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View on the main drainage canal, 26 to 40 feet wide and 6 to 8 feet deep. Over sixty miles of canals and ditches gridiron the farm.

A heavy disc plough, drawn by a powerful tractor, breaking newly retrieved muck soil on the big farm.

HOW WALL STREET TILLS THE SOIL.—[See page 120.]

The Protoatom of a World*

A Suggested Cosmogony to Account for the Evolution of a Stellar System Without the Necessity of Matter Being Originally Present

By L. B. Buchanan

SEVERAL theories of celestial evolution have been elaborated by able minds and have received the appreciative consideration of the thinking public. The nebula hypothesis of La Place, with modifications introduced by later astronomers and the alternatives presented by Prof. See and by Prof. Lowell, are so well known as to need no description here.

All of these theories deal with the agglomeration of matter as such, by various probable methods, into stellar systems such as our own solar system and those which our galaxy reveals. Whether the origin be considered as gaseous, as meteoric dust, or as the result of near approach or collision of dark or visible stars, in all cases matter identical, or analogous to what we know as such, is presupposed to exist and be involved. Whatever action supposed to take place is accounted for on the theory of universal gravitation continuously acting.

Quite recently the writer, who is not an astronomer—in fact, is only what might be called a commercial scientist—had the privilege of talking with one of the foremost astronomers of the world. The general subject of these remarks being touched upon, that eminent authority expressed himself to the effect that the astronomer does not ordinarily go into the constitution of matter in his investigation of such subjects.

The writer's courage in perambulating the infra-red precincts of cosmic evolution may therefore partake of the fearlessness of fools. Fully conscious of this, he is nevertheless about to embark on this adventurous course, with the hope that what he here sets forth, if patently unsound to the informed, may awaken a new line of thought in some readers.

Not necessarily as a substitute for the great theories mentioned in the first paragraph, but merely to be considered simultaneously therewith, is presented the following quasi-theory of cosmic evolution, which proposes the building of a stellar system, or of a galaxy, without of necessity any matter as such, originally present in the region of construction.

The theory presupposes the existence of the ether, the existence of one or more galaxies, the formation of atoms from electrons, the emanation and movement of electrons with velocities from zero to almost the velocity of light, the transmission of light by electromagnetic waves in the ether, the transmutation of so-called elements by radio disintegration, as evidenced terrestrially by uranium, radium, etc., the conservation of energy and continuity. Universal gravitation continuously acting is not presupposed; but gravitation is assumed as a universal property of all organized matter of the kinds with which we are familiar.

No new property of the so-called ether is prescribed. We can conceive of no limit to universal space, no beginning nor end to time and no beginning nor end to the universe, it presumably always was and always shall be.

Always there have been celestial bodies radiating electromagnetic waves and electrons in all directions, the waves always so far as we know with constant velocity, the electrons with all magnitudes of velocity up to that approaching the velocity of the waves themselves. Detached electrons are undoubtedly affected by electromagnetic waves, as for instance the repulsion of small particles by light waves, by electrical action upon each other, possibly by a resistance to motion in the ether itself, possibly also by gravitation, but scientists believe that any gravitational action of electrons is small compared with the electrical actions.

With the preceding in mind, consider in a large region remote from organized celestial systems a collection of electrons which have come from various radiating bodies and by virtue of various reactions and interactions have, relatively to each other and possibly absolutely, almost no motion, the probability is that the space density of these electrons will not be uniform, that by virtue of interference-wave residual effects, their distribution may be analogous to that of the sand on a vibrating plate after it has come to rest. Electrons of higher velocity may be continuously passing between them, changing their relative positions and likewise similar effect may result from electromagnetic waves from the remote stellar organisms, whence they themselves came. Let us consider that none of these electrons are in close enough proximity, or proper orbital relation, to constitute an atom of any matter which we know, but rather that the whole group, which let us imagine occupies several cubic light years of space, is at a particular instant one great protoatom, with little kinetic energy but with enormous potential energy, let us classify it as an ultra-mega-uranium, possessing enormous atomic weight, but owing to its loose organization and susceptibility to disturbance, having almost an infinite rate of decay. Imagine the decay to go on with the formation of smaller but still enormous protoatoms, each such successive decay occurring with increase of kinetic energy, radiations, loss of electrons, spliting off of groups, capable of becoming hydrogen, helium, etc., just as we observe in the case of terrestrial radium, recalling also the sustained temperature of radium above surroundings. Consider as a possibility the occasional happening of a configuration corresponding to that existing in known elements, that is, a resonator capable of responding to proper excitation, let the excitation be the repeated impetus received from some electromagnetic wave or combination of them coming from remote stars, we then by reason of the existence of an eternal element determine its persistence; like begetting like. Possibly some of the chance stable configurations resonate to electromagnetic overtones, in which case we have perhaps prescribed a condition of procreation of analogous rather than identical matter. So soon as we admit the formation of known matter, even if not before, we will gain the assistance of gravitation in the condensation of our proto-nebula. With increased kinetic energy and closer grouping of the electrons, we would expect the protoatom to disappear, always with relatively large amounts of hydrogen and helium as products, the occasional production of other known elements and possibly many mega-uraniums, matter far down the scale from the protoatom first considered, yet much more active as to rate of decay than any radioactive element we know.

Now what as to the temperature of this proto-nebula? We have seen that the evolution considered means the giving out of energy in enormous quantity as radiation and expelled electrons; such action may well be capable of being seen from a remote distance, therefore the above question. First we must be sure we know what we mean by temperature; if we conceive of ether as incapable of possessing temperature, and for example, that in a given region of interstellar space there is one molecule of gas per cubic centimeter, no thermometer that we know would tell us anything about the temperature of that space, if we mean by temperature the kinetic energy of the gas in it. If, on the other hand, we mean the temperature of some discrete mass, as a thermometer or a meteoric stone which happens to be there, we must know the relative absorption and radiation rate of the mass, which will vary for every different shape, size and kind of mass. For present purposes we will take temperature to mean the heat intensity measured by the kinetic energy of the gas molecules, and with our relatively widely scattered molecules in our supposed proto-nebula we may have a high temperature but a small quantity of heat. Our nebula is hot, in that its mean molecular vibration velocity is high, but a ponderable body therein may be cold because there are not enough molecules or radiations striking it to make it take up heat faster than it radiates it, after a very slight rise. Any condensed nodule in the nebula might therefore act as a condenser for matter it came in contact with. Cold nodules might thereafter coalesce with such evolution of energy as to raise their temperature; indeed, having generated our matter for the construction of a stellar organism from the electrons that came from those organisms which were before, we may choose any of the theories of condensation of the nebula which pleases us.

It should be remembered that the question of temperature may be of maximum importance in considering hot celestial organisms, or for that matter terrestrial matter heated to temperatures higher than those subject to past research, on account of the possibility of endothermic combinations at those temperatures and pressures which would be impossible at temperatures with which we are workingly familiar.

In order to get a rough idea of what we have herein considered, the following approximate calculation has been made.

The nearest star is of the order of 4 light years away, consider the sun controls to one half that distance, viz., 2 light years, for simplicity's sake a cube of space whose side is 4 light years. The volume of this space is 64 cubic light years or approximately 13 by 10^{39} cubic miles.

Consider the entire solar system to be equivalent to a sphere 1,000,000 miles in diameter, of density 1, a volume of approximately 5×10^{17} cubic miles, weighing 2×10^{33} grammes. Let this be imagined distributed in primeval state substantially uniformly throughout the 64 cubic light years; the amount of matter per cubic mile would then be 1.5×10^{-7} grammes. A cubic mile is roughly 4×10^{15} cubic centimeters, therefore the matter per cubic centimeter $= 4 \times 10^{-23}$ grammes. Imagine, for example, that the matter is water vapor, of which at standard temperature and pressure 1 cubic centimeter weighs 8×10^{-4} grammes; we then have $\frac{4 \times 10^{-23}}{8 \times 10^{-4}} = 0.5 \times 10^{-19}$ of the amount present in a standard cubic centimeter. Assuming a standard cubic centimeter of gas to have 10^{19} molecules, there would be ½ molecule per cubic centimeter average density. At 20,000 electrons per molecule there are 10,000 electrons per cubic centimeter. Assuming them placed equidistant they would average about ½ millimeter apart. The relation of this distance to their distance apart in ordinary matter is of the order of the relation of the distance between members of the solar system to the distance of the farthest stars from the sun.

A comparatively short interstellar distance has been chosen for this example; we can conceive of the region occupied by the protoatom as being so remote from any star system as to include many hundred cubic light years instead of the paltry sixty-four above considered, in which case the electron density could be very much less than what has been shown and yet the aggregate would be more than the entire solar system.

Consider our galaxy 40,000 light years in diameter and the space which it occupies included by a cube of that dimension, viz., 64×10^{12} cubic light years; on the basis of the same electron density assumed in the previous calculation, there would be matter enough to construct 10^{12} solar systems.

If we assume that our sun is an average star, we have provided for more by 5,000 fold than Roberts calculated on the basis of 4,000 stars per square degree, which he found in a rich portion of the Milky Way in Cassiopea, assuming that density to hold throughout the sphere, and more by far even than the same sort of calculation derives based on the Omega Centauri Cluster. This would certainly allow for enough dark stars to satisfy those who believe they greatly outnumber the visible ones and perhaps for enough to explain the velocities of 1830 Groombridge, Arcturus and Mu Cassiopea, which Prof. Newcomb found anomalous, considering only visible stars.

Recent computations have arrived at 10^8 as the number of stars visible in our largest telescopes and from the fact that successively larger telescopes have not disclosed proportionally more stars, it is believed to be a reasonable approximation to the total number of visible stars. If we allow tenfold that number, viz., 10^9, the original electron density of our calculation is 1,000 times too great, so under the previous assumption that our sun is an average star, we could account for the entire galaxy with an original density of 4×10^{-26} grammes per cubic centimeter. Strangely enough, this would be just about the density of matter which Prof. Schiaparelli calculated would completely intercept all light within the distance of the visible limits of our galaxy.

While this discussion has been confined to the generation of a stellar organism, there is nothing to preclude consideration of a similar action taking place in a smaller way within our sun's domain, in which case we must look to the comets as the little descendants of protoatoms formed from stalled electrons within gravitational reach of the solar system.

A highly speculative attempt to build a world from mere electrons has here been made; if, as some of our leading scientists have thought, electrons are merely vortices in the ether, our world has been built from ether, not spontaneously but in a measure like ourselves, offshoots of those which were before. Thus the ovum of stellar life is the electron, a carrier of energy which changes from kinetic to potential and *vice versa*, is bartered and borrowed, but is never lost so long as continuity is assumed; the milt that starts the life may be the electromagnetic waves from the remote parent bodies.

Far beyond the infra red of the spectrum may be the line autographs of protoatoms whose vibrations are so slow and feeble that though their wave length is enormous compared with the longest Hertzian waves we know, the amplitude is so small that detection by any resonator of the high periods we are constrained to use is impossible. The protoatom thus may be beyond our senses, but some of the intermediary line of descent

** Science Conpectus.*

toward atoms of our acquaintance may be disclosed to future searchers for the truth. Possibly the summational waves resulting from combinations and recombinations of the long waves above conceived may come into our sense scale, provided we can find the means to sufficiently keen our senses to the necessary observation; the Rosetta stone which shall make sensible that which is beyond direct impression.

Referring back to the subject of gravitation. Let it be said that biased by our experience, which is consistent and identical, we always think of inertial mass and gravitational mass as one and the same, a little consideration will show that this is not necessarily true. If there was a coherent substance which was repelled by the earth and by all substances we now know, or if it were neither attracted nor repelled, we have no difficulty in imagining it to possess inertial mass, although in one case there would be negative, and in the other, no gravitational mass. If there were any such permanent substance ever on the earth it has long since been repelled to a remote distance, so that our inability to find such is no proof of the impossibility of its existence.

Such a substance may be possible by proper arrangement of electrons under the right conditions, high temperature may be essential, perhaps such substances exist temporarily in the sun and stars but decay to matter of ordinary properties before they get away, owing to drop in temperature. Such substances may be present among our protoatoms: if so the effect of gravitation may not always be present at all points in the proto-nebula. Inertial mass has been found to increase with velocity, but no direct observation of corresponding increase of gravitational mass has been reported, nor has the question of whether gravitation has a finite velocity of transmission been determined.

In considering cosmogony, it is essential to take as broad a view of possibilities as may be permitted to tellurimental intelligence; with a plea for, if not a practice of, this attitude the above crude effort is submitted.

Amount of Water to Use in Concrete*

By Ernest McCullough, C.E.

Many years ago the specifications of the majority of engineers called for a dry concrete. In order to impress upon the minds of workmen just what was wanted, such expressions as the following appeared in specifications: "The mass shall appear to be about as damp as moist brown sugar;" "The consistency will be deemed to be right when a handful squeezed in the hand will not stain the skin but will show the shapes of the fingers when the hand is opened and will thus stand until the hand is shaken, when the concrete will fall down," etc. Such concrete had to be tamped until the contained water rose to the surface and the whole mass was quaky. It took strong forms and the labor-cost was high.

In 1835 some French engineers wrote a paper describing experiments made by them prior to that date in which they advocated the use of more water. In fact, the ideal consistency discovered by these engineers was the consistency by general consent deemed ideal to-day. General Gilmore in his classic work on mortars and cements, the first edition of which appeared just before the civil war, and the second edition about 1870, mentioned the French experiments approvingly, yet American engineers clung to the dry mix until the introduction of reinforced concrete. Within the past fifteen years the wet mix has become the sloppy mix and an agitation has commenced against excessive use of water.

For several years arguments have arisen over the proper amount of water to use and nothing tangible has been presented until lately. Numerous laboratory experiments to show the effect of water have been published and they all point in one direction, that is, toward the necessity for using less water. A very slight increase in the amount of water used will cause a tremendous decrease in strength of concrete, far out of proportion to the difference in water. Unfortunately, the experiments merely mentioned the amount of water by per cent.

The man in the field is puzzled to know whether the per cent is by weight or bulk. One cubic foot of water weighs 62.5 pounds and one cubic foot of average material used in concrete may be said to weigh 100 pounds. Ten per cent of water by bulk would mean 6.25 pounds of water, but 10 per cent by weight would mean 10 pounds of water for each cubic foot of material.

Then again the question arises in the mind of the man reading the article, "Does it mean per cent of loose materials or per cent of compacted concrete in the forms?" Studying the ranges given by different experimenters the average man is puzzled to understand whether the per cent is based on the whole mass or merely on part of it. Is it the cement, or is it the cement and sand? The writer has had these questions asked of him. The truth is that the majority of experimenters base the percentage of water on the sand and cement mortar, but some base it by weight and some by bulk. However, when a statement appears that the water is 12 per cent we think that the per cent is based on all the materials loose, but again we do not know if it is by weight or bulk. It is a strange thing that the men of the laboratories do not use language of the men for the results of their experiments.

The writer about nine years ago published the results of meter payments made for water, which showed that the average on a large number of jobs showed the weight of the water paid for to be almost exactly the weight of the cement. This was for all the uses of water, which included mixing, washing tools, drinking, waste, etc., in fact, all the water paid for. He stated that the water used in mixing the concrete was about one third of the total. Prof. Falk in his work, "Cements, Mortars, and Concretes," about ten years ago gave the following rule: "Multiply the parts of sand by 8, add 24 to the result and divide by the sum of the parts of cement and sand." For example, for a 1:2:4 concrete,

$$\begin{aligned} 1 \text{ cement} &= 24 \\ 2 \text{ sand} + 8 &= 16 \\ \hline 3 \text{ parts} & \quad 40 \end{aligned}$$

then $\frac{40}{3}$ = 13.4 per cent of the combined weight of the cement and sand. Assume the cement to weigh 94 pounds and the sand to weigh 100 pounds, the total weight will be 294 pounds, and the water = 294 × 0.134 = 39.5 pounds of water. Adding the 4 cubic feet of stone gives a total of 7 cubic feet of loose materials, or practically 5.6 pounds of water per cubic foot of loose materials. This gives the ideal consistency for mortar.

Right here is where there is a chance to impress upon the mind of the reader just what concrete is. It is not a mixture of water and stone and sand and cement sloshed around loose in any old way and made into a pudding-like mass. Concrete is a manufactured stone in which the principal ingredient is a lot of broken stone, the interstices between the pieces being filled with a soft cement mortar. Therefore, it is only necessary to get the cement mortar of a proper consistency and we at once have the proper amount of water for our concrete.

For ten years past we have had in the rule of Prof. Falk a good guide to the proper amount of water to use, but his rule was expressed in the language of the laboratory and not in the language of the man on the job. It is known that if the sand and stone are bone dry and the stone is of an absorbent nature it will be necessary to use more water. It is known that if a rain soaks the sand and stone it will be necessary to use less water. We do know, however, that if the extremely dry materials are not encountered and the extremely wet materials are not encountered, the rule is good for ninety jobs out of one hundred as a guide.

Expressed in the language of the man on the job, "Use not to exceed six pounds of water for each cubic foot of loose materials in the concrete," varied, of course, according to weather conditions. Suppose a man is using a two-bag batch, then he will have 2 cubic feet of cement, 4 cubic feet of sand, and 8 cubic feet of stone, a total of 14 cubic feet of loose materials. This means 94 pounds of water, or 94 ÷ 8.33 ÷ 11.3 gallons of water.

Consistencies have been variously described:

1. Soupy means little, for we have bouillon, which is a thin soup, and vegetable soup and a thick broth. In all, however, there is considerable free water and there should be no free water.
2. Sloppy expresses the bouillon soupy mixture. It should never be used.
3. Gravy concrete is a thin, somewhat easy flowing concrete in which the materials are well mixed and no free water shows for a long time after the material has stood. It is, in fact, like a very well worked mortar.
4. Dry cement has been described. It is used only when forms must be quickly moved and for ordinary work is too dry and, therefore, very expensive if properly tamped, which never happens when the inspector is not watching the work closely.
5. Stiff concrete is dry concrete tempered with enough water to handle nicely.
6. Pasty and sticky concrete is the ideal. It will not run freely from a wheelbarrow, but requires a little assistance from shovel or hoe. It fits nicely into corners in forms when well worked and finishes with a fine surface against forms.

With materials of an average character as regards amount of moisture the ideal consistency is produced with about 5½ pounds of water per cubic foot of loose materials. Therefore, the writer sets as a positive maximum 6 pounds of water per cubic foot of loose materials. If this makes the concrete too soft, use less water, but stop guessing for the first few batches. Use the maximum here mentioned, no matter what the proportions for the first batch, and increase or decrease as found necessary in the succeeding batches until the right amount is hit on for the materials being used.

In ignorance of just what would be encountered experiments were made in Milwaukee, Wisconsin, in November, 1915, to determine the amount of water required for mixing concrete and the time required to properly mix a batch. An accurate water weighing device was used on the mixer and the following consistencies determined upon:

1. A mixture considered the ideal, being pasty and sticky.
2. A mixture somewhat softer, but considered about right for the quick handling on concrete road work.
3. A very soft mixture, not considered good for any work but often used on roads and for reinforced concrete. It was of the heavy vegetable soup type.
4. A sloppy mix.

After some batches had been run through, the reading of the water measuring device was taken, so the same amount of water could be used for all batches. When the experiments were concluded the water measuring device was experimented with to determine just the amount of water used and it was found that slightly less than 6 pounds of water per cubic foot of loose materials produced the ideal road mix.

It was found that while ten revolutions of the drum produced a fair concrete, it took a full minute to get the water distributed through the mass. The committee, therefore, recommended that each batch be mixed not less than one full minute. This disposes of the man who advertises batches in less than one minute. It cannot be done and give good concrete. Experiments made on cylinders of the various batches of different consistencies showed that the concrete containing the least water was the stronger and the reduction in strength was more marked than the percentage increase in the water.

"But," some will say, "all concrete is not a 1:2:4 nor a 1:2:3. How about the water then?" The only answer is that the exact amount of water will vary between 5.5 pounds and 6.5 pounds and that the first batch will probably not be just right and it will take two or three batches to adjust the matter. This being the case, differences in proportions will make practically no difference. Let us figure it out: Assume 1:2:4, the sum of the parts being 7. Divide 40 by 7 and thus get 5.72 bags of cement per cubic yard of concrete; 2 × 5.72 = 11.44 cubic feet of sand, and 4 × 5.72 = 22.88 cubic feet of stone, total = 40.04 cubic feet of loose materials in one cubic yard of packed concrete. Producing in a similar way we get 41.05 cubic feet for a 1:3:5 mix and 40.08 cubic feet for a 1:2:3 mix. It will make practically no difference just what mix is used, for the 6 pounds of water per cubic foot of loose material will be a good guide on which to depend.

The ideal consistency has been described as one in which a stone the size of a man's fist, placed on top of the mass, will sink less than half its thickness before the concrete obtains the initial set.

*The Cement Age.

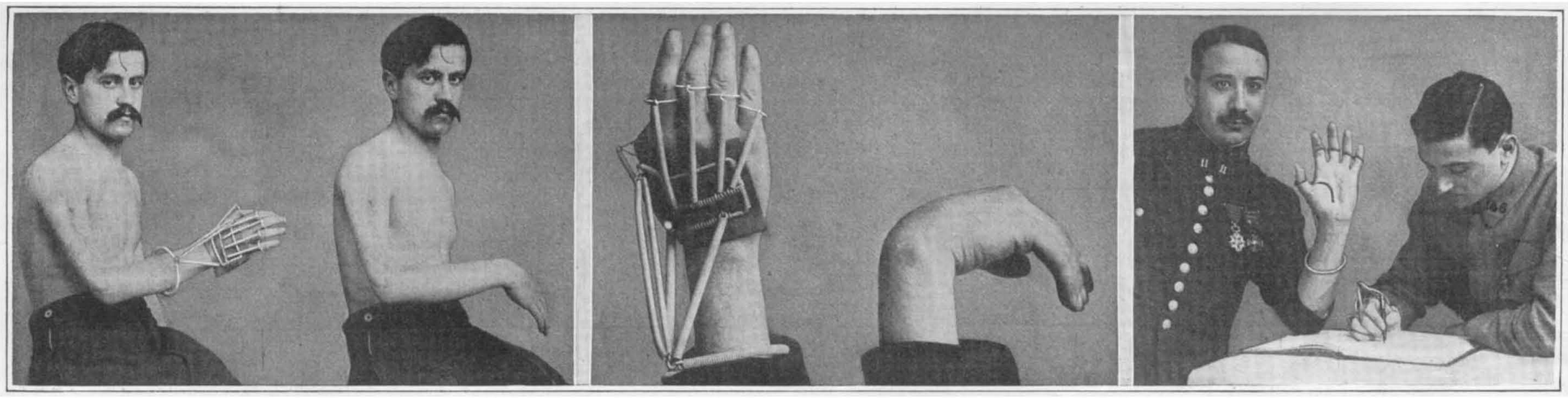
Sudan Grass for Fodder

The growing of Sudan grass in the last few years has become an industry of no small importance. Seed growers have exploited the growing of this crop very extensively and farmers are usually well satisfied with the results which they have obtained. Sudan grass gives a very heavy yield of fodder, and this, together with its drought-resisting qualities, makes it a very valuable forage in sections where it will grow.

Favorable reports concerning this crop have come from all sections of the country, from central South Dakota to Texas, and eastward to the Atlantic seaboard, showing that it has an extremely wide range as a useful forage crop. Yields of from 2 to 5 tons of hay per acre are usually secured when the grass is planted in rows and cultivated. It very closely resembles Johnson grass, but does not have the creeping rootstocks, so does not become a pest. When cultivated it sometimes attains a height of 8 to 10 feet, and when sown broadcast it grows from 4 to 5 feet high. Experiments indicate that it has a feeding value about equal to that of the sorghums and timothy hay.—*Report 112, U. S. Dept. of Agriculture.*

A Substitute for Platinum

According to the *Electrical World*, an alloy of 2 per cent palladium with silver forms a good substitute for platinum in contact and spark devices. The alloy that gives the greatest resistance to spark erosion is 60 per cent palladium and 40 per cent silver. The palladium raises the melting point of the alloy and lowers the thermal conductivity.



An inert hand, helpless from the paralysis or loss of important nerves, is made useful by the application of this ingenious combination of springs.

New Devices to Aid the Wounded

Hands and Limbs That Enable Expert Operations to Be Performed

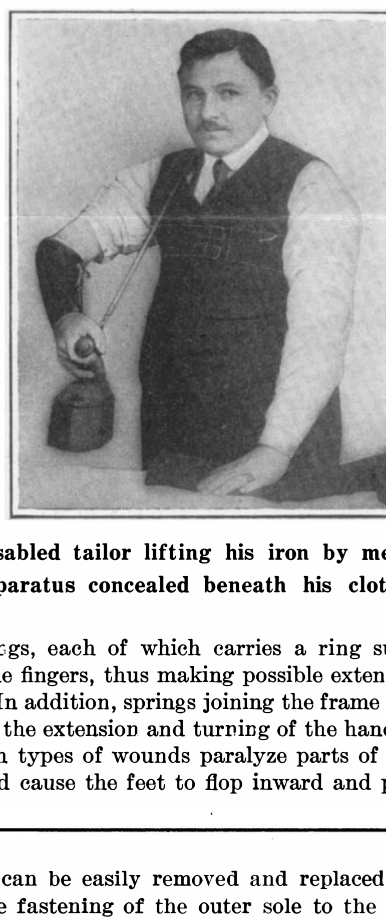
By Jacques Boyer

Those wounded in the present war present a great variety of mutilations, so that every day doctors and orthopedists are inventing new devices for the amelioration of their glorious infirmities. Articulated systems have been constructed permitting a man deprived of both arms to engage in the manufacture of brushes; while by means of a universal tongs or mechanical arm perfected by Dr. Jules Amar in collaboration with the specialist M. Canet, mutilated workmen are able to take places at cabinet making, and violinists can again handle the bow. Prof. Pierre Delbet has invented an artificial leg of an original type, whose operations are based upon the deformability of a parallelogram, and by means of which one who has suffered amputation of a lower member may work with a spade. Finally, and more recently, Dr. Pierre Robin has suggested a very general technique for the attachment of artificial limbs and parts thereof, based upon the equilibrium between opposite members which is so fundamental a factor in the operations of many of our organs.

Inasmuch as to every alteration of the human form there corresponds a physiological disorder by consequence of the destruction of the equilibrium between the constituent parts of the damaged organ, the skillful practitioner will seek apparatus which must at once be removable and very simple, remedying the malformation by re-establishing this lost equilibrium between the groups of opposite members. This functional restoration creates, so to speak, a new machine replacing, so far as may be, the old one.

Let us examine how Dr. Robin applies this ruling idea to the solution of the various problems presented by those wounded in the war—problems of replacing muscles paralyzed or entirely gone, and of supplying more or less important parts of the bony leverages on which they work. Some typical cases will suffice to show the extreme adaptability of the system.

Let us first consider paralysis of the radial nerve, leading to inertia of the hand, which hangs helpless at the end of the arm. Of course, the remedying apparatus ought to raise the hand, make it turn, open and close the fingers. It consists of a rectangular frame of iron wire held over the back of the hand by a hook passing between thumb and index finger. To this are attached



A disabled tailor lifting his iron by means of apparatus concealed beneath his clothing.

five springs, each of which carries a ring surrounding one of the fingers, thus making possible extension of the latter. In addition, springs joining the frame to a bracelet allow the extension and turning of the hand.

Certain types of wounds paralyze parts of the sciatic nerve and cause the feet to flop inward and portions of the legs to lose their self-sustaining power. To mee these conditions Dr. Robin has devised a method of wrapping a steel wire about the foot to the level of the ankle bone, forming a support for two springs at right angles to each other, applied one to the leg and one to the foot. A strap and a hook from the side of the latter make it possible to lace it to the stocking, and a protective plate holding the entire outfit in position is fitted along the leg over the calf.

In the event of complete paralysis of the leg resulting from a head wound, there is added to the apparatus just described, which supports only a single region of the leg, a spring extending up to a belt held in place about the chest by two braces. The flexion of the upper portion of this spring makes it possible for the wounded man to rotate his leg from outside inward. In this manner, by simultaneous contraction and twisting of the spring, he raises his leg with his shoulder, and is able to walk along the level or upstairs with the aid of an ordinary cane.

The loss of bone or muscle tissue from the shoulders or arms leads to various functional disabilities, of which the general characteristic is inability to raise the arm from the side. So the apparatus constructed for such a patient by Dr. Robin has for its object the supplying of means for making those movements rendered difficult or impossible by paralysis of the deltoid, fracture of the humerus, or almost complete loss of the cubitus. It is composed again of a spring fastened on one end to an armlet, on the other to a thoracabdominal belt. By means of this arrangement, slightly modified according to his profession and the nature of his mutilation, the subject is able to place his arm in a variety of positions. We illustrate a zouave who holds his book and raises his hand to his face without difficulty. Another cut shows a tailor who raises his iron with ease in spite of loss of the head of the humerus and paralysis of the deltoid.

His apparatus is concealed beneath his clothing, and in the street no one would observe his infirmity.

Wooden Soled Shoes in Germany

If it may be considered a sign of scarcity or high cost of leather when wooden soled shoes become more popular, it would seem that leather is getting scarce in Germany, as wooden soled shoes are being seriously considered there.

The accompanying illustrations show some designs of wooden soled shoes that appeared in a recent issue of a German shoe trade paper.

The first shows the sole of a new work shoe with a

Fig. 1.

flexible wooden sole. Between the upper and lower wooden lifts *A* and *B* there is an elastic between-layer *G* and both wooden lifts are provided with divisions in proper space or sufficiently deep grooves *D*, whereby to the outer layer of the wooden sole is secured the necessary flexibility. As the outer sole *A* becomes worn down, it can be easily removed and replaced by a new one. The fastening of the outer sole to the upper sole *B* can be accomplished by wooden pegs, iron rivets or screws.

Figs. 2 and 3 give two views of another wooden sole

Figs. 2 and 3.

shoe in which the wooden soles are so well shaped as regards the arch and also as regards the surface that the shape is adapted to a leather walking shoe. This style of shoe offers a use for much waste wood.

The design of the wooden soled slipper is not so attractive looking. The sole is made flexible through a diagonal division being cut to divide the toe part *A* from the heel part *B*, thereby making the walking movement easier.

Moreover, the slipper is provided with upper *D* covering the counter, which possesses a strap *G* fastened to the side of the slipper.

A report from The Hague states that wooden shoes are becoming popular in Germany, due to the scarcity

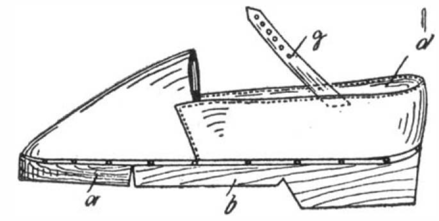
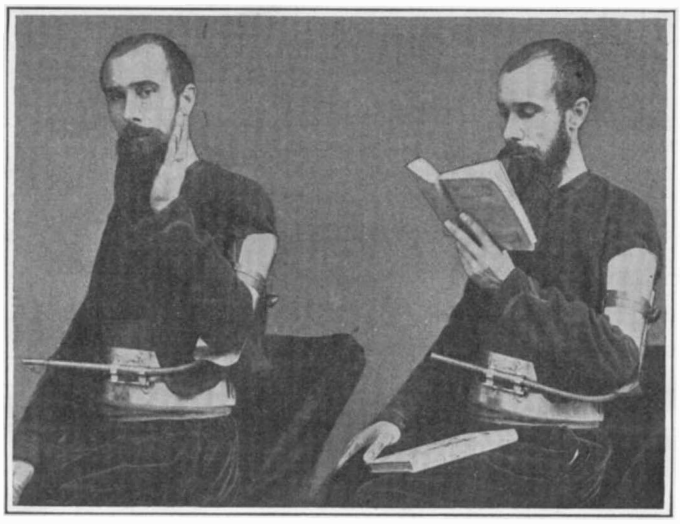
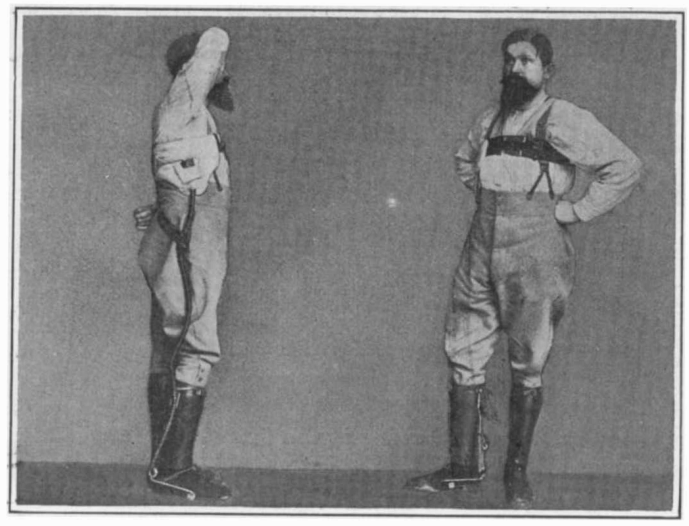


Fig. 4.

of leather, and that many of these shoes are being exported from the Netherlands to Germany. The Germans never took to wooden shoes very much, but war has changed things. However, a flexible wooden shoe, such as the first one mentioned above, surely has many points in its favor.—*The Superintendent and Foreman.*



The loss of bone or muscles of the shoulder is made good by a spring fastened to an armlet and connected with a belt around the waist.



A completely paralyzed leg is made usable by braces attached to the foot and ankle and connected to braces over the shoulder.

Flexibility in Steam and Gas Engines*

IN SPITE of the fact that several runs have been made by cars over long and hilly courses, such as London to Edinburgh, using the top gear the whole way, it is axiomatic that the gasoline engined car requires a speed gearbox if it is to be a go-anywhere vehicle. Every motorist, if not everybody, knows this to be a fact, just as he knows that a locomotive or a steam car has, in general, no need for such a device. But does he know the fundamental difference between the two classes of engine that will satisfactorily explain why the one has and the other has not this need? The engineer does, instinctively; but not so, we venture to think, the layman in these matters, in which category the bigger proportion of motorists may be placed. He, the layman in question, has a fairly comprehensive idea of what horse-power means, but a very vague idea of what is meant by torque. He knows that of two cars, the one of 15 horse-power and the other of 30 horse-power, the latter should be the faster and more powerful, but he cannot for the life of him see why on some hills it is the lower-powered car that outstrips the bigger, or why the 10 horse-power steam car should be able to climb hills on its direct gear that the 30 horse-power car has to come down to its lowest ratio for. In the first case, he might, if asked, say airily, "Its gear ratio is better suited to the gradient," though probably he would understand but dimly what gear ratio has to do with it; and in the second case he would doubtless own that the answer to the question was beyond him, especially as, having no gearbox, the question of gear ratio scarcely enters. We will do our best to try and make these things clear to even the least technical of our readers.

In simple language, then, the essential difference between the two classes of engine, the steam and the gasoline, is that the former does its work by a more or less uniform and continuous push, whereas the latter does the same amount of work by a succession of comparatively small blows. To give a familiar simile, and a very good one for our purpose, first propel a small car along a level road by getting behind it and pushing; it will be found that for a very obvious reason the magnitude of the push that can be given is greatest when the car is stationary, and that as the speed becomes greater the less the push that can be given. The same thing could be done by a number of small blows of the fist on the back of the car, if they were given in quick enough succession, though because of the need for the latter possibly many fists would have to be employed for the purpose. In the first case it will be seen that the work done depends entirely on the magnitude of the push exerted in a given unit of time, this push being greatest when the car is stationary and gradually decreasing as it, the car, accelerates. In the second case it depends on the strength of the blows and their frequency, the first of these being practically unaffected by the speed of the car and the last entirely so.

So in the case of the two engines. In the above analogy the car becomes the piston, and the propulsive effort on the car becomes the pressure of the steam or gas behind the piston. In the steam car the one continuous push on the piston is strongest when the piston itself is stationary; and when moving, the slower its mean speed the greater the effective push. In the gasoline car the effect of a single blow is small because the magnitude of the blow is small as compared with the push in the former case, and this propulsive effort is, in theory, practically independent of the piston speed.

Technically, the net propulsive effort on the piston, after deducting certain losses due to friction and other causes, is known as "brake mean effective pressure," which is in direct proportion to the torque or turning effort on the crankshaft. Hence we see that in the steam car the torque is greatest when the mean piston speed is lowest, that is, when the car itself is stationary. We also see that in the gasoline engine the torque is no greater at low speeds than it is in high, and is small as compared with that of the steam engine. Moreover, as a matter of fact, the torque of a gasoline engine at low speeds is much less than at normal speeds, because there is then more time for the heat energy of the inflammed charge to dissipate itself to the metal walls of the cylinder, but this is a practical rather than a theoretical consideration.

Having established these facts, the question will occur: If the torque is so small in a gasoline engine, how is it that it can be made to do the same work and the same amount of work per unit of time as can a steam engine? The answer to this is that, in effect, the latter engine does not have to depend on speed for its power, whereas the gasoline engine does. Power is the rate of doing work, so that it is immaterial whether the work to be done is accomplished in small fractions quickly or in large amounts slowly. For instance, assume that the engine of a steam driven car propels the vehicle four feet per crankshaft evolution, while a crankshaft revolution of the gasoline engine takes the car only one foot. But if it does this in one fourth of the time of the steam engine. then the power developed will be the same in each case, In both cases the horse-power the engine is delivering depends on the number of revolutions it is running and the torque; in the steam engine, as we have said, the increase in speed is accompanied by a falling off in pressure, the one as it were countering the other and tending to keep the horse-power constant, but in the gasoline engine, however, there is no corresponding decrease in brake mean effective pressure, and in actual practice, in fact, it increases usually with the revolutions as does the horse-power itself. To obtain the necessary torque and power, therefore, it is essential that the gasoline car must be provided with some means for allowing the revolutions to be maintained under all conditions, and this is done, first, by a large reduction of gearing in the back axle, and, secondly, by the provision of a gearbox whose purpose and effect is to further multiply the torque on the road wheels whenever circumstances demand it.

The gear ratios it contains must—if the car is to be a go-anywhere vehicle—be such that the full horse-power from the engine is available under any conditions, and, further, that for best results as regards speed, they should be so numerous and so chosen that with the throttle full open the revolutions are just sufficient and no more to enable the full horse-power to be developed. This, of course, is impracticable, but the argument indicates the need for as many ratios as are practicable, and these carefully chosen. It also shows that whereas the ability to climb a hill on a given gear ratio depends on the torque, the speed with which it is climbed depends on the horse-power. And from this it consequently follows that even where the car seems to be taking a hill on top gear without apparent need for a change down, such change down might be beneficial from the point of view of speed; and this, we hope, explains why it is that, irrespective of consideration of engine "tune" and car weight, the smaller-powered car, in the hands of a capable driver who appreciates these matters, can, under certain conditions, make a better showing on a hill than one of greater power.

It will probably be helpful in fixing the above ideas if we draw a parallel between concrete instances of the two types of engine. Take, for example, the 10 horse-power Stanley steam car, now practically the only car extant, in this country at all events, employing this type of prime mover. This has two double acting cylinders of a bore and stroke of 3¼ by 4¼ inches which would be equivalent to four single acting cylinders of like dimensions or to eight cylinders of a four-stroke cycle engine, as is the usual gasoline engine used in cars. According to the R.A.C. rating such an engine would have a horse-power of about 33 horse-power, and by present standards might be actually capable of between 60 to 70 horse-power at a piston speed of 2,000 feet per minute, or practically 2,800 r.p.m.; a revolution speed, by the way, that though not at all impracticable is very much higher than is likely to be the case except with engines designed for racing purposes. As it happens, however, this is not of much significance, since what we want now to find is the brake mean effective pressure giving rise to the torque on the crankshaft, since to do this it does not matter whether we take the horse-power as being, say, 32.5 at a piston speed of 1,000 feet per minute, or as 65 at 2,000 feet per minute. For, provided the power curve be a straight line between zero and 65 horse-power, then the mean torque, and also the brake mean effective pressure, will be the same at all speeds. Without going into the why and the wherefore, the mean torque can be found by the equation:

$$T = \frac{\text{b.h.p.} \times 33{,}000}{2\pi n} \text{ lbs./ft., where } n = \text{revs. per min.}$$

At a mere glance at the above equation, it will be seen that, provided the b.h.p. is proportional to the speed, T, the torque, will remain constant. Substituting in the equation those terms which are known, we have

$$T = \frac{65 \times 33{,}000}{2 \times 3.1416 \times 2{,}800} \text{ lbs./ft.}$$

From which it will be found that the mean torque is approximately 122 lbs./ft.

To arrive at the brake mean effective pressure, which, as we have said, is strictly proportional to the torque for any given engine, we can use the formula:

$$T = \frac{1}{192} a^2 \eta p s N$$

where ηp = the brake mean effective pressure, N = number of cylinders, s = stroke in inches, and a = bore in inches. From this evolves:

Brake mean effective pressure (ηp)
= 65.25 lbs. per square inch approximate.

This, then, is the mean pressure behind the pistons, giving the torque on the crankshaft of 122 lbs./ft, and which is, according to our premises, that virtually available for starting the car from rest when the clutch is let in. As a matter of fact, it is a good deal less than this, as we have already pointed out, owing to the relatively large loss of heat to the cylinder walls at low speed, but the figures may stand for the moment for the purposes of comparison.

Now let us try and find what these values would be in the case of the particular steam car referred to. Other things being equal, the torque of this engine would be in the same proportion to the brake mean effective pressure as is the case of the gasoline engine above. The "other things" may be summed up in the term mechanical efficiency.

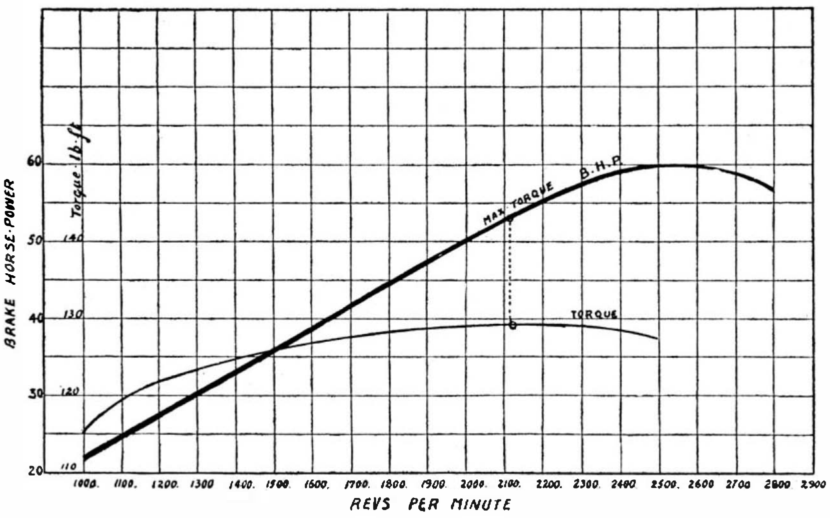
Now the brake mean effective pressure behind the gasoline engine considered was given at 65.25 pounds per square inch; in the case of the Stanley the maximum pressure is that which the boilers will stand, but as the safety valve on these boilers is set to open at 650 pounds per square inch pressure, we can safely take this as being the numerical value. The brake mean effective pressure, however, will not be so high, because some of the energy will be expended in overcoming internal resistance and because of heat losses, just as with the gasoline engine, but it may plausibly be taken at 550 pounds per square

* *The Automotor Journal.*

inch in round figures. In the case of the gasoline engine we have derived the torque from the brake mean effective pressure. Given the brake mean effective pressure in the steam engine as 550 therefore, the torque can also be deduced by the same means, the question merely resolving itself into an arithmetical problem in simple proportion: If a pressure of 65.25 pounds per square inch gives a torque of 122 pounds/feet, what torque will a pressure of 550 pounds per square inch give? Approximately eight times as much; and therefore we can state that the given steam engine at its point of highest mean torque, as when starting, gives eight times as much turning effort on the crankshaft as does the given gasoline engine at its maximum mean torque—which is in practice when running at between one and two thousand revolutions per minute.

It must be pointed out that in arriving at this figure eight, the difference in the number of cylinders and therefore in piston area does not affect the case, since, as we stated in our premises, the eight cylinders of the one will be equal to the two cylinders of the other, because the latter are double acting and get four power strokes to the other's one. Neither will the fact that in the steam engine both pistons are receiving pressure at one and the same time affect the calculation, since the crankshaft receives two impulses per stroke just as does the gasoline engine. Consequently, and in fine, if the mechanical efficiency is the same in the two engines the mean torque of the steamer will be in the same proportion to the numerical value of its pressure per square inch as in the case of the gasoline engine.

Having deduced, then, that from this two-cylinder steamer we are getting eight times the mean torque on the crankshaft as from the eight-cylinder gasoline engine, let us see what this means: it means that to enable the gasoline engined car to be able to compete with the steamer it must be provided with a gearbox, which will allow the engine revolutions to be maintained so as to develop the maximum mean torque on hills and a sufficient torque for starting purposes; and, conversely, it means that not only is there no need for a gearbox on a steamer, but also that the single gear reduction to the back axle can be at least eight times as low a reduction (or the ratio eight times as high in value) as lowest gear on gasoline car.



If the latter, for instance, be 16 to 1, then the former can be 2 to 1, and yet have the same turning effort on the driving wheels for starting and hill climbing Again, it means that if the top gear ratio of the gasoline can be 4 to 1—a very usual ratio—then the steamer with the 2 to 1 back axle ratio will only need to run at half the same number of r.p.m. for an equal car speed. As a matter of fact, on the Stanley the back axle gear reduction is 1½ to 1, whereas on a gasoline car it is ususally about 3.5 to 1.

It is in respect of the relatively great torque developed by a steam engine at low speeds that constitutes its flexibility, using the word in its true sense. In this sense the gasoline engine possesses none, except to a very limited extent at high revolutions, since the torque can never be greater at low than at fairly high speeds; on the contrary, it usually, as shown in the accompanying graph, falls away rapidly as the engine speed decreases. True, the word flexibility is often used in connection with gasoline engines, but it is merely in the sense that the engine can be run over a wide range of speeds, leaving altogether out of consideration the matter of torque.

Optical Glass

Various Qualities Required, and Something of the History and Methods of Its Manufacture

The public probably understands that the supply of optical glass is a matter of vital national importance. What they hardly grasp is the difficulty of securing an adequate supply for the war equipment, even now in the second year of the war. In this and other respects the three Cantor lectures, delivered before the Society of Arts by Dr. Walter Rosenhain, F.R.S., will prove both instructive and suggestive. That the optical-glass industry was a key industry, he remarked in introducing his subject, had been recognized by Abbe in 1880. The article which Abbe then wrote might have been translated and printed two years ago.

Optical glass, Dr. Rosenhain stated, might simply be defined as better than ordinary glass, purer, and possessing various properties for special optical purposes. The variety of purposes introduced difficulties; spectacles, telescopes, photographic lenses, etc., required different properties, apart from certain fundamental requirements. As regards transparency, the best glasses were nearly perfect. They should also be colorless, but that claim might be overdone; the greenish color due to the presence of traces of iron could be reduced by adding manganese, but at the expense of transparency, because the glass then absorbed both green and blue rays. The color was not necessarily due to impurities, moreover; certain dense flints looked yellow, especially when heated, because they absorbed the ultra-violet, and the absorption bands shifted in the hot glass. The transparency was also impeded by solid impurities (bits of clay, etc.) and by bubbles, which were continuously liberated from the carbonates and nitrates of the melting glass mixture; big bubbles carried small bubbles away, but a mist of very fine bubbles was a very troublesome feature. The fused glass finally formed a very complex solution of great viscosity and stiffness, which yet remained in a state of flow (which might become a serious matter in big telescope lenses) and inclined to crystallize. This tendency to crystallize limited the admissible proportions of salts which favored devitrification. Even a block of window glass, cooled in the furnace at an extremely slow rate, might devitrify—a specimen exhibited was full of crystals of wollastonite—and heavy barium glasses had to be chilled lest crystallization set in.

Striæ, Dr. Rosenhain proceeded, arose from imperfect homogeneity of the glass, and were very difficult to avoid. They were visible in good plateglass when looked through edgeways, and the worst striæ were almost invisible, though capable of disturbing definition. To test for striæ the specimen was put between two biconvex lenses so illuminated from the focus of the first lens that the second lens appeared as a brilliant disk; striæ in the specimen then showed as bright and dark lines on that disk. Internal strains arose in the congealing glass mixture, because it was a bad conductor of heat; the hot mass within the cooled crust might break loose from it, or, at any rate, the physical homogeneity of the glass and its refractive index might be affected. To cure this defect—which was tested by means of the polariscope—the glass was annealed and slowly cooled; but slow cooling was only essential between 500 deg. and 200 deg. Cent., fortunately. Hardness was a necessary requisite, because lenses had to be handled and wiped, and could not always be protected. As regards durability, glass was chemically fairly stable; but some optically splendid glasses were unfortunately very sensitive to atmospheric attacks. Alkalinity was particularly objectionable. To test for it, a piece was broken, and the fresh surface was exposed to the moist atmosphere within a vessel containing water; then globules of water formed on the surface in bad cases; the glass was afterward immersed in a solution of iodesin (in alcohol and ether), and the slightly pink solution wiped off from the sides, while the surface film was dissolved in sodium iodesin, and the color intensity estimated.

Passing to optical properties, Dr. Rosenhain explained briefly why the new Jena glasses of Schott and Abbe (brought out in 1886 to 1890) had been so important. The two chief properties were refraction and dispersion. The refractive index n was determined for the prominent Fraunhofer lines A, B, C, D, E, b, F, G, G_1, h, H; C, F, G were hydrogen lines, D the sodium line, b a magnesium line. The dispersion Δ depended on the relative distances between the lines; in practice the interval F-C was generally considered, disregarding the extreme lines, and the practical formula for the dispersion coefficient was

$$\nu = \frac{n_D 1 - 1}{\Delta}$$

Owing to the dispersion each color gave, so to say, a different picture, and white light gave a picture with colored fringes. By combining different lenses of different glasses, achromatism could be secured; but it was only approximate and for parts of the spectrum, and a residual spectrum always remained. For the old glasses the old plotting of the dispersive power against the refractive index practically yielded a straight line, the n_D and ν being proportional to one another. The new glasses allowed of combining any n_D with any ν. The old glasses were essentially alkali-calcium silicates (crown) or lead glasses (flint); the new glasses contained also phosphates, borates, etc., and many hitherto unused metallic oxides; their refractive index rose above 1.7, the density above 4, and barium crown glass (of high index and low dispersion) could be substituted for flint glass. A little color did not matter for gun-sights and some telescopes; spherical aberration, coma, and other defects, which the Jena glasses also allowed to be corrected, were more serious.

In his second lecture Dr. Rosenhain dealt with glass-making. Ordinary glass was melted in pots, in a journey (*journée*) of 24 hours, the mixture being gradually introduced, and the glass ladled out or gathered. A number of pots stood in a ring in a fire-brick chamber. When Dollond had combined crown and flint lenses for achromatism in London, in 1757, the Society of Arts offered, in 1768, a prize for improved glass-making processes, and awarded a prize. But little was achieved until P. L. Guinand, a Swiss watchmaker, proposed, in 1790, to stir the glass in the pot and then allow it to settle at rest, not to form fresh striæ. His work attracted the attention of Fraunhofer, and with financial aid from the Bavarian Academy, optical glass was made by Guinand and Fraunhofer in Munich; these works passed into the hands of Steinheil, who, when the Jena glass industry opened, made glass merely for his own use. A son of Guinand joined Bontemps in Choisy-le-Roi; Feil was a grandson of Guinand; the firms of Mantois and Parva-Mantois represented other branches of the family. One Bontemps came over to Birmingham in 1848, and entered Chance's glass works. That was, briefly, the genealogical tree of optical-glass making up to the introduction of the Jena glasses, though the researches of the Royal Astronomical Society, of Faraday, J. Hopkinson, and Stokes should certainly not be overlooked. What was novel in Abbe's work concerned chiefly the materials; the method which Dr. Rosenhain had found in use in Jena when visiting the works ten years ago was practically that of P. L. Guinand. In ordinary glass-making many pots were arranged in one furnace. Optical glass was melted in one, perhaps two, pots; for each glass required different materials and treatment. Each pot was provided with a dome, to keep off the gases and dust, and had a side opening near the top. The pots had diameters of 40 inches and more, and the same height, the bigger the better. Only the best clay could be used, and it should be matured for years or generations, if possible, by a kind of fermentation process of its colloidal constituents; the Chinese porcelain makers knew that. The bottom was molded first and dried to a certain extent; then the dome was molded on in a moist atmosphere at a certain temperature; the building up of the pot took four months, and the whole pot-making eight months, or, better, a year. The pot was then wrapped in straw and smoked, and heated up to a red glow in a kiln for five days. It was afterward transferred to its proper furnace by means of a balanced fork on wheels. If it had not cracked before, invisible cracks might appear when the pot was fired up in the now bricked-up furnace, standing on a pillar; the heating was by gas, the gas and air being preheated. Before the materials were introduced, broken glass, of the required composition, was dropped in and well spread all over the inner surface to serve as a glaze, lest the materials attacked the pot. All the materials had to be pure, the absence of iron, manganese, chromium, etc., which would impart color

to the glass, being most essential. The glass contained 50 per cent and more of silica, introduced as purest, very fine-grained, sand; there was no good sand in the United Kingdom, but such could be obtained from Fontainebleau; coarse-grained sand was not sufficiently soluble. All the other materials—carbonates and nitrates of potassium, sodium, barium and calcium, aluminium hydrate, oxides of lead, zinc, etc.—had to be pure and most finely powdered; hence the workers had to wear respirators. Nitrates were needed to oxidize any carbonaceous matter present. Traditionally two or three pounds of arsenic were added per 5 cwt. of sand; the advantage gained was doubtful. The charge, together with broken glass (cullet, to act catalytically, so to say) was introduced in six or eight portions, all in from 24 to 72 hours. The heating of the pot—which was not quite filled—was then pushed to expel bubbles, but the highest temperatures obtainable (now controlled by instruments) were sometimes barely sufficient.

Every five hours a sample was taken with an iron spoon to watch the bubbles. When they ceased to appear, the temperature was lowered, and the stirrer was introduced. This was a solid cylinder of the same fire-clay as the pot, provided with a square axial recess at the top, into which an iron hook fitted. The hook was rested on the lip of the pot and slowly swept round the pot, whose walls it must not touch, however. As air-bubbles adhered to the cylinder, the temperature had to be raised again. The stirring, for four hours, was very laborious for the man who stood in front of the hot furnace; electric-motor stirring had been tried, but was not considered perfect. When the glass solidified, stirring was discontinued; the cylinder might be left in the glass or be very carefully pulled out. When sufficiently cool—chilling by water was sometimes required as mentioned—the pot was wheeled into a kiln, where it cooled for three or four days. The pot was now withdrawn and broken by the hammer to obtain one or more lumps of good glass, rarely more than one third of the charge. As the rough pieces could not be examined, they were replaced in the kiln and molded to a slab which was sufficiently polished for examination. Sometimes prisms, etc., could be molded. They all required annealing at 400 deg. to 600 deg. Cent. in gas or electric furnaces and cooling at the rate of 8 degrees per hour for two days.

In the third lecture Dr. Rosenhain commented on possible improvements of the rather primitive method of optical-glass making. By heroic efforts the output in this country had been raised to twenty times what it had been before the war. But that was not on business lines, and to carry the optical-glass industry on after the war would require either direct or indirect State subsidy, or better, combined research of scientists and manufacturers. The task was difficult; for Dr. Rosenhain doubted whether the optical-glass industry was really profitable anywhere. At Jena, Schott and Genossen co-operated with Zeiss in instrument-making and in the manufacture of chemical ware; those branches yielded the profit, while even Jena thermometer-glass was being supplied at a loss, he believed. Examining the present process in detail, he pointed out that it was slow and laborious, and the yield low. To hasten the melting (which took up to four days) by higher temperatures was not advisable, if feasible. As the temperature rose, the erosion of the pot by the glass increased. The fire-clay itself would not stand more than 1,800 deg. Cent., and the heat could only reach the mixture through the walls and dome of the pot. The door and cover or dome could not be removed, because that would expose the mixture to contamination by gases (reducing gas was dangerous to flints in particular), dust, and crumbling particles dropping from the furnace arch. Electric furnaces and crucibles might be tried. Wire resistances did not yield temperatures above 1,400 degrees; with spiral carbon resistance the required 1,600 deg. or 1,800 deg. Cent. might easily be obtained, but not for pots 30 inches in diameter; induction furnaces (of the Kjellin type) were unsuitable, because efficient stirring in the annular groove would hardly be possible; in arc furnaces the heat was too concentrated, though something might be done with the Stassano radiation arc, if contamination by the ash of the carbons were not too dangerous. Arc-resistance furnaces (in which the arc was formed between the carbons and the slag floating on the fused metal) might answer if something akin to the protecting slag layer could be found. It might also be possible to float the crucible on a molten bath, or place it in that bath, of glass or slag, heating the bath by the arc-resistance method. Electric glass-furnaces were already used to a certain extent; but a satisfactory type had yet to be evolved.

That the pots were the real difficulty would be clear from what he had said. Their manufacture was costly and very slow, breakages were frequent, and finally each pot only served once. The melting glass attacked the pot and, unfortunately, extracted the iron (which was difficult to eliminate completely) from the pot by preference. In America and Germany fire-clay had much been studied of late, with good results, especially in Germany. Here in England little had been done in this respect, and when he (Dr. Rosenhain) had recently asked a well-known firm for some of their best fire-clay for experimenting, he had been told that their clay was perfect and could not be improved upon. Excellent fire-clay should, however, be procurable in the empire. But even the best clay was attacked by the glass, and the glazing referred to was of little use when the glass itself was the invader. Other glazes and linings had hence been tried; then the expansion and shrinkage trouble came in. A cylinder of fire-clay shrank by several per cent when first heated. In metallurgical furnaces magnesia linings gave satisfaction; all that should be investigated. The National Physical Laboratory was experimenting in various directions; Dr. Rosenhain there has the assistance of Mr. Claude Pryor, who was in charge of the lecture demonstrations. They really wanted some revolution in pot materials, as Abbe and Schot had revolutionized the glass materials, and there was hope. There was the whole group of refractory rare earths; there were silundum, carborundum, and other new substances, and lastly, tungsten and molybdenum were being put to uses not dreamt of a few years ago. Supposing they found a suitable pot material. They could then stir to complete homogeneity even near the pot walls, which they dared not do now, lest the sticky, stringy glass adhering to the walls should contaminate the bulk; they could pour the glass, get a yield of perhaps 80 per cent instead of 20 or 30, and re-use the pot or crucible; that was the key to the problem.

Many of these troubles became accentuated in some of the new glasses. An ordinary crown glass was a tri-silicate, e. g., Na_2O . CaO, 6 Si O_2 (three times more acid than basic elements), while a dense barium glass of high n and high v was extremely basic in character (Na_2O . 4 BaO . 2 SiO_2 . 2 B_2 O_3), and eroded the pot very severely; Dr. Rosenhain showed photographs of very bad cases. Some of those glasses, moreover, were exceedingly liable to absorb color (from the clay, gases, possibly the sulphur), and they were chemically unstable and required chilling to prevent crystallization. Finally, opticians were looking out for materials of higher refractive index (above 2), and v ranging from 100 to 10 (the present range was about 64 to 32). To satisfy those claims, recourse would apparently have to be had to natural or artificial crystals, because the atoms or molecules in an under-cooled liquid like glass seemed to be unable to retard light-waves beyond a certain amount. Thus the artificial-glass industry found a limit, and suitable crystals had to be found or to be made. Considerable use was already made of fluorite (fluorspar), which had a low n = 1.4388, combined with an extremely high v = 95.4. Such fluorite was not obtainable now in this country; but there were many promising crystals besides diamond—e. g., perovskite (Ca Ti O_2)—and as large good crystals were rare, they should be prepared. Dr. Rosenhain had suggested a precipitation method in 1905 at the First Optical Convention. In a U-tube he had a solution of sodium chloride, and above it, in the one limb, a solution of calcium chloride, and in the other a solution of sodium carbonate. The liquids slowly diffusing into one another deposited crystals of calcium carbonate near the boundary face, between the NaCl and $CaCO_3$. Other crystals could be obtained by fusion, and be made to grow by coalescence. That possibly meant looking a long way ahead. But optical glass making was one of the most difficult, as well as most interesting, operations, and many-sided research, backed by manufacturers' enterprise, would be needed to put the industry on a rational basis, and to gain a lead in that field.—*From Engineering.*

A Simple Test For Nickel Plate

For the thickness and uniformity of zinc plate there is a simple and rapid test, based upon the decomposition of copper salts in contact with iron or zinc. If the zincked object is immersed for a short time in an aqueous solution of copper sulphate, the immersed surface becomes rapidly veiled under a black coating of metallic copper. This coating disappears in a bath of running water if the zinc plating is of sufficient and uniform thickness; but if the iron base is anywhere exposed, or the zinc deposit uneven, it adheres strongly at the defective places.

No such test has been known for nickel plate. In view of the very uneven surface presented by commercial iron, making uniform plating a matter of considerable difficulty, this task has been a decided drawback. A French chemist has succeeded, according to a recent number of *Revue Générale de Chimie Pure et Appliquée*, in making good the deficiency.

The test depends upon the combined action of a cold solution of hydrogen peroxide and hydrochloric acid upon nickel, copper, and iron. If a nickeled object is immersed in such a solution, there will take place:

(*a*) A more or less rapid mechanical penetration, by the liquid, of the more or less pronounced interstices between the molecules of the nickel deposit;

(*b*) A rather sluggish chemical reaction between the liquid and the nickel;

(*c*) A much more rapid reaction between the metal of the base and such of the liquid as reaches it by virtue of action (*a*) or (*b*).

In attempting to standardize the workings of this test for practical use, the following observations must be made. In general, if the nickel coating is thin or irregular, mechanical penetration proceeds at so rapid a rate that the formation of nickel chloride is completely outstripped by that process and the resultant action between the liquid and the metal of the base. If, on the other hand, the plating is up to the mark, the production of chloride and oxide of copper or iron, as the case may be, is accompanied by a laying down of nickel chloride to an extent no longer negligible. Nickel chloride is mauve in color; the deposits made by this process from copper and iron are respectively bluish and yellowish or brownish.

Directions for performing the test are given as follows: Wash the article to be tested for a few seconds in a concentrated bath of S O_3, rinse well with water, and wipe dry with a clean linen cloth. The testing solution may be compounded from the formula:

H N O_3	10 parts
H Cl	20 "
H_2 O_2	20 "
Distilled water	50 "

A single drop of this fluid should be placed upon the desired spot by means of a glass rod or a dropper. After two minutes a drop of ammonia solution should be added to check the reaction; this should be given a minute more in which to work. At the expiration of the three minutes, the body of liquid should be picked off, upside down, onto a white plate, and examined carefully.

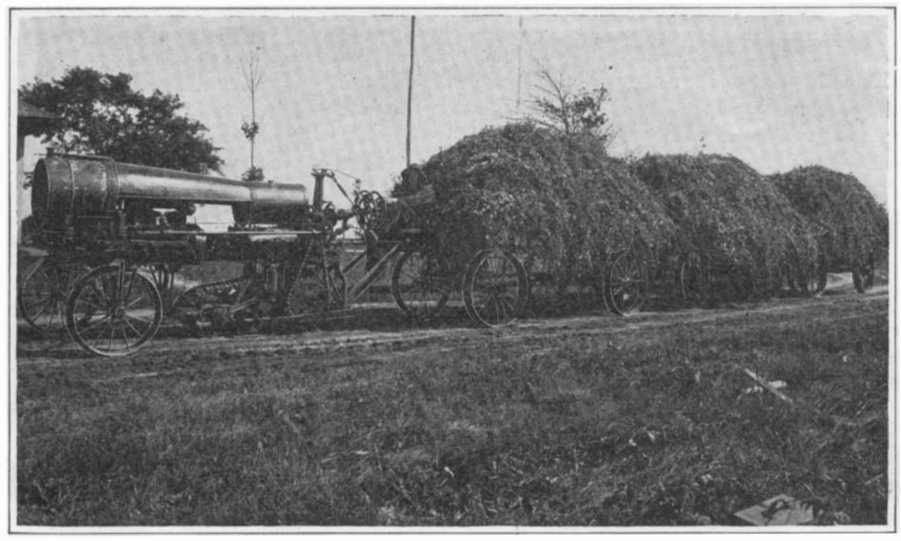
If it shows blue alone or brownish alone (for copper or iron base respectively), the conclusion to be drawn is that the plating is defective at the spot in question. If, in addition to the color mentioned, mauve also appears, the plating may be assumed to be up to grade at this spot. If the base of the article to be tested is copper, and doubt exists whether mauve appears with the blue, the question can be settled by a one-minute application of a drop of potassium ferrocyanide. If the plating was up to the mark, this process will show no trace of red (copper ferrocyanide); otherwise it will.

The time allowed in these directions for the several reactions is based on an estimate that the minimum serviceable thickness of nickel plate on a copper base is one which gives one milligramme of nickel per square centimeter of surface, and, on an iron base, three milligrames per square centimeter. The difference is due to the peculiarly unfavorable surface presented by the iron, as mentioned above. It is suggested that iron to be plated should always be subjected to some kind of grinding or milling process, to minimize this disadvantage; or that it might even have a preliminary coat of copper-plate.

Observations on the Atomic Weight of Lead

Of recent years the atomic weight of lead has attracted the attention of all chemists, because the unexpected discovery of radio-active elements in lead showed the even more surprising result that the lead recovered from such sources not merely had an atomic weight different from that previously attributed to this element, but that its atomic weight actually varied with the different modes of production. By analysis of lead bromide Baxter found the value 207.19; of the chloride, 207.21. These determinations were effected with lead secured from remotely separate and widely variant sources, and showed such accord that 207.2 was accepted as the international value. But lead from radio-active substances gave figures diverging widely from these. Lead from thorite yielded figures between 208.3 and 208.5 (Soddy and Hyman). Maurice Curie investigated Lead from pitchbende, carnotite and yttrotantalite and found its atomic weight to be between 206.36 and 206.67. Lead from monazite and zincblende showed itself more normal. Other investigators, by analysis of the chlorides from pitchblende, get the value 206.735. So it appears that radiation lead has a variable atomic weight, and the only supposition which can be made is that the absolutely pure metal is yet to be isolated; nor is the relationship between the various kinds of radio-active lead and the ordinary variety entirely cleared up.—*Prometheus.*

A vast bean patch, showing the luxuriant growth on the rich muck soil.



A steel mule hauling a train loaded with pea vines to the threshing station.

How Wall Street Tills the Soil

Putting the Farm on a Manufacturing Basis

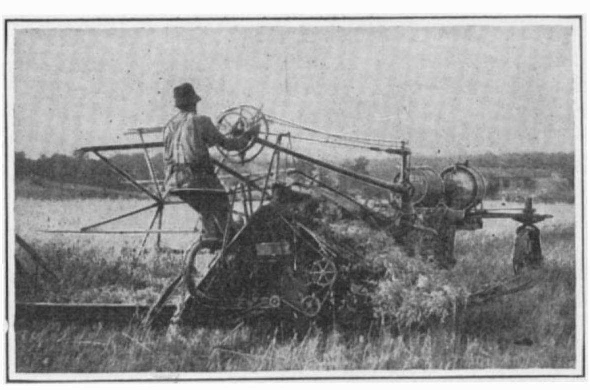
By John R. Colter

THE activities of capital in railroading and industrial enterprises in the United States have usually brought progressive methods and leaping development to these fields, so that when you see capital turning to the plow, after years of neglect of the possibilities of the good brown earth, you naturally look for interesting progress in the business of farming—perhaps an approximation of efficiency to the *n*th power, and certainly the overcoming of mighty obstacles The first real sounding of the East's ignored farming areas will not disappoint you. The gigantic Oak Orchard Farm in Genesee County, New York, only recently reclaimed from a sunken marsh and brought under cultivation by a large New York city farming company, is well worthy of the best traditions of "Big Business" for tackling large enterprises. Big as the island of Manhattan, fertile as an indoor hotbed, swarming with caterpillar tractors and other labor-saving machinery that is revolutionizing the business of farming—the great Oak Orchard Farm stands out among general farming ventures as the largest and most systematic of them all. In the West there are larger grain fields than even Oak Orchard's nine mile by two mile stretch—but you will find no such general farms, no immense country produce manufacturing plant such as this humming valley actually is. Corporation ideals, corporation methods of handling employes, machinery, costs, manufactures and sales, and corporation efficiencies—all these are being applied to the tilling of the soil on the Oak Orchard Farm on a scale and with an energy never quite tried before. Capital is growing things in the ground—after the fashion of her own successful experience in other lines.

You need but look hastily over the great farm to realize that the spectacular extent of it and the newness of its working methods are significant. To make it a complete fruit and vegetable factory, capable of supplying huge quantities of produce for the hungry markets of the Atlantic seaboard, no expense has been spared. Several thousand acres of the precious muck land are already yielding bountiful crops of lettuce, beans, celery, spinach, and potatoes. On the uplands that skirt the muck hotbed some two hundred acres of orchards are under the care of expert pomologists. A stock-farm of four hundred cattle lies at the northern end; a colony of ditch-diggers and another of lumber jacks form separate communities by themselves; and three miles away, by the side of the railroad that puts the Oak Orchard Valley in marketing communication with the outside world, a large cannery, cold storage plant and potato cellar are in process of construction.

The story of the reclamation of the Oak Orchard Valley—its conversion within the last few years from jungle swamp to super-wealthy gardening soil—is a record of engineering achievement and agricultural skillfulness. The first engineers to arrive at the task saw before them a vast marsh, overgrown with dense underbrush and studded with small forests of heavy trees. Through the center of the whole waste area the lumber jacks, brought down from the Adirondacks for the purpose, hewed something in the nature of a path. Dynamite and mighty dredges tore and scraped away the earth. And, finally, the countryside saw a deep and wide canal flowing down the middle of the valley. But to drain the whole area, over a hundred miles of lateral ditches had to be scooped out till the Oak Orchard Valley began to take on the appearance of the Netherlands minus the windmills. In certain parts of the farm the reclamation work was accomplished in phenomenal time. One immense patch, which in the autumn of 1913 was a heavily wooded swamp lake, was changed in nine months to a harrowed field, ready for planting. Three months later—just a year after—it yielded a bountiful crop of delicious head-lettuce. Drained of water, cleared of brush, stripped of forest, plowed, harrowed, sown and harvested within twelve months—such is one of the accomplishments that corporation farming holds to its credit.

The old order is changing in this business of tilling the soil, and you can see the passing clearly right on Oak Orchard Farm. There are few horses employed in the fields—the steel "mule" and the caterpillar tractor are supplanting them. You expect to see the traditional bright-eyed farm boy following behind a horse-drawn plow perhaps—as you used to see on your uncle's farm



The light tractor is valuable in harvesting oats.

when you were a boy. But not so on this farm. The bright-eyed boy is there all right—but he is shifting gears at the end of an eight-foot steering and control wheel of a steel "mule," or running the five-gang plow behind a ponderous tractor under the guidance of a plow-gang foreman. Speak of old-fashioned rail fences and they will laugh at you.

"When land is worth as much as this precious muck," you are told, "it is a criminal waste to strew fences through the valley. We have just as few as possible, only along the highways. Think of the aggregate waste we would have if even a ten-inch strip of soil were covered by a fence! On this farm we figure fences in miles, so we aren't very lavish with them."

The rambling barns which once formed so picturesque a group on the old-style farm have been clean forgotten by the operators of the Oak Orchard expanse. Instead they show you neat concrete garages and maintenance-shops. In these are housed the steel "mules" that play so active a part in the tilling of the soil. The "mule" is nothing more or less than a light, powerful gasoline tractor, built much on the order of a live mule and scarcely larger, but capable of hauling loads on the highway or dragging heavy plows through the muck that would not budge for eight stalwart horses. Four steel wheels it has, corresponding to the live mule's feet; but it has an inexorable engine for a torso and a broad, corrugated "crawler" that grips the ground and propels it, caterpillar style, over even soggy ground. You quite agree with them when they liken the Oak Orchard Farm to the armies of Europe and tell you that the modern farm depends heavily upon gasoline. The new order of tilling has brought new demands.

Perhaps the most progressive step in the management of the farm is to be seen in their comprehensive cost-accounting system. To figure costs on a farm has always been a hard problem, and to figure them on a gigantic tilling community such as this one was of course an extremely difficult task. But it was accomplished in a very short space of time. Machine labor, horse labor and man labor—all are charged to the certain acre of crop upon which they are expended. The intricacies of fertilizing-cost, seed-cost and drainage-cost are included in the system, along with the scores of other entering cost-factors. It is probably the most complete system of its kind in the country, and, of course, as time brings experience it will be placed upon even more of a scientifically minute basis.

"They figure costs with great accuracy in industrial enterprises," says Mr. T. E. Knowlton, general manager of the big farm; "why shouldn't we do it here? Farming is rapidly becoming a manufacturing business."

With these words ringing in your ears—"Farming is rapidly becoming a manufacturing business"—you start out from the hilltop that lies to the south of the great muckbed on a tour of seeing the Oak Orchard Farm. Suppose you take an automobile; they talk in terms of square miles in the valley, and it is best to travel that way. There is no trouble in getting an auto; for the farm maintains nearly a dozen for the use of the officials and foremen. It is not a case of luxury, however. They are absolutely necessary to the efficiency of the organization. You quite agree with them on this point, after hearing that a sixty-mile tour is necessary to pay the farm hands off.

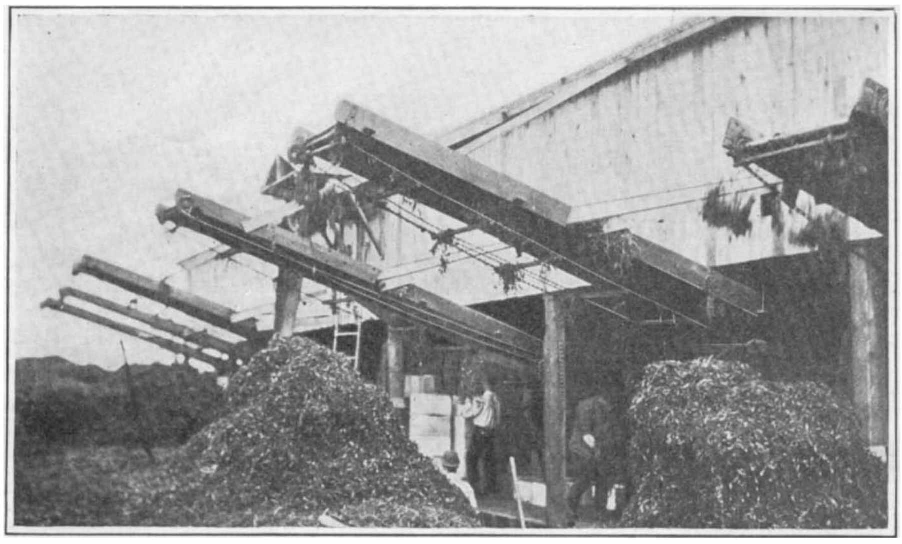
They run you down substantial roads—built by the farm's own road-squads—into the basin of the valley, drive you still farther along, over lateral canals and subsidiary ditches, until you reach an isolated spot in the center of the great muck hotbed. Before you, stretching away into distant woods, runs the wide drainage ditch that draws off the constantly flowing streams from a hundred miles and more of lateral ditches. This is the main canal. On both sides of it thousands of acres of the precious muck land, black and mushy and heavy, stretch away. With knee-boots on, it is safe to walk out upon the stuff and examine it.

"Wherein lies its special richness?" you inquire.

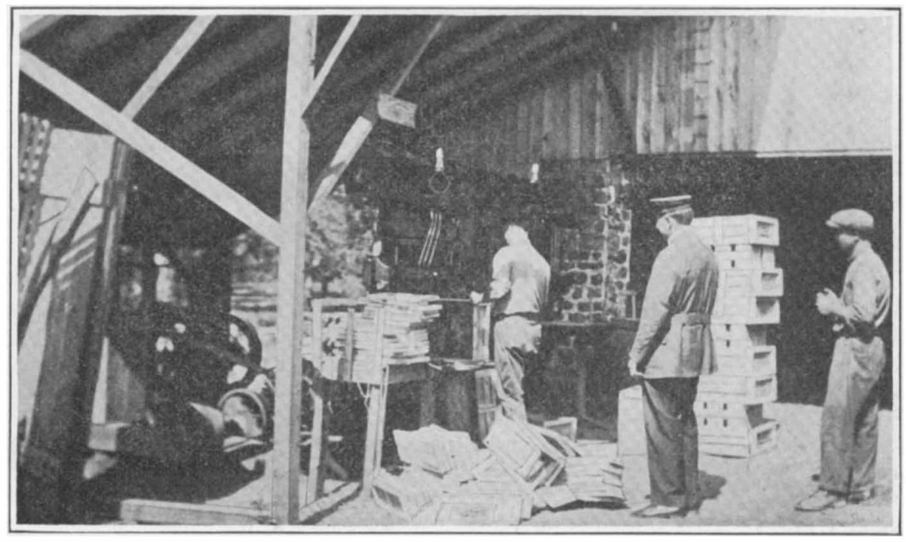
"In the great stores of nitrogenous deposits that it contains," is the answer. "It is permeated with vegetable matter, and is considered very rich soil. For most garden stuff, especially lettuce, celery, potatoes, spinach and cauliflower, it is ideal. In some spots this muck is as much as eleven feet in depth."

They take you over to see their experimental stations—modest little 35-acre lots which they use for testing out the soil for certain crops.

"We have a few patches of experimental stuff over here," that is the way they refer to it. Their "patches" would look like ranches to many an individual farmer. On one of them he could keep pretty busy for a good



At the thresher. Pea vines being discharged after passing through the machine.



Boxes for shipment of fresh vegetables are made in great numbers on premises.

many years. But in the Oak Orchard Valley they talk in big terms and think in big terms—and when they speak of growing a crop they visualize a scene of a square mile or two of vegetation. So they do their experimentation on "patches."

Off at your left you see two conical spires rising out of the muck expanse like lighthouses from the sea. They are the silos located at the stock-farm branch of Oak Orchard Valley. Within these buildings are stored the corn supplies which feed the cattle during the winter. Yes, they have a few cattle—four hundred odd, you learn. But it is only a side issue; what the big farm really does is to "manufacture" fresh produce.

Practically self-sustaining, that is what the countryside calls "the Wall Street Farm." Along the roads of its own making are miles of telephone wires of its own stringing. Each outlying camp and station is in touch with headquarters and with each other part of the farm. Comfortable dwellings of concrete house the men on the hillsides. Electric light, phonographs, a real club house with facilities for playing many kinds of games—a tennis court that is far above the average private court —all make life pleasant for the hundreds of workers on Oak Orchard Farm. The trim stucco bungalows in the headquarters camp would do credit to Long Island or Nantucket. With corporation far-sightedness and efficiency, the welfare of the worker has been provided for in practical ways.

Perhaps you think young fellows do not care to work on farms nowadays. Some pessimist has told you that the city-ward exodus is soon to leave the producing sections without tillers of the soil. Do not believe it of corporation farms. The labor problem has been met squarely at Oak Orchard, and may well act as a model for other such projects.

"It's the machinery that keeps our young men with us, interested, enthusiastic and eager for their work," the managers say. "We have an unusual amount of it. It is fascinating to the men on the farm. They learn something else but hand-labor. They seem to catch the spirit of the bigness of the enterprise, the need for conquering the earth with gasoline, dynamite, steam and other romantic means. This new sort of farm life appeals to them immensely."

When Oak Orchard Farm is completely brought under cultivation within the next couple of years, there will be over 4,000 workers on the great tract. Sites for more houses, constituting many little villages in one large community, have already been chosen. The plow-gangs, each under a foreman just as in a city factory squads work under a foreman, are monthly biting off the reclaimed land for productive purposes. The planted acreage this year has been far in advance of expectations. Already the corporation farm has immense selling problems on its hands. Special representatives are maintained in the great Atlantic coast cities during the marketing season to handle the shipments from the farm and see to their profitable disposition to wholesale merchants. Special canneries and packing plants are going up on the premises. The entire project gives the farming lands surrounding it an example of business-like, efficient, manufacturing of foodstuffs.

The effect of a successful outcome to the experiment of Oak Orchard Farm will be twofold. In the first place, it will have a tremendously stimulating influence on the reclamation of other marsh lands in the East. The rich soils that lie a-wasting, for instance, along the banks of the Hudson, may be put to some practical use. It is rich land. The West has regained its marshes; why not some of the choicest spots in the East, where land is even more scarce? Secondly, capital will look more carefully into the soil as a profitable investment. Mines, mills and railways have formed the greatest interest for capital—what sound reasons are there for neglecting intensive farming?

"We are facing the necessity of choosing," says so good an authority as Hugh J. Huges, editor of *Farm, Stock and Home*, "between co-operative effort on the one hand and corporate farming on the other, at least along many lines. The economic tendencies are, of course, all in the direction of *larger units of operaion*."

Oak Orchard Farm, a large as well as efficiently conducted unit, is an experiment in American agriculture that may, in the near future, exert an influence of significance.

A New Glass; and an Application of the Low Reflectivity of Glass for Radiant Heat*

A GLASS has recently been developed which is unique among borosilicate glasses in that it combines very low thermal expansion with great resistance to attack of reagents. It is of simple chemical composition, being free from heavy metals and metals of the magnesium-calcium-zinc group. Its characteristic properties are due, in part, to very high silica content which incidentally has necessitated special technique for its melting and working. Some of the measured properties of the glass are as follows:

Specific gravity 2.25.

Mean linear expansion coefficient (19–350 degrees) 0.0000032.

Attack by Reagents.—Water at the boiling point dissolves several times as much from the best imported laboratory glass as from this glass.

Softening Point.—A thread 1 millimeter in diameter and 23 centimeters in length suspended vertically and heated through the upper 9 centimeters elongates of its own weight at the rate of 1 millimeter per minute at 800 deg. Cent.

Culinary ware made of the glass was found to bake food more rapidly than earthenware or metal. The reason for this lay in the case of the metal in the greater reflectivity of the metal for radiant energy. Magnus found that silver reflected 83 to 90 per cent, glass only 6 to 14 per cent of the rays incident at an angle of 45 degrees,[1] while Hagen and Rubens[2] give 98 to 99 per cent as the proportion of heat reflected by silver and Coblentz's[3] curves indicate 3 to 11 per cent as the reflection by glass. The following experiment, devised by Dr. J. T. Littleton, showed that this difference in reflectivity is of practical importance in the baking process:

A baking dish was silvered on the outer surface in alternate quarters and a cake baked in it in an ordinary kitchen oven over a gas flame. Where the cake had been protected by the metal coating the bottom after baking was light colored, sticky, and imperfectly baked while in the other quarters it was brown and well done.

Experiments showing that bread bakes faster in glass than in tin were made by baking equal quantities of dough in two glass bread pans and two tinned iron pans of the same internal dimensions. The metal pans had been in service for some time and their outer surfaces were somewhat tarnished. The pans were placed in the oven of a gas stove, the two glass pans diagonally opposite each other and the metal pans diagonally opposite each other. All four were left in the oven the same length of time. When taken out of the oven the crust in contact with the glass was browner than the corresponding portions of the crust in the metal pans. The bread in the glass had risen higher than that in the metal. On cutting the loaves the bread in the glass pans was found to be more thoroughly baked than that in the metal pans. This experiment was repeated with the same result.

A more accurate comparison of the rates of heating in various materials was obtained by placing the dishes containing one liter of water on the shelf in the oven for a definite time and noting the temperatures reached by the water. The determinations are given in Table 1.

TABLE 1.—RATES OF HEATING WATER IN VARIOUS MATERIALS.

Test No.	Thin Glass		Aluminium	Tin	Enameled Earthenware	Thick Glass
1	90°	91°	78°	..	..	..
2	88°	86°	..	73°	..	86°
3	89°	89.5	..	73°	83°	..
4	89°	89°	..	..	..	..
5	94°	..	78°	74°	81°	86°
6	88°	..	..	..	..	..
Average	89.4		78°	73.3	82°	86°

The resistance of the glassware to fracture by blow was compared with that of crockery ("china") and enameled earthenware by dropping a 350-gramme weight on the bottoms of inverted dishes of approximately the same shape. The height of drop was increased by 2-inch intervals until the dishes failed. The results appear in Table II and show that the glassware withstands a blow very much better than the other ware.

TABLE II.—RESISTANCE TO FRACTURE BY BLOW.

Dishes Tested.	Thickness of Bottom	Result.
Glass:		
2-quart	4.8 mm.	Cracked at 22 in.
2-quart	5.8 mm.	Not broken at 34 in.
1-quart	4.9 mm.	Cracked at 26 in.
1-quart	4.3 mm.	Cracked at 22 in.
Enameled Earthenware:		
German, 2-quart	5.4 mm.	Cracked at 6 in.
Domestic, 2-quart	8.1 mm.	Crazed at 8 in. Shattered at 18 in.
German, 1-quart	5.6 mm.	Cracked at 14 in.
Crockery:		
New Jersey	6.20 mm.	Broke at 16 in.
Domestic	4.27 mm.	Broke at 10 in.
English	5.62 mm.	Broke at 12 in.
German	2.76 mm.	Broke at 4 in.

*E. C. Sullivan and W. C. Taylor in the *Journal of Industrial and Engineering Chemistry*.

[1]Poggendorff's *Annalen*, 138 (1869), 174.

[2]Drude's *Annalen*, 8 (1902), 1.

[3]"Investigations of Infra-red Spectra," Part 4, p. 88.

Effects of Atmospheres Deficient in Oxygen

THE results of experiments by the United States Bureau of Mines may be summarized as follows: Atmospheres that are deficient in oxygen begin to affect men when the percentage of oxygen is about as low as that affecting canaries and mice. Canaries are slightly more susceptible to "oxygen want" than are mice. In mixtures of air and nitrogen containing about 7.6 to 7.8 per cent oxygen, canaries show pronounced distress. When the oxygen content is about 7 per cent, mice show considerable distress, and a man is in grave danger of dying; hence canaries and mice should not be used by exploring parties in mines to show when men unequipped with breathing helmets should retreat, because the atmosphere is low in oxygen. Mice and canaries, especially the latter, are chiefly of value for indicating to exploring parties the presence of dangerous proportions of carbon monoxide. In an atmosphere in which oil-fed lamps will not burn, an exploring party should not depend upon canaries for further guidance, but should use breathing apparatus in advancing into the atmosphere.—*Technical Paper*, 122, *of the Bureau of Mines.*

Carillons and Chimes*

How They Are Rung, and Facts Relating to the Making and Tuning of Bells

By William Wooding Starmer, F.R.A.M.

First I will deal with the magnificent tower of Malines, which is 320 feet high, and the finest of its kind in the world. Although not completed according to the original design, which provided a spire (the total height of the tower and spire being greater than any structure in Europe). I think it will be readily admitted that the tower, as it stands, gains very much artistically by its incompletion. It is perfectly designed for the good disposition of the carillon, and the nature of the surrounding country greatly helps the effect of the bell music and enables the bells to be heard over an extensive area. The height of the bells in the tower, too, is an important factor—the lowest being quite 200 feet from the ground. Then there are no obstructions to prevent the sound from traveling to the farthest limit in any direction. In passing, it may be stated that a carillon should never be less than 100 feet high. Of course, there are many considerations which might modify such requirements, but I doubt whether, under any circumstances, a good result could be otherwise obtained. There must be no immediate reflection of sound about the tower, and there must be no hindrance whatever to the sound traveling in all directions equally well.

The beautiful effects obtained by M. Denyn from his wonderful instrument are made possible by the excellence of the bells, the good suspension, and the satisfactory height at which they are placed.

Next the bells may be dealt with. There are forty-five—the reputed weight of the largest being 8¾ tons, while the reputed weight of the whole of the bells is 33½ tons. The oldest bell is dated 1480, twenty-six being cast by the famous Pierre Hemony in 1674. The compass is four octaves, less one note. Many of the bells are of great antiquarian interest, and the ornamentation in some instances is very fine.

The uses of bells in this country and the special requirements of the bells when made and hung for the purpose of change-ringing, have caused variations in shape and thickness which have proved to be unfavorable to the bell, when considered as a musical instrument.

Many of our bells are poor in tone and inaccurate as to tune. Change-ringing is responsible for the alteration of shape—the shortening of the body—so that the series of harmonic tones has been completely upset, to the detriment of both tone and tune.

In times gone by, instead of improving the method of bell-hanging and the proper adjustment of the balance of the bell, our forefathers indiscriminately treated the bell itself and altered it in such a way as to impair its symmetry, in order that greater ease in ringing might be attained. Now, however, this problem presents no difficulties which cannot be overcome.

A consideration of the greatest importance is the difference in the construction scale in making bells for carillon use and for change-ringing. The following table will show where these differences occurs.

	For Carillons Cwt	qr.		For Change ringing Cwt.	qr.
1	1	2	G	6	0
2	2	0	F	6	1
3	2	2	E	6	2
4	3	2	D	7	1
5	5	0	C	8	0
6	6	0	B	9	0
7	8	2	A	11	0
8	11	3	G	13	0
9	16	0	F	17	0
10	20	2	E	20	2
11	28	0	D	28	0
12	40	0	C	40	0

(Middle C)

The reason of the heavier weights in the smaller bells of the change-ringing scale is to prevent them being swamped by the larger ones, and, for the purpose, increased thickness is an absolute necessity. This upsets the harmonic tones more or less, and although the most important ones can be satisfactorily dealt with, at times no tuning can completely rectify the subordinates.

Then, of course, the difference between the methods employed in sounding the bell has to be taken into account. In the carillon the clapper strikes the bell (hung "dead" or "fixed") from a very short distance; consequently no great volume of tone is produced. In change-ringing the bell completes a circle for each blow of the clapper, which thus hits the bell with great force.

* Read before the Royal Society of Arts.

Taking these things into consideration it is difficult to make any true comparison between the use of English bells cast on a different scale and operated upon in an entirely different manner and Continental bells made for *carillon* use, automatic or otherwise.

There is not much to say with reference to bell sounds produced by a mathematical formula in which musical considerations have hitherto played only a small part, although in recent years much attention has been given by composers of peals to the elimination—as far as possible—of changes containing unmusical cadences. It is not possible, however, to get rid of the unsatisfactory musical effect of the finals of some changes.

Far be it that change-ringing should in any way be discouraged; but music played from the clavier raises the bell to a much higher plane and makes the musical expression almost as great in its possibilities as in pianoforte playing. It is difficult to realize how such effects can be obtained by means of a mechanism that is of comparatively rude construction. There is much room for improvement in the action-work connecting the clavier with the bells, but there is not the slightest difficulty in accomplishing this.

It is probable that in the near future the action-work will be pneumatic, electric, or both—ensuring such control of expression that the player can use a keyboard identical with that of the pianoforte, thus avoiding the great physical exertion which is now often necessary. With such an action the finger will do what is now done by hand, and the playing of the pedal will be no more laborious than is the case with the modern organ.

The clavier is arranged on the same principle as the manuals of an organ. The keys are made of oak. They are round, being about ¾ of an inch in diameter. There are two rows of them, the upper representing the black notes of the ordinary keyboard, projecting 3½ inches, the lower corresponding to the white ones and projecting 6½ inches. The pedals are one octave or more in compass. The pedal board is a necessity, because the larger bells require much more force to bring out their tone. The clappers are consequently much heavier, and demand a considerable expenditure of energy to move them. The pedal clavier also greatly increases the resources of the instrument, and permits the music to be played in three or more parts.

The keys are struck with the closed hand, the little finger being protected with a leather covering to prevent injury when playing. As the leverage of the key has to move the weight of the clapper, which in large bells is very considerable, and as the amount of tone produced depends entirely upon the amount of force with which the key is struck, it will easily be understood that carillon playing required a great deal of strength as well as celerity and skill.

The connection between the key and the bell clapper is exactly the same in principle as the tracker action used in organs, iron levers, squares and wires being used in the places of the wooden materials of organ building. On the clappers of the smaller bells springs are fixed to bring them back into their original position quickly after striking. In the larger bells the clappers are too heavy for this arrangement. They have a simple appliance consisting of a chain which is attached to the "flight" of the clapper and passed over a pulley. A weight is fixed to the other end of the chain sufficiently heavy to bring the clapper within a very short distance of the sound-bow of the bell, so that the key has only to upset the balance between the weight and the clapper.

The mechanism connected with each key is fitted with an adjustable screw-plate, or other device, by which the tension can be regulated to a very great nicety, and the touch adapted to the requirements of the player.

The bulk of the playing is done on the smaller bells, with only occasional use of the larger ones. The reasons why this should be so are:

(1) The small bells are more easily manipulated;

(2) The effect of chords is much more satisfactory than on the large bells, owing to the fact that in the latter the harmonic tones are very prominent and frequently interfere with each other when sounded together in a disagreeable manner.

This is not the case with the smaller bells when used in combination, as their harmonic tones are too high in the scale of sounds to inconvenience the ear.

Concerning the chime apparatus, there is much to be said. With us melody only is played, and rightly, too, for as a rule, our bells are much heavier than those on the Continent, which are used for two, three, or four-part harmony. Heavy bells, especially when the notes are near together, would be unbearable in combination, because their harmonic tones would greatly interfere with each other. This interference would be greatly accentuated in any extended compass, because until recent years all sets of bells in this country—whether diatonic or chromatic—have been on the ringing scale, which means that they are thicker and heavier than they should be for carillon use. Perhaps this has been unavoidable, as in several instances a specified number of bells in the scale have been hung for change-ringing. It is well to state that it is most undesirable to make bells on the ringing scale for carillon use, and it is equally undesirable to use bells made on the carillon scale for ringing purposes. The demands in both instances differ widely, and the bells cannot be made to serve two purposes satisfactorily or equally well. Until recently this has not been properly understood in England. The late Lord Grimthorpe is responsible for much of the trouble relating to thick bells. He insisted on having all bells over which he had any jurisdiction made on an abnormally thick scale. Experience has shown that on this point he was wrong although his crusade may have prevented many bells from being made too thin.

Our ancient chime machinery is very simple, and consists of a weight-driven barrel, sometimes as large as 3 feet in diameter, generally made of wood, into which pins are fixed on exactly the same principle as in the barrel of a musical box.

The pins in the chime barrel pulled down levers, which lifted the hammers with which they were connected by wires, and released them, so that in their descent they fell upon and struck the bell from the outside.

In passing, I might mention that in mechanical chimes the hammers always strike the bell from the outside.

Of course, in such a machine the barrel had to do all the work. It was satisfactory so long as the requirement was merely the playing of a regular succession of notes of equal value at a moderate speed—a simple hymn tune, or the like. But as there are very few melodies of real interest which come within these limits, particularly as regards secular tunes, more elaborate airs, consisting of unequal notes, mixed long and short note values, groups of short notes in quick succession, etc., were set on the chime barrel. Such demands had the effect of obliterating everything in the shape of correct time in the rendering of the music, because the chime barrel with the same motive power had to play, perhaps, four notes in the same time as one which preceded the group of four and two which followed, e. g., "Rule Britannia."

As you can well understand these unequal demands made the speed of the barrel very irregular, with the result that one bar was played at a quicker or slower time than another. This made the musical effects of many chimes very unsatisfactory, and, in not a few instances, quite grotesque. The fault was in trying to make the mechanism do what it was incapable of, and for a time, no doubt, this tended to mar the popularity chimes had gained.

About fifty years ago improvements in chime mechanism were made by Messrs. Lund and Blockley. The general principle was good but certain parts of the machine were too weak to bear the strain of the very heavy driving weight used.

Other improvements were made by Messrs. Gillett, of Croydon, who erected their first carillon machine at Boston parish church in 1868. The particular advantage of their machine is that it divides up the mechanical operations. A separate movement is fitted to raise the hammer-levers into action immediately after they have fallen and struck the bells. When raised into position they are prevented from falling by a spring trigger, which can be released by the slightest touch. The only work the chime barrel has to do is to release the triggers, so that the demand on the barrel is reduced to a minimum.

The most recent invention in our carillon machinery has been made by Messrs. Smith and Sons, of Derby. It differs from Messrs. Gillett's machine principally in the subdivision of the driving power.

Each hammer, or set of hammers, has its own special mechanism driven by a separate weight instead of the motive power required being derived from one source, as is the case with other machines. Consequently the weights are so adjusted that the driving power is at all times adequate for the proper working of the hammers, individually and collectively. I mean that, however

great the demand is, it never makes the smallest difference in the efficient working of all the parts, thus securing perfect time in the playing of the tunes.

This is a decided advance, and with such a mechanism almost anything can be played, although it is undesirable to set very quick tunes on the chime barrel.

At Malines, in some instances, there are as many as four hammers to each bell, so as to ensure the quick repetition of the note when required. The connections there between the chime-machine and the hammers are made by means of wires, squares, etc., just as in our own chimes. These vary from 15 to 40 feet in length. Although the connections are in appearance somewhat clumsy, they require a very nice adjustment.

The chime-barrel is made of gun-metal, with two rim cogs and a center guiding cog. It was cast in 1733, completed in 1734, and is 5 feet 3 inches in diameter. The driving weight is 1 ton 6½ cwt., being about 4 cwt. in excess of that which is absolutely necessary for the purpose. The chain to which the weight is attached is over 90 feet long, and is wound round an oak drum fixed on the axle of the chime-barrel, so that the weight-force exerted is direct—i. e., there is no gearing.

The chimes are set twice a year—at Easter and in October—and as the barrel is a permanent part of the mechanism the chimes can only be altered by a rearrangement of the studs. This takes about four days to do. There are no interchangeable barrels such as we have in England—a disadvantage; but against this must be set the greater accuracy of the rendering of the music obtained by using a large barrel, and by providing such generous driving power.

The Malines chimes play no less than eight times during the hour; a short flourish at each half quarter, a short piece at the quarter before and after each hour, a longer piece at the half-hour, and at the hour a piece of still greater length. The hour is struck as in England, but the hour to come is announced after the half hour on a smaller bell than that used for the hour strike.

In our country many of the disgusting exhibitions we are forced to listen to, and which in many instances set people against chimes, are the result of gross carelessness and inattention to the proper upkeep of the chime mechanism. In many instances, when chimes are put in a church and set going, there seems to be a general idea that they will work for the next century without any attention whatever. If mechanical chimes are to be successful they require very frequent attention and regulation. The chimes at Malines could never be so satisfactory if it were not for the fact that they are under the constant care of an expert specially employed to look after them, and who almost lives in the tower.

It is not so long ago that our bells and belfries were allowed to get into a very disgraceful state. Now, happily, this is utterly changed; but I regret to say that chimes, generally speaking, are grossly neglected.

The adjustment of the hammer connections and the regulation of the different parts require just as much care and attention as the action of a pianoforte to ensure the most satisfactory results and to prevent the extravagant wear and tear of the mechanism caused by neglect.

In conclusion, I cannot do better than repeat what I have already said on many occasions when lecturing on this subject. The carillon with clavier is the finest musical instrument in existence for educating the people in and cultivating their love for folk-songs and in teaching them the great melodies of their fatherland; for the music best suited to the carillon—excepting music specially written for the instrument—includes the folk music which has successfully stood the test of time.

New Data on the Archæology of Venezuela*

Notes on the Results of a Recent Reconnaissance

By Herbert J. Spinden, American Museum of Natural History, New York

The archæological reconnaissance of Venezuela made under the auspices of the American Museum of Natural History had for its purpose not so much the study for their own sake of Indian remains in Venezuela, but rather for the light that these remains might cast on certain fundamental problems of American archæology. The field, although untried, is theoretically of the greatest importance. It is generally recognized as the point of departure for the original culture of the West Indies. Moreover, it is intermediate between the rich and well-known fields of Colombia and Costa Rica on the one hand and of Eastern Brazil on the other, and might be expected to furnish proofs of cultural connection if such exists. The success attendant upon recent stratigraphic work in the Southwestern States and in Mexico, and the great advance in our knowledge of actual chronology in Cenral America, tempt us to widen the recognized horizons of ancient American history whenever this seems possible.

Northern and Central Venezuela were visited. The route passed from Maracaibo to Bobures, a port on the southern shore of Lake Maracaibo, and thence across and along the Eastern Andes to Mérida, Trujillo, Tucuyo, and Barquisimeto. Next the rich interior valley running from Valencia to Caracas was examined. From this populous region the road led southward across the llanos to San Fernando de Apure and thence by the Apure and Orinoco rivers to Ciudad Bolivar, the British island of Trinidad, and a number of Venezuelan coast ports. Private collections, mostly small, were found in the principal cities. Notes and drawings were made of important specimens in these collections and considerable information obtained from local students. A few important sites were visited.

Space forbids detailed descriptions of archæological specimens that came to light in Venezuela. Suffice it to say that stone implements, including celts, pestles, etc., vessels and figurines of clay with painted and modeled decorations, personal ornaments of shell, nephrite, jet and serpentine, as well as petroglyphs and pictographs, occur in considerable quantity. Various provinces may be marked off for detailed study, in each of which the ceramic products are sufficiently peculiar to be readily distinguished.

In the Andean region painted pottery is common, but elsewhere it is rare. In caves and near sacred lakes on the wind-swept paramo many interesting figurines of men and women have been discovered, the former seated on stools and the latter in a variety of standing and sitting poses. These are seemingly the idols of a primitive agricultural people. By the peculiar style of construction and decoration of these figurines the student of ancient art can clearly demonstrate a cultural bond between Venezuela and Central America. Breast ornaments of shell and serpentine, carved to represent highly conventionalized bats, are common in the Andean province, but become rarer as one passes toward Central Venezuela.

The shores and islands of Lake Valencia are rich in archæological remains. The level of this body of water has fallen about twenty feet since the coming of the Spaniards, leaving old shore villages high and dry, and making possible stratigraphic studies. Irregular earthen mounds containing a wealth of material, broken and entire, are found at a number of sites. Unfortunately for science the most remarkable group of mounds is now being destroyed in a hasty and unguided search for specimens. In this region collars of carved shell beads are often unearthed as well as stone pendants in the form of frogs. Pottery is decorated by modeled designs, among which the highly conventionalized bat with outstretched wings is prominent. Figurines that represent human beings, jaguars, frogs, etc., are common, and often finely executed. Connection with the Andean region is evident in pottery shapes as well as in the styles of decoration. A development over a long period of time doubtless took place here with a succession of somewhat different types.

Passing toward the east the material available for study falls off in quantity. On the llanos to the south very little collecting has been done, although ancient village sites exist along the rivers. The few pieces brought to the attention of the writer show that an ancient sedentary culture of the "archaic school" once flourished here. Archaic pottery is also found at points along the Orinoco, and it may be remarked that this ancient ware is very different from the varnished pottery now made by the uncivilized Indians of Southern Venezuela. Little is yet known concerning the archæology of Eastern Venezuela. Collections made in Trinidad show a marked change from the types of the central region, but not a complete break. West Indian forms are well developed here.

But while regional study shows what might be expected, namely, a series of merging types in accordance with the principle of divergent development, there are features of Venezuela archæology that offer evidence of customs once prevalent over the entire area. Urn burial is such a feature, reported from the island of Aruba, from the vicinity of Maracaibo, Mérida, Valera, Carache, Valencia, Maracay, La Union on the Portuguesa River, San Fernando de Apure, Atures on the Orinoco, etc. The urns are from two to two and a half feet in height, usually with rather narrow mouths closed by an inverted urn or by a shallow bowl. In these urns human remains are encountered in a sitting position, with the knees under the chin and with the hands at the side of the face. The small size of the urns raises an interesting question concerning the method of inserting the bodies. It is not unlikely that desiccation preceded burial. These burial urns are sometimes found in caves and sometimes in low mounds, but for the most part they are met with at a depth of about two feet below the apparently unmodified surface of the earth. The distribution of this method of burial probably extends beyond the limits of Venezuela, and may be continuous over the open lands of the interior to Brazilian Guiana and even to the island of Marajo in the mouth of the Amazon. On the west urn burial is well known in Nicaragua. The extension of this feature to the West Indies deserves to be studied with care, since it is found in our Southern States.

The statement has already been made that the figurines found in the Eastern Andes resemble closely those of Central America. This might be made stronger and the conclusion brought home that the plastic art of Venezuela is one and the same with the "archaic art" already known in Mexico and Central America. The proof is both objective and subjective. To be sure we must always stand ready to evoke the doctrine of divergent development, but with a knowledge of transitional types the very fact that an orderly and systematic change is to be observed makes stronger the proof of cultural dissemination. In Mexico and Central America the archaic art was succeeded by other and higher styles. In Colombia some influence from these later cultures is manifest in pottery and metal work. But in Venezuela no later inflow has been noted, and but slight evidence of independent local uplift.

The writer has elsewhere expressed the opinion that the diffusion of ceramic art of the so-called archaic type was contemporaneous with the primary diffusion of the concept of agriculture, together with the actual passing of certain cultivated food plants, such as maize, beans, and squashes, that are universally known among American Indians on the agricultural plane of life.

As regards Venezuelan archæology, the question of time should perhaps be held in abeyance. In Mexico and Central America we have reason to believe that the archaic culture gave way to the higher civilization of the Maya at about the time of Christ. It had doubtless lasted a very long time, since the deposits of this period are very thick. But once implanted in Venezuela the archaic culture, free from the pressure of higher arts, might have maintained itself till the coming of the Spaniards. There is evidence, however, of considerable pressure of population by wild tribes from the South, and the little that is known of Venezuelan ethnology is not in full accord with the archæology.

Beyond Venezuela we may be permitted to indicate the probable course of ancient empire. There is little doubt in the mind of the writer that the archaic culture—standing everywhere for sedentary agricultural communities, skillful in making pottery and textiles—was once laid down across Northern South America and that the remarkable pottery of Marajo, at the mouth of the Amazon, will prove to be a distant but congenital relative of the ware from the lowermost stratum of human handicraft in the Valley of Mexico.

The full data resulting from this exploration, together with that obtained by further field studies, will appear in the *Anthropological Papers* of the American Museum of Natural History.

*Proceedings of the National Academy of Sciences.

Electricity in the Kitchen

In an interview in the *Electric Review* an official of an electric heating company states that the time is not far removed when the electric power required for cooking will exceed that used for power purposes, which means that cooking by electricity will be universal wherever current can be obtained. It is asserted that electric ranges are being sold where natural gas costs but 25 cents a thousand feet, not because electric cooking is cheaper, but because of its convenience and the results obtained. A strong claim that is made for electricity, as compared with gas, is that the efficiency of the electric range is 85 per cent, as compared with 15 per cent for gas, still it is admitted that the electric range is of much better construction, and that more careful attention has been given to details.

Plate I.—Sheaths of Leptothrix ochracea; x 500.

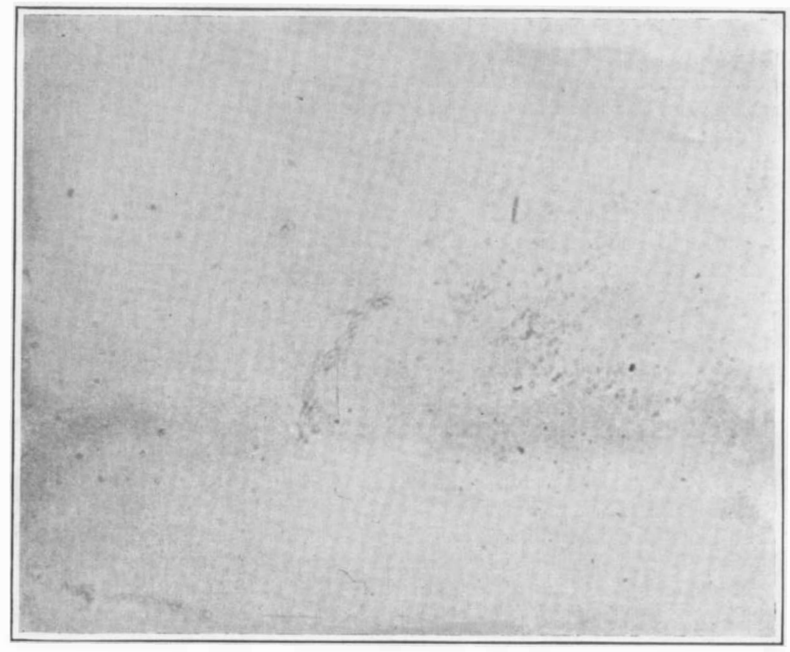


Plate II.—Gallionella ferruginea; x 450.

The Iron-Bacteria—I*

A Curious Class of Organisms, Their Physiology, and Their Action on Iron Solutions

By David Ellis, Ph.D., D.Sc., F.R.S.E., Royal Technical College, Glasgow

Among the higher bacteria is to be found a certain class of organisms that almost always inhabit ferruginous waters. As a result of their growth and multiplication, their mucilaginous outer membranes become impregnated with ferric hydroxide. This gives them a rusty red appearance, and on this account, and because of their constant presence in iron-laden waters, they have been named Iron-bacteria by Winogradsky. Now part of the iron in these waters is in solution in the ferrous form, and the changes for which the iron-bacteria are responsible consist in a transformation of these soluble ferrous compounds into the insoluble ferric hydroxide. If a microscopic examination be made of the red deposit which forms the bed of ferruginous streams, or the deposit which rings the mouth of ferruginous springs, in nine cases out of ten the deposit will be seen to consist of a multitudinous number of small hollow tubes such as are figured in Plate I. These tubes are the remains of Iron-bacteria. During their lifetime the enveloping sheath which each individual possesses becomes impregnated with ferric hydroxide, which is an excellent preserving medium, with the result that when the organisms die the sheath which covered them does not disintegrate, and in time their number becomes so great that the bed of the stream is colored a deep red and in many cases a thick deposit is formed. The majority of these sheaths originally formed a covering to *Leptothrix ochracea* (syn. *Chlamydothrix ochracea*), the best known and most widely distributed of the Iron-bacteria; others, however, may have covered other Iron-bacteria such as *Cladothrix dichotoma* or *Crenothrix polyspora*. A more detailed description of the sheaths will be given when we come to consider the individual species. It will suffice here to state that in the living organism the sheath is at first a delicate pliable covering which gradually grows into a thicker and stiffer membrane as it becomes impregnated with ferric hydroxide. When the protoplasm dies the sheath sinks to the bottom and contributes its mite to the general stock.

To observe *Leptothrix ochracea* in the living condition the ochre-waters are kept under observation, particularly at the close of winter and during the autumn months. There will then be found fluffy brown-red streamers waving in the water, and attached to bits of grass or to stones under the water. These will probably be living threads of *Leptothrix ochracea*, and we will describe it first.

LEPTOTHRIX OCHRACEA (SYN. CHLAMYDOTHRIX OCHRACEA) (KÜTZING).

The cylindrical, unicellular threads of Leptothrix are easily recognizable. The ends are rounded and the membrane, or sheath, is a delicate covering which a judicious staining renders visible. The threads measure from 1μ[1] to 2μ in breadth according to the age and to the amount of deposition which has taken place (Fig. 1). Old threads may show a measurement of 3μ or about double the average width. This happens when the deposition of ferric hydroxide has been very active.

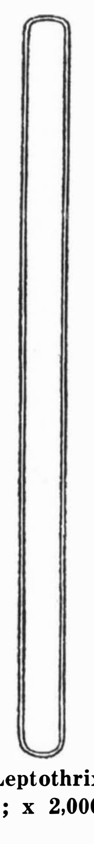


Fig. 1.—Leptothrix ochracea; x 2,000.

Fig. 2.—Gallionella ferruginea; x 1,000.

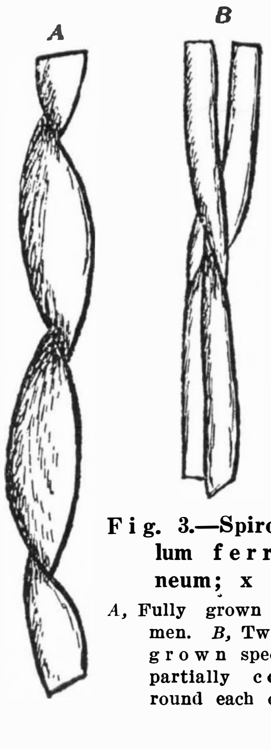


Fig. 3.—Spirophyllum ferrugineum; x 1,500.
A, Fully grown specimen. *B*, Two half-grown specimens partially coiled round each other.

Reproduction takes place by fragmentation, small or large portions being liberated by a process of constriction. The liberated portions grow in length and repeat the process. When this takes place the length of the thread is not very great, but when the period of fragmentation comes to an end the threads elongate and may then reach a length of 200 μ or more. Another method of reproduction is by the formation of *conidia*. A little swelling is formed on the outer surface, and when this reaches a certain size a process of constriction takes place resulting ultimately in the liberation of a small oval cell, the conidium. These conidia are formed over the whole surface. Germination takes place, probably by direct elongation, and a new thread is formed. Pure cultures have been obtained in artificial media by Molisch. In such cultures conidia formation does not take place, but there is instead a liberation of "Schwärmer." These are short threads which have evidently not arisen by fragmentation, but have sprung out laterally from the Leptothrix thread, and assumed motility as soon as they have been cast loose. There seems little doubt that these motile threads developed each as a protuberance as conidia do, but instead of being cut off to form conidia, continued their elongation until a certain length was reached, when their liberation from the parent thread was effected by the setting in of a process of constriction.

GALLIONELLA FERRUGINEA (EHRENBERG).

In nature we scarcely ever find Leptothrix without at the same time meeting a peculiar organism in the shape of a long, flexible, thin thread which from its earliest stages shows a marked tendency to coil one end of the thread round the other. Examples are shown in Fig. 2 and Plate II. This coiling tendency is shown in the very youngest and ceases only when deposition of ferric hydroxide, by stiffening the periphery, and old age by the loss of capacity, make further coiling impossible. The process must be regarded as a case of contact-irritability, not essentially different from the irritability of the higher plants which enables tendrils, for example, to climb round their supports. In thickness the threads vary from ½ μ to 1½ μ. Migula claims to have found a delicate membrane limiting the organism on the outside, but neither Adler nor the writer has been able to verify his statement. It certainly is not present in older threads impregnated with iron, when, as in the case of Leptothrix, if present it would be a fairly well marked structure.

Multiplication takes place as in Leptothrix by fragmentation, small portions of coiled threads being cast loose into the surrounding water. These elongate and coil until the normal size is attained. The writer has also observed a method of conidia formation in Gallionella which is identical in all essentials with the same process as observed in *Leptothrix ochracea*. Sometimes the deposition of iron results in a complete obliteration of the form of the organism. In such cases the deposition increases the breadth of the organism to two or three times its normal dimensions.

* *Science Progress.*
[1] 1μ = 1/100 millimeter.

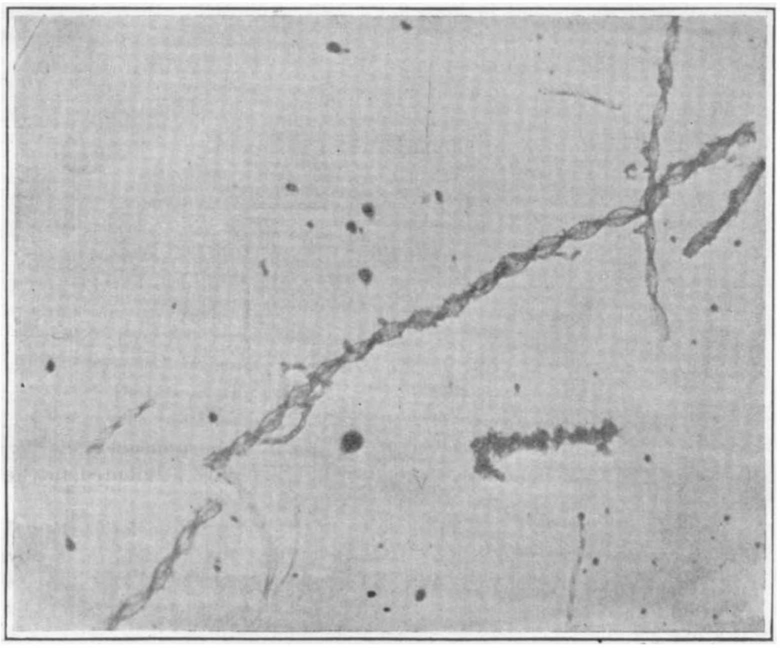


Plate III.—Spirophyllum ferrugineum; x 450.

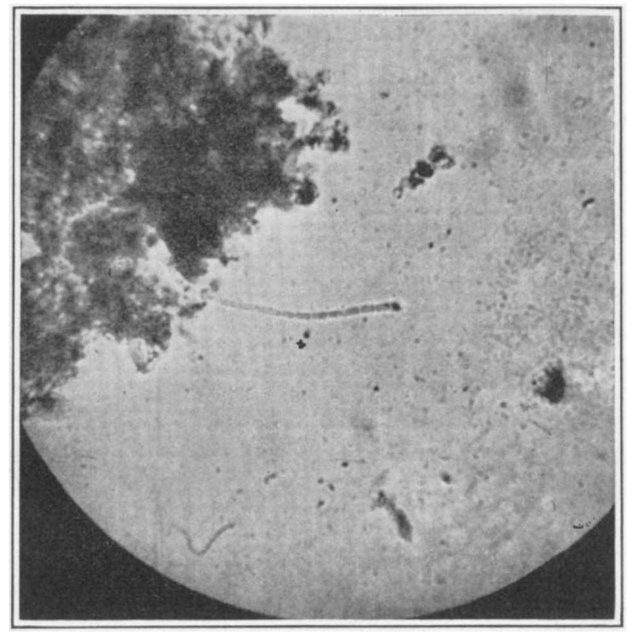


Plate IV.—Crenothrix polyspora (young thread); x 500.

SPIROPHYLLUM FERRUGINEUM (ELLIS).

A new genus of Iron-bacteria was found by the writer in the neighborhood of Glasgow. Like Gallionella it exhibits the coiling habit, but differs from this organism in that the body takes the form, not of a thread, but of a flat band. An example is shown in Plate II. The presence of two individuals coiled round each other is not an infrequent aspect in cultures of this species (Fig. 3 *B*). Multiplication takes place as in the two preceding organisms, by fragmentation and by conidia-formation. Like these two also its power of collecting ferric hydroxide round itself is very considerable. As seen in Plate III in the figure to the left, the deposition of iron has completely obliterated the form of this organism. The other figures in the same plate show youngest individuals the color of the bands is rusty red and assumes a deeper tint with increasing age. Since the discovery of this organism its presence has been observed in various parts of Great Britain and lately in America also. On the Continent its presence has not so far been recorded, though there can be little doubt that a search there for it would be attended with successful results.

INTER-RELATIONSHIPS OF LEPTOTHRIX, GALLIONELLA, AND SPIROPHYLLUM.

An intimate study of these three organisms engenders the thought that perhaps they are more closely connected than appears on the surface. With regard to Spirophyllum, Molisch maintains that it is identical with Gallionella. This view, however, is based on the except in the presence of Leptothrix. The same is very nearly true of Spirophyllum. In fact their association is too close not to suggest a very close relationship. Add to this that in their methods of reproduction, in their powers of attracting iron, and in every other respect, except in the shape they assume, these three organisms are identical. Some biologists, like Schwers, have already suggested that Leptothrix and Gallionella are probably identical. The writer is of the same opinion, and considers that Spirophyllum, Gallionella, and Leptothrix will probably in the future be discovered to be one highly pleomorphic genus. If so, whatever the factors are which determine the shape, they are brought to bear in the very earliest phases of the existence of each individual. At present, however, we do

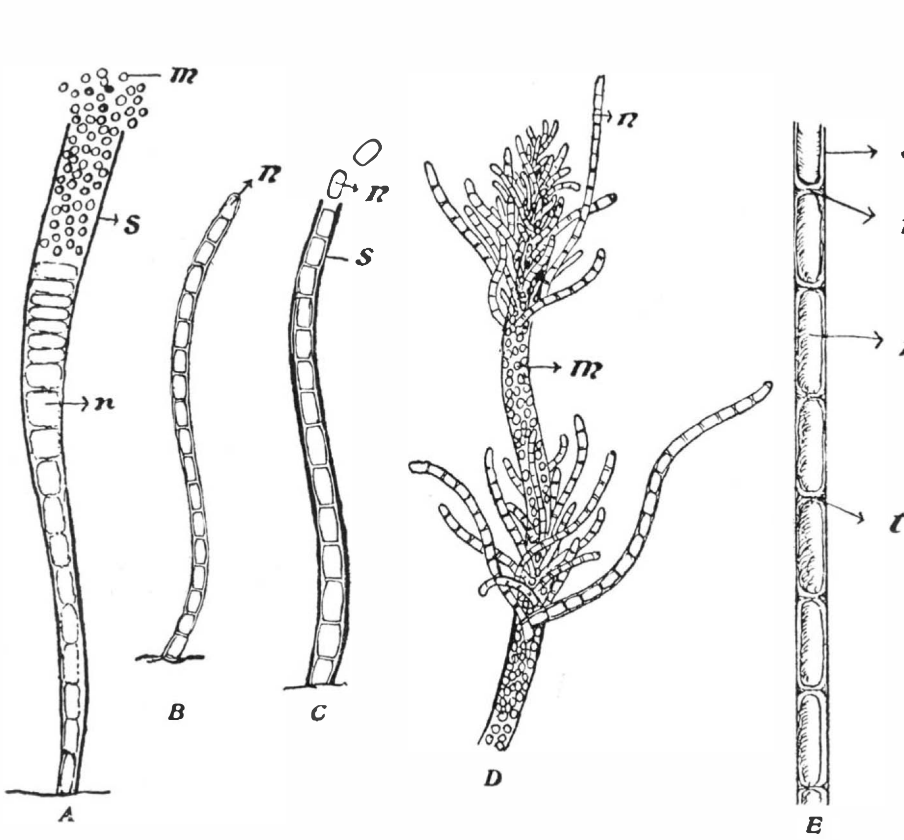


Fig. 4.—Crenothrix polyspora; A—D, x 1,000; E, x 2,000.

A, Mature thread open at the top. *B*, Young thread. *C*, Thread with rod-cells in process of liberation. *D*, Appearance of thread during period of very rapid multiplication. It is filled with cocci, which in germinating push out laterally through the sheath. *E*, Young thread strained to show transverse walls of the sheath. *s*, sheath; *n*, rod-cells; *m*, cocci; *t*, transverse walls of sheath.

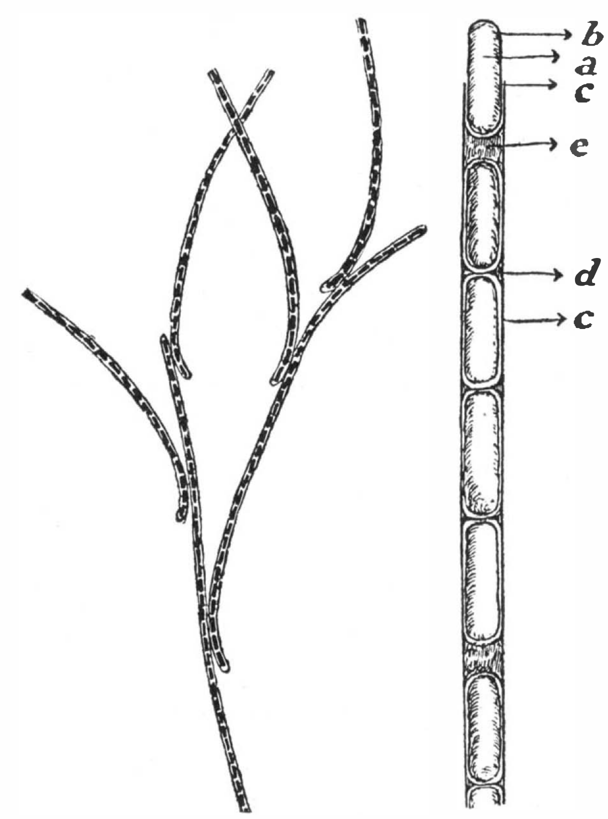


Fig. 5.—Cladothrix dichotoma; x 1,000.
Fig. 6.—Cladothrix dichotoma; x 3,000.

a, rod-cell; *b*, wall of rod-cell; *c*, lateral wall of sheath; *d*, transverse wall of sheath; *e*, thick transverse wall indicating spot formerly occupied by rod-cell. Latter escapes laterally, the space occupied by it being gradually encroached upon by the growth and division of the lower rod-cells.

that there is much variety in the number of twists, in the width of the bands, and in the lengths of the individual twists. The bands vary in width from $1\,\mu$ in the youngest forms to about $6\,\mu$ in the fully matured specimens. The thickness is, roughly speaking, from a sixth to a tenth of the width. The youngest specimens that were observed consisted of very thin half-twisted bands measuring $1\,\mu$ in width and from $4\,\mu$ to 6μ in length. These exhibited an independent movement, partly of a trembling and partly of a pendulum nature. The deposition of ferric hydroxide, however, seems to effect an early stoppage of this movement. The fully grown specimens (see central figure in Plate III) may show thirty to fifty twists, and are correspondingly wider and thicker. Except in the very superficial resmblance which undoubtedly exists between old iron-laden bands of Spirophyllum and similar threads of Gallionella. An accidental resemblance between the "corpses" of these two organisms cannot, however, weigh against the fact that during life from their earliest beginnings the band-shaped structure of the one and the thread form of the other are respectively the distinctive features of the two organisms. Molisch apparently presumes that Spirophyllum is identical with dead Gallionella threads, the spaces between the coils of which have become filled with ferric hydroxide, thus converting the coiled threads of this organism into a band-shaped structure. We must look deeper for an insight into the relationships of these forms. It is noteworthy that Gallionella is never encountered not possess any evidence in support of the above hypothesis, and we can give expression to what at the present is a matter of feeling and not of fact.

We are now about to discuss three organisms which likewise form a natural group. They are of greater interest to water-engineers and to medical officers of health than the preceding on account of their tendency to spasmodic immoderate multiplication causing a serious hindrance to the flow of water through pipes. Their influence on water is not of a pathological nature, no poisonous excretions being liberated as a result of their growth; but they seriously inconvenience the engineer and give a little anxiety to others who are concerned to see their water reservoirs assume a rusty red color. We shall not anticipate here the discussion on the physi-

ology of these bacteria further than to state that as a result of their activity the iron which is in solution is precipitated, causing a deposition of ferric hydroxide on all substances with which the water comes in contact. When a certain at present unknown sum-total of conditions holds, these organisms multiply at an extraordinary rate, with the result that the number in the water of individuals each coated with ferric hydroxide is so great that the whole mass of water in a very short time takes on a very disquieting rusty red color. These sudden rapid multiplications never last long because the organisms themselves probably make the water unfit for their continued existence. In the intervening period their activities are subdued. In fact they take their place on an equal footing with other water organisms, and it is possible at most seasons of the year to detect their presence by a diligent search in their haunts.

CRENOTHRIX POLYSPORA (COHN).

This organism has been known since 1852, and since then attention to the details of its life-history has been stimulated by the trouble and expense incurred when rapid multiplication has taken place. In Germany it is known as the "Brunnenpest." Among its visitations may be mentioned Breslau in 1870, Berlin in 1878, Lille in 1882, Rotterdam in 1888, and Cheltenham in 1896. At Cheltenham in 1896 the water supplied to the town became red and turbid, and from it there emanated an offensive odor. Within a fortnight the filters had become clogged. This state of affairs continued for about six weeks, after which the water once more began to assume its normal appearance. In spite of this alarming state of affairs Garrett reports that there was no evidence to show that the organism had any pathological influence. The appearance presented by an adult specimen of Crenothrix is very characteristic, and when once seen is subsequently easily recognized. This is shown in Fig. 4*A*. It consists of a hard cylindrical sheath, narrow at the base, but widening at the top. Inside the sheath are a number of short rods. When growing under normal circumstances these rods in young plants are arranged in a single row (Fig. 4*B*), but in older specimens the rods at the apex tend to break up into a number of round cells or "cocci" as they are called. This is shown in Figs. 4*A* and 4*D*. If a young specimen be compared with an old one it will be seen that in the former case the sheath completely invests the enclosed rods and is equally wide at base and apex (Figs. 4*B* and 4*C*), but that in the latter case the sheath, now somewhat hardened, has burst at the top and shows much wider at the apex than at the base (Fig. 4*A*.) A young Crenothrix plant is shown in Plate IV. The bursting of the sheath at the apex enables the rods or cocci, as the case may be, to gain access to the outer world, and when liberated they elongate and in their turn form new threads.

With regard to the dimensions of this organism, the rods vary in length from 2 μ to 7 μ or 8 μ. The cocci measure from 2 μ to 4 μ in diameter. The sheath closely invests the contained rods, and while measuring 2 μ to 4 μ at the base may attain five or six times this width at the apex in a mature specimen. In normal times the rods or cocci are gently thrust out through the apex of the sheath, but when, as stated above, inordinate multiplication takes place, the individuals appear to be galvanized into leading a very strenuous life. The whole contents of the sheath break up into cocci, with the result that each sheath will contain several hundreds of these bodies. Then not only do the latter emerge from the apex, but they also break through the sides. Many even elongate into new threads from inside the sheath. In this condition the sheath is covered with a fine tangled mass of projecting filaments as shown in Fig. 4*D*. On these occasions we may presume also that the rate of growth of each filament is considerably quickened, so that it is small wonder that there is such a phenomenal increase in their numbers, and that they are able to impress their color on the water in which they thrive. Garrett calls attention to the fact that in young threads the sheath is in reality a tube divided up into compartments each containing a single cell. The writer has some unpublished notes on this organism which bear out the accuracy of this statement (Fig. 4*E*). As will be seen below, the same cellular structure of the sheath holds good for *Cladothrix dichotoma*. Garrett further alludes to another characteristic of Crenothrix that is very remarkable. He states that when the cocci are massed together in a common mucilaginous envelope after extrusion from the sheath, the further development is effected by numbers of these cocci forming themselves into line, each line becoming presumably a new Crenothrix thread. It is far more probable that each thread is formed by the growth of a single coccus, but at the same time during its period of phenomenal activity we must expect unusual peculiarities of growth. The statement at any rate demands confirmation. Searchers after *Crenothrix polyspora* will have a little difficulty in distinguishing young Crenothrix from young Cladothrix threads. The identification is considerably facilitated by noting the fact that, as seen in Plate IV., the individual cells of Crenothrix are distinguishable without staining. The cells of Cladothrix do not become individually distinguishable without subjecting the threads to the action of appropriate staining reagents.

(To be continued.)

Cultivation and Canning of Mangoes in India*

By Tarini Charan Chaudhuri[1]

THE mango tree, *Mangifera indica*, is a large evergreen and native of the south of Asia. It grows in the Tropical Himalayas at 1,000 to 3,000 feet above sea level, from Kumaun to Bhutan, Bengal and Southern India. It has been known and cultivated all over India from very remote ages. It is profusely connected with Sanskrit mythology and some religious rites of the Hindus, and finds a place in the old Hindu tales and folklore. Mention is made of it by most of the foreign travelers in India. F. Jordanus notes the remarkable quality of the fruit about 1328 A.D., and Baber, the founder of the Moghul Empire in India, speaks of the excellence of the mango. Later on, Gracia de Orta, in the year 1563, states that the fruit is so delightfully tasteful and highly refreshing that, when in season,[2] no other fruit can sell. There are numerous varieties[3] of mangoes in India, the best and most widely grown being Fazlee, Langrah and Bombay. The plants can be grown from the seed or stone of the fruit; but it is found that on the same soil the seedlings rarely produce fruit equal in size, taste and flavor to the parents. The usual method of cultivation and propagation is by *inarching*. Maries states that the best place for a mango plantation is a raised, well-drained piece of land with a good depth of soil. The nature of the soil, however, does not appear to interfere much with the growth of the tree. It is found that in Bengal it succeeds equally well on a rich, deep, river deposit, on clayey or on sandy soil; while in Gwalior good trees are grown on Kankara—a soil with a large proportion of lime or stone nodules.

For purposes of inarching, the stones of the fruit when the mango is ripe in season are usually sown, and when the plants have become one year old, they are potted out to be grafted by inarching with desirable trees. This is done during setting-in of the rains in the second year of the growth of the seedling, the union being usually complete at the growth of the rainy season. The essential principle in this method of grafting consists in bringing the cambium of the stock and the scion together before the graft is completely severed, the parts being fastened carefully so as to exclude air and water and to keep the plant and the mother tree healthy during the short growing period. It is to be noted that the scion and the stock should be of the same thickness. The best season for planting out the young grafts is in the early part of the rainy season. Firm states that shade is necessary during the following six months, and the intervening land between the rows of grafts is cultivated with moderate irrigation and rich manuring and crops grown until the mango trees have attained the flowering size. Generally speaking, in five years the trees should bear a considerable quantity of fruit.

The principal localities in India where good mangoes are said to be produced are Mazagon in Bombay and Durbhanga; but the finest varieties of the fruit in extensive scale are grown at *Malda in Bengal*. In Assam, on the other hand, the fruit ripens very badly and is extremely diseased, the mango weevil being very destructive to the fruit.[4]

Besides being eaten as a ripe fruit in India, numerous preparations are made of it. When green, it is peeled, cut into slices, and after removing the stone, it is put into curries or made into sauces, chutnies or pickles of various kinds. When young and green it is boiled, strained, mixed with milk and sugar and thus prepared as the custard, known as *mango-phul*. When it is cut into pieces and dried, it is known as Indian *amchoor;* and when very young, small pieces are taken in salad. So, also, ripe mango is used in curries and salads; and the mango juice, expressed and dried in thin cakes, is known as Indian *amsath*. In recent years, pickles and chutnies are largely exported to Europe, Africa and elsewhere. Watt believed that if mangoes, in fresh condition, could be conveyed cheaply into England, a trade as extensive as the fruits of the West Indies might be immediately anticipated.[5]

The use of this fruit cannot be considered as a mere luxury. It is thought to be a necessity by medical authorities from medicinal and dietetic points of view. In medicine, the ripe fruit is considered invigorating, fattening, laxative and diuretic. It is a current view that in many cases fresh ripe mangoes, eaten in large quantities, give rise to troublesome boils, and on abstaining from taking mangoes, the eruptions heal up. Gibson and Issabella, of the Medical College in the Philippine University,[6] conclude that if a mother eats sufficient mangoes, the boils appear in her sucking infant, the cause being mainly attributed to the richness of the gums in mango juice.

The present writer has examined the Bengal mangoes both as regards their gum content and physiological influence. The juice of this fruit contains a small percentage of gums and is rich in sugar. In sixty-three cases of men, women and children, who were overfed with mangoes (Fazlee and Langrah) for seven days, not one case of eruption occurred. These two varieties of mangoes, especially preserved in pure sugar syrup, while possessing all the medicinal and dietetic value, are absolutely free from any such objection.[7]

The modern methods of preserving fruit may be briefly classified under five heads: (1) heat or cold storage; (2) drying; (3) excluding air; (4) adding a third substance which acts as a preservative; (5) pickling in suitable liquors.

Each of these methods, considered individually, is unsatisfactory for preserving mangoes. Sometimes the combination of (3), (4) and (5) is applied. But the aim of scientific canning is not only to preserve the fruit but to retain all the delicacies of the fresh ripe fruit, viz., the natural color, taste and flavor. To preserve the mango with all its delicacies requires a thorough familiarity with the character of the fruit and also the climatic condition of the country where the preserves have to be stored, for the selection of the proper process depends roughly on these factors. It has been found that no cut-and-dried process or combination of processes can preserve the mangoes in fresh condition. The writer announces that with regard to mangoes, which are sensitive fruits, he has been successful almost to the ideal standard by first sorting the ripe fruit suitable for canning and estimating its degree of sweetness and then determining the strength of the crystalline sugar syrup, which has to be so regulated that it does not impart any additional artificial sweetness to the fruit. A different temperature is also used for different varieties of mango, according to the durability of the flavor and stiffness or softness of the slices. In this process no preservative substance which may act prejudicially on the fruit, immediately or after a period of storage, is used.

*Journal of Industrial and Chemical Engineering.

[1]Government Research Scholar in Chemistry.

[2]The general flowering period of mango trees is from December to February, and the principal ripening season for mangoes is from May to the middle of August. Watt, D. E. P., Vol. 5, 147.

[3]Woodrow, "The Mango, Cultivation and Varieties," II, 1911; Firminger, *Mango-Gard. Ind.*, 1904, 256-61.

[4]M. Lefroy, *Agr. J. India*, I, II, 164.

[5]Watt, C. P. I., 1908, 765.

[6]*The Philippine Journal of Science*, 1915.

[7]In Malda, the poor people, as a matter of moral right, live almost exclusively on mangoes of the garden owners. On inquiry the writer has almost no information of pimples, boils, or cancers, excepting the usual stray cases.

Gas From the Earth

THERE is certainly no dearth in the number of natural products from which gas can be extracted, and when consideration is given to the multitude of raw materials such as wood, peat, manure, etc., which have at some time or other been called into use for the purpose, it might almost be wondered why the gas engineer should regard his coal stocks with a watchfulness bordering on affection.

The latest recruit to the already diverse list of gas-making substances is a form of brick-earth which, in the neighborhood of Fletton, has been found, when distilled at a dull red heat, to yield about 500 cubic feet of gas per ton, with about six gallons of crude oil and 25 gallons of ammoniacal liquor. The substance from which the gas is obtained is known as Oxford clay, which has been found to contain a quantity of bituminous matter, and evidently resembles, although of a poorer nature, the well-known Kimmeridge variety. The results of experiments seem to indicate that by the utilization of the gas some considerable economy may be effected in brick-making, not only by employing the gas as a substitute for steam-power or producer gas, but also by firing the kilns with gas instead of the small coal now generally used. It is stated that a refined oil may be obtained from the crude tar formed in the first place, while the ammonia is recoverable in the usual way.—*Engineering Supplement of the London Times.*

Farm Water Supplies*

Causes of Pollution and Precautions to Be Taken

WATER is the one natural beverage which is an absolute necessity for the preservation of all life. The physical comfort and health of every individual depends to a very considerable extent upon having an adequate and suitable supply of water. Several factors enter into the consideration of this problem. Water to be satisfactory for drinking purposes should be pleasant to the sight and taste, free from disagreeable odor, and incapable of causing discomfort or disease.

It is the disease portion of the problem that particularly interests health authorities. In up-to-date municipalities which supply water to their citizens, elaborate means are now taken to prevent the presence of material in the water which might cause disease among the consumers. Precautions to the same end should be employed in obtaining a water supply for the farmer.

To understand the difficulties of obtaining a sanitary water supply it is necessary to be familiar with a few of the principles which underlie the spread of infectious diseases. It is now known that infectious diseases are caused by very minute forms of vegetable life, known as bacteria, which are so small that they can not be seen without the aid of a very powerful microscope. Many different varieties of bacteria are found everywhere in nature; some kinds, and of these there are a very great number, are absolutely harmless to the human being; a few other kinds, which are known as disease producing bacteria, will cause sickness, and sometimes death. In order to bring about sickness, they must find some way of getting into the body. This usually is done through the mouth. Once inside, they reproduce very rapidly, so that soon enormous numbers result, and the individual who has been unfortunate enough to have swallowed them begins to feel sick. Nature attempts to cure the sickness, in part by getting rid of the bacteria, so that during the illness, and in certain cases for some time after, the patient discharges the bacteria which have caused his disease. If these discharges from an individual who harbors disease-producing bacteria should gain entrance to a water supply, that water would act as a means of carrying the disease to persons who used it for drinking purposes.

The diseases which are most apt to be conveyed by water are typhoid fever and dysentery. In these diseases the bacteria leave the body for the most part in discharges from the bowel and bladder. If the safety of a drinking water supply to be used by people is to be preserved it is necessary to prevent such discharges from getting into the water. It is known that under ordinary circumstances these disease-producing bacteria do not live for any great length of time outside the body, so if a person gets typhoid fever it means that he has swallowed some discharges, comparatively fresh, from someone else who harbors the bacteria causing that disease. These discharges contain such enormous numbers of bacteria that only a very small amount of discharge, so small as to entirely escape ordinary notice, may be sufficient to cause a very serious pollution in water.

Water supplies may be polluted either by these discharges being dumped directly into water or by the discharges being placed in or on the ground and subsequently washed or carried into the supply. Sometimes water from a safe source is polluted after it is drawn by coming in contact with hands or fingers, or something else, which has recently touched discharges containing disease-producing bacteria.

What has already been said is enough to indicate that to have a safe water it is necessary to take at all times every possible precaution to prevent discharges from the bowel and bladder getting into the supply. To accomplish this object, the greatest care must be taken regarding three features, namely, the water supply must be properly *located*, *constructed* and *managed*.

There are various kinds of supplies which are used by the farmer to provide his family with drinking water. These may be grouped as follows:

Group I. Underground water supplies:
- a. Wells (dug, bored, drilled and driven).
- b. Springs.

Group II. Surface water supplies:
- a. Cisterns.
- b. Surface reservoirs.
- c. Lakes and ponds.
- d. Rivers and streams.

*Extracts from a Bulletin issued by the Minnesota State Board of Health.

One important difference from a sanitary point of view exists between these two groups, namely, that under ordinary circumstances the second group as found in nature are usually polluted and are difficult to make safe without artificial treatment, while the first group as found in nature are usually pure and are easy to keep pure. This can be readily appreciated if the principles of natural purification of water be understood. Lakes, ponds, rivers and streams receive the surface washings from the drainage area in which they happen to lie, and any pollution which is on or near the surface of the ground may find its way directly into the water, especially after rains. It requires only that the discharges from an individual throwing off typhoid bacilli, for instance, should form a part of this pollution to have such a supply capable of conveying the disease to those who may drink this water soon after it has received these discharges. Underground waters, on the other hand, get water from the surface only after it has passed through the soil which lies between the water-bearing stratum and the surface, unless natural or artificial communications have been made between the supply and the surface. It is known that in this movement of water through the soil natural purification takes place. If a sufficient layer of soil exists between the surface and the supply, complete purification will occur. The amount of intervening soil necessary for this purpose depends upon the nature of its composition. Under ordinary conditions ten vertical feet of soil will be sufficient, provided the well itself is properly located and constructed.

It is a common belief that pollution may seep through the soil for long distances and gain entrance into the well in this way, but such an idea is not universally true, and as a matter of fact the danger of surface wash getting into a well in this manner is very slight and in most localities can be ignored as a source of danger.

There is, however, one practice which is sometimes used for disposal of sewage which may lead to pollution of underground waters, namely, the use of "sewer wells." By these are meant wells which have been dug to a considerable depth, into which sewage is discharged. The danger lies in the fact that by so doing it may happen that the water bearing level is reached and the water polluted in this way. The nearer such a "sewer well" is to a drinking water supply, the greater the danger. This method of disposing of sewage should never be used.

In general, a well should be located as far away from gross pollution as possible, such as privies, cess-pools, sewers, etc. Surface slopes should be such that a natural or artificial drainage is established away from the well in all directions. This location should be selected so as to be above the point at which surface flooding may occur. The convenient location of a supply should be carefully considered so as to lessen the labor of distributing the water and to promote its more general use and increase the general cleanliness. The construction of a well should be of such a character as to absolutely prevent the entrance of surface wash into the well at any point whatsoever. These general principles apply to all wells and springs; the details of construction will be discussed under the description of the various types.

To determine the best type of well for any locality, it is necessary to get information concerning the underground formations and the various underground water levels in the locality. These can be obtained usually from records of other wells in the vicinity.

Careless management is the cause of many a good water supply becoming contaminated. The casing of the well may become leaky or the pumping apparatus may get out of repair. Any portion of the construction or protection may become faulty and thus open avenues through which pollution may gain entrance to the supply. A very common fault is "priming" which is dangerous from a sanitary point of view as the priming water may be polluted and so contaminate the whole supply. The pump cylinder should be placed near or below the level of the water in the well so that priming will not be required. Where it is not practical to do this, a type of pump cylinder which does not require priming should be used. Waste materials of any description should not be thrown on the surface of the ground near the supply.

TYPES OF UNDERGROUND WATER SUPPLIES.

Dug Well.—The dug well is probably the oldest type of well known. It consists of a round or square excavation several feet in diameter, the depth usually varying with local underground water levels. A wide range of construction has been applied in different localities. The crudest form consists of a shallow hole in the earth's crust, which collects water from the upper formations and not infrequently from the surface. Such a well seldom has a cover. As it became necessary to construct the deeper dug wells, casings were required to hold back the earth; they should serve the additional purpose of excluding surface and shallow ground water. The casings commonly used include such materials as wood, stone, brick, concrete and tile. To afford satisfactory protection to a dug well, the casing should be water-tight, for a distance of ten feet below the surface, the distance depending upon the character of the earth. It should also extend sufficiently high above the natural surface level to provide for grading which will allow the drainage to be established away from the well. The covering of this type of supply is very important and must be water-tight if the maximum protection is to be obtained. Various materials are used, the most common being wood or concrete. The latter is much to be preferred as it is difficult to keep a wooden cover water-tight when exposed to the weather for any length of time. Water is usually drawn from the dug well by means of the ancient rope and bucket method, or by various types of wooden or iron hand pumps. The former is a dangerous practice as it necessitates the handling of the rope and bucket by each individual using the well. Any infectious material on the hands of such a person is thereby carried directly into the well when the bucket is again lowered for refilling.

Bored Well.—The bored well, which is common in certain sections of the country, is frequently dug by means of augers of various sizes, usually less than one foot in diameter. The earth is removed by rotating and elevating the instrument. This type as usually found incased with wood, tin, tile, concrete, and in rare instances, iron pipe. Water is drawn from bored wells with slender tin or sheet-iron buckets with loose bottoms, or with the ordinary types of hand pumps.

Drilled Well.—The drilled well is installed by means of various kinds of drilling apparatus. This type is found most frequently in sections where water is reached only at a considerable depth and rock formations are present. The casing is invariably of iron which in some wells of this type extends throughout the entire depth, while in others only to the rock formation. Sometimes the casing is brought up to the surface and attached to the base of the pump, but more often only to the bottom of a well pit. Well pits are dug around the casing at the surface for the purpose of providing easy access to and protecting certain parts of the pumping apparatus from frost; they are usually eight to twelve feet in depth and three to four feet in diameter. Not infrequently these pits are factors in the pollution of the well, since they act as catch basins for surface or shallow ground water, which later enters the well proper between the well casing and the pump casing. This is especially true where the well casing extends only to the bottom of the well pit and is not attached to the pump casing with a water-tight connection. Whenever possible, the well casing should be brought up and attached to the base of the pump, thus eliminating the necessity of a pit. In cases where the pit is used, it should be made water-tight in a manner similar to that recommended for dug wells. Another way for surface water to enter this type of well is by following down the outside of the casing. This is made possible by the fact that the process of drilling in certain formations has a tendency to loosen the material immediately around the casing. This can be remedied by pouring sand around the casing at the surface.

Driven Well.—The driven well is installed by driving directly into the earth successive lengths of iron pipe, the first of which is armed with a sharp, perforated metallic point. This type is found where water is reached relatively near the surface and the earth formations are comparatively soft. Well pits are even more common for this type than for drilled wells. On account of the similarity of the drilled and driven well, the same general rules can be applied to their protection and construction.

Springs.—In comparison with the other underground types, springs are used to a limited extent on farms. This is largely due to the fact that their location is not always convenient. Most rural springs consist of a small basin in the surface formations from which the water overflows into some natural water-course. Water

is taken from such springs usually by dipping with a pail. This type, unless protected, is dangerous as it is subject to contamination at all times. Certain of these springs can be made safe if protected against surface pollution by water-tight casings and covers. A discharge pipe should be provided so that the water as needed can be caught in receptacles and thus eliminate the dangerous practice of dipping. The general factors suggested for safeguarding dug wells can be applied to springs.

SURFACE WATER SUPPLIES.

Cisterns.—The cistern is an exceedingly common form of farm water supply. As a source of drinking water, it is used extensively in localities where the underground waters are unfit for consumption on account of high mineralization. Cisterns are simply storage reservoirs for rain water collected from the roofs of dwellings or other buildings. They are usually located underground or in the basements of houses, and are constructed of wood, brick, stones, or concrete. Some cisterns are constructed of galvanized iron and built in the form of tanks. Leaks offer one of the greatest opportunities for the pollution of cisterns and this is especially true of the underground types. If a cistern is well located and so constructed that it will exclude contamination from outside sources, it should provide a satisfactory means of storing water. Water usually is drawn from cisterns by means of ordinary pitcher pumps. This type of pump not infrequently requires priming, which is an exceedingly dangerous practice from a sanitary point of view.

Surface Reservoirs.—This type of surface supply is found in sections where the underground water is undesirable or difficult to reach. The construction of the ordinary type is quite simple. A portion of the soil is removed, thus forming a depression for the collection of water from a small natural or artificial catchment area. These reservoirs are located usually in a more or less impervious soil but not infrequently clay is used to line those located in lo[illegible]e earth material. Water is taken from such source[illegible]pping or with ordinary hand pumps. Water from [illegible] a source is rarely, if ever, fit for drinking purposes. Their use is confined usually to the watering of live stock and plant life on the farm.

Ponds, Lakes, Rivers and Streams.—These natural types of surface supply are used to a very limited extent as sources of drinking water for human beings on farms, except in the pioneer sections of the country. Like surface reservoirs, their use should be confined to watering live stock, plant life and for cleansing purposes. Their potability depends entirely upon their sanitary environment. Such waters practically never can be safely used for drinking purposes unless they have been artificially purified.

CHOICE OF SOURCE OF SUPPLY.

Other than cisterns, surface water supplies can not be recommended, as such are subject at all times to contamination.

It is impossible to formulate general rules which can be applied without variation to all types of underground water supplies. In selecting the type of well which is to be used, the final decision must rest upon a consideration of all the conditions surrounding the source of supply. In studies that have already been made of the conditions existing at the present time in farm water supplies it has been found that the relative safety of the different types of underground supplies in rural districts is as follows, the types being mentioned in the order of their safety: driven well, drilled well, bored well, dug well and spring. It should be understood that this statement applies to conditions that are actually found at the present time. It does not mean that it is impossible to adequately protect the latter types of supplies under all circumstances. As a matter of fact, it is possible, as already stated, by the proper location, construction and management of farm water supplies to do away with many of the dangers of pollution that now exist. Most of the means that have been recommended in this bulletin for the protection of farm water supplies are common sense methods which can be applied at comparatively small expense, so that there is no reason why it should be impossible for a farmer to obtain a safe and sanitary water supply.

Concrete Lighting Standard Made by Centrifugal Process*

IMPORTANT advantages are claimed for lighting standards of reinforced concrete. The initial cost of the concrete post is low and the expense of maintenance and upkeep represents an almost negligible item, no painting being required to preserve the appearance.

An improved type of reinforced concrete post for street lighting is now being manufactured in southern California and it is used in many municipalities in that vicinity. This standard is made by a centrifugal process of molding which offers some interesting features of operation. The centrifugal method of formation indicates, both in theory and in practice, a logical and effectual means of production, at the same time showing reduced cost factors that tend to enhance the extensive employment of these standards for all practical and economical purposes.

The fundamental principle involved in centrifugal concrete manufacture is that of effecting proper compression by centrifugal action. As is evident, in revolving a wet mix by this process the area of greatest compression is at the point of greatest radius. This affords the desired density in sections where it is most needed, resulting in a product, with cored center, of great structural strength and stability.

As indicated, the hardest portion will be at the outside and the thickness of wall can be governed by the amount of material used. This placement of the heavier and the finer particles in concrete by centrifugal action, forming the densest mass at the outside, affords a consistent distribution in the proper proportions of the respective ingredients.

These standards are composed of a 1:3 mixture, consisting of one part Portland cement and three parts clean washed sand and gravel. This aggregate is mixed with sufficient water to permit pouring into forms which, of wood or metal as required, are of the desired outline and dimensions, and made in two or more parts as the exterior design may necessitate. The steel reinforcement is built up and placed in the mold, supported from the wall on a dead center.

When filled, the forms are locked in a machine and revolved at a proper speed to compact the mixture, sustaining the wet concrete against the walls. The exact rotating speed is dependent upon the diameter of the post. In this operation all voids are filled and the resultant product has a hard, smooth surface that cannot be obtained by ordinary tamping. The preliminary set is obtained in about 30 minutes and the mold is withdrawn and allowed to stand for 24 hours before removal. After this time, the formed structure is capable of being handled without danger of injury to the surface; an additional curing in the open air, keeping the product thoroughly moistened, completes the process of manufacture.

The shaft is reinforced with twisted steel rods, equally spaced around the circumference and ¾ inch from the outside wall. The rods are wired and held in place with No. 14 wire hoops. The standards have a hollow core, varying slightly for different types of design, but not less than 3 inches, extending from end to end. This core is concentric with the outside surface of the post.

The base, of square or octagonal pattern, as desired, and capital are cast separately under the centrifugal process. The former is provided with a cut-out box with concrete cover. Foundations for the standards are cast in place, reinforced with ⅝ inch twisted steel rods 5 feet long in center, and the post securely anchored to this footing.

The hollow core of the shaft is arranged for the electric conduit, which extends from the cut-out box to the lighting fixture at the top. The conduits enter the sides and are bent up to go into the cut-out box in the base of the standard. After the conduit is installed, the core is filled with cement grout and a cast brass shade holder screwed in position on the end of the conduit.

In finished surface these standards resemble cut or polished stone. The post being hollow, is accordingly lighter than a solid column, and at the same time, is considerably stronger. Tests for absorption show that the surface of these posts take up less than one half the moisture absorbed by well tamped concrete of the same mixture in a like period of time.

While this method of concrete manufacture is suitable for other products of post or column type, it has become particularly applicable in making reinforced concrete electroliers, and extensive activity is being given this line of operation. Classic designs modeled after Greek and Roman architecture are being adopted for various column types, supplemented by bases and capitals of harmonizing pattern.

Many cities and towns in southern California are now employing these lighting standards along important thoroughfares.

*L. R. Allison in *Concrete.*

A Wasteful System of Cattle Raising

COTTONSEED meal, a southern product, is being extensively used at northern feeding plants. Many southern cattle are shipped into the North and West to be finished for market, while the meat is often returned South for sale. In the South, where enormous quantities of grass and fodder are going to waste, not a large percentage of the cottonseed meal is being used for feeding. The Southern States should raise, fatten, and slaughter their cattle to the extent of supplying their own needs; after that if a surplus of either cattle or cottonseed meal exists it should be shipped to other sections of the country. Freight is often paid several times on feeds and feeders for fattening purposes, paid again on the cattle going to some far-off market for slaughter, and again on the dressed meat going back to the place where the cattle were fattened. This seems like a most extravagant waste of money and is a state of affairs which, to a certain extent, could be remedied by raising, fattening, and slaughtering cattle in the same section.—*Report* 112, *U. S. Dept. of Agriculture.*

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