infty^{\infty} : 1$. It would have been simpler and much more convincing to say that, as the second law of thermodynamics is based only on finite experience in a very limited time, it may possibly not hold good everywhere, and may not have held good in past times.

Let us pass, however, to the conclusion of Dr. Johnstone's physical deduction. Let us suppose that energy is and has always been degraded throughout infinite time. Yet we see concentrated forms of energy still in existence: are we then bound to infer that "there must be a restoration of available energy"? Certainly not. Dr. Johnstone is fond of dealing in infinities; let us add one more. Let us suppose that the energy in the universe is, like time and space, also infinite—an entirely reasonable hypothesis. Then even the lapse of infinite time would not involve the extinction of all differences of energy-potential. Dr. Johnstone's argument is only sound (even in appearance) on the assumption that the universe is limited; but that surely far exceeds our possible knowledge. We know our own world and solar system; we behold in the inconceivable depths of the universe other worlds and solar systems much like our own. May not these worlds extend right away to the uttermost limits of conceivability? What right has Dr. Johnstone to assume that space is infinite and that the universe is finite? Does he suppose that "the universe"—the great stellar systems which are disclosed by powerful telescopes—are a dot in the midst of infinite and empty space? They may be, but how does he know? How can he venture to found a theory of life upon such an assumption? We know that light travels with a velocity of about 186,000 miles a second. We know that there are stars so remote that the light which they emitted when Christ was alive is only now reaching us. The space which separates us from those stars dwindles to a mathematical point when looked at from the standpoint of infinite space. If we represent that vast distance on a star map by a space of one inch, there may, for all we know, be other stars at a distance which we should have to represent on the same scale on the map by a yard, a mile, a million miles, a million light-years! We cannot say that the universe is limited, because such a statement is overwhelmingly beyond our present or possible knowledge; and if we cannot say that the universe is limited, we cannot say that the energy of the universe is limited, nor can we share Dr. Johnstone's surprise that the available energy has not already all been dissipated. Indeed, one cannot but feel that Dr. Johnstone does not appreciate the magnitude of the factors with which he tries to operate. He affirms with confidence that restoration of energy is the "only way out of this deadlock." He forgets the other possible way out named above: which, indeed, seems far more probable than his. But even had I been unable to indicate another way out, it does not follow that because you can only think of one solution, therefore that solution must be true. This is not sound reasoning in any department of science: it is less sound than ever when you are dealing with such incomprehensible doctrines as the infinity of time and space, and similar intangible conceptions, which we are bound by the limitations of our intellect to believe, and yet are forever incapable of understanding.

Reverting to the above suggested star map in which the distance of the most remote of visible stars is represented by the length of one inch, we may imagine that on the same scale at a distance of a million miles there may be other bodies; and others again at a distance of a further million and so on *ad infinitum*. Even were these bodies actually no larger than a pea, and even were their temperatures not more than 1 deg. above the average of *our* stellar universe, yet the total amount of energy contained in them would be infinite, and they never in finite time would lose any fraction of their excess of potential over that of our universe. Energy, moreover, may be infinite not only in *extension*, but in *intension*. The vast sources of energy lately discovered within the atom may be paralleled by other infinite stores within the electron. In short, Dr. Johnstone's attempt to argue that the second law of thermodynamics *cannot à priori* always hold good, fails absolutely: he cannot prove any such doctrine by deduction, more especially by deductions with such shadowy and metaphysical premises: he can prove it, if at all, only by induction—by citing a case in which the law is found to be in abeyance: and he does not even hint at any such case.

Except indeed in the case of living organisms! And I now turn to this, the second part of Dr. Johnstone's argument. He has established that there must be somewhere a *restoration of available energy*: he has established it, that is, to his own satisfaction, but not (I hope) to the satisfaction of readers of *Science Progress*.

*From *Science Progress*.

Reviewing:

1. "Is the Organism a Thermodynamic Mechanism?" Article by Dr. James Johnstone in *Science Progress*, April, 1915. (*Scientific American Supplement*, Nos. 2066 and 2067.)
2. "The Mechanistic Principle and the non-Mechanical," by Paul Carus.
3. "The Principle of Relativity," by Paul Carus.
4. "The Analysis of Sensations," by Dr. Ernst Mach. Translated from the First German Edition by C. M. Williams.
5. "The Mirror of Perception," by Leonard Hall, M.A.

[1] Dr. Johnstone has an inveterate habit of canceling out infinities on the two sides of an equation. We know that twice infinity = 3 times infinity; but we cannot cancel infinities and say that 2 = 3.

He goes on to affirm that living organisms effect that restoration. Plants absorb radiant energy for the purposes of chemical synthesis. They exhibit therefore endothermic reactions: that is to say, their chemical processes are accompanied not by the evolution but by the absorption of heat. This apparently he regards as opposed to the second law of thermodynamics. He admits, of course, that endothermic reactions do occur in inorganic substances; but he says "they do not occur of themselves." What does he mean by that? Presumably that they only occur in human experiments. But an experiment is simply a method of bringing together conditions not very frequently or conveniently realized in nature. The reaction occurs "by itself;" and the peculiar set of conditions under which it occurs may quite possibly and in course of time must certainly happen to come together in nature, as we bring them together in the laboratory. The entire activities of human beings consist in altering the relative positions of objects, i. e., in moving things. The whole work of man and power of man is limited to moving objects from one place to another: and the rest happens "by itself." An experiment is nothing more than a rearrangement or transference of various objects; and then the same thing happens as would happen if the same collocation of objects occurred in nature. If sulphur vapor passes over red hot carbon, carbon disulphide is formed. This is an endothermic reaction, and it occurs "by itself." Presumably Dr. Johnstone will answer that, except in a laboratory, you do not get sulphur vapor in contact with red hot carbon. You have to heat the carbon, and then pass sulphur vapor over it. But surely, although this particular reaction may not occur in the districts frequented by Dr. Johnstone, he would find it occurring if he were to make a descent into a volcano: and it certainly occurred at large in early periods of the earth's history, and does now occur in all parts of the Sun. Similarly acetylene is formed when carbon and hydrogen come in contact at high temperatures. The reaction again, like that of the plant, is *endothermic*: and it occurs "of itself;" not perhaps in Liverpool, but at all events in the Sun. Dr. Johnstone is discussing the restoration of energy, not on the Earth, but in the Universe; and we can no more decide the attributes of the Universe by the capacities of Liverpool than we can decide the attributes of God by the capacities of the Lord Mayor.

Hydriodic gas is another endothermic compound which is formed by itself *at ordinary temperatures* when sulphureted hydrogen passes through iodine suspended in water: there are many other endothermic substances, as, for instance, hydrazoic acid; and of all these it can be said that they occur by themselves. In physics, as well as in chemistry, absorption of dissipated heat happens too constantly to require mention. It happens when a gas expands against external pressure; when water evaporates; when crystals are dissolved in water; when snow is mixed with salt, etc. In some cases the dissipated energy of heat is concentrated into a new form of much higher potential than any previously present. A slight rise of temperature over the ocean causes many tons of water to rise into the sky, where they become condensed as clouds. These are precipitated as rain which gives rise to a kinetic energy that may easily be reconverted into heat of a far higher potential than existed at the commencement of the operations.

Dr. Johnstone appears in short to have misapplied the second law of thermodynamics. When a gas expands against external pressure, it becomes cooled below the temperature of surrounding objects; but that is no breach of the law, for if the gas were restored to its original condition, the cycle of operations would display some dissipation of heat. The heat evolved in the second part of the process would be greater than the heat absorbed in the first part. Similarly in the case of plants the synthesis of compounds of high energy value involves some absorption of heat; but this again does not contradict the law, for if the compounds were broken up again into their former constituents, the certain result of the entire operation would involve a certain dissipation of heat. Dr. Johnstone fails absolutely therefore to show the slightest deviation on the part of organisms from the second law of thermodynamics; he fails to name a single condition in the synthesis of organic compounds which is not realized in "free" nature, far from the dwellings of any human experimentalist. Certain secondary considerations are raised by Dr. Johnstone in the course of his article; but I venture to hope they are disposed of by the destruction of his primary argument.

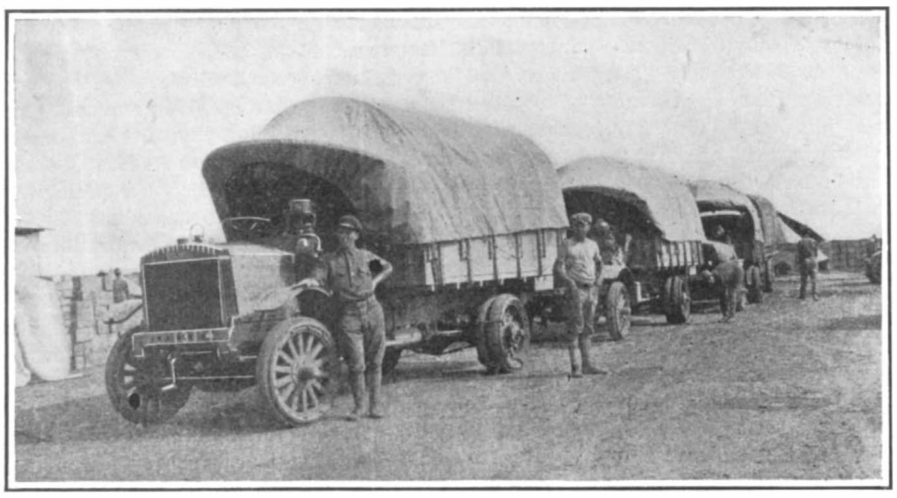
I may perhaps be allowed briefly to allude to one. In the case of warm-blooded animals, there occurs an obvious wastage of heat by radiation into the environment; this would appear at first glance as an illustration of the second law of thermodynamics; but Dr. Johnstone is compelled by his theory to deny this apparently obvious application. He affirms accordingly that the production of heat is not a mere chance by-product of organic metabolism, but is a "purposeful" activity of the organism. With this view we may quite well agree; but we cannot agree that because the evolution of heat has a teleological value, it is, therefore, any the less a manifestation of thermodynamic principles. Nearly all the bodily functions are "purposive;" but for all that they are produced by "blind" physico-chemical means. In steam engines, there occurs a wastage of heat from the boiler, by the loss of hot furnace gases up the chimney and in other ways. This wastage is that contemplated in the second law of thermodynamics. But it may be, and constantly is, greatly minimized by fitting in the flue an "economizer," or nest of tubes exposed to the hot gases and containing the water to be fed to the boiler. By increasing the size of the economizer, it is possible to extract as much heat as is desired from the wastage and add it to the boiler water. In this case we may affirm that the heat in the waste gases has a purposeful signification, for it markedly raises the efficiency of the engine. The case is analogous to that of heat production in animals. The exhaust steam turbine provides another analogy. This turbine, especially used for the winding engines of collieries, is driven by steam (taken at atmospheric pressure or a few pounds above it) that is exhausted from ordinary non-condensing engines. The heat dissipated under the second law of thermodynamics from one engine is thus used to drive another. But the fact that it is put to a definite purpose does not in any way invalidate the fact of its original production as a frictional by-product.

It is interesting historically to note that, whereas the older vitalists attempted to show that organisms were outside the control of the first law of thermodynamics, the newer now apparently have shifted their attention to the second law. It has at length been proved abundantly that organisms fall within the first law: even Dr. Johnstone admits that. The proof was a severe blow to the vitalist party, which Dr. Johnstone now tries to retrieve with the help of the second law. Not in this case, any more than in the other, is there any sort of basis for the allegation; and we can only contemplate with calm the desperate expedients to which vitalists are now driven.

The work of Dr. Paul Carus, "The Mechanistic Principle and the Non-Mechanical," is in great part an attempt to deny that evil consequences in practical life flow from a belief in mechanism. There are many writers—and Dr. Carus quotes Mark Twain as an illustration—who are inclined to believe in the mechanistic principle, but deplore the supposed slight which it involves upon the dignity and "divinity" of man. To use such an argument against the truth of the theory is of course nothing else than setting up our ignorant and uneducated desires as the standard of truth. Just the same argument was used during the evolution controversy; some people felt that man lost something of his "divinity" if he was descended from an ape-like ancestor; they denied in consequence that he was descended from such an ancestor. It is scarcely necessary in *Science Progress* to point out the hopeless confusion of thought involved. The truth of a theory does not depend upon whether or not we like it: to say so would be to prostitute truth to sentiment and desire. Nevertheless it is very difficult to see why anyone should be depressed by the establishment of one or other theory of human functions. As Dr. Carus remarks, "A man's a man for a' that." No theory, either of his origin or of his physiological processes, alters in the slightest degree his actual nature. He remains just the same, whatever view we take of his constitution; and if we regarded him as suffused with divinity before, we must still regard him as suffused with divinity after we have corrected our theories about him. The whole matter is, however, too elementary and too obvious for further discussion. Dr. Carus examines the mechanistic theories of four different writers, somewhat strangely assorted, Mark Twain, La Mettrie, Prof. W. B. Smith, and Dr. Bixby, a theist. Dr. Carus deserves our thanks for his defence of the views and character of La Mettrie. That most remarkable philosopher, born in 1709, was the first to apply to human beings those principles of physiological mechanism which Descartes had asserted in the case of the lower animals. La Mettrie had an intellect of surpassing power and originality: he was able to think right off the lines of the conventional beliefs of his day. He drew a sharp and much-needed line of distinction between science and ethics; and his philosophy even at the present day still retains high interest. But it was his misfortune that nearly all the theories which he espoused were unpopular. He was an atheist and a materialist: he regarded man as an animal. His character was uncontrollably gay and lively: and in certain respects he disregarded the code of morals enjoined by the Church. He even wrote and published in his "Œuvres Philosophiques" one or two charming essays, which, however, would scarcely obtain the approval of a Wesleyan Methodist, nor perhaps be accepted by the editor of a parish magazine. He has therefore been attacked on the grounds of morality; and Dr. Paul Carus well points out that he was certainly no "worse" than his times. He might have added that the writings in question cannot, as regards morals, be compared for an instant with certain productions of Voltaire, Diderot and other great contemporaries. The opponents of La Mettrie, finding that they disliked his views and were unable to answer them, flew to the resource of blackening his moral character; and so ready was the world to believe his theories false, that his works lapsed almost into oblivion for nearly a century. Lange in Germany first did justice to his memory; and now happily an American translator has published his "L'homme machine" in Chicago.

"The Analysis of Sensations," by Dr. Ernst Mach, is a book already tolerably well known in England. Originally published in Germany in 1886, it was translated into English in 1897. A second translation has now been made from the fifth German edition; and the book is in many ways more complete than that with which English readers were previously acquainted. Among several new chapters, one of the most interesting is that dealing with "Physics and Biology: Causality and Teleology." Dr. Mach deals with the special difficulty, which many people find, of bringing the conception of purpose into a mechanistic scheme of the universe. This difficulty is not to be met by denying the reality of purpose. It is obvious that the structure of animals is purposive; and that many of the actions of mankind are directed to a conscious end. All that we assert is that blind physical forces are the true agency in the production of the phenomena called purposive, as well as of all other phenomena. Their purposive character is no more than a subjective attribute. To other kinds of organic beings, other kinds of physical events would be considered as purposive, while those which we now consider purposive would be regarded as obviously mechanical. Taking a physiological view, Mach observes that "Purposiveness only comes in when the organic functions are resolved into one another, when they are seen as interconnected, as not limited to the immediate, as proceeding by way of détours." "By an imperceptible modification in our thought, we can formulate every teleological question in such a way as completely to exclude the conception of purpose." He points out further that in ancient times purpose filled a much larger sphere than it does at present. "Aristotle, for example, conceives heavy bodies as seeking out their position; Hero thinks that, from motives of economy, nature conducts light by the shortest paths and in the shortest times." To which we may add, as a more recent example, that Bernardin de Saint-Pierre believed that melons have ribs for the purpose of facilitating their consumption in family circles. Dr. Mach epigrammatically describes animal life as "nothing but combustion in complicated circumstances," for it is a conflagration which "keeps itself going, produces its own combustion temperature, brings neighboring bodies up to that temperature and thereby drags them into the process, assimilates and grows, expands and propagates itself."

"The Mirror of Perception," by Mr. Leonard Hall, is a work of originality and ability, though we are wholly unable to agree with its conclusions. He endeavors to show that the physical world is not real, while the psychical world is; the main object of the book is to show that "the material world does not really exist." It appears, in fact, that he has fallen into a very common misunderstanding of the idealist position; for the representation of matter in terms of consciousness does not, properly understood, involve any falling off in the "reality" of material existence. It would be as reasonable to say that because color can be represented in terms of ethereal undulation, therefore it ceases to be real. Mr. Hall endeavors to prove, further, that the mind of a man is "the result of the social evolution of a community of protozoan minds"; and that the minds of Protozoa again are compounded from the aggregate minds of their constituent molecules—a belief which at present can be regarded as nothing more than vague speculation. He desires to supplement Natural Selection as a factor in Evolution by "purpose"; that is, the purpose, not only of the "principal mind" of the animal, but of "all the minds and parts of the minds of which the animal consists." The author here gets into very thin air; and it is scarcely worth while to follow him.



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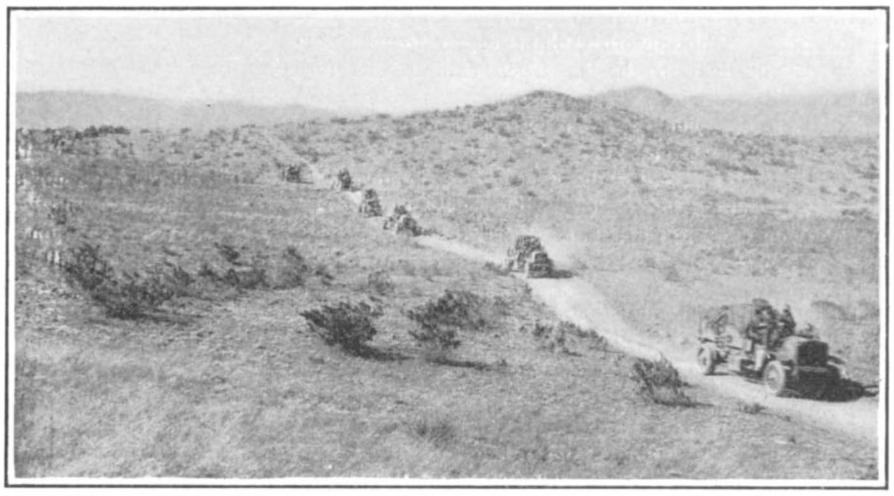
Three-ton Army trucks ready for the trip.



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A train of thirty-one trucks in New Mexico.

Motor Trucks and The Army

Experiences of Great Military Value

FRANCE, Belgium and Germany are crossed by such a network of railways that the battle lines on the Western front are reached by them at frequent intervals, and this makes it a comparatively simple task to keep the armies provided with the numerous supplies required; and these railways are supplemented by light and quickly built narrow gauge roads that connect the supply depots, located at a safe distance in the rear, with the actual fighting lines, so that railway communication is, in most cases, continuous right up to the most advanced posts. Moreover, in some parts of France, we are told that little special locomotives even run through the trenches themselves. Of course, there are many places where automobiles are used, and many thousands of them are in constant service in the armies of Europe; but by far the greater part of the transportation of men and supplies is performed by the steam railroads, many of which were originally located and built with this particular object in view.

In America everything is different, for not only are distances vastly greater, but the number of lines reaching any given district, except in certain limited sections, are few and far between. As a consequence other means of transportation would be necessary in case of war. Here the little secondary distributing lines would be possible to only a very limited extent, and the only apparent resource is the automobile truck, of which many thousands would be necessary in a region like the Mexican border to adequately meet the requirements of even a moderate army.

The recent experience on this border has afforded an excellent opportunity for studying this vital question of transporting supplies, and undoubtedly much of value has been learned. Among other things, various experiments in operating supply trains were made, and as an example may be cited the record established by the United States Army Truck Train No. 13 by an overland run from Columbus, New Mexico, to SanAntonio, Texas. The train was composed of thirty-one 3-ton trucks, and was commanded by Captain Pearson, 11th Infantry.

The distance covered was more than 800 miles and was negotiated in 13 days actual running time. Two days were spent in El Paso and two on the road, making the total elapsed time 17 days. According to the United States army regulations, the standard day's travel for a 4-mule team is 17 miles. Thus it would have required at least 47 days, exclusive of the 4 days' loss en route, for this trip to have been made by mule-train—a comparison which shows clearly the relative merits of the old and new style of military transportation.

With the exception of a stretch of about 30 miles leading into San Antonio, there was practically no road at all. The greater part of the route was across untrailed desert, whose only tractive surface was a thin sunbaked layer over the bottomless sand. Sometimes it was necessary for the men to build roads for the trucks from fire wood taken from the chuck trucks. Added to that, it was necessary to ford streams, flooded by the torrential rains of the border district, and pull through long stretches of gumbo mud, which one driver says is "several times as bad as Wisconsin red clay."

Through all these unfavorable conditions the train had to carry its own supplies, gasoline, subsistence and water for men and machines.

In spite of all this Truck Train No. 13 averaged better than 66 miles a day running time, an average that is considered in military transportation circles as little short of phenomenal.

The trucks ran into San Antonio on September 2nd with every truck in good condition, completing a trip, which for number and distance covered under the worst condition, sets a mark in motor-truck efficiency.

Science and Beliefs of the Tewa Indians

THE Bureau of American Ethnology, which makes a special study of the American Indians, has issued a report including an interesting paper on the geographical knowledge of the Tewa Indians of the upper Rio Grande, New Mexico. These Indians belong to the Tanoan linguistic family, and at present about 1,200 of them occupy five villages on the Rio Grande, San Juan, Santa Clara, San Ildefonso, Nambe, and Tesuque, and one among the Hopi Pueblos of northeastern Arizona, known as Hano.

As described by the author, John Peabody Harrington, the Tewa possess some curious ideas in connection with the cosmos, the symbolism of natural phenomena, and their periods of time, as well as geographical and mineralogical nomenclature.

The material for the book was collected through the co-operation of the Bureau of American Ethnology and the School of American Archaelogy at Santa Fe, N. M. Mr. Harrington has spent much of his time during the last few years in the study of the Tewa Indians, especially those of the Pueblos of San Ildefonso and Santa Clara. His task has proved a difficult one. The Tewa Indians are most conservative, even secretive, in all matters regarding their religious and social organization, making it extremely hard for the investigator to gather information on these phases of their life, without the exercise of great discretion and tact. Nevertheless, the author has succeeded in throwing considerable light on the concepts of the Tewa people.

After dealing briefly with the phonetics of the Tewa language, the author takes up the subject of cosmography as the Indians themselves understood it. They distinguished six cardinal directions or regions; north, west, south, east, above, and below, attached to each of which there were series of symbols such as colors, persons, animals, plants, and inanimate objects. For example, the north has the allied color of blue or green, the mountain lion as a cardinal animal, the eagle as the bird, and Bear Mountain as an inanimate object assigned to it. To these people the sky, which was personified and literally called "Sky Old Man," was supposed to be the husband of the earth which was called "Earth Old Woman." The Tewa had names for the sun and moon also, as well as for many stars and constellations.

The ancient beliefs, which still obtain among the Tewa, include a rather remarkable conception of the daily course of the sun. The sun is said to walk through the sky during the day clothed in white deerskin ornamented with many fine beads. In Winter he is said to be yellow and in Summer green; he has a beautiful face which is hidden by a mask. Together with the moon he passes from east to west over a trail above the great waters of the sky, and when either of them sets he is supposed to pass downward through a lake to the underworld, through which he travels all night toward the east, where he arises in the morning to start out again.

This world below, or underworld, through which the sun and moon are believed to be passing when they are not above in the sky, is held by the Tewa to be the place from which the human race and the lower animals originally came; it is the base of the universe to them. It is dark and damp, the sun shining there only at night and then pale, like the moon. This place is also what white people call the "happy hunting-ground" of these people, where they go as spirits after death; there seems to be no division in afterlife of the good from the bad, all passing to this "happy hunting-ground."

The Tewa are not aware, seemingly, of the existence of the equinoxes, as they have no designation for them, but go by the solstices; when the Winter sun appears to stand still, December 21, their year begins. Their calendar is determined by noticing the point at which the sun rises, though who it is that does the determining and just how it is accomplished are not known to the author.

Two seasons only are distinguished, Summer beginning with Spring and lasting until Fall, and Winter commencing in the Fall and extending to Spring. Like the Zuni year, the Tewa contains 12 months, each supposed to commence at the time of the new moon. Every month has a name which differs considerably according to the speaker and his village. Some of them are interesting: January is known in several pueblos as "ice month"; February, "wind month"; March, "month when the leaves break forth," or "when the snow lies not in the pathways"; August, "wheat-cutting month"; October, "month of falling leaves," and December, "Christmas month," literally, "ashes fire," significant of the dying year, it is supposed.

The geographical names of the Tewa, primarily local, are abundant and most precise, as was probably very necessary, for their restricted limits consisted of an arid and little-settled region where accurate descriptions of places seldom visited were necessary for identification. The list of place names forms the most complete collection of nomenclature in the book, and establishes the very early residence of the Tewa in their present localities. A remarkably large number of tribes and peoples were and are known to these Indians. Tewa itself is a native name of the tribe, and is not derived from the American-Spanish *Tegua*, or "moccasin," as was once believed.

"There is, and always has been, considerable dislike for the Mexicans on the part of the Tewa," says the author, "and this feeling is responsible for the purist tendencies of many Tewa speakers. The Tewa are apt to avoid the use of Spanish place-names when speaking Tewa, either translating them or using the old Tewa equivalents." When they are speaking Tewa in the presence of Mexicans they are said to be especially careful not to use any Spanish words, lest they be understood and the subject of their conversation be betrayed. In this manner their dislike for the Mexicans has tended to preserve their language.

Twenty-nine maps, following the political divisions of these Indians more or less faithfully, are included in the report to show the places and geographical features to which the Indian names are applied.

Many minerals were known to the Tewa, among them salt, alkali, several forms of stone used in making pipes and axes, clays of various sorts, petrified wood, mineral paint, jade, mica, sandstone, limestone, gypsum, pumice-stone, coal, basalt, turquois, and white flint, but they did not know of copper, gold, or silver before the advent of the Spanish.

Analysis by Machinery*

Devices That Facilitate Laboratory Work

By Eric Sinkinson, Demonstrator in Technical Analysis in the Imperial College of Science and Technology, South Kensington

In the department of analytical chemistry little has been devised to lighten the manipulative requirements of the chemist. Every operation undertaken requires the utmost skill and patience, while often the time expended is out of all proportion to the results obtained.

The wash-bottle—the chemist's staff—is ever in his hand, which, when so occupied, is not free for any other operation.

The washing of precipitates is one of the greatest time-absorbing factors in the laboratory. Yet there is no escape from it, demanding as it does the utmost attention and skill; in this way the output of a laboratory is considerably limited.

With a view to minimizing the loss of time, and thus increasing the scope of the chemist, the machine is illustrated in Fig. 1.

After thorough and severe tests it has shown itself capable of satisfying this long-felt want, and hence is worthy of the notice of analysts. The machine can carry out quite automatically the washing of any precipitate in a more efficient way than can be done by hand. The constructional details are set out briefly in the following: The apparatus intrinsically is a balance, on one arm of which is fixed a supporting ring for a filter funnel, on the other a movable counterpoise weight and also an electrical commutator. Over the beam is fixed a table carrying two electric motors, shown in diagram as *B* and *C* in Fig. 2, one to control through a specially constructed mercury valve (*A* and *B*, Fig. 3) the flow of water to a jet which is rotated by the other motor. The two motors are connected to the current supply through the commutator arm *A*, Fig. 2, in such a way that when the funnel end of the beam is up the water supplied by gravity flow from a flask or tin-lined copper tank, which may be heated if necessary, passes freely to the jet which sprays the water around the edge of the paper containing the precipitate to be washed reposing in the funnel.

The counterpoise weight at the other end of the beam, which is regulated by a screw, is moved into such a position that when sufficient water has flowed into the funnel the increased weight causes the beam to drop, thus shutting off the water supply to the jet, so that no current is washed during the period it is not required.

As the water drips from the funnel the arm supporting it becomes lighter, the beam rises, and water again enters the filter through the rotating jet. In this manner the washing process continues until it is complete.

The valve controlling the water supply to the jet is a glass bulb, shown in Fig. 3, containing mercury represented in the figure by shading, fitted with an inlet tube *C*, which reaches to the bottom of the bulb, and an outlet tube *D*. When the bulb is in an upright position, as in *A*, Fig. 3, the water supplied to it cannot flow on account of the resistance of the mercury to it. If the valve be turning through 90 degrees, as in *B*, Fig. 3, the mercury rolls away from the inlet tube, thus allowing the water a free passage to the outlet *D*.

This bulb is mounted on the machine in such a way that the motor *B* (Fig. 2), which is reversible, will turn it from the horizontal to the vertical plane and *vice versa*, as the commutator arm *A* is raised or lowered. In order to check the rotation of the motor in either direction after it has turned over the valve, it is cut out of circuit by a turn of the wheel *O*, fixed to the valve on which are mounted two steel contacts, *P* and *R*., Fig. 2, capable of alternately dipping into the mercury cups, *H* and *J*, so that while one is out of circuit contact is made in the other ready for the return journey as soon as the commutator moves over.

The apparatus is simple in construction, robust, and with few moving parts. The electric contacts are made by steel rods dipping into steel mercury cups carried on ebonite insulators. The working parts are enclosed from dust and chemical fumes by suitable covers, and when in use appear as in Fig. 1.

If it should be required to wash a precipitate, with a predetermined quantity of wash-water, say 200 cubic centimeters, a small float can be arranged, attached to a cut-out on the main circuit to the apparatus, and this will arrest the washing quite automatically when the amount of water has passed through the filter.

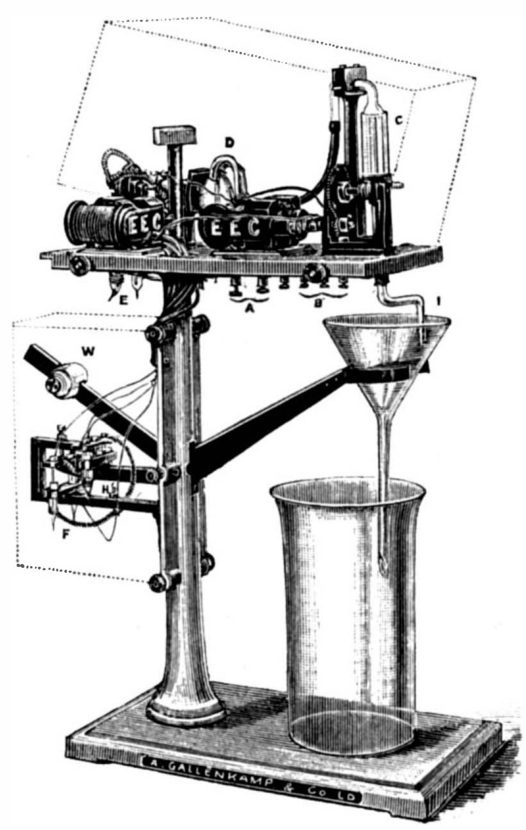

Fig. 1.

Six or twelve of these machines can be mounted together for use in laboratories where a considerable portion of the analyst's time is consumed, as in steel

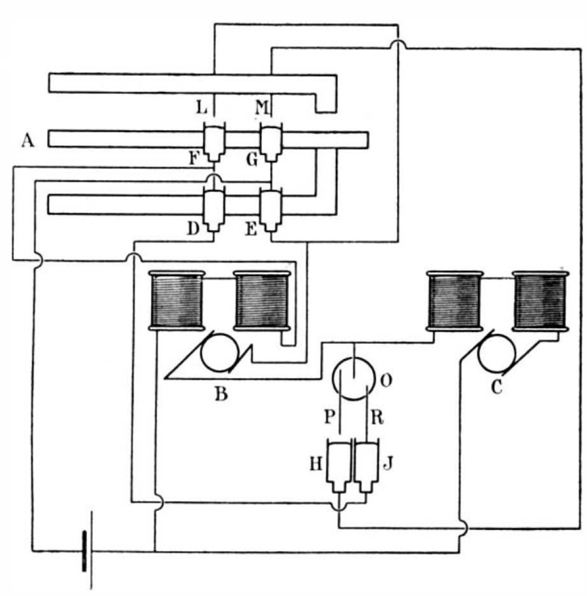

Fig. 2.

and refractory materials laboratories, in this laborious operation of filter-washing.

The current, which is only intermittently used, that

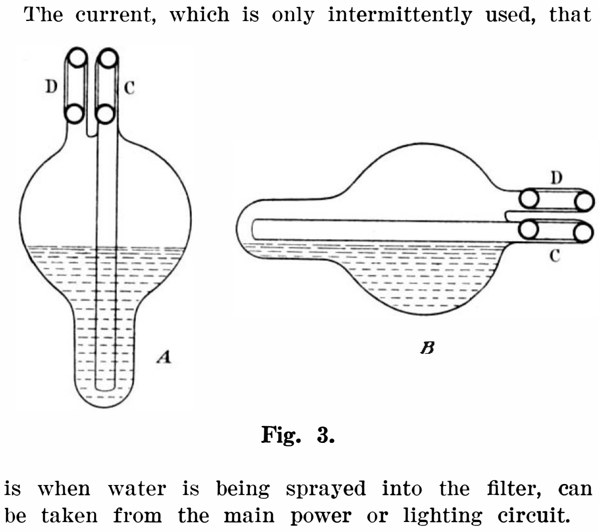

Fig. 3.

is when water is being sprayed into the filter, can be taken from the main power or lighting circuit.

The machine shown in the accompanying illustration is actuated by a pressure of 240 volts in conjunction with a suitable resistance. If, however, electric power or lighting is not laid on in the particular laboratory in which the apparatus is to work, a pressure of eight volts from an accumulator is sufficient to control it.

The apparatus thus becomes to the chemist a companion of the first order. It gives him a means of completely and effectively washing precipitates with the minimum quantity of hot or cold water in the shortest possible time. As the complete apparatus may be covered during the process of washing dust can be excluded and the contents of the filter-paper left uncontaminated. The machine may be left to complete a washing after the laboratory is closed down for the night.

In conjunction with this machine a decanting apparatus, the details of which may be communicated later, can be used, so that large bulks of liquid may be automatically decanted through the filter-paper. This apparatus is of especial value in agricultural laboratories, where much time is spent in this operation.

It is hoped that this brief account may interest readers in an endeavor to minimize some of the time-absorbing operations of the analytical laboratory

*The Chemical News.

An Oil Pipe Line Across the Atlantic Ocean

An interesting scheme for a submarine pipe line to convey oil is proposed by an Irish inventor. The flexible pipe he has designed for the purpose is constructed of mild steel ribbon on the helical tube principle, the helices being packed with asbestos twine. The steel ribbon is coated with a protective metallic alloy, and is of such a thickness as to render the completed pipe capable of withstanding an internal pressure of 2,000 pounds and an external pressure of 10,000 pounds per square inch. Finally, a cotton casing is woven over the outside of the pipe and coated with preservative compound. To give longitudinal strength a stranded steel cable or hawser is put inside the pipe. The inventor considers that a pipe line between England and America could be laid in three or four months. The course would be divided into twenty sections, and as many laying ships would be employed, so that each would have about 130 miles to lay. The ships would be provided with sufficient steel ribbon on reels, with cotton, cable, and other requirements, to complete their allotted distance, and each would carry a tube-forming and sleeve-weaving apparatus. The former consists of a cross frame carrying reels of ribbon and asbestos and the forming and bending rollers, the whole being rotated round a steel mandrel. As the frame rotates the rollers press the steel ribbon to the required shape, enclosing the asbestos and interlocking the edges of the ribbon, and, finally, the cotton casing is woven on, the preservative compound being applied at the same time. The operations take place round the steel cable, by means of which the pipe would be fed into the water. The apparatus is designed to produce at least sixteen feet of pipe a minute. When beginning work each ship would attach its pipe cable to an anchored buoy. The cable would be wound on a drum having its rotation controlled frictionally, and when a predetermined amount of cable had been produced the drum would be allowed to unwind a proportionate length of cable, on which the whole strain of laying would rest. Subsequently the sections would be joined together, the pipe by means of bronze couplings, cotton covered and preserved, and the internal cable by similar couplings of steel. The inventor calculates that a single Anglo-American pipe line, 3,000 miles long and 18 inches in diameter, would deliver about 700 gallons a minute, or about 6,000,000 gallons a week, with a pump pressure of 2,000 pounds per square inch. The capital outlay he puts at £10,000,000, and the annual working and maintenance costs, exclusive of clerical and directorship costs, at £50,000—power (at ¼d. per unit) accounting for £13,500, wages and salaries for £4,000, repairs and renewals to plant for £500, and a repair ship always in commission for £32,000, including repair materials. On this basis he estimates the cost per 1,000 gallons per 1,000 miles at 2s., as compared with £12 with tank steamers.—*Engineering Supplement of the London Times.*

Medicine as Practiced by the Chinese*

Complicated and Fantastic Theories That Have Survived for Ages

By William W. Cadbury, M.D., Physician to the Canton Christian College

Medicine in China may be considered under two divisions—the purely superstitious, which depends on charms and magic and is largely fostered by the Taoist priests, and the art of medicine as practiced by the Chinese doctor. These two phases of treatment of the sick are closely interwoven with one another so that it is sometimes impossible to draw the line between them.

Let us first consider the superstitious practices and beliefs. In the city of Canton may be found temples dedicated to the "Spirit of Medicine," or healing. The ignorant people, especially women, believe that the deity presiding in these temples can restore health upon the payment of small sums of money to the priest and the performance of certain rites.

Chinese medicine like philosophy rests on a dualistic basis. At the bottom of all the laws of the universe are two principles, the "yang" and the "yin." They are generally represented by a circle divided into two parts, each of which is a comma shaped object resembling a serpent. One is white and the other black, or one is green and the other red. The circle represents the great absolute and the two divisions within it the "yang" and the "yin." Again the "yang" or male element or force is represented by straight lines, and the "yin" or female element by broken lines. Thus the pantagram was devised by a Chinese emperor about the year 2900 B. C. This is made up of combinations of straight and broken lines surrounding the circle and its two divisions, making a perfect emblem of the balancing of the forces of the universe. Over many a doorway in China this sign is displayed to warn off evil spirits. The principle of duality typified by the "yang" and "yin" is more comprehensive than "male" and "female." They stand for positive and negative, the sun and the moon, light and dark, acid and base, heaven and earth, and they correspond to Ohrmuzd and Ahriman of the Zoroastrians, Osiris and Isis of the Egyptians, the even and the odd of Pythagoras.

The universe with its dual forces is a Macrocosm. Man is the Microcosm. Thus we read that as heaven has its orders of stars, and earth its currents of water, so man has his pulse. As earth has its water courses, called lakes, springs, etc., so man has his courses in the pulse—the three "yang" and the three "yin."

The priests explain these forces of the universe by personifications in the form of evil spirits or devils, and the people are kept in constant fear of these demons of the air which they believe are constantly bent on bringing disease or death. Hence, the many superstitious practices resorted to for deceiving or warding off the evil spirits. The priests recite incantations, paper money is burned, and the pantagram is hung over the doorway. The demons are especially fond of marring beautiful children, hence the parents invent disgusting names for their offspring in the hope of misleading these tormentors. Boys are especially liable to injury at the devils' hands. Hence a guest never inquires into the sex of a new-born child, and a boy is often dressed as a girl and called by a female name.

The Chinese physician is quite a different individual from the Taoist priest, although magic and astrology are inextricably bound in with his theories of the human organism.

The first authority on medicine in China was the Emperor Chen Long, who lived about 2737 B. C., and made a classification of some hundred medicinal plants. A later emperor wrote up medical science so far as it had progressed in 2637 B. C. In the earlier ages there was some progress in anatomy, but for the last one thousand years, at least, there has been practically no advance. The profound respect for the dead has interfered with dissecting and the performing of autopsies. Again, there is no co-operation between doctors and no medical organization. The so-called Imperial Academy of Medicine at Peking has no jurisdiction over physicians in other parts of the country. It is composed of the physicians to the emperor. They give instruction to the younger members in the medical classics. Generally speaking the practice of medicine is unlicensed. Most doctors receive their library from a father or relative who also imparts the secret remedies on which his reputation was established. During his apprenticeship the young doctor diligently studies the classical books and practices palpation of the pulse. The doctor is called upon only for more serious maladies. For the simpler complaints home remedies and the formulas of old women are used. In times of war the Chinese soldiers attend to their own wounds. Advertisement is quite ethical and the office of a doctor may be recognized by the tablets displayed about the entrance, on which the skill of the physician is testified to in high sounding phrases. These testimonials are usually signed and presented to the doctor by grateful patients. The name of the doctor is of great importance, thus one hears of Dr. "Root-of-Strength," Dr. "Rhubarb" and Dr. "Salts of Hartshorne."

*From the *Medical Record*.

As one would suspect from the absence of dissection and the experimental methods, the Chinese conception of physiology and anatomy is fanciful to the extreme. The body is said to be divided into three parts: (1) the upper or head; (2) the middle or chest; and (3) the lower part or abdomen, and the lower extremities. Life depends on the equilibrium of the "yang" and the "yin." It is but one manifestation of the universal life. The body is the microcosm, the universe the macrocosm. The "yang" is the warm principle, actively flowing. The "yin" is the moist principle passively flowing. As the whole order of the universe results from the perfect equilibrium of these two forces, so the health of man depends upon their equilibrium in the body. If the "yang" or active principle predominates there is excitation; if the "yin" or passive principle predominates, there is depression of the organism. The action of these two forces manifests itself through 11 organs: the heart, liver, lungs, spleen, left kidney, large and small intestines, stomach, gall-bladder, urinary bladder, and right kidney.

The lungs are divided into 4 large and 2 small lobes. The larnyx passes directly into the heart, which is the organ of thought, together with the spleen. The liver has 7 distinct divisions. The gall-bladder is the seat of courage. The urine passes directly from the small intestines into the urinary bladder through the ileo-cecal valve. The brain and spinal marrow produce the semen which passes directly into the testicles. There are said to be 365 bones in the body.

Functionally, the viscera are divided into 2 groups known as the 6 viscera in which the "yang" resides, and the 5 viscera in which the "yin" resides. The first group is composed of the gall-bladder, stomach, small intestine, large intestine, bladder, and left kidney, with its 3 heat centers, the 3 lumbar sympathetic ganglia. The 5 viscera are the heart, liver, lungs, spleen, and right kidney. The diaphragm is placed beneath the heart and lungs, and covers over the intestines, spine and stomach. It is an impervious membrane and covers over the foul gases, not allowing them to rise into the heart and lungs. The stomach, spleen and small intestines are the digestive organs. They prepare the blood which is received by the heart and set in motion by the lungs. The liver and gall bladder filter out the various humors. The lungs expel the foul gases. The kidneys filter the blood, while coarser material is evacuated by the large intestines. The "yang," which is of subtle nature, has a constant tendency to rise. The "yin," which occupies the brain and vertebral column as well as the five viscera, tends to descend.

Each of the organs has a canal whereby it communicates with other organs. Thus the liver, kidney and spleen are connected with the heart by special vessels and the vas deferens arises from the kidney. Some of these communicating channels end in the hands and some in the feet. One of the vessels in the little finger is used to determine the nature of infantile diseases. Six of these vessels carry the "yang" and 6 carry the "yin." These two forces are disseminated through the whole organism by means of the gases and the blood. The former act upon the latter as the wind upon the sea. The interaction of these two as they circulate in the vessels produces the pulse. The blood makes a complete circulation of the body about 50 times in 24 hours. In these 50 revolutions the blood passes 25 times through the male channels or those of the active principle and 25 times through the female channels or those of the negative principle. The blood is said to return to its starting place once in every half hour, instead of once in 25 seconds, according to modern physiologists, having traversed a course of some 54 meters.

Each organ is related to an element: fire rules the heart, metal the lungs, etc. There is likewise a close relationship to the planets, to season, color and taste. This interrelationship is well illustrated by the following table:

Organ	Planet	Element	Color	Taste
Stomach	Saturn	Earth	Yellow	Sweet
Liver	Jupiter	Wood	Green	Sour
Heart	Mars	Fire	Red	Bitter
Lungs	Venus	Metal	White	Sharp
Kidney	Mercury	Water	Black	Salt

Auscultation and percussion are wholly unknown as diagnostic aids to the Chinese physician. Entire reliance is placed on palpation of the pulse and the general facies of the patient in making the diagnosis. The taking of the pulse is almost like a solemn rite.

The pulse may be palpated at 11 different points, as follows: Radial, cubital, temporal, posterior, auricular, pedal, posterior tibial, external plantar, precordial, and in 3 places over the aorta. Usually, however, the physician is satisfied with the palpation of the pulse of the right and left wrist. With the right hand he feels the left pulse and with the left hand the right pulse. He applies 3 fingers—the ring, middle and index finger over the pulse and the thumb underneath the wrist. Then he palpates the pulse with each finger successively. Under the ring finger the pulse of the right hand reveals the condition of the lung, middle of chest and large intestines, while in the left hand the ring finger determines the state of the heart and the small intestines. The pulse under the middle finger corresponds on the right to the condition of the stomach and spleen, on the left to the state of the liver and the gall-bladder. The index-finger placed over the pulse of the right radial shows the condition of the bladder and the lower portion of the body, over the left radial it reveals the state of the kidneys and ureters. For each of these 6 pulses the physician must practice weak, moderate and strong pressure, to determine whether the pulse be superficial, moderate or deep. This must be done during 9 complete inspirations. If the pulse be rapid the "yang" principle is predominant; if slow, the "yin" is predominant. There are 24 main varieties of pulse. The Chinese physician must be trained to palpate the pulse so skilfully that by this single means the nature of diseases and even the months of gestation in a pregnant woman may be determined. Ten or more minutes must be spent in the palpation of the pulses.

Sometimes a Chinese physician will consider other factors. For example, it is said that by examination of the tongue 36 symptoms may be diagnosed according as the tongue is white, yellow, blue, red or black, and depending on the extent of the coating. From the general appearance of the face and nose the state of the lungs may be discovered. Examination of the eyes, orbits and eyebrows shows the condition of the liver. The cheeks and tongue vary with the state of the heart, the end of the nose with the stomach. The ears suggest the conditions of the kidneys; the mouth and lips the state of the spleen and stomach. The color and figure of the patient also count in a diagnosis.

Diseases are spoken of as internal and external. External cases are those apparent on the surface, such as all skin affectations, tumors growing on the surface and of late all surgery has been classified as the practice of external diseases. Internal diseases include all fevers and diseases of the heart, lungs and abdominal organs. More specifically diseases are classified under 9 heads as follows: (1) Affections of the great blood-vessels, including smallpox; (2) diseases of the lesser blood-vessels; (3) fevers; (4) female complaints; (5) cutaneous diseases; (6) conditions requiring acupuncture; (7) diseases of the throat, mouth and teeth; (8) disease of the bones; (9) affections of the eye.

Diseases are said to be produced by internal and external agents. Among the external causes are (1) wind, which causes headache or apoplexy, dizziness, chapping of face, diseases of the eye, ear, nose, tongue, teeth, etc.; (2) cold may cause cough, cholera, heart pains, rheumatism and abdominal pains; (3) heat causes chills and diarrhea; from dampness comes constipation, distention of abdomen, watery diarrhea, gonorrhea, nausea, pain in kidneys, jaundice, anasarca, pain in small intestines and pain in the feet; (5) from dryness come thirst and constipation; (6) fire causes pain in the sides, diabetes, etc. The diseases of internal origin are classified as disorders of the gases, blood, sputum and depressed spirits.

The treatment of disease by the Chinese doctor con-

sists chiefly in the administration of drugs. Surgery has been an unknown art. Recently two charitable institutions have been established in Canton for the treatment of the sick according to native methods of practice. At one of these so-called hospitals I was informed that bullets were removed by placing a kind of plaster at the wound of entrance. The ingredients of the plaster have a remarkable magnetic power over the imbedded bullet and gradually draw it out through the same opening by which it entered. My informant had never seen this line of treatment actually carried out, however.

Perhaps in no line does the native practitioner show his ignorance more than in the treatment of fractures. No attempt is made to reduce the parts. A special clay is placed in a wooden bowl. The heads of several chickens are cut off, while incantations are repeated and the blood is allowed to flow on the clay in the bowl. Blood and clay are now mixed together and applied to the fractured extremity. Bandages are used to bind on thin strips of bamboo. When the last turn of the bandage is being wound on, the blood of another chicken is poured on.

The only real operation performed by the Chinese is the castration of eunuch, and castration as a penalty for adultery. With one sweep of a sharp knife the genital organs are completely removed on a level with the skin of the pubis. A metal plug is inserted in the urethral opening and a cloth rung out of cold water is applied to the bleeding surface and firmly bound on. The patient is allowed to drink no water for three days when the dressing is removed, the plug withdrawn and the patient allowed to urinate.

Coming now to the real field of the Chinese doctor we find that the number and variety of remedies recommended in the Chinese Materia Medica can only be compared to our own National Pharmacopeia. The great Materia Medica, compiled in the 16th century, is composed of 52 books and contains 1,892 remedies. Kipling's verse applies to the Chinese as to the British people, for whom he wrote it:

"Alexanders and Marigold,
Eyebright, Orris, and Elecampane,
Basil, Rocket, Valerian, Rue,
(Almost singing themselves they run),
Vervain, Dittany, Call-me-to-you,
Cowslip, Melilot, Rose of the Sun,
Anything green that grew out of the mould,
Was an excellent herb to our fathers of old."

The drugs and other medicaments are weighed out according to a decimal system as follows:

1 tael or leung	equals	40.00	gm.
1 tsin	"	4.00	gm.
1 fan	"	.4	gm.
1 lei	"	.04	gm.
1 ho	"	.004	gm.

Often a prescription is given because of the resemblance of the drug to the organ affected. Thus for renal diseases, haricot or kidney beans are given. Minerals are administered as salts. Plants are used in the form of roots, stems, leaves, flowers and dried fruits. The bones of a tiger are frequently ground up and given to a debilitated person. The grasshopper is dried and used as a medicine and the shells of the cicada are collected from the bark of trees and mixed with other ingredients. Tinctures and extracts are prepared from rice wine. Pills are often made with a thick shell of parafine which is broken off and the contents chewed up. Various forms of plasters and blisters may be applied to the skin. The actual cautery is often used as a revulsive.

Among the pills the best are the "Wai Shaang Uen" or life preserving pills, costing about a dollar apiece. They are composed of Manchurian ginseng, deer's horns and other drugs. Among other common remedies may be named dried, powdered rattlesnake skins, the bile of the ox and dog for jaundice, dried shrimps, etc. Quicksilver is often poured into gun-shot wounds in order to dissolve the bullet. In some drug shops two signs are hung at the entrance: on one are written the names of venereal diseases, on the other such diseases as hemorrhoids, wounds, ulcers, etc. The patient explains in which class his disease belongs and is promptly given the appropriate remedy. Among the most used drugs are some that are found in the western pharmacopias, viz., ginseng, rhubarb, sulphur, pomegranate root, aconite, opium, arsenic and mercury.

Diseases of the liver and eyes, which are sympathetic organs, are cured by giving pork's liver. In Kwangtung Province human blood is considered an excellent remedy and at executions people may be seen collecting the blood in little vials. It is then cooked and eaten. A genuine prescription written by a physician to be used as a laxative was composed of Rumex hydrolepathium, Quercus glauca, Sodium sulphate and Magnolia hypoleuca. The parts from these plants are boiled with the sodium sulphate and the "tea" is drunk by the patient.

A remedy which I have not infrequently seen applied to a patient *in extremis* is as follows: A rooster is killed and the body is cut in half, longitudinally, and the bleeding half is quickly applied to the skin of the patient's abdomen. If there is any possibility of cure this is supposed to be infallible.

The use of the acupuncture needle seems to be seldom resorted to in the neighborhood of Canton. The theory on which it is based is that if one punctures the blood-vessels connecting different organs the disease will be aborted. Three hundred and eighty-eight points suitable for acupuncture are described. There is a mannikin at Peking pierced with holes at all the points suitable for acupuncture. Paper is pasted over it and students learn to find the proper holes through the paper. The needles vary from 1½ to 28 centimeters in length and are made of gold, silver or steel. During the operation the patient coughs and the errant humors are directed back into their normal courses.

Such in brief is medicine as it is practiced by the Chinese doctor of to-day. One is reminded of the old humoral theory of Europe in the Middle Ages. But modern education in China has brought a new light to the people and in all the large cities and many of the small ones, Western medicine is slowly but surely winning its way.

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"Nacoochee Mound" Investigated

An investigation of the so-called Nacoochee Mound in White County, Georgia, has shown it to be of comparatively recent origin, having been made by the Cherokee Indians and not abandoned by them until the 19th Century. This information comes as a direct blow to many natives of Georgia who have for years cherished the belief that this particular mound dated back to the days of the Spanish conquest, and was connected intimately with the beautiful legend inspired by the writings of a well-known Georgian, whose publications were taken too literally.

The investigations state that the word "Nacoochee" is not identifiable by the Cherokees as belonging to their language, and that by no means does it signify in any Indian tongue "the evening star," as has been claimed. Without intending to be iconoclastic, the ethnologists feel that the truth concerning this long held "mysterious" mound should be cleared up, both for the sake of American history, and for the purpose of differentiating between fact and fiction. It is now known that there is nothing mysterious about it, its history does not cover a very long period, and there is no ground for believing that this or any other mound in the United States was reared by people other than our Indians.

The legend of Nacoochee, Sautee, and Yonah, of Indian "kings" and "queens," and of the reputed visit of De Soto to this locality in the 16th Century, is purely imaginary; it is nowise Indian in character or concept, nor is it even based on an Indian story, and needless to say, nothing was found by the excavators in the mound, which, by the wildest flight of imagination, could give credence to these fairy tales.

The archeological investigations of the Nacoochee mound, which stands on the property of Dr. L. G. Hardman, of Commerce, Ga., were undertaken jointly by the Bureau of American Ethnology of the Smithsonian Institution, and the Museum of the American Indian, sometimes called the Heye Museum, of New York. The top of the mound, which was leveled for cultivation some 30 years ago, now forms an irregular circle varying in its diameter from 67 feet to 83 feet. From the field in which the mound stands to the top is just a little over 17 feet, while the circumference at the base is 410 feet. It is evident, however, that the size of the mound has changed somewhat by cultivation since its abandonment by the Cherokees, not only as to diminished height but also in the extent of its slopes at the base.

Following the custom of the Indians of the South, the Cherokees built this mound, partly for domicile and partly for cemetery purposes, by piling up the rich alluvial soil from the adjacent fields. They did not rear it all at one time; generation after generation is represented by the stratification exposed in the excavation, and bodies buried at different levels with undisturbed earth above them. The presence of fire-pits and the evidences of fires throughout the varying levels, and the finding of some objects procured from the white man in the upper part and near the surface on the slopes, but not in the lower levels, indicate that the mound was built up gradually, and extended well into the modern historical period, which fact is supported by the statements of oldest inhabitants of the Nacoochee Valley.

The graves of seventy-five individuals were unearthed at levels varying from near the top to below the original base of the mound. Most of the graves were unmarked, but in some of them there were stone implements, shells or shell ornaments, smoking pipes, pottery vessels and similar objects. Nearly all the skeletal remains were so greatly decomposed that preservation or measurement was impossible, but an interesting fact was established when it was discovered that usually the individuals were buried with their heads pointed in the direction of the sunrise.

Near the very base of the mound two graves were found to have been encased and covered with slabs of stone, and in one of them a beautiful effigy vase of painted pottery, the only piece of painted ware found in the mound, was recovered. The type of this vessel and the stone graves themselves suggest the possible occupancy of the site by Indians before the settlement of the Cherokees in this locality.

The large number of smoking pipes of pottery made in many designs and shapes and the amount of broken pottery found here form the most remarkable features of the excavations. But little ornamentation, except in the case of the single painted vessel, was noted in the pottery, other than incised and impressed designs worked out in the moist ware before the firing.

While the work of the ethnologists may have shattered the fanciful legend in regard to this location, it has done more for the actual history of this branch of the American aborigine in that a few more pages of fact have been added to the great book on the American red man which is gradually being perfected by the operation of Uncle Sam's Bureau of Ethnology.

Electric Station at Petrograd

According to a recent report by Engineer Makarieff, the electric plants in this city have made a great increase within recent years. He compares the present status with that of the year 1901, and at that time there were in operation four separate electric plants of good size which gave a total of 16,500 kilowatts, and comprising 37 dynamos. These plants can be designated as Nos. 1, 2, 3 and 4, omitting the names. Plant No. 3 produced alternating current at 3,300 volts and the rest of the plants operated on 2,200 volts, all using steam engines. Plant No. 1 had 18 groups realizing 5,500 kilowatts; No. 2, 8 groups at 5,000 kilowatts; Nos. 3 and 4 had 7 and 4 groups respectively at 5,250 and 800 kilowatts. An increase commenced in 1904, using steam turbines, which practice is continued to the present date. In 1904, No. 1 received a 680 kw. Parsons turbine, followed by a second one the next year, and a 2,000 kw. turbine was erected in No. 2. In 1907 this latter received another group of the same size and No. 1 a 1,600 kw. set, while No. 3 received a 1,800 kw. group. This year also saw a large municipal electric plant erected in town for tramway use, of 6,600 kw. output, using 3 turbines of 2,200 kw. size. Next year, plant No. 4 ceased working, and its load was divided among the rest, adding a 3,000 kw. turbine in plant No. 2. At that date the total output was double that for 1904, or 36,000 kilowatts. For 1909, the increase was 1,800 kw. in No. 3 and 3,000 in the No. 1 plant, while in 1910 No. 1 again received 3,000 kw. and the tramway station 5,000 kw.; in 1911 there were installed 3 turbines of 3,500 kw. in No. 3, and a turbine of 5,000 kw. each in Nos. 1 and 2. Thus in 1911, or last date of the report, the city had a total of nearly 60,000 kilowatts, in which steam turbines figure for 45,000 kilowatts.

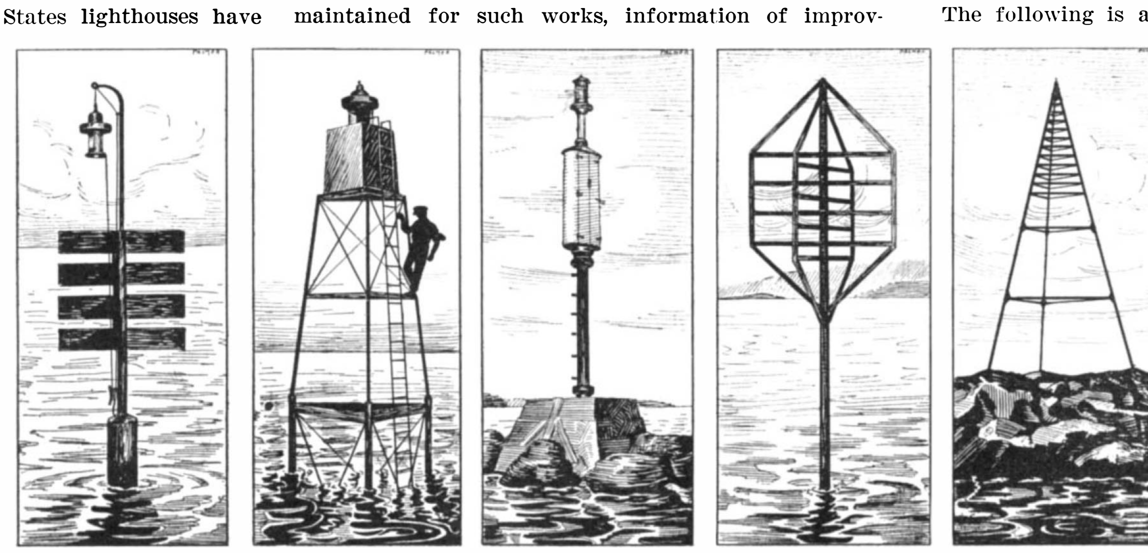
The United States Lighthouse Service—I

Its History, Growth and Methods

THE history of lighthouses in the United States dates back to 1715-16, when the first lighthouse on this continent was built at the entrance to Boston Harbor by the Province of Massachusetts. This light was supported by light dues on all incoming and outgoing vessels, except coasters. Several other lighthouses were built by the colonies, and, by the act of August 7th, 1789, Congress authorized the maintenance of lighthouses and other aids to navigation at the expense of the United States. These, 13 in all, were ceded to the General Government by the States. The Lighthouse Service of the United States is supported entirely by appropriations out of the general revenues of the Government, and the United States lighthouses have been free to vessels of all nations from 1789 to the present time. There is no system of light dues, as is the case in a number of foreign maritime countries.

Cape Hatteras lighthouse; 200 feet high; the tallest tower in the service.

The maintenance of lighthouses, buoys, etc., was placed under the Treasury Department, and up to 1820 was directed personally by the Secretary of the Treasury, except for two intervals when supervision was assigned by him to the Commissioner of the Revenue. In 1820 the superintendence of the lights devolved upon the Fifth Auditor of the Treasury, who was popularly known as the General Superintendent of Lights, and who continued in charge thereof until 1852, when the United States Lighthouse Board, consisting of officers of the Navy and Army and civilians, was organized, with the Secretary of the Treasury as *ex-officio* president of the board. The board selected from its own number a member to act as chairman.



Various types of beacons and small lights in sheltered waters.

The Lighthouse Service was transferred to the Department of Commerce on July 1st, 1903. On July 1st, 1910, the Lighthouse Board was terminated and the present Bureau of Lighthouses established.

DUTIES AND ORGANIZATION.

The Bureau of Lighthouses is charged with the establishment and maintenance of aids to navigation, and with all equipment and work incident thereto, on the coasts of the United States, the term "aids to navigation" comprising all land and sea marks established or adapted for the purpose of aiding the navigation of vessels, and includes light stations, light vessels, fog signals, buoys of all kinds, minor lights, and day beacons.

JURISDICTION.

The jurisdiction of the Lighthouse Service extends over the Atlantic, Gulf, Great Lakes, and Pacific coasts, the principal interior rivers, Alaska, Porto Rico, and Hawaii, and all other territory under the jurisdiction of the United States, with the exception of the Philippine Islands and Panama. In the Philippine Islands the lighthouse service is maintained by the insular government and supported entirely out of the revenues of the islands. At Panama the canal government has charge of the lighting of the canal and approaches.

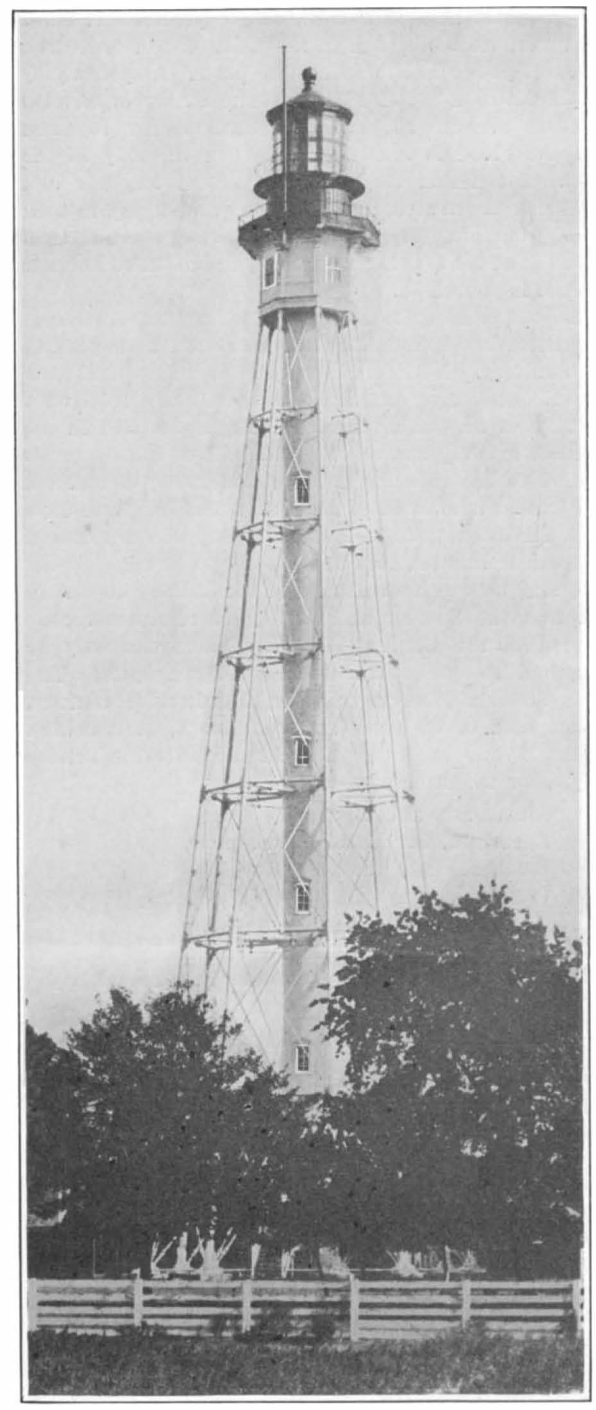
In the American Samoan Islands, the island of Guam, and Guantanamo, Cuba, the aids are maintained under the supervision of the naval commandants under allotments made from the appropriations for the Lighthouse Service. The Lighthouse Service also has supervision over the establishment and maintenance of private aids to navigation and the lighting of bridges over navigable waters of the United States.

At the present time the United States assists in the maintenance of but one lighthouse outside of its territory, this being at Cape Spartel, Morocco. This light is maintained in accordance with the convention between Morocco and the United States, Austria, Belgium, Spain, France, Great Britain, Italy, Netherlands, Portugal, and Sweden, in force since March 12th, 1867. The lighthouse was constructed at the expense of Morocco, but it is maintained by the other contracting powers. The annual appropriation by the United States for this purpose is $325, and it is not under the control of the Lighthouse Service.

The jurisdiction of the Lighthouse Service over rivers not included in tidewater navigation is restricted to such as are specifically named in the various acts of Congress. These now include practically all the important navigable rivers and lakes of the country.

CO-OPERATION.

In performing its duties, the Lighthouse Service co-operates actively with all other branches of the Government engaged in related work. Notices to mariners are issued jointly with the Coast and Geodetic Survey, and information affecting charts is supplied to that office for publication. Similar information is furnished the Lake Survey and other offices publishing charts. Co-operation is had with the Corps of Engineers, War Department, in connection with river and harbor improvements, as to special aids to navigation maintained for such works, information of improvements that will affect aids to navigation, the marking of river channels, lighting of wrecks, etc. The Public Health Service aids in matters of sanitation affecting lighthouse vessels and stations, the Bureau of Standards in the design of radio apparatus and in special tests, the Forest Service in the growing and management of timber on lighthouse reservations, the Steamboat-Inspection Service in the inspection of steam plants of vessels, etc. The Lighthouse Service supplies information respecting aids to navigation to all branches of the Government having need for this data and co-operates placing of buoys for special purposes.



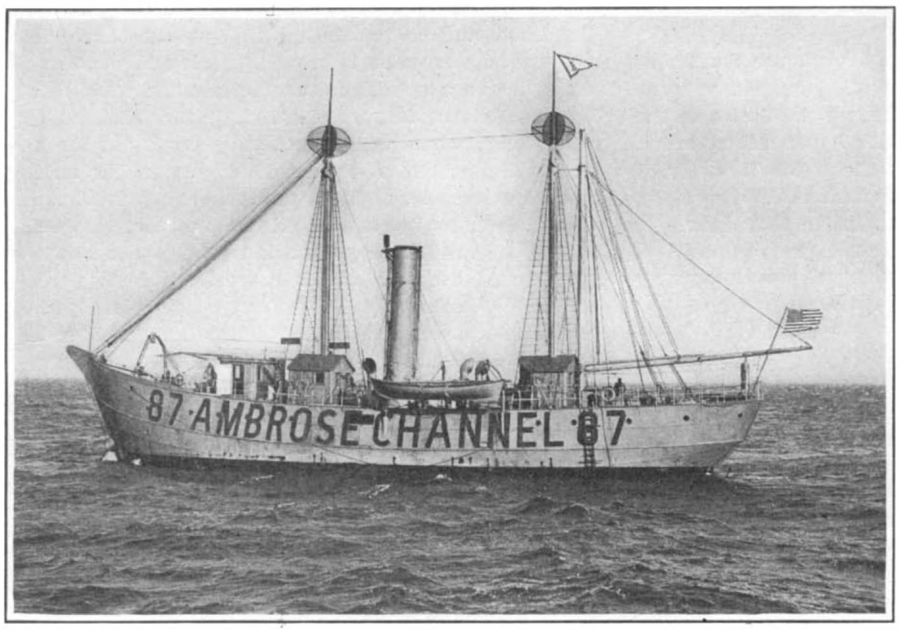
Cape Charles light, Virginia, 191 feet high, showing Iron skeleton construction.

AIDS TO NAVIGATION.

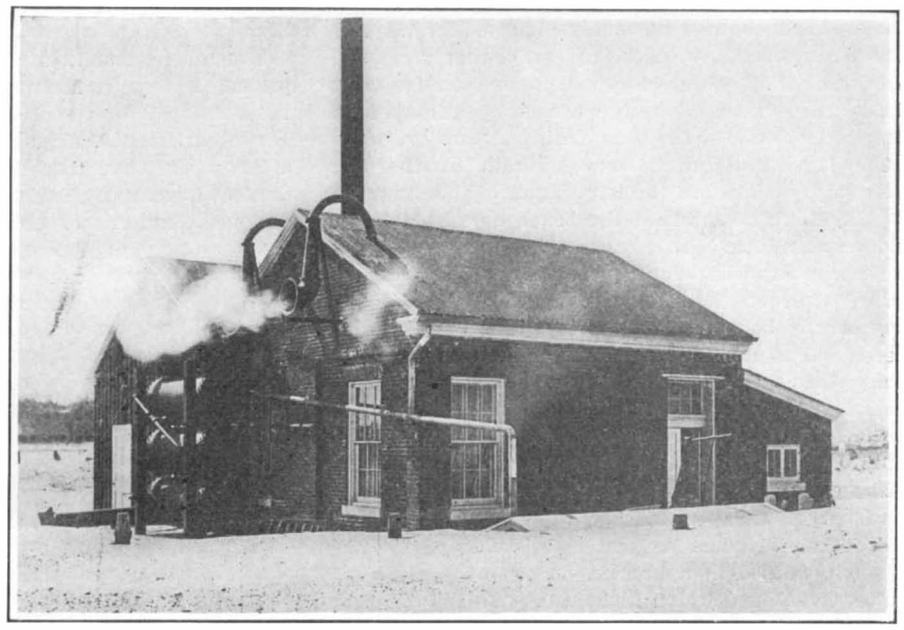
The following is a summary of the 14,544 aids to navigation, under each principal class, in commission on June 30, 1915.

The term "minor light" includes post lights and small lights generally not attended as a rule by resident keepers. These lights are usually cared for by persons living in the vicinity, who are not obliged to devote their entire time to the work and who sometimes have several lights, if conveniently located, in their charge. This type of light is commonly used on inland rivers and particularly on the Mississippi River and its tributaries.

Light vessels are used as a



A modern light ship, at the entrance to New York Harbor.



A siren fog signal, at Cape Henry, Virginia.

rule to mark offshore dangers, or the approaches to harbors or channels, where lighthouses would not be feasible or economical.

Lighted aids:	
Lights (other than minor lights)	1,662
Minor lights	2,837
Light-vessel stations	53
Gas buoys	479
Float lights	124
Total	5,155
Unlighted aids:	
Fog signals	527
Submarine signals	50
Whistling buoys, unlighted	86
Bell buoys, unlighted	237
Other buoys	6,488
Day beacons	2,001
Total	9,389
Grand total	14,544

Gas buoys are used to mark important channels or shoals or as general guides for navigation. Float lights are usually small lights borne on a float or raft.

Fog signals include various types of aerial sound-producing apparatus for use in foggy or thick weather. They embrace various types of whistles, sirens, or horns, actuated by steam or compressed air, and bells, operated by machinery of various types or by hand.

Submarine signals are auxiliary fog signals consisting of bells operated under water. They are commonly a feature of light-vessel equipment, but are employed also at some light stations or attached to buoys.

Whistling and bell buoys, as the names imply, are buoys fitted with sound-producing apparatus operated by the motion of the buoy in the sea. Whistling buoys are more efficient in rough outside waters, and bell buoys are more commonly used in harbors or inside waters.

Other buoys include cans, nuns, and spars of various types, and are the most extensively used of all aids. They are more frequently employed in channels and inside waters generally.

Day beacons include minor fixed structures not bearing a light. They are of various types, the most common being a post or spindle bearing a target or some other object of a distinctive shape and color.

The number of light stations, light vessels, and fog signals of the world, as listed in the British Admiralty List of Lights for 1915, is approximately as given in the table below. The statistics do not include the Great Lakes of North America nor rivers above the limit of seagoing navigation, and the lights are given in greater completeness for some countries than for others.

Continents.	Light stations.	Light vessels.	Fog signals.
Europe	7,335	192	779
North America	2,913	49	645
Asia	1,355	36	116
Australia and Oceania	746	3	21
Africa	519	0	10
South America	358	10	15
Total	13,226	290	1,586

The lists for 1915 show that the United States Lighthouse Service has under its charge materially more lights and fog signals than any other organization, and this would be numerically increased if there were included the lights on the lakes and rivers, and if all aids to navigation were counted, including buoys and unlighted beacons.

LIGHTHOUSE WORK IN ALASKA.

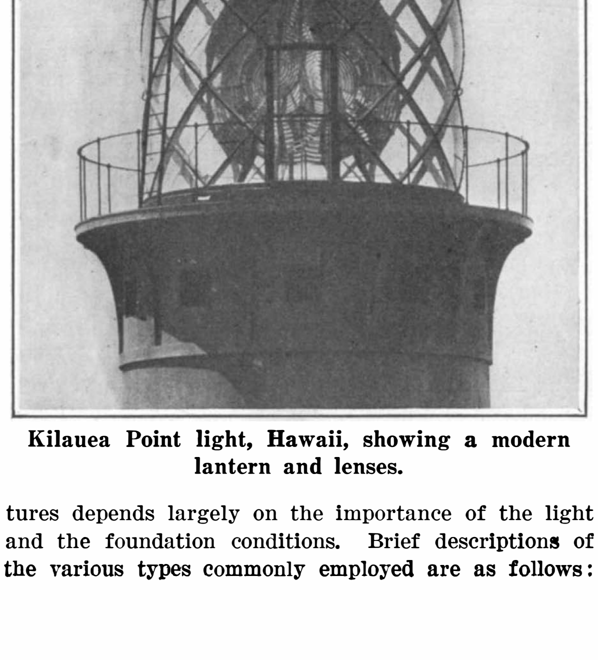
The first aids to navigation of the Lighthouse Service in Alaska were established in the Spring of 1884 (14 iron buoys) and the first light in June, 1895.

In 1915 there were in this territory 338 aids to navigation, as follows: Lights, 112; fog signals, 10; buoys, 167; daymarks, 49; a total of 338.

Minot's Ledge light, Massachusetts Bay, 102 feet high.
Modeled after the famous Eddystone light, and required five years to build.

TYPES OF CONSTRUCTION OF LIGHTHOUSES.

The type of construction adopted for lighthouse structures depends largely on the importance of the light and the foundation conditions. Brief descriptions of the various types commonly employed are as follows:



Kilauea Point light, Hawaii, showing a modern lantern and lenses.

Post lights are generally a single timber post, with a shelf or bracket for the lantern. In some cases ladders are attached, and to assist in identifying the aid by day, wooden wing boards for daymark purposes are frequently added. For similar construction in water, single piles, either timber or concrete, are used. A small service box for the lantern and supplies is often added.

Where the light is of more importance, framed timber towers have been used, built on proper foundations. Similar structures in water are generally of three or more piles, forming a cluster at the top. Recent improvements along this line include structural steel skeleton towers, also similar towers of iron pipe.

In addition to the foregoing types, which are principally adopted for nonattended lights, mention should be made of unlighted beacons, or daymarks. Some of these may be merely a pile or stake, occasionally with a pointer indicating the channel; others are timber structures of various designs, carrying a target or some other characteristic feature to attract attention; others are iron or steel spindles with a barrel or some form of cage work at the top, and some older types are monuments of stone. In some localities, particularly on rivers in California, where fog is prevalent part of the year, echo boards are used. These are rather long wall-like structures with projecting wings, to permit steamers obtaining an echo from their whistles in passing. These sometimes carry a post light on top of the board.

In case of attended lights where resident keepers are employed, which may be considered as lighthouses proper, there are also many types. A common form, frequently used for harbor or lake lights, is a combined tower and dwelling of timber or brick construction. Sometimes the tower only is of masonry, while the dwelling is frame. For the more important lights, the tower is detached from the dwellings and as a rule is of fireproof construction. Most of the older towers of this type are built of brick or stone masonry, with stairways, lantern, and other appurtenances of cast iron. Others of a more recent type have a structural open framework of wrought iron or steel, usually with an inclosed stair well in the center. In still more recent years reinforced concrete towers have been used and will probably be more extensively adopted in the future.

In the case of lighthouses on submerged sites the engineering features are important and often present great difficulties both in design and construction. Where the bottom is rocky or hard, the lighthouse is either built directly on the rock or on a pier. Two important lighthouses on the Great Lakes were built by constructing cofferdams, pumping out the water and leveling off the bed rock on which the lighthouse was built of cut stone, securely fastened. In other types, particularly on the Great Lakes, cribs filled with stone are placed on the bottom and capped with concrete or other masonry.

For submarine sites, where the bottom is sand, either a pile or caisson foundation is commonly employed. The caisson type usually consists of a cylinder from 21 to 35 feet in diameter, built up of cast-iron plates, and sunk by dredging or by the pneumatic process into the shoal until a firm bearing is attained, after which the interior is solidly filled with concrete.

In designing lighthouse structures, particularly towers, it is customary to assume the wind, wave, current, ice, and other external pressures at the maximum in each instance, as lighthouses are commonly exposed to severe

action from the elements. The superstructures are calculated in the manner commonly employed for chimneys and viaduct bents, with the exception that great stiffness and rigidity must be provided, as excessive vibrations are detrimental to the proper operation of the lamps and clocks of the illuminating apparatus.

The heights of towers vary according to the character of the shore and the importance of the light. On the Atlantic coast, where the beach as a rule is low and presents little relief, comparatively tall towers are required for the principal coast lights, while on the Pacific coast, which is generally bold and high, a low tower erected on a prominent headland is generally sufficient. The tallest tower in the service is at Cape Hatteras, N. C., and is 200 feet high.

LIGHTING APPARATUS AND ILLUMINANTS.

The earliest type of lighting apparatus consisted of an open coal or wood fire, with other inflammable materials, such as pitch, burned in a brazier, on top of the tower. When Boston Light was established, in 1716, the common oil burner of the period was used, inclosed in a lantern consisting of a cylinder of heavy wooden frames, holding small thick panes of glass. The illuminant was fish or whale oil, burned in spider lamps with solid wicks and suspended by iron chains from the top of the lantern. Sperm oil was in general use about 1812, and was burned in a lamp constructed on the Argand principal, with a rough reflector and a so-called lens or magnifier. This apparatus was inclosed in a heavy wrought-iron lantern glazed with panes about twelve inches square. By the year 1840 the useless bull's-eye "magnifiers" had been entirely removed, and the reflectors were made on correct optical principles, approaching the paraboloid in form, heavily silvered and properly placed. The lanterns were also improved by making the frames lighter, the panes larger, and by providing more adequate ventilation. To provide illumination all around the horizon, sets of from 8 to 20 lamps were used, placed side by side around the circumference of a circle. This arrangement, in its most complete form, is designated as the catoptric, or reflector system, and its relative merits as compared with the lenticular system originally devised by the French physicist Augustin Fresnel about 1822, was the source of much controversy in the years preceding the establishment of the Lighthouse Board in 1852. The first lens in the United States was installed at Navesink Light, N. J., in 1841, and is still preserved by the service.

The Fresnel apparatus consists of a polyzonal lens inclosing the lamp, which is placed at the central focus. The lens is built up of glass prisms in panels, the central portion of which are dioptric or refracting only, and the upper and lower portions are both reflecting and refracting, described as "catadioptric." The advantages of this system lie in the greater brilliancy owing to the fact that a large proportion of the light given out by the source is concentrated by the prisms into beams useful to the mariner, and the consequent economy in the consumption of oil or other illuminant employed.

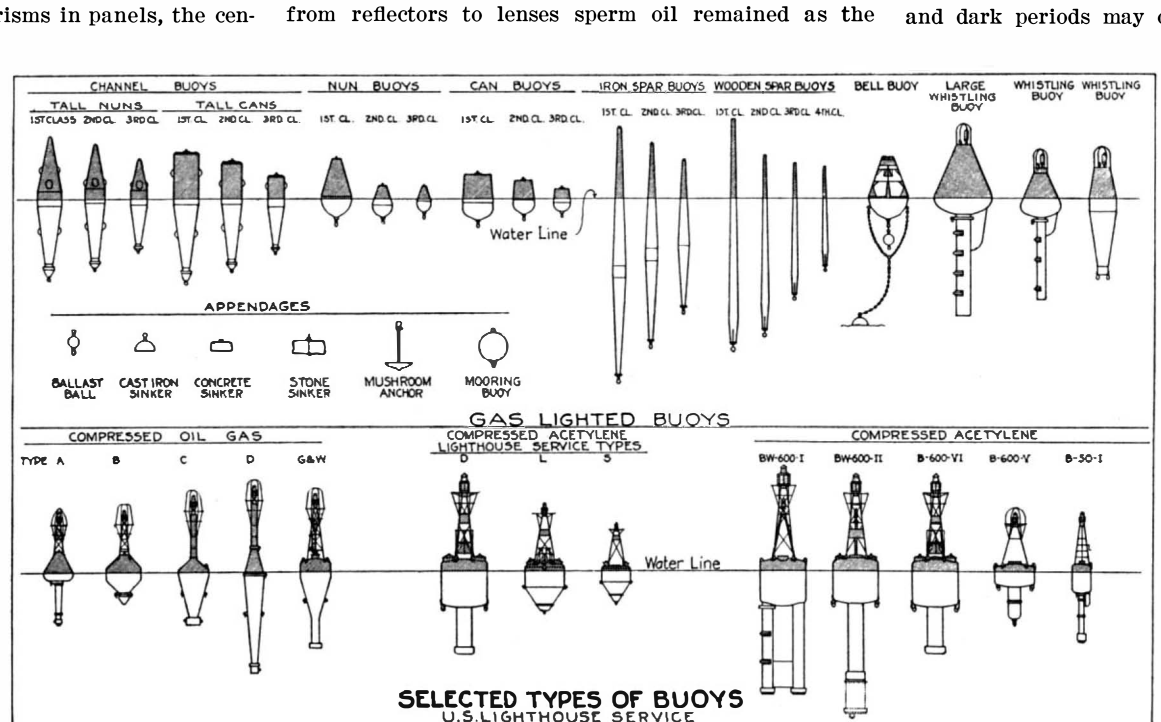
One of the first steps taken by the Lighthouse Board in 1852 was to install lenses generally throughout the Service in place of reflectors, and this change was practically completed in 1859. Lenses are in use at the present time at all important stations, with many subsequent improvements, however, in the design and arrangement of the panels. Improvements were also made from time to time in the lantern inclosing the lens, and the standard type now in use is of cast iron and bronze, with helical bars bent to the curvature of the lantern supporting lozenge-shaped panes of curved plated glass. These bars, crossing the beams of light diagonally, offer the least possible obscuration to the beams toward any point of the horizon.

The largest lens in use in the Lighthouse Service at present is that at Makapuu Point, Oahu, Hawaii, the landfall light for vessels bound from the States to the Hawaiian Islands. This is of the hyperradiant order, a larger size than those listed; the inside diameter of the lens is nearly 9 feet, and it is inclosed in a specially designed lantern of 16 feet inside diameter.

General lighting scheme of the busiest part of the Atlantic Coast in the neighborhood of Boston, New York and Philadelphia, showing how the radii of visibility overlap, as seen in clear weather.

Reflectors are also in use, particularly for range lights, which are frequently employed to mark the center line of a channel. For ranges two lights are necessary, and are placed a proper distance apart, usually with the rear light higher than the front, so that both lights show in line in the same vertical plane when the observer is in the center of the channel. Such reflectors are either silvered surfaces of metal in the form of a paraboliod, similar to head lights for locomotives or automobiles, or in improved forms of glass lenses with prismatic glass reflectors back of the light source.

During the transition period of lighthouse apparatus from reflectors to lenses sperm oil remained as the leading illuminant, but with the yearly diminution of the whale catch it gradually increased in price until its use became prohibitive. Colza oil was used in small quantities about 1862 and succeeding years, but during the period 1864-1867 lard oil was adopted as the standard illuminant, and was generally employed to 1878, when kerosene came into use. Its use was gradually extended, and by 1884 kerosene became the principal illuminant and so remains at the present time. The lamps used were also improved, passing through various styles to a special form of concentric wick, using 5 wicks for the largest sizes. The incandescent oil-vapor lamp, which is now generally employed for important lights, burns vaporized kerosene under an incandescent mantle, giving a much more powerful light with little or no increase in oil consumption.



Various other illuminants are now in use; oil gas is extensively used, particularly for lighted buoys; acetylene gas is used for lighted buoys and unattended lighted beacons; electric arc and incandescent lights and coal-gas lights are also used in special instances. Electric lights with distant control are employed in a number of cases where a reliable source of current may be obtained. Such lights may be on pier heads or structures built in the water, and can be easily operated by a switch on shore connected to the light by cable. A flashing characteristic may be arranged by means of an automatic make and break apparatus consisting of a small motor driving a clockwork and wheel with cams.

All lights on the seacoast, with a few exceptions, are exhibited throughout the year, between sunset and sunrise. On the northern lakes and rivers lights are exhibited from sunset to sunrise at all seasons when vessels can enter the ports or are navigating in their vicinity. Some of these lights, notably on Lake Michigan, are maintained throughout the year. The closed time varies with the seasons, generally embracing a part of December, January, February, and a part or all of March. Gas buoys and light vessels in these localities are replaced by unlighted buoys in the fall when endangered by ice conditions, and again placed on their stations as early as practicable in the spring.

DISTINCTIVENESS AND CHARACTERISTICS OF LIGHTS.

In order to avoid the likelihood of confusion between lights, endeavor is made to give the lights distinct characteristics. The original lights were as a rule fixed, but at the more important of these stations apparatus has now been installed to make the lights flashing or occulting. This effect is produced in the case of flashing lights by revolving all or a part of the lens, which is specially constructed with panels of prisms for concentrating the rays into beams; and in the case of occulting lights by some form of traveling screen or shutter which obscures the light at intervals. In either case the motion is regulated by a clockwork generally actuated by weights wound over a drum and provided with the necessary governing mechanism so that the light and dark periods may occur in accurate sequence and produce the proper characteristic. The usual phases so attained are as follows: Fixed, showing a continuous steady light; flashing, showing a single flash at regular intervals; fixed and flashing, showing a fixed light varied at regular intervals by a single flash of greater brilliancy; group flashing, showing at regular intervals groups of flashes; occulting, showing a steady light suddenly and totally eclipsed at regular intervals; and group occulting, showing a steady light suddenly and totally eclipsed by a group of two or more eclipses at regular intervals. The foregoing refers only to lights which do not change color, commonly white, but further diversification is obtained by the use of red screens, changing the color from white to red in various combinations, such lights being known as alternating. In the case of gas or electric lights, the supply of gas or current is cut off at intervals by specially designed mechanisms whereby the characteristic may be adjusted as desired.

The terms "flashing" and "occulting" refer to the relative durations of light and darkness, a flash being

an interval shorter than the duration of an eclipse, and an occultation being shorter than, or equal to, the duration of light. To assist identification in daylight, towers are frequently distinguished by characteristic painting, in addition to peculiarities of form or outline.

Under normal atmospheric conditions the visibility of a light depends upon its height and intensity; the distance due to the former being known as the geographic range, and to the latter as the luminous range. As a rule, for the principal lights the luminous range is greater than the geographic, and the distance from which the principal lights are visible is limited by the horizon only, and under some conditions of atmospheric refraction, the glare or loom of the light and occasionally the light itself may be visible far beyond the computed geographic range of the light. On the other hand, and unfortunately more frequently the case, these distances may be greatly lessened by unfavorable weather conditions due to fog, rain, snow, haze, or smoke. Weak and colored lights are more easily obscured by such conditions.

The highest light in the Service is at Cape Mendocino, Cal., the focal plane (or center of the light) of which is 422 feet above mean high water, thus giving it a geographic range of about 28 miles, under normal atmospheric conditions and with the observer's eye at a height of 15 feet.

The brightest light in the Service, and considered by some authorities as one of the brightest in the world, is at Navesink, N. J., on the highlands at the entrance to New York Bay, the candle-power of which is estimated at 25,000,000. The geographic range of this light is 22 miles, but its glare has been seen at a distance of 70 miles at sea under unnusual conditions of the atmosphere. This great intensity is produced by a powerful electric arc inclosed in a modern lens of high magnification.

(To be concluded.)

The Densitameter*

A Simple Balance for Determining Specific Gravity

By G. A. Shakespeare, The University, Birmingham

I HAVE adopted the above name for a simple balance for finding, without calculation, specific gravities of solids; and also for detecting small differences in specific gravity (such as might be due to flaws or blowholes in castings).

Four years ago, being asked by a manufacturer for a method of determining specific gravities (of samples of optical glass) which could be worked by a comparatively unskilled operator, I devised the instrument here described, which proved very useful in practice. Having since learned that there is a demand for such an apparatus, I give a description of it in case it may prove useful to others. The account here given applies to an instrument capable of dealing with samples of any weight between twenty and six hundred grammes (say one ounce to one and one half pounds), but it could, of course, equally well be made on a larger or smaller scale.

The Balance.—A steel strip 21 inches long, $\frac{3}{8}$ inch wide, $\frac{1}{8}$ inch thick, has knife-edges at its middle and near each end, as in an ordinary balance-beam, the central knife-edge being supported on a plane, and a suitable arrestment being provided to raise it from the plane when not in action. The left-hand end of the beam is pointed and moves in front of a scale attached to a mirror, which enables deflections to be observed with accuracy.

The left-hand end of the front of the beam is graduated in reciprocals of distance from the central knife-edge, thus: The lateral knife-edge, which is 10 inches from the central one, is marked 1, while the point five inches from the center is marked 2, the product of the number of any scale division and its distance from the central knife-edge being constant.

Weights.—Sets of weights are provided, each consisting of two of equal value, and others of $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, 1/10, e. g., two of 100 grammes, and one each of 50, 25, 12.5 and 10 grammes. One of the 100-gramme weights (called "the counterpoise") is fitted with two hooks, so that it can be hung on the right-hand knife-edge. All the others (called "compensating weights") are fitted with single hooks, so that any one of them can be hooked on to the beam at any point.

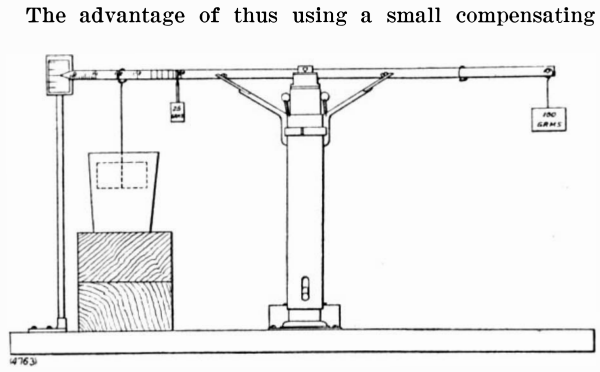
Method of Using.—*(a) Determination of S.G.*—Suppose we wish to find the specific gravity of a sample of some substance heavier than, and insoluble in, water —e. g., india-rubber—and that its weight is between 100 and 200 grammes. The 100-gramme counterpoise is hung on to the right-hand knife-edge so as to swing freely.

The specimen of rubber is attached by means of a fine wire to a loop of thin steel wire capable of sliding along the left-hand arm of the beam, which it embraces. The loop carrying the rubber is now adjusted by trial to a position on the beam such that on releasing the arrestment the balance is found to be in equilibrium. A vessel of water is now carefully raised under the hanging lump of rubber until the latter is completely immersed, and the vessel is supported by a block of wood. The up-thrust of the water, of course, destroys the equilibrium of the beam, but this can be restored by hooking on to the left-hand side of the beam the second 100-gramme weight and adjusting it until, on releasing the arrestment, the beam oscillates equally about the zero of the mirror scale. The specific gravity of the rubber is now read off directly on the scale on the beam.

*Engineering.

Theoretically, exactly the same procedure could be used for a piece of iron, lead, or platinum of the same weight, but in practice it is found better to use one of the smaller compensating weights. For example, for lead the ten-gramme compensating weight would be used (one tenth of the weight of the counterpoise), and as the specific gravity of lead is 11.37, the compensating weight would be found to be at the division 1.137 on the scale, and this multiplied by ten gives the specific gravity.

The advantage of thus using a small compensating



weight is that the part of the scale used is the more open part near the end of the beam, where not only is the compensating adjustment easier to make, but the position of the compensating weight can be more accurately read. Similarly for a specimen of aluminium the fifty-gramme compensating weight would be used and the number on the scale would be multiplied by two (i. e., 100/50); while for iron the twenty-five-gramme compensating weight would be suitable and the scale-reading would then be multiplied by four (i. e., 100/25).

If the instrument were intended to be used always for one particular class of bodies of nearly the same specific gravity (e. g., different kinds of brass), the scale could be numbered to give values directly, without even the simple process of multiplying by a small number. The degree of accuracy attainable by a comparatively unskilled worker is about one per cent, while a skilled worker can get results accurate to about one in one thousand.

(b) For Comparing Specific Gravities of Substances which are of nearly the same density.—Comparison can be made still more rapidly. For example, suppose some steel castings are suspected of having concealed flaws in the form of blow-holes. A sound casting of the same material is selected and hung by means of very fine wire to the sliding loop on the left-hand arm of the beam, and the suspected casting similarly hung to a similar sliding loop on the right-hand arm, the lighter of the two being as near the end of its arm as possible, and the heavier being adjusted to balance it. Both are now immersed in water (at the same temperature), and if the two are of the same specific gravity the equilibrium of the beam is not altered. If, however, the suspected casting has a small concealed blow-hole, its average specific gravity will be less and on immersion it will appear lighter than the sound one. In the same way it is easy for an unskilled person to distinguish between gold of different degrees of purity.

In the apparatus described 1 centigramme placed at the end of the beam produces a very appreciable deflection. Suppose the steel casting weighs about 80 grammes, it would displace about 10 grammes of water, and a blow-hole of volume 1/100 cubic centimeter would be detected with ease. If the specimen weighed about 800 grammes (say 2 pounds), a blow-hole of about 1/10,000 of the volume of the casting could be detected.

The back of the beam is divided from the center into inches and tenths. This enables specific gravities in cases such as that just described (i. e., when small differences from a standard are to be determined) to be compared with a high degree of accuracy. Let us suppose, for example, that specimens of an aluminium alloy are to be tested for being up to a particular standard of specific gravity. A sample of the standard is made. Suppose it is of 2.7 specific gravity and weighs 270 grammes. It will then displace 100 grammes of water. Let this be hung on one of the knife-edges and the sample to be tested be suspended and balanced as before described. Then, on immersion, suppose the equilibrium is destroyed owing to the sample being slightly less dense than the standard. A weight of one gramme can now be slid along the beam as a "rider" until equilibrium is restored (provided the difference of density is small enough). Suppose this occurs when the gramme weight is 5.2 inches from the center; this implies that the specific gravity is about 5.2 parts in 1000 less than that of the standard. If it is denser than the standard, the rider must be placed on the other arm of the balance. Thus 1/10-inch movement of the rider corresponds to a difference of specific gravity of about 1/10,000.

Points Requiring Care.—It is, of course, important that air-bubbles should not cling to the immersed body. Iron has a marked tendency to collect air-bubbles, but I have found in practice that a previous immersion in methylated spirits greatly diminishes the troubles arising from this source. Boiled water also is advantageous as being much freer from dissolved air than water drawn directly from a tap. For very accurate work it is important that the temperature of water on the two sides in (b) should be the same, and that in (a) not much above 15 deg. Cent.

The adjustment of the position of the sample to be tested requires a little skill, especially if this be much heavier than the counterpoise. I find that it is advisable to use a counterpoise not less than half the weight of the sample; the nearer the weights of counterpoise and sample the easier the adjustment. It would be easy, however, to get over this difficulty, if desired, by moving the carrier by means of a screw running along the beam from which the sample was to be suspended, but the extra complication would not be worth while unless accurate results were required from an incompetent worker, and it is always better to educate the worker than to complicate the apparatus. An arrangement of the kind, however, would probably be necessary if the instrument were to be designed to deal with very heavy castings—some hundredweights or tons, for example.

The densitameter could evidently be arranged for use with solids lighter than water if required. There is no point in applying it to liquids, since ordinary immersion hydrometers are much simpler for this purpose. The accompanying figure shows the general appearance of the instrument described. The method of dividing the beam is, however, only indicated. The specimen on the beam is a piece of steel.

Agricultural Production of the U. S., 1915

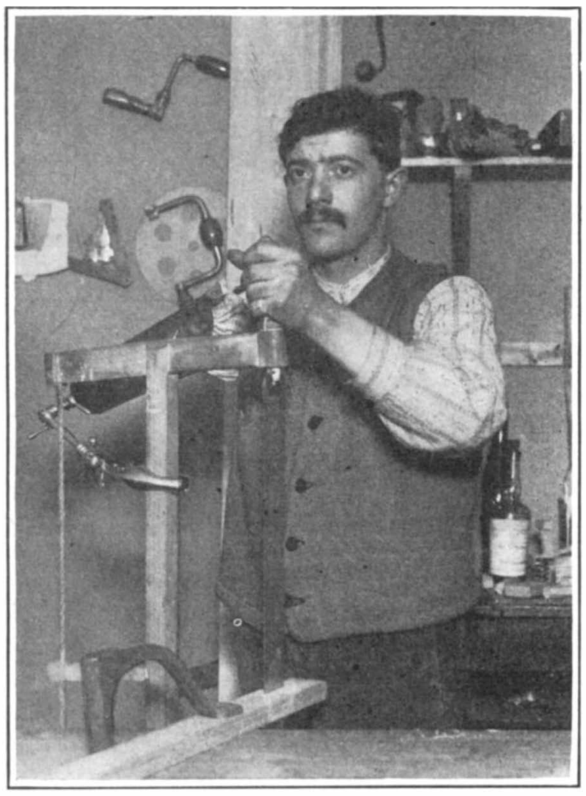
ACCORDING to the *Pacific Rural Press*, the last harvest seems to have been a record one. The following figures, given by that journal, show the totals of the different crops harvested this year:

Description of Crop.	Quantity.	
Winter wheat	685	million bushels.
Spring wheat	206	" "
Maize	2,673	" "
Oats	1,141	" "
Barley	195	" "
Rye	43	" "
Buckwheat	17	" "
Potatoes	406	" "
Tobacco	1,035	million pounds.
Hemp	16	" bushels.
Hay	70	million tons.
Apples	253	" bushels.
Peaches	54	" "

The Care of the Wounded in France

Methods and Instruments for Aiding Men Who Have Lost Hands or Arms

At a gathering held recently in Paris, under the presidency of M. Painleve, Minister of Public Instruction, for the discussion of plans looking to the formation of a general organization to take complete charge of the work of physical and industrial rehabilitation of the "ampulés" and "mutilés"—soldiers who have lost limbs or been otherwise incapacitated for resuming their ante-bellum occupation—a lengthy address of great interest was given by Prof. Jules Amar. Dr. Amar, whose name has appeared in the Scientific American *on more than one occasion in connection with accounts of artificial arms and hands, has been connected in an official capacity with the work of prosthesis from the very first. His combination of theoretic insight and practical ability has enabled him to achieve brilliant results; and we believe that his remarks will be of greatest interest to our readers as indicating the present status of this extraordinary branch of surgical science. Dr. Amar spoke as follows:*



Operating a saw with Prof. Amar's mechanical arm.

A grave problem was laid upon the national conscience when it became necessary for it to occupy itself with the question of occupation for the mutilated heroes of this great war. I shall not undertake to recount all that has been done, alike in France and among our allies, in the effort to find useful work for these men. But the hour is now come, I believe, to organize the business of caring for the future of the wounded so that each may take his proper place in the social machine, contributing of his best to its functioning, and thus aiding in the general march toward prosperity.

The object of this organization is the rational utilization of human capacities. In dealing with employment for the wounded we are facing, of course, a question in its essence scientific and technical; but we must not overlook that it pertains also to the social order of things, where are mingled, in proportion I do not feel competent to define, legislative factors, and elements political in the highest sense of that word. For upon the solution, let us not forget, depend both the material and the moral prospects of many thousands of French families, constituting a considerable item in the economic rehabilitation of our country. We wish to stimulate labor, whether industrial, commercial, or agricultural, so that there may be in no manner a loss or waste of potential energy. Our national wealth is the stake.

The resources in energy which would be brought to the nation by a completely successful effort to evaluate and strengthen the professional aptitudes of all wounded soldiers by a course of methodical re-education, with a view to immediate employment, are far from inconsiderable. It is not enough to know merely that 80 per cent of these men are to some extent re-educable and capable of resuming a place in the social structure. We want no makeshifts or misfits; we want each man to know that his new place in the national fabric is surrounded by all the guarantees which go to make it, like his old one, a durable thing, with satisfaction to himself and all concerned.

And let us not be deceived by sad appearances. The *mutilé* possesses always a perfectly utilizable capacity for some kind of work; he represents a value, occasionally even an integral one. For he may actually compensate for his physical deficit by an active good will which increases his social value. This is a psychologic fact which must be turned to advantage. Do not imagine, gentlemen, that any enthusiasm on my part affects the impartiality of my judgment. Our wounded soldiers, among whom I have practiced for 15 months, are as admirable in the works of peace as they are every day in the exploits of war. Their spirit is excellent, their sang froid remarkable, their courage and decision leave nothing to be desired. Never do they refuse to listen to an authoritative opinion. Let us then do them the justice of striving to assure them an existence worthy of their sacrifices; let us bend every effort to save these noble conquerors from becoming conquered.

Few indeed are those who mistakenly seek to capitalize their disabilities by demanding material assistance, who would willingly accept degrading support in idleness instead of the work which is the only regenerator. Those superlatively unfortunate to whom no other alternative is open know what the Minister of the Interior has accomplished for them in the domain, proper to him, of relief. But the great majority, that is to say the re-educables, await a concerted effort of scientific supervision which shall direct them along fixed pathways into the professions for which each one is most exactly fitted.

Now this demands an efficient method, a studied programme of action. I thank the Committee of Assistance to the Wounded for having extended to me the privilege of addressing you and adding my little twig to the diverse branches of the general structure you are to erect.

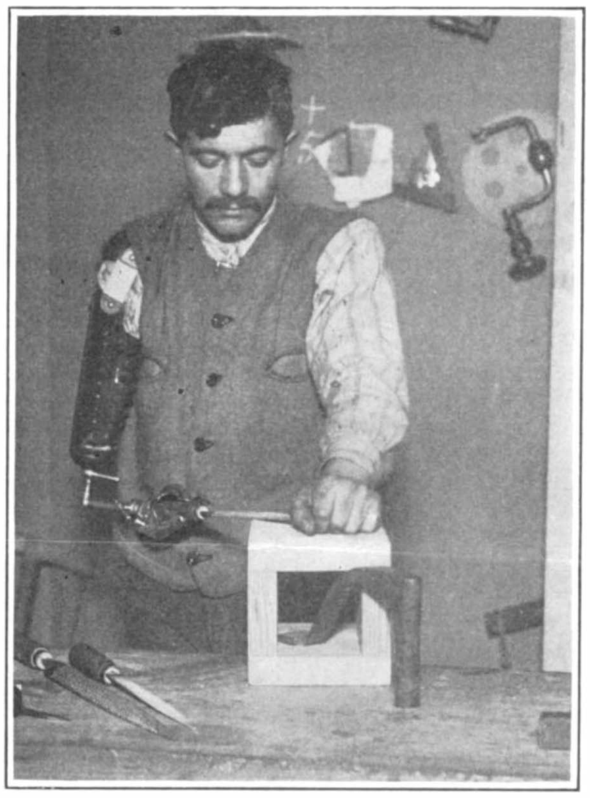
In my opinion, this business of providing occupation for the wounded ought to fall into three periods. In a first period, that of *functional re-education*, we are concerned with analyzing the movements of the individual in order to determine his precise functional condition, with restoring, so far as possible, his impaired psycho-motor powers, and finally with assuring that a prolonged exertion shall have no unfortunate effect upon his organic resistance. In a second period we should set ourselves the task of making good, by means of an orthopedic system, the patient's physical deficiencies, adapting to each mutilation the appropriate prosthetic appliance. After this is done begins the professional re-education, properly so-called, which constitutes the third and last period.

It is clear that those wounded who are but slightly impaired, or who are susceptible to immediate orthopedic treatment, may resume without delay their old occupations. When a radical paralysis, for example, has suspended the action of the extensor muscles of the hand, permitting the latter to fall inert, it suffices to restore this organ to its normal condition by means of a small aluminum brace, thus retrieving its ordinary strength and power of movement. The subject at once regains all his professional value. I have had most interesting cases of this character. But when the disability is very great or very extensive, when it defies all direct re-education and all simple mechanical aid, it becomes necessary to consider a change of occupation.

Canet model of Prof. Amar's articulated hand.

Whatever the good judgment brought to this question of change of profession, with the total loss of an experience laboriously acquired, a re-apprenticeship is occasionally necessary. This remark applies with especial force to those who have suffered amputation of an arm.

Let us review rapidly each of the three periods of re-education. In the functional period, the concern is with the subject's psycho-motor condition, as revealed by the play of those joints and muscles over which he has command. It is necessary to combat stiffness alike of muscles and of joints themselves, and even certain forms of ankylosis, or bone-adhesions; to relieve muscular atrophy; to restore tendons and cartillages to a normal state of softness or suppleness; to stimulate local nutrition and cellular vitality. This physiological preparation demands of the patient a progressive increase, by insensible gradations of effort and of rapidity of movement. At the same time, his every motion is carefully analyzed for irregularities, and minute observations made of the rhythm and precision attained, and the distribution and intensity of each component force. These diverse factors all contribute to good results when the patient finally gets to actual work, and they are always valuable guides to the intelligent application of mechanical therapy. The greatest share of time and attention is bestowed upon the functional readjustment of the hand.



Using a file with the aid of Prof. Amar's mechanical arm.

To effect all these observations I have set up certain precise but uncomplicated instruments, whose use has given the greatest satisfaction. They have been described in the public prints, so I shall be content with throwing them upon the screen before you. [*Lantern slides were here shown of the ergometric cycle, the chirograph, and the dynamograph, whose names indicate sufficiently their purposes. All three make a needle record upon a revolving cylinder or a flat sheet.*] This technique has the advantage of appealing to the eye and of being nevertheless exact; it affords a graphic register permitting visual evaluation of the muscular force and visual note of its increase as treatment progresses. It shows at every moment the exact progress in the functional re-education.

Among the *amputés* the stumps, almost always atrophied by a long sojourn in a convalescence depot, are developed and strengthened, and the scope of their movements enlarged. The most favorable conditions must be attained before the application of the prosthetic attachments, which are usually of very considerable weight.

Other items must be considered in the functional diagnosis. The senses may have suffered depreciation, especially those of sight, touch and hearing—for the latter various courses of auditory re-education are open. Then, too, the heart, lungs and nerve centers are not

always in shape to support conditions of intense muscular activity. It is necessary to discover such organic defects, in order to remedy them when possible, and in any case in order to estimate fairly the degree of physical power of the individual.

When I say that re-education has a physiological basis, I refer to all these fundamental preliminaries, and I express a truth which can be ignored only with uncertainty and peril. Before giving a *mutilé* his prosthetic outfit, before consigning one of our wounded men to store or office or shop, it is indispensable to have attained a maximum amelioration of all his functional abnormalities and to have brought to the highest possible point his resistance to fatigue. The utility of such efforts is testified to by employer and employee, and the results are such as to inspire in them that confidence in science as the highest form of social economy which the latter so richly merits but so often fails to get.

Let us now approach the question of prosthetic apparatus, the one of greatest importance among all those embraced in professional re-education. Our surgical manufacturers must make every effort better to harmonize their appliances to the work to be undertaken by the wearers. Prosthesis has not for its goal the replacement of a missing *member* or part of a member, but the replacement of a *function* entirely lost or seriously impaired. If by definition it is anatomic, in fact it is physiological and utilitarian. Always copying from nature, it is yet not her slave, because it is obliged to proportion weights and dimensions of its attachments to the muscular strength at the patient's command. I set forth in three propositions the scientific aims which should govern this matter.

I. To furnish prosthetic appliances which may be securely attached without inconvenience to the movements involved, or to other articulations.

II. To proportion these to the strength of the stump.

III. To furnish, with artificial upper limbs, an organ of prehension capable of long and varied use.

This triple condition guarantees the solidity, the simplicity, and the service of prosthetic appliances. There results from them a better utilization of the potential human energy of the amputé, and that in professions to which it had seemed he would never find access. I do not believe that I am too forward in thus declaring that our orthopedists of to-day no longer hesitate before this problem. The Under Secretary of State for Public Health has constituted a Research Laboratory which exercises a technical supervision over inventions in this field, in addition to subjecting appliances of old models to the transformations necessary to fit them for actual work; so that at the present moment French orthopedy is in a state of actual progress, and our wounded are much better provided for than at the beginning.

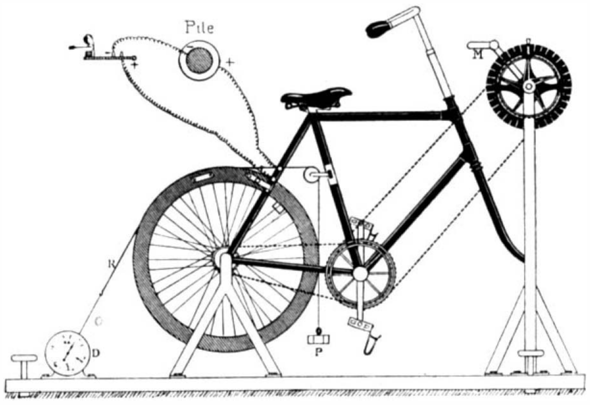
Working arms, for instance, of very solid construction, assure to them great advantages, as much in executing their movements with ease as in gripping well their tools or whatever other object may come to hand. To this end the fore-arm is made of a steel bar jointed at the elbow, and the hand consists of a simple, automatic, universal pincers, which at the end of the day's work can be replaced by a more elegant dress hand attached to a sheath of leather that fills out the sleeve in lieu of a fore-arm; the whole meets every practical and esthetic demand.

I have constantly encouraged such inventors as have communicated with the laboratory, either for consultation or to work out there an idea which appeared worth while. It is in this way that, after several months of research and with a special installation prepared under my supervision, one of these has constructed an articulated hand which has given complete satisfaction, being superior to all those, domestic or foreign, which I have seen heretofore, and of very moderate cost. This hand is clearly indicated for all liberal professions. [*An amputé equipped with it here executed before the gathering a series of the ordinary manual evolutions of life, lifting a glass, tipping his hat, playing the violin, and performing certain technical tasks such as boring, planing, etc.*] I have had opportunity, on the other hand, to examine numerous high-priced hands *de luxe*, of German or German-American origin, and have found them all notably inferior to the French model you have just seen. In an entirely similar way, among our better French orthopedists, improvements already appreciable are under way in the structure of artificial arms and legs. The very near future will demonstrate the reality of this progress, at once in the directions of elegance and utility.

It would have been indeed extraordinary if, in this country, where prosthesis had its birth, to which in all times knights who had lost their hands in battle came to get them back, as it were, from our specialists, often small locksmiths and members of other skilled crafts—it would have been, I say, very surprising if the ingenuity of our savants and our mechanics had not been brilliantly manifested in this domain, the meeting-place of art, science and humanity.

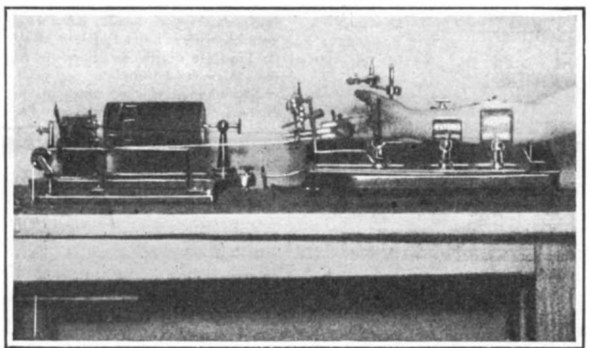
Re-educated functionally and supplied with prosthetic appliances—arm, hand, jointed foot, leg—the mutilé will with profit undergo a course of professional re-education. It is then that the analysis of all the physiological and mechanical factors of work becomes decisive.

With the physiological point of view always in mind, the conditions of speed and effort demanded and the length of the working day are carefully fixed so as to



The "Ergometric Cycle," designed to furnish appropriate exercise for the *mutilé*, and to record on the dial the effort of which he shows himself capable.

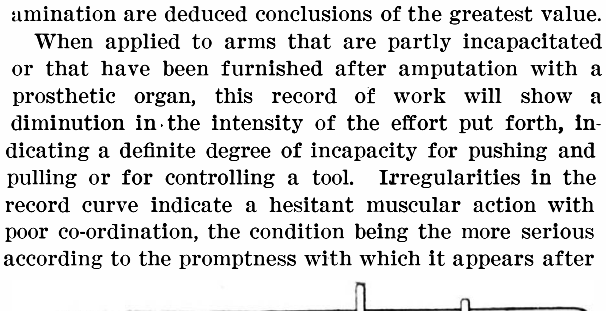
enable the wounded man to give a maximum return. The method consists in making the tools he uses themselves record their movements and the muscular efforts which put them in action. The intensity of the latter is then measured, together with the extent in time and in space of each action. The implements of every profession are easily made to serve as recorders of work (dynamographs)—file, hammer, plane, typewriter, pencil, it matters not. The analysis made of the data thus obtained lets escape no detail whose cause could be a hidden weakness, a bad prosthesis, or an inability of the



The "Chirograph," by means of which injured fingers are restored to usefulness and a record made of their tensile strength from day to day.

subject in any direction. From this circumstantial examination are deduced conclusions of the greatest value.

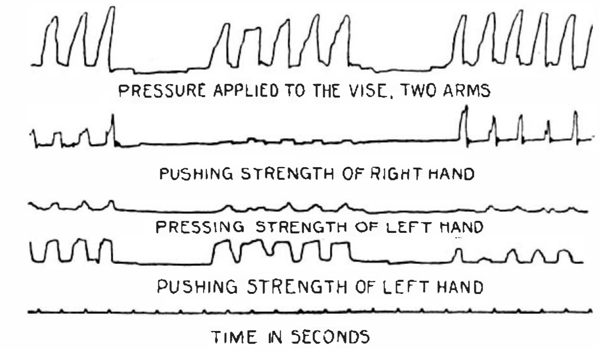
When applied to arms that are partly incapacitated or that have been furnished after amputation with a prosthetic organ, this record of work will show a diminution in the intensity of the effort put forth, indicating a definite degree of incapacity for pushing and pulling or for controlling a tool. Irregularities in the record curve indicate a hesitant muscular action with poor co-ordination, the condition being the more serious according to the promptness with which it appears after



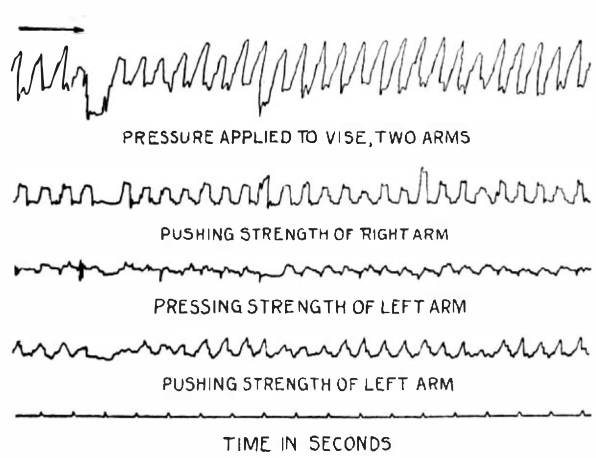
Plan of the "Chirograph." The fingers are inserted in the clamps *e*, which can be moved by adjusting the screw *d*; the fore-arm is held rigid by the bracelets *a*, *a'*. The registering mechanism appears in the accompanying view.

the beginning of the test. When this tendency, however slight, is not curbed by an artificial member, the dynamographic curves of the given subject are all similar, assuming a personal, individual character. The experiments are continued, verifying the advantages of this or that modification in the construction of the prosthetic appliances and the method of their attachment and use—now to seize and direct the tool, now simply to sustain and support it—until the needs of the patient are completely and satisfactorily met.

I say that the artificial arm ought in general to serve to sustain, leaving the effective work to the other and natural arm. This works out naturally in the case of amputation of a left arm, the right retaining its normal condition of activity. But in the contrary case it is necessary to re-educate the subject entirely so that the



Graphic comparison of the efforts of a normal subject and of infirm patients in manipulating a large file. The left hand section of each curve shows the record of the normal subject; the central segment that of a man whose right arm has been weakened; the right hand part that of one with damaged left arm.



Graphic demonstration of the effective re-education of a filer who had received a fracture of the left wrist.

left arm shall acquire the strength and address of the amputated member. Thanks to having hit upon a very suitable implement—the registering jack-plane—I have succeeded, in three or four weeks, in making plenty of perfectly good left-handers, working, writing and playing correctly with the left arm.

Parallel to this series of observations, I pursued another line having for its goal the measuring of the respiratory changes, from which may be deduced the degree of fatigue of the wounded. There is revealed by study of these results either a waste or a conservation of energy at some point of the body or of the tool or of an artificial member. From such studies are drawn extremely valuable pointers alike for the apprentice and the skilled worker, a veritable object lesson indeed for the workman who chooses to observe and seek the light. The example thus brought out, graphically and yet impersonally, possesses in his eyes a sovereign virtue, carrying him far beyond the point at which he is left by written or oral explanation.

I do not unduly emphasize the other physiological factors, such as height and weight of the subject, the state of his reflexes, the speed, greater or less, of his reactions. These are individual constants pertaining to the initial state; and they should be given their proper weight as a guide in the method of re-education, and more especially in the choice of a trade. Physiologically, then, the wounded man receives an education which pays attention to his muscular effort and his speed of action, disciplining his movements and applying them to precise operations which have been worked out in full detail. All superfluous fatigue, all waste of time and energy, are thus avoided. This economy, and the patient's address and competency to work, are always increased by the intelligence of the latter, which, if it has not previously been awakened, should be so by theoretic instruction given during the period of re-education.

All the subjects, physical and mental resources, are in this manner made known and incited to act. The mechanical factors of the work then alone remain to be considered. These have to do with choice of tools, use of machines and power, and the special apparatus which in factory and shop places the *mutilé* in a professional status favorable to the good utilization of his services.

Mechanical perfection always gives results worth while. By a simple invention a maneuvre which has always demanded the use of two hands can be effected with a single one and occupy a large number of *mutilés*. Another operation, in which the contribution of the machine far surpasses that of the man, would accomplish the same result. I would mention as example an

automatic punch upon which I have passed at the request of the Minister of Public Works. It is designed to punch railroad and subway tickets with the use of a single hand; it is simple in construction and operation, and reasonable in price. Further progress in this direction should be stimulated, by prizes, if necessary.

I cannot here cover all the experimental data which may eventually serve as aids to the industrial relocation and re-education of the wounded. I have so often treated the matter in writing that it is no longer a secret from men attentive to the progress of science.

The balance of Dr. Amar's address was given over to a discussion of ways and means for furthering the projected organization, and is omitted as of insignificant general interest.

We are indebted to *Le Genie Civil* for the illustrations of the instruments referred to by Dr. Amar, together with the dynamographic records.

Growing of Drug Plants in the United States*

Conditions Necessary for Success and Profit

By L. Wayne Arny

Drug plants are wares in which we all have a most vital interest, and as consumers of them, we are entitled to know by whom they are being produced and under what conditions. Any less satisfactory arrangement would jeopardize the accuracy of the pharmacist's work and render the physician's critical profession less dependable.

There is, of course, a very picturesque side to the business of producing plants with which to cure human ills. It appeals to our sense of the fitness of things very much more strongly to be able to grow these products, than to have them collected by laborers whose sole ambition is to gather a maximum number of pounds during certain working hours, and whose only care regarding them is to have them delivered to market safely. But the problem is a much more complicated one than those who are impelled more or less by humanitarian reasons often realize, and it is only just, both to ourselves, who must trust our lives to these herbs, and to the man who contemplates investing a part of his fortune in the production of them, to view the situation carefully from both sides, to see, if possible, whether this is just as wise a step as at first thought it appears.

First, let it be known that on a basis of pounds of crude drug laid down at the doors of our American markets, we could not compete with the European producers. It is the same old story of cheap labor. We, with our extensive greenhouses, our intensive cultivation in which much hand labor forms an expensive part and our luxurious way of doing things, must be able to deliver our produce to New York at the same or less price than the European broker who receives the goods from the hands of peasants working under conditions of the strictest economy, and living on a scale of which we Americans are wholly ignorant (or to which we are possibly indifferent). Hence the man who says to himself, "Belladonna is now selling for one dollar per pound, and I can produce possibly a ton; there must be money in that—I will grow belladonna," is comparable to the fellow who speculates in wheat or quinine. Such a man is doomed to financial failure. There is no reason why a manufacturing pharmaceutical house would purchase his belladonna rather than that imported. There would be nothing distinctive about it.

The popular idea is that there is an unlimited market for crude drugs. Drug stores are numerous and they all carry drugs, and hence the consumption of drugs must be enormous! But the public is careless about looking at the matter from a business point of view. Last year about one hundred acres were planted with belladonna in this country. This year there are about two hundred acres, each acre producing an average of three hundred pounds of leaves of just belladonna; not better belladonna, or more potent belladonna, or cleaner belladonna, but just belladonna. Consider, then, the prospects for the future of a crop when two hundred acres will probably produce a satisfactory yield when there are about one hundred million acres planted to corn in the United States. Our optimist will then say, "But look at the price of belladonna to-day." And we will have to remind him that the great European war will some day be over, after which we will have added to the production of our two hundred acres of just belladonna the normal importation. Surely, an outlook to shake the faith of even an optimist!

Hydrastis canadensis offers a somewhat more hopeful promise, although the limited market aspect remains unchanged. This plant is indigenous to the woods of America, and hence is not imported. Ten or fifteen years ago the dried root sold on our market for thirty cents per pound, while to-day it brings about four dollars!—the result of wasteful methods of collecting and a wanton disregard of the laws of conservation. But who knows how to grow hydrastis? Surely not the farmer nor the suburban garden lover, nor yet the pharmacist. There are a few men who make a business of growing hydrastis, and who are considered authorities concerning its culture. But compared to the rose expert or the grower of carnations the would-be hydrastis grower is childish in his methods—he doesn't know.

Hence, from the viewpoint of present financial opportunities, advisability and desirability of growing medical plants, an impartial survey of the situation will not encourage the prospective drug grower toward the investment of capital or effort.

But there is another phase of the question which should stimulate every man who is on friendly terms with plants. The experimental side of drug growing must appeal to the man who seeks investment, for it is only by working out many experimental problems that a sane industry may be built in this country. Experimentation is the only way by means of which better drugs may be produced; and the man of science is glad to find a channel for his efforts which will lead to the advancement of one of the oldest and noblest of sciences—medicine. To put this in another way—the growing of drug plants offers unlimited opportunities. Not, however, in the mere production of native plants, but in the production of crude drugs of high and uniform alkaloidal content, free from adulterants and capable of continuous standardization. This is experimental drug growing, and opens one of the most interesting chapters of biological research—the improvement of hereditary characters by means of horticultural technique.

The plant atropa belladonna, commonly known simply as belladonna, is one of the most widely used drug plants which may be grown in the temperate zone, carrying as it does the drug atropine. It is typical of many others so far as hereditary characters go and will be used here as an illustration. The leaves of the first year plant and leaves and roots of the second year plants are used. It is particularly desirable to improve this mydriatic drug since the native supply during the last few years has been far from satisfactory, regarding quality.

The leaves from five belladonna plants were assayed for alkaloid with the following result: Plant No. 1 contained 0.324 per cent of alkaloid; plant No. 2, 0.329 per cent; plant No. 3, 0.701 per cent; plant No. 4, 0.841 per cent; and plant No. 5, 0.918 per cent.

From these figures it is obviously possible for plants to contain 0.918 per cent of alkaloid, and probably much more than this. Hence, so long as this is possible, there is no excuse for the production of plants containing only 0.3 per cent, and the problem becomes one of plant breeding, or a raising of the whole range of figures to approximate to the theoretical point where the entire crop gives a maximum yield of alkaloid, with minimum variation.

The plant breeder possesses two means of attacking such a problem: One, hybridizing or crossing one species with another; and by selection, or the continual propagation of desirable individuals. The crossing of species, varieties or individuals has given but little desirable result so far. There has not been nearly enough work done along this line, and a definite statement cannot be made until the subject is exhaustively investigated. But so far, results with this method have been disappointing. If two characters were involved, such as color of flower and alkaloidal content, it is probable that positive results could be obtained.

We should at least be familiar with the manner in which many plants behave when hybridized, and to do this we must know something of the theoretical tendency of hereditary characters. Here we are dealing with a most profound subject, one which abounds in hypotheses and theories. It is generally recognized, however, that characters are represented in the germ cell by definite bodies which pass from one generation to another unchanged. Hence, an individual possesses all the character factors of its parents which in turn possessed the character factors of the race—an endless combination of millions of tendencies, most of which are recessive and never appear, and a few of which are dominant and comprise the exhibited personality of the individual. The passing of character factors from two parent individuals to an offspring is a marvelous complexity of countless numbers, all sifting down according to the mathematical laws of chance to represent the equation 3 : 1.

To make this clearer, we will assume that a plant having high alkaloidal content is crossed with one having many leaves. The seed from the resulting hybrid will produce plants in the proportion of 1 with high alkaloidal content, 1 with many leaves and 2 with both many leaves and high alkaloidal content or 3 : 1 as far as visible characters are concerned. During the second generation from the first hybrid or the F_3 generation, there is a marked tendency toward atavism or the breaking up of type and a return to the parental characters. There will, however, usually be enough individuals which remain pure to the type to propagate from and thus fix the desired characters.

But selection has thus far given much more satisfactory results in the improving of drug plants than has hybridizing. Selection is, as the name implies, characters to carry on the species. Simple as the simply selecting individuals possessing the desired method at first seems, it is fraught with difficulties and problems. The chief obstacle to success is the fact that comparatively few people possess enough judgment or keen enough observation to choose the plants that they really want. To simply walk through a field and select a plant as one having desirable characters is generally futile. Accurate measurements must be made. To reduce this selective method to a tangible and workable basis a card system is employed which solves this problem.

The belladonna seed is sown in the greenhouse in January. When the seedlings are of workable size they are potted and given very careful treatment until they are ready to be set out in the field in May. The five hundred individuals from this lot which have made the most vigorous and healthy growth are planted in the breeding plot. Each plant is then card indexed on special cards made for the work. Each plant is inspected once every week, and such data as size, color, shape of leaves, size of root, greenhouse record, assay, etc., are carefully recorded. The seed from those individuals showing the highest alkaloidal yield is planted the following year, and again the plants are subjected to this test.

Growers who have had no previous experience in selecting plants will find many discouragements to be bravely met and times where there is apparently no real progress. But, nevertheless, the goal is being slowly but surely achieved, and if the experimenter does his work carefully and has the patience to continue in the face of apparent negative results, he will eventually possess a fixed type of plant, one having the character of high alkaloidal content as an inherent part of its being, and will have done some real and tangible service to medical science and the future of the American drug-growing industry.

The results of the second year of selection will, under most conditions found in the Middle States, be detected by the card system by a very slight average increase in alkaloidal content. But the third year is generally a trying one to nerves and patience. The goal seems farther away than ever, for results are apparently negative. This is the turning point, the crucial moment. There is often a marked tendency towards retrogression, and the type seems less stable than ever. But the more it breaks up, the more must the investigator hold fast to his ideal and discard every plant which does not perform properly, even though that plant may have given unusual promise. The fourth season will probably bring the long awaited result of having the majority of individuals of the desired type. Sometimes, however, under peculiar soil and climatic conditions this encour-

*The *Druggists Circular*.

aging year is delayed until the fifth or possibly the sixth season. But it is sure to come if the selection has been patiently and persistently carried on. An error commonly made by breeders is to assume that the type has been fixed before it really has. Occasionally in the second or third year such a large number of individuals are desirable that the investigator is misled into believing that the race is pure and afterward discontinues his rigid selection. When this error is made, the chances are exceedingly great that the race will break up very quickly under field conditions and what results have been obtained will be entirely destroyed in a single growing season. Selection must be continually practiced, even after it seems unnecessary; not only because this is the best method we have of guarding against retrogression, but also because there is no way of being sure that maximum results have been attained. Even though the mean alkaloidal content may have been increased many times, there is always the possibility that it may be increased many times more, and the selective work should go on.

Other characters besides alkaloidal content are under observation. For the purpose of increasing the alkaloids alone that data is unnecessary, but they serve two very important offices. If simply the alkaloids were assayed at harvest time and the selection made from these data, it would be very difficult to avoid breeding in undesirable characters, together with desirable ones. For instance, if the total weight of leaf decreased as the alkaloids increased, the progress would not be very great. It is therefore desirable and necessary to watch every detail, not alone the one under direct observation.

Then, again, the drug breeder is under a distinct disadvantage compared to the corn or wheat breeder. The latter is dealing with morphological characters which are apparent, and this is an inestimable advantage from the standpoint of numbers of individuals involved. Generally speaking, the greater the number of individuals under observation, the more certain will be the results, since the average reduces the probable error arising from accidents, mutants, abnormal individuals and faulty technique. But with the drug breeder, the numbers are limited by the number of assays which may be made, since alkaloidal content cannot be detected by observation. This is a serious handicap, since it reduces to hundreds a breeding plot which should include thousands. But there is a ray of hope in the possibility of there being a correlation between alkaloidal content and some morphological character. If it could be demonstrated that high alkaloids were found in those plants making the most rapid growth, for instance, the selection then could be founded on this character and the costly assay reserved for a few choice individuals. If such a correlation exists, the use of the cards will demonstrate it. After each season these cards are subjected to a compilation of a correlation table. So far, however, no definite correlation has been found. It is probable that certain climatic conditions, notably a hot, dry growing season, favor alkaloid production, but the morphologic correlation remains to be demonstrated. Even if any one investigator found a definite correlation, it is more than probable that the results would only be locally applicable since other environments would strongly tend to alter many conditions of the plant's development and performance. It is, therefore, a problem which must be worked out for different sections of the country and repeatedly collaborated before it can be utilized with accuracy by breeders, as a whole, but its importance warrants extended investigation.

The medicinal plants which are of greatest importance at this time from the standpoint of cultural possibilities in the temperate zone are: belladonna (atropa belladonna), indian hemp or cannabis (cannabis sativa), foxglove (digitalis purpurea), golden seal (hydrastis canadensis), henbane (hyoscyamus niger), saffron (crocus sativus) and jimson weed (datura stramonium). It is probable that others might be added to this list depending upon local conditions and market facilities.

It is not advisable to attempt the culture of these interesting plants without adequate equipment, including a greenhouse, good garden soil, cheap labor and economic shipping facilities. The lack of any one of these items would lead to financial failure or seriously handicap the enterprise. It is, therefore, impossible, contrary to popular conception as to the ease of cultivating wild plants, to sow the seed of these crops and obtain good and uniform results. Cannabis is a possible exception to this statement. The seed, gathered from the previously selected plants, should be sown in shallow boxes in the greenhouse in January or February. When the seedlings begin to crowd, they are transplanted into pots and cared for under greenhouse conditions until the weather begins to settle. Then they are placed in cold frames and "hardened off" by gradually accustoming them to fluctuations of temperature. When all danger from frost is over they are planted in the fields which have previously been prepared with the same care given a garden bed. Frequent cultivation is essential during the entire season.

Belladonna, digitalis, hyoscyamus and stramonium are harvested when the plant is in full bloom by stripping or cutting the leaves. Cannabis is cut when the plant has attained maximum growth, and hydrastis, the roots of which are used, is dug generally at the end of the third season when the plant is preparing for winter conditions.

The curing of these products opens new and important fields for investigation. The leaves should be placed immediately after collection in wire racks swung in a light, airy building, the ventilators of which are easily controlled. Curing by this method requires from two to three weeks, depending upon climatic conditions, and the results are satisfactory in that the cured product has a good color and retains a desirable freshness. It is possible, however, that certain conditions of artificial curing would bring even more desirable, or at least quicker, results. This must be determined by careful investigational work carried on under conditions of temperature and humidity which are always under control.

The reader may well ask: "Of what interest to me is an enterprise in which there is little hope of rich financial rewards?" The answer depends upon what type of reader he is. If he is a city-inhabiting individual with a small back yard or thoughts of a roof garden, it is of no interest. The results of his efforts would be too small to have any financial or experimental interest. But if he is a city-inhabiting individual having a country home, a love for outdoor things, and a scientific inclination, or a farmer having had training in handling special crops and possessing a greenhouse, then the whole subject becomes one alive with interest and abounding in possible achievements.

Such a man should approach the work with a belief in several fundamental principles: That there is a great possibility for the production of crude drugs of *superior quality* in America; that there is at present no room for the fellow who feels inclined to raise a few pounds of just belladonna, simply because the price happens to be high and he sees apparently an opportunity to make a few dollars; and that the possible results of his scientific investigations will lead to the production of American crude drugs of a uniform and standard quality which will provide the American pharmaceutical houses and the medical profession with raw products of a degree of purity and excellence demanded by vital and exacting science.

Effect of Altitude on Engines

It is a known fact among aviation experts and aviators that at high altitudes the engine will not produce the power that it will when flying at sea level. This has caused considerable trouble to exhibition fliers and cross-country pilots when they wanted or tried to make flights from high altitudes, or had to make a high altitude in order to accomplish their purpose.

This reduction in power is due to the decreasing of the air pressure the higher up the machine climbs. At sea level, the atmospheric pressure is 14.7 pounds per square inch; at 5,000 feet above sea level, the pressure is 12.13 pounds per square inch, approximately, and at 10,000 feet, the pressure is 10.0 pounds per square inch. It can be readily understood then, after the piston has driven the gas into the compressed condition ready for firing, that the final pressure so attained would vary as the atmospheric pressure dropped, the gas pressure in the cylinder would also drop, and when this takes place there is not as much power in the charge as there would be at a lower altitude or higher pressure.

Table showing atmospheric pressure at various altitudes.

Height.	Pressure. Lbs. Sq. Inch.
Sea level	14.7
1,000 feet	14.2
2,000 feet	13.6
3,000 feet	13.1
4,000 feet	12.6
5,000 feet	12.1
6,000 feet	11.7
7,000 feet	11.25
8,000 feet	10.8
9,000 feet	10.3
10,000 feet	10.0

The common compression ratio for an average motor is 4.5 to 1. That is, the air space above the piston has 4.5 times the volume when the piston is at the bottom of its stroke than it has when the piston is at the top of its stroke. This figure 4.5 is chosen because it is considered to be the best for maximum horse-power, and is one where the compression pressure will not be so high as to cause pre-ignition.

By having given the compression ratio, it is possible to determine the final pressure immediately before ignition by the formula:

$$\left(P' = P\frac{V}{V'}\right)^{1.3}$$

Where P′ is the compression or final pressure, P is the atmospheric pressure, and $\frac{V}{V'}$ is the compression ratio of 4.5, $P' = 14.7\ (4.5)\ 1.3 = 104$ pounds per square inch, absolute, at sea level. Since this pressure comes directly from the compression ratio, it is the most efficient final compression pressure at sea level for an engine with such compression ratio.

This same engine at an altitude of, say 7,000 feet, however, would have, since the atmospheric pressure at 7,000 feet would be 11.25 pounds per square inch instead of 14.7, as at sea level, $P' = 11.25\ (4.5)^{1.3} = 79.4$ pounds per square inch, absolute, which is 25.6 pounds per square inch less than the most efficient pressure, above determined. It is clearly evident then that not as much power will be obtained as when the engine was at the lower altitude.

These pressures calculated above are all "absolute," and by that is meant that the atmospheric pressure is also included in the figures, and in order to get the compression above atmosphere, the atmospheric pressure used in the calculations must be deducted. In the figures given, 104 — 14.7 gives 89.3 pounds per square inch, at sea level, and 79.4 — 11.25 gives 68.15 pounds per square inch at 7,000 feet.

In order to bring the final compression pressure up to the efficient figure, a different compression ratio would have to be used, that is, the final volume would have to be less, and since it is impossible to vary this to meet the conditions of altitude, the loss of power cannot be helped unless some arrangement could be devised whereby the compression ratio could be increased or decreased at will by reducing or increasing the space above the pistons when on top center. Then, if the ratio be thereby increased to some figure like 5 to 1, the motor would again have its proper final pressure, but even then, not as much power would be developed as at sea level, owing to the further fact that, with a constant final compression pressure, the horse-power varies directly as the atmospheric pressure. For example, the horse-power of an engine developing 80 horse-power at sea level when raised to an altitude of 7,000 feet would be equal to $\frac{11.25}{14.7} = 61.2$ horse-power. If the original compression pressure of 4.5 was used in circulating the drop in horse-power would be even greater.

These computations and remarks make it very clear that the flier or builder who contemplates any altitude work must see to it that sufficient surplus power be provided to allow for any variation or loss of power resulting from such altitude work.—*Aircraft.*

Origin of the Indo-Aryan Type of Temple

The problem of the origin of what he called the Indo-Aryan type of Indian temples was never completely solved by James Fergusson, and later inquirers have done little to produce a solution. In the June issue of the *Journal* of the Bihar and Orissa Research Society Dr. D. B. Spooner, well known for his excavations at the site of Pataliputra, has in a great measure solved the difficulty. Beginning with the most primitive form of shrine, little more than a square box, he shows that the desire of the Indian architect was to produce a play of light and shade by advancing the central portion a little way, and then to repeat the process, so as to produce a lower structure decorated with three miniatures. At some stage of the local architectural history this threefold division seems to have come prominently into notice, and the architect conceived the idea of balancing this triplicity rhythmically by a corresponding threefold division of his tower in horizontal stories. This idea of the architectural rhythm is very ingeniously developed by Dr. Spooner, and his paper deserves the attention of architects. He closes by saying: "The people of Tirhut are to be warmly congratulated on the possession of so complete a series of temples as they now possess, a series sufficient to illustrate the whole development of this important style, and a series including many shrines of special interest and beauty. Let us hope that they will do their best to safeguard their inheritance, and to maintain the temples in good condition."—*Nature.*

Ethyl Alcohol from Sawdust

Ethyl alcohol is prepared on a large scale by fermenting sugar, which is usually obtained by conversion from the starch of corn, barley, rye, potatoes, etc., or from the molasses of the sugar industry. Within recent years these materials have been made to include sawdust and the waste or spent liquor from sulphite-pulp manufacture. In view of a possible extension of this process toward larger utilization of forest products, a brief description of the commercial plants now in operation will be given.

Attention must be called to the difference between the product obtained by this process and that mentioned in wood distillation. The latter is methyl alcohol (CH_3OH), commonly known as wood alcohol, and is produced from the decomposition of wood by heat. On the other hand, ethyl alcohol (C_2H_5OH), commonly known as grain alcohol, is obtained by fermenting the sugar derived from wood by chemical treatment.

Although four plants for the manufacture of alcohol from sawdust have been erected in the United States, only one was in operation in August, 1914. This plant used in 1912 the equivalent of 35,000 cords of wood, consisting of sawdust and waste from North Carolina pine, from which 372,000 wine gallons of 95 per cent alcohol were obtained. During the year 1913 the plant was in operation for only a part of the year, as the sawmills were destroyed by fire. They have been rebuilt, and since the alcohol plant resumed operation in the Fall of 1914 it has consumed more sawdust and produced more alcohol than at the rate given for 1912. The operating company regards this plant as still in an experimental stage, and cost data are unavailable. A description of the process in general outline, however, follows:

The sawdust is conveyed on a belt from several sawmills to the alcohol plant and lifted into storage bins by means of an elevator. From the storage bin it is distributed to four digesters as required for charging. These digesters are of spherical shape, 12 feet in diameter. They are of steel-plate construction and are lined with acid-proof brick. After a digester is charged with sawdust, diluted sulphuric acid is added until it constitutes about 0.5 to 1 per cent of the weight of the dry wood. The digester is then slowly rotated by means of a worm gear and heated by direct steam. The pressure gradually rises to 120 pounds and a maximum temperature of 335 deg. Fahr., is reached. The total time of digestion, including charging, heating up, cooking, blow-off, and discharge, is about one hour. Upon the completion of the digestion the digester is discharged, and the wood, now known as "hydrolized" wood, is carried by belt conveyors to the diffusion batteries. In these the soluble constituents of the mass are extracted with hot water in the same manner as in tannin-extract manufacture and in sugar extraction. The product of the digester contains more water than the raw material (which often contains 50 per cent water), owing to the addition of the dilute sulphuric acid and the condensation of steam used for heating. After extraction the washed residue, consisting of unchanged sawdust, is conveyed to presses where the water content is reduced to about 55 per cent. It is afterwards burned as fuel and is sufficient for the generation of all the steam and power required in the plant.

The liquor from the diffusion battery, known as wood liquor, contains sulphuric acid, sugar, and other organic compounds and is next neutralized with milk of lime in tanks fitted with agitators. It then flows into a settling tank. It is further clarified by decantation and after cooling is pumped into the fermenting vats. Yeast grown in wood liquor is added, after which fermentation proceeds. The fermented liquor is then distilled in column stills for the production of rectified alcohol. The alcohol thus produced is of a high grade and is reported to contain only traces of fusel oil, esters, and acids. When properly purified, it differs in no respect from ordinary grain alcohol.

The process of alcohol manufacture from wood is dependent on the proper set of conditions under which a maximum quantity of sugar will be formed. This involves numerous factors of operation, which have, to a large extent, been determined by the American plant above described in a general way. The exact details of successful operation are not available for publication at this time, but it is known that the process is economically feasible and capable of ultimate extension.

In the manufacture of sulphite pulp cellulose is subjected to the action of a dilute acid under pressure and elevated temperature. Under these conditions the same reaction as described above takes place and spent sulphite liquor accordingly contains some sugar in solution. In three paper mills in Sweden the utilization of the sulphite liquor produces about a million and a quarter gallons of alcohol per year. In the United States two similar plants have been established, and while at the time of this investigation they were operating in an experimental manner the process appears promising in many respects. A description of the process will be given, but cost data and exact details are not yet available.

The liquor from a sulphite mill with a capacity of 130 cords of spruce wood per 24 hours constitutes the raw material for alcohol. This liquor is pumped to three concrete tanks, known as "sour-lye" tanks, of 35,000 gallons capacity each. The daily supply of liquor is, accordingly, 105,000 gallons. From the sour-lye storage tanks the liquor is pumped into two neutralizing tanks of 35,000 gallons capacity each, where lime sludge from the causticizing tanks of the soda-pulp mill is added. This lime sludge ($CaCO_3$) combines with the free acid (H_2SO_3), forming sulphite of lime ($CaSO_3$). The combined sulphur dioxide (SO_2) in the liquor is also precipitated as sulphite of lime. The liquor is next aerated by compressed air under 60 pounds pressure for three hours, after which it is pumped into two neutral lye tanks. The solid matter in suspension settles out, and the clear liquor is decanted or filtered and enters the fermentation tanks. These tanks are also of concrete construction and 35,000 gallons capacity each. A yeast tank of 32,000 gallons capacity is provided, and into this tank the sediment of each fermenting tank, after fermentation is complete, is pumped. After a new tank has been filled with the clarified and aerated liquor it is planted with yeast from the yeast tank and fermentation proceeds for about 72 hours, after which the liquor is distilled in a column still and rectified in the usual manner. The yield is reported to be slightly in excess of 15 gallons of 95 per cent alcohol per ton of sulphite pulp. The initial cost of this plant is approximately $2,000 per ton of sulphite pulp.

Operators are optimistic as to the ultimate success of this process, although several adjustments must be made to increase the yield, such as the proper regulation of digesters in cooking the pulp, and the addition of more nutritive material to yeast than is ordinarily permitted in distilleries operating in grains or sugar extracts. The use of closed fermentation tanks to save the carbon-dioxide gas for use in the preparation of electrolytic bleach required in the pulp and paper mills would also contribute to greater economy.—*Special Agents' Series No. 110, Bureau of Foreign and Domestic Commerce, U. S. Dept. of Commerce.*

Strike-A-Lights

Only 89 years ago lucifer matches were first sold at Stockton-on-Tees in boxes containing only 50 for a shilling, and some time elapsed before it was possible to buy 25 of them for a sixpence, and at the popular price of "four a penny" they were cheap only to the well-to-do. Elderly people can tell us a good deal about the use of the flint and steel and home-made non-frictional matches. Tinder had to be prepared by burning a few old rags, but some people preferred touchwood to tinder. This consisted of decayed and pulverized wood or bark, or else of certain fungi taken from trees. Tinder-boxes known as "strike-a-lights" or "strike-a-sparks" usually carried their own flint on the lid or base. The world is indebted to one John Walker, a Stockton-on-Tees chemist, who placed on the market the first match lit by friction in 1827.

Brandon, the little Suffolk town, still supplies the world with the primitive flint strike-a-lights, which even the excellent safety match and wax vesta have not rendered obsolete. British troops during the South African campaign were supplied with Brandon flints—the best in the world—combined with steel, fuse, and lens; while Brandon gun-flints were used at the Battle of Waterloo and during the Crimean War. Spanish and Italian peasants have always been glad to secure Brandon flints, which, in one form or another, constitute part of the outfit of soldiers, travelers, and explorers in tropical lands. The modern flint, steel, and fuse combined is cheap, quite safe, and is contained in the smallest possible space.—*H. Brierley, in English Mechanic and World of Science.*

Goitre in the Alpine Regions

The prevalence of goitre in different regions was always connected with the character of the soil, and this in turn influences the nature of the watercourses. As a matter of fact the action of the soil only enters in indirectly, and this disease is spread by the effect of the water. In the deep valleys of the Alps the inhabitants use the water of numerous small watercourses which are easily contaminated, and this explains the frequency of goitre to be found here. Dr. Francis Messerli, of Lausanne, made a series of exhaustive researches on this subject in the Vaud Jura and other Swiss regions, making a careful examination of the water, which he also gave to animals to drink, especially water that was reputed as causing goitre. He concludes that in the case of Switzerland the disposition of the geologic strata, such for instance as an impermeable layer near the surface of the ground, allows of easily infecting the water which comes from a shallow subterranean source. The goitre which is characteristic of such regions comes from intestinal infection due to germ-bearing water absorbed by the system. While it is true that the germs can also be disseminated in other ways by human beings (feces, saliva, or by contact), infected water is the main source of the disease, and due measures should be taken to secure a proper system for keeping the water pure, especially as concerns springs or streams. He also thinks that the wood of reservoirs or conduits may enter in here, for wood is favorable to the presence of colloidal matter, which if not toxic in itself, affords a good medium for the development of disease germs.

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