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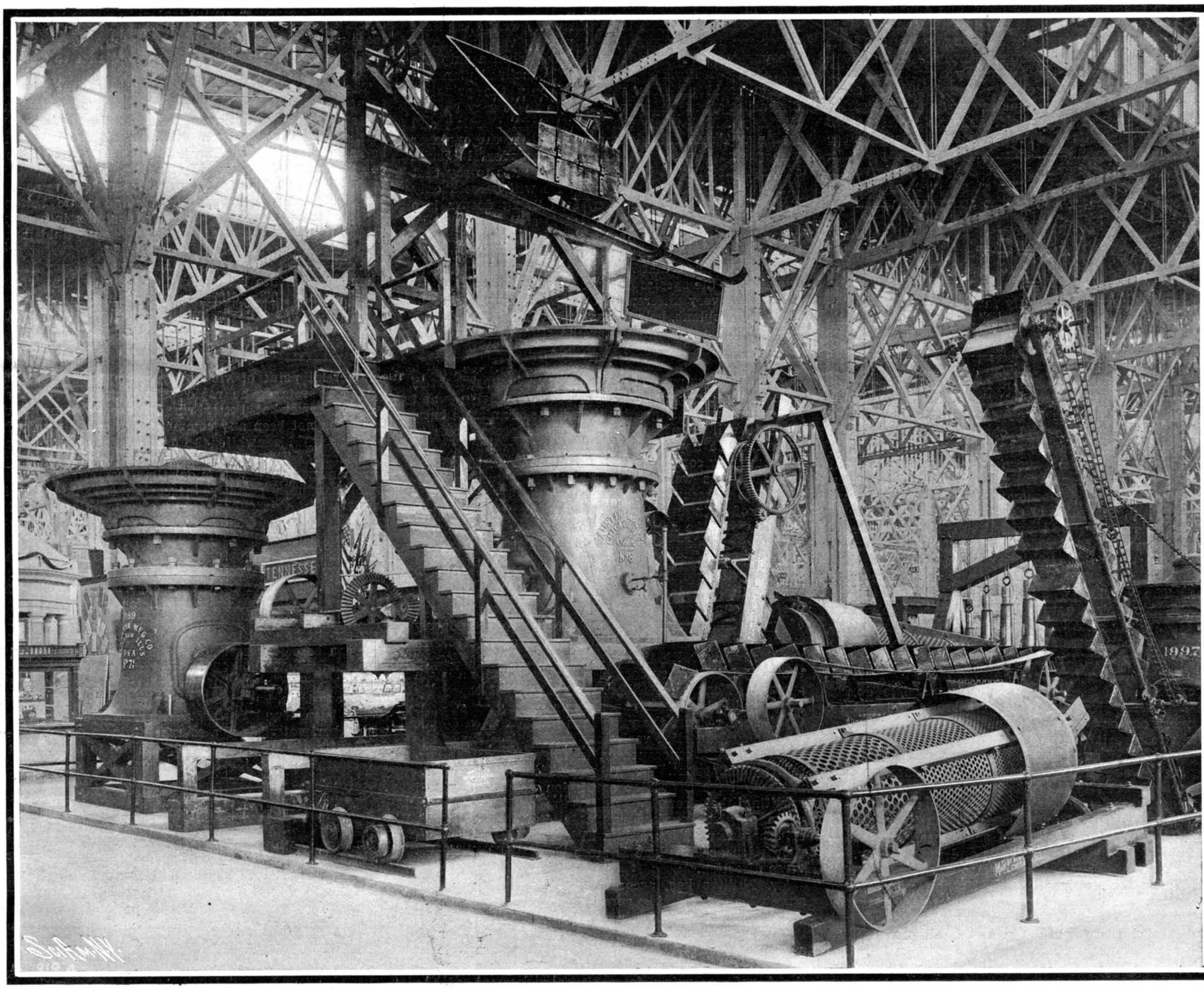
## AN EXHIBIT OF GYRATORY ROCK AND ORE CRUSHERS IN THE MINES BUILDING.

By the St. Louis Correspondent of the SCIENTIFIC AMERICAN.

A STRIKING feature of the exhibits in the Mines Building is the massive appearance and great capacity of many of the implements and machinery. We present a view of a characteristic exhibit, made by the Austin Manufacturing Company, of their apparatus for crushing and screening ore and rock. The central feature is a splendid specimen of the No. 8 gyratory crusher, which is shown complete with the overhead track for delivering the rock from the quarry to the crusher, with the type of elevator used for raising the broken rock from the bottom of the crusher to the spout of the revolving screen. The exhibit also contains several revolving screens, whose work it is to separate the broken material into its various grades from large to small. Down one side of the exhibit stands an impressive row of several sizes of crusher, ranging from the big No. 7 down to the smaller portable sizes. The big crusher known as No. 8 weighs 100,000 pounds and each receiving opening for the rock, etc., measures 18 x 63 inches. The driving pulley has a 20-inch face, is 48 inches in diameter, and is run at a speed of 350 revolutions per minute. For operating the crusher elevator and the Morgan screen from 100 to 150 horse-power is required, and when it is running full capacity this machine is capable of crushing as high as 200 tons per hour.



AN EXHIBIT OF ROCK AND ORE CRUSHING AND SCREENING MACHINERY IN THE MINES BUILDING AT THE ST. LOUIS FAIR. THE LARGE CRUSHER IN THE CENTER CAN CRUSH 200 TONS PER HOUR.

## THE AEROPLANE.*

By M. RUDOLPHE SOREAN.

THE solution of the problem of aerial navigation thus far has been chiefly by the dirigible balloon, which is often called the "lighter than air" type of flying machine, although, in good logic, it should be called the "as heavy as air." The other type is the "heavier than air."

The fact is well known, so noisy have been their quarrels, that the partisans of the "lighter than air" and those of the "heavier than air" types have shown themselves irreconcilable enemies. In reality, the doctrine that must be proclaimed is more eclectic and broader. Far from being exclusive of each other, the two solutions complete one another, and correspond to different phases of the same problem.

*The Aeroplane Considered as the Prolongation of the Dirigible Balloon.*—Suppose, in fact, we utilize the continuous progress made in the technics of dirigible balloons, and in the construction of motors, screw propellers, etc., for progressively increasing the velocity of these airships. In order to balance the pressure due to the headway and keep the balloon constantly inflated (a condition that we know to be necessary), it will be necessary progressively to increase the pressure of the hydrogen, and also to give the fabric a greater and greater resistance. Hence, theoretically, the dirigible will become too heavy, starting from a certain velocity, and so the "lighter than air" solution of the problem will become eliminated of itself. In practice, it will be necessary to stop at a velocity much less than this theoretical one. It seems to be difficult, with the present means at our disposal, to exceed 20 miles an hour without endangering safety, as much from the viewpoint of a straining of the fabric as from that of inclination. Now, the resistance produced by speeds such as this may, upon properly-arranged surfaces, give rise to vertical reactions from bottom to top, that is to say, to sustaining forces. We thus, very naturally, succeed in passing from the dirigible to the aeroplane; and perhaps the latter will give a death blow to the former. There is, moreover, no reason, even in aeronautics, for putting the cart before the horse.

Without entering in this place upon a study of the "heavier than air" type of flying machine—a solution which is not yet mature and which needs a methodical preparation, we shall briefly summarize the principal difficulties that it presents.

*Resistance to Headway.*—We have just been led to

* This interesting and thoroughly scientific article, which shows some of the difficulties met with in the construction of an aeroplane flying machine, is an extract from a lecture given before the French Society of Civil Engineers.

regard the aeroplane as the natural consequence of the dirigible balloon. Like the latter, the aeroplane should form a rigid whole, with the sole exception that it should be possible to slightly modify the inclination of the sails that replace the balloon. Like the dirigible balloon, it will have a car, and a network of suspension ropes more or less entangled. At the high velocities that form its *raison d'être* the displacement of this car and of these suspension ropes will absorb considerable motive power. For, if it is true, as Mr. Langley claims to have discovered a century after George Cayley, that the power necessary to sustain the system of sails is less in proportion as the velocity is greater, the power necessary, on the contrary, to propel all the rest of the aeroplane increases as the cube of the velocity, if there is no pitching; and more quickly than the cube if the opposite is the case. It must not be imagined, then, that the abolition of the balloon introduces into the resistance to headway a considerable economy, thus permitting of greatly increasing the velocity (say of quintupling it), and of making it possible to float the aeroplane with a relatively small spread of sails.

Dupuy de Lome estimated the resistance of the car and suspension arrangement of his airship to be two-thirds of the total resistance. The abolition of the balloon in this case gave, therefore, but a slight gain from the point of view of the resistance per unit of speed. But it might be objected that the Dupuy de Lome suspension is very complicated, and that the calculations of this eminent engineer appear too low for the resistance of the balloon, and too high for the resistance of the cordage and car. Let us place things in the most favorable light, and suppose a dirigible the suspension of which is so well arranged that the resistance of the non-sustaining parts shall be but one-eighth of the total resistance instead of two-thirds; let us replace the balloon by a system of sails capable of carrying at a certain velocity, $V$, the same effective weight and the same motor as the dirigible; and let us neglect the weight and the resistance to headway of the sails and the apparatus employed in the aeroplane for starting it, steadying it, landing it, etc. The motive power remains the same, and we have the following relation between the velocity, $v$, of the balloon and the velocity, $V$, of the aeroplane, which we substitute for it:

$$K v^3 = \frac{K}{8} V^3$$

whence $$V = 2 v.$$

Thus, under such eminently favorable conditions for an aeroplane of the type considered, we double the velocity only. In reality we would obtain a much lower velocity. The reason is, it will be said, that the type is bad. Perhaps so, but not certainly, since if it be desired to improve it from the viewpoint of resistance to headway, we shall encounter difficulties of another nature. There is no doubt that, in order to reduce this resistance and obtain sufficiently great velocities to allow the use of relatively small sails, it would be necessary to have a closed car in the form of a cigar, rigidly connected with the sails. But then would reappear the phenomena of tilting that we escaped by the abolition of the balloon. If, in order to prevent this tilting, we spread the sails upon a frame forming the back of the cigar, we shall have a sort of large bird; but the stabilizing couple will be then much reduced, and this will prove a great inconvenience. The problem will be modified, but not simplified. This problem nature has wonderfully solved in the bird, under conditions, moreover, much less exacting than those imposed by the aeroplane ship. In the first place, in fact, the bird, which is a genuine animate aeroplane, as has been demonstrated by Penaud, Drzewiecki, and myself without any possible doubt, weighs notably less than the aeroplanes designed to carry but one or two passengers. A moderate velocity suffices to give it a sustaining resistance equal to its weight. For analogous velocities, man requires much longer sails and also light and resistant ones, or else greater velocities if it be desired to reduce the sails to reasonable dimensions. And that is not the sole difficulty of the problem. The aeroplane is submitted to other exigencies, of which I shall recall but two—the slight inclination of the sails and the stability.

***Law of Slight Inclinations.***—An elementary calculation shows that, even with the lightest motors, the inclination of the sails should be maintained between very approximate limits. If the current of air strikes them above, there will be a rapid, almost vertical fall—a catastrophe such as put an abrupt end to the curious experiments of Otto Lilienthal; and if it strikes from beneath, but at an angle greater than a few degrees, there will be a slower fall according to an inclined trajectory. In order to solve the problem, it is necessary, then, to maintain the inclination with certainty between limits spaced by a few degrees solely. This is necessary in spite of the variations of the wind, pitching, tilting, and the flexibility of the materials composing the aeroplanes. To whom is it not evident that such a necessity is one of the great difficulties of the problem? This law of slight inclinations is not so hard on the bird, owing to the truly extraordinary sustaining quality of its wings, and to its instinct, which, according to requirements, surely and rapidly modifies the inclination, spread, and concavity of the said wings.

***Of Stability.***—Aeronauts are persuaded that the question of stability will be solved by copying the arrangements employed by nature, and which are as follows: In full flight or in hovering flight, the wings of the bird form a sort of dihedron, the angle of which is on the side toward the ground. If, then, the bird happens to lean toward the right and no longer sustains itself, it begins a fall which causes a stronger reaction under the right wing than under the left, and this brings it back to its natural position. Thus is found solved the question of transverse stability. As for the longitudinal stability, we know that the center of pressure, $C$, upon a sail approaches the edge of the sail the more closely in proportion as the sail makes a smaller angle with the air current. If, therefore, the inclination increases or diminishes, the center of pressure will be no longer upon the perpendicular of the center of gravity, $G$, but will retard and advance, and the sustaining force, applied at $C$, will form a couple with the weight of the aeroplane applied at $G$. This couple will bring the inclination back to what it was before. In reality, the phenomena are more complex. Thus, among other things, the longitudinal tilting would cause upon the keel formed by the bird's body disturbing effects analogous to those mentioned in the paragraph upon the tilting of dirigibles, were such effects not counteracted by a sort of air channel under the wings, by the instinctive displacement of the legs, and by the intervention of the tail.

And then, as a last resort, the bird might, at times at which the sustentation was accidentally inadequate, permit itself to fall and take on the necessary velocity. All those who have seen the swift fall of birds of prey, their great resources in the successive turns made by them to fasten upon and dispatch their victims, understand that the fall does not constitute a great danger to the bird. The same is not the case with the aerial ship, in which the automatic apparatus of most improved character serve to increase the weight, and are never equal to instinct. Moreover, by very reason of the purpose for which it is designed, such a ship can move only in horizontal or slightly inclined planes.

This rapid analysis shows us only the principal difficulties when under way, and to these may be particularly added those that result from starting and landing. These difficulties are such that the engineer who prides himself upon so many wonderful results accomplished in the last century, hesitates to say that there will be any end to them. He will succeed only by a methodical preparation, by delving deeper into the laws of aerodynamics, which is still disclosing so many secrets, and by instituting progressive experiments under conditions of acceptable security, say with mixed aeroplanes, that is, those provided with a safety buoy under the species of balloon. And since the conditions are very different with the ship aeroplane and the bird aeroplane, he will have to avoid servilely copying the latter, to demand for the study of flight only indications otherwise valuable, and to seek a solution of this great mechanical problem only in the judicious use of processes proper to mechanics, which, moreover, puts at his disposal parts that have an efficiency and power incomparably greater than those of animate ones. Thus it will be necessary for him before all else to proscribe the flapping of wings, which would greatly and uselessly complicate the maintenance of the slight inclination as well as the stability. Nature has recourse to it because an alternating motion is the sole means of bringing the muscular energy into play. But it would be as illogical to imitate the motion of wings in aeroplanes as it would to imitate the motion of legs in automobiles.

Among the means adopted for rendering the stability and the maintenance of inclination less precarious, there is one that consists in replacing the plane sail of wide dimensions by a system of plates properly curved and elongated like the wings of a bird. In the first place, with this arrangement, the reaction of the air per unit of surface is much greater for a given surface. Wenham, Phillips, and Lilienthal especially have made significant experiments upon this subject. On the other hand, the variations in inclination do not involve such marked variations in the direction of the resultant, and, consequently, in the value of the sustaining component. For these two causes, the pitching may have a greater oscillation without any fall resulting therefrom. Finally, the oscillations of a plane of given surface result in displacements, $CC'$, of the center of pressure which are less marked in proportion as the plane is more elongated in a transverse direction.

Mr. Phillips has, according to this principle, constructed an interesting aeroplane of which I gave an illustration in my memoir of 1897. Unfortunately the safety is null, and it would be necessary either to add to the plates a large sail forming a parachute in case of necessity, and which would destroy a part of the benefit accruing from the arrangement of the plates, or to combine the plate system in a different manner.

In conclusion, I may recall the fact that in 1897 I pointed out a means, a little heavy perhaps, of assuring the maintenance of the sails between the necessary limits of inclination, by utilizing the permanence of the axis of revolution of revolving disks.—Translated for the Scientific American Supplement, from the French of Rudolphe Sorean in La Vie Automobile.

## BRIQUETTING FUEL MATERIAL.*

By George E. Walsh.

The art of briquetting fine dust and loose raw material for fuel is of rather ancient lineage, but only in comparatively modern times has it entered the industrial field as an exact science, demanding the attention of all users of fuel for power purposes, and promising to develop into a factor of no inconsiderable importance. The real object of modern briquetting of fuel is to recover some waste matter, or at least to utilize raw material which in its natural state could be of little use. In this broad comprehension of the science we find innumerable articles of raw material and waste matter teeming with unknown possibilities. On all sides of us there is waste material which contains sufficient burning properties to make it useful as a fuel if we could separate the foreign impurities from it, and compact the rest in a close mass so that it would ignite and burn steadily. The waste and sweepings of the city streets, the straw of the Western grain fields, the corn stalks of the great cereal belt, the leaves of the forest, the bogs and peat of the swamps, the soot and dust of blast furnaces, and the powdery dust of the coal mines, all present loose and insufficient fuel with fine possibilities for the experimental briquetting factory.

Briquetting any substance must necessarily depend for its success on the cost of the fuel when delivered for use, and on the relative efficiency of it in the furnace. Sundry other questions, such as that of economical handling and storage, and freedom from dust and dirt, or any impurities which might injure the furnace and boiler of a steam plant, enter into the problem; but these are more questions of detail than of anything else. They can be solved in time by different methods, applicable to each individual case. The quantities of raw material in different parts of the world suitable for burning when briquetted have always made this work attractive. We find very primitive people working up in brick form straw, leaves, and peat to burn in ovens and open fires. It is natural to compress any loose material into a solid brick for burning, especially where it is to be transported some distance to the furnace.

The effort has repeatedly been made in this country to utilize the waste stalks and straw of our corn and wheat crops by compressing them into solid, portable bricks, which would burn well and satisfactorily, and be easy to transport. Several factories have at different times started to manufacture briquets of this raw material, but their output does not seem to have passed much beyond the experimental stage. One method proposed was to cut the straw and stalks into short pieces, and then steam and cook them to a fluid mass. A mixture of earth, oil, and coal dust in different proportions made the paste of a heavier consistency. Then when pressed into bricks, and dried, they were ready for burning. The difficulty experienced in making these briquettes of straw and corn stalks seemed to be that they burned too freely, and their cost, even with straw and stalks plentiful on all sides, was altogether too high to make the experiment satisfactory from a commercial point of view. By adding a binder that tended to retard the rapid consumption of the briquettes, somewhat better results were obtained, but there has not been any commercial success in this direction yet. Meanwhile, the demand for western corn stalks and wheat straw for various other industries has increased so that this one-time worthless raw material has been steadily increasing in value. It is possible that this enhancement of price alone will be sufficient to make further efforts to briquet straw and corn stalks useless.

Forest leaves, sweepings of the city streets, and the peat bogs of New England have also attracted a good deal of attention, and different experiments have been tried to make use of this material for briquetting. The forest leaves are of little use to-day for burning, and they cannot be used to any good purposes at all unless they can be compressed into solid masses so they will burn slowly and steadily. Leaves are like bales of paper, however, which, if pressed too hard, will smolder a long time, but give forth very little heat and fire. It has been found necessary, therefore, to mix them with other materials of a coarser grain to separate the fine layers of leaves and enable the fire to penetrate to the interior. The ideal fuel is one like coal, which will give forth a glowing heat, and will remain so for a long time. It has been found that by mixing with the forest leaves certain proportions of dried forest mold or dirt, and using a binder which will hold the mass together firmly, better results are obtained than when it is attempted to compress the leaves alone. Another method that has been tried with fair success has been to mix leaves and good peat together, compressing the two under hydraulic power, and holding them in position by a good binder. The burning of such bricks is excellent from many points of view, and the results satisfactory under certain conditions.

Of all these experiments, however, the most interesting are those made with the sweepings of city streets, mixed with the waste gathered from the different households, stables, and ash barrels. The burning of this city waste in modern crematories to reduce it to an ash is a wasteful process. In many parts of England the city's waste is employed in operating electric light and power plants, and the saving to towns and municipalities in this way is considerable. This direct method of burning waste has its advantages, but it is proposed by others to establish large briquetting establishments to compress the waste in fuel bricks for common household and factory use.

The amount of burning material found in a varied collection of this nature is sufficient to justify one in undertaking to briquet it for fuel purposes. A large percentage of this waste is of woody fiber, ground paper and cloth, pulverized soot of coal and wood, vegetable fiber of all kinds, and general miscellaneous rubbish that will easily burn. All of this material

* From Power.

when saturated with moisture in a steaming vat, mixed with a small percentage of coal dust gathered from the local coal bins and yards, and then compressed and held together with a good binder, makes a fuel which gives a strong and continuous heat whether used in the factory or mill furnace, or in the stoves and heaters of the private houses. This waste to-day is towed out to sea and dumped overboard, or burned in crematories which produce very little good. The question of briquetting it and making it of commercial use is one that must continue to grow in importance until something definite is accomplished in utilizing the material. At present the material could be obtained for the mere asking, and in some cities the waste would actually be gathered and carted to the briquetting establishment free of cost.

Our fuel problem is bound to assume a more acute aspect from now on, and it may not be many years before coal and oil will no longer monopolize the whole field as they practically do to-day. The gas engine is rapidly becoming a formidable competitor of the steam engine, but unless used as an auxiliary to a steam plant this engine must consume coal for generating its fuel. Numerous coal-saving devices are on the market, and also inventions for saving the gas and escaping heat up the flue. In fact, the modern trend of science and invention is toward the discovery of new methods to economize in fuel consumption. It seems as if the limit of these inventions was pretty near at hand, and that in order to make further improvements the inventors must turn their attention to the fuel itself. If no new fuel can be discovered in the earth's surface, it may be that new methods of utilizing the waste will make up for this. One of the best-known methods of economizing in the use of coal in parts of Europe is to briquet the pulverized portions of the fuel which could not otherwise be easily transported and burned. For years past, Germany and England have engaged very largely in the use and manufacture of coal briquets. The dust and waste of coal mines have always been enormous, and for years past much of this material has been allowed to accumulate at the mouths of the pits. It was not more than a decade ago that thousands of tons of culm went to waste near the coal mines. We have learned to use this waste to-day, and year by year we find new material to utilize in the same way. The briquetting of bituminous coal robs it of all its unpleasant smoke and soot, and makes it as easy of transportation as anthracite. In Germany the coal briquets are rendered almost smokeless and odorless, even when made of soft Silesian coal, because there is a preponderant amount of coke mixed with it.

Briquets of coal and coke in Germany are used extensively on the railroads, steamships, and in factories and private houses, and one rarely sees trailing clouds of smoke issuing from the chimneys. In 1901 the total output of the briquet factories of that country amounted in round numbers to about 1,643,416 tons. The average selling price was $3.16 per ton, and the year before that $2.92. Most of this amount was used at home either by railroads, mills, or German steamers, and a small proportion exported. The industry is one that has steadily increased, having doubled itself within five years. Most of these briquets in Germany were made from coal screenings, with a binder of pitch and inflammable material which cost three or four times as much as the coal screenings. In fact, it has always been found that a suitable binder is the most expensive part of the briquetting industry, and unless good supplies of the right materials are within reach it is useless to attempt the work.

From official sources it is learned that the total output of coal briquets of all the European countries averages nearly 20,000,000 tons. England and France are large consumers and makers of the briquets. French, English, and German steamships use it partly because of the economy of storage. When made in convenient sized bricks, the briquets can be stored away in the coal bunkers of the ships so compactly that there is little waste of space. That is of the utmost importance in ships which have a long journey to make, and in the case of men-of-war it frequently increases their radius of action from 10 to 20 per cent by virtue of their larger coal supply stowed away in the bunkers. A considerable number of the German and English steamers on the Asiatic stations have tried burning coal briquets, with perfect satisfaction to the companies. German capitalists have already negotiated to construct a briquet factory on the China coast, where they intend to furnish German ships with fuel made from the coal dust and screenings that are to-day practically wasted.

Coal briquets have only in recent years been manufactured in this country. There are several factories now in operation, but the demand for this form of fuel has been small and the popularity of it comes slowly. Inevitably, however, briquets must be used extensively here as in Europe, because economy in fuel is growing more urgent every year. We cannot afford to waste fuel as in the past. Business competition is surely making it apparent to all that the concern which ignores the small economies in fuel is paving the way to failure. Not more attention is given to machine inventions to-day in the industrial world than to the question of securing greater results from fuel. It is the study of the engineering profession to make each ton of coal yield a greater amount of work. Fuel economizers and feed-water heaters are but other names for saving the cost of producing power. "Slack coal," brown coal, peat and coal screenings, culm, and cheap grades of bituminous coal can be compressed into briquets, when the proper binding material is obtained, which will furnish power and heat equal to the best anthracite. The only question that remains to be settled is whether the cost will enable the manufacturers to sell at a reduction. The coal-briquet plants so far established have adopted machinery for compressing the bricks that shows a decided improvement on the type in use in most of the European factories. It is admitted that most of the German briquet factories use from 8 to 10 per cent of binding material, and in some instance as high as 12 and 15 per cent; but the plants in the western part of this country have reduced the quantity of lime in the binder to 2 per cent and the pitch to 5 per cent. The presence of lime in the briquets in any large quantity is bound to have a deleterious effect on the furnace and flues, but it has been found to be necessary in order to harden the bricks so as to prevent rapid disintegration.

The briquetting of iron flue dust is a more recent enterprise than any of the foregoing, and it represents an industry that may have a far-reaching effect on the operation of our blast-furnace plants. The experimental work in this direction has more distinct promises for the future than it has in a record of past achievements. It has not yet arrived at the stage where it may be called an exact science, but on the other hand it has accomplished results sufficiently important to justify the erection of a number of briquetting plants. The manufacture of flue-dust briquets is an economical recovery of waste material, and the blast furnaces where the operation is carried on show an increased saving and profit. The amount of iron contained in the flue dust and the amount of lime required in the bonding agent, necessarily determine to a considerable extent the value of the briquets. The fine flue dust of the blast furnaces is very difficult to handle, except by means of improved machinery and methods of manipulation. It has been found necessary to install good dust catchers in the flue, and then by an endless chain system carry the hot material through a revolving screen to hoppers below. The briquet plant should be located near the large blast-furnace mill, so that the dust can be delivered promptly either while hot from the flue or in cars that can back straight up to the receiving bins. The flue dust is separated from the coke by means of the screens, and the latter is run back in the furnace, while the former goes to the briquetting plant.

When the flue dust is deposited in the receiving hopper of the plant it is thoroughly mixed by revolving blades, and carried by them to an inclined belt conveyor. The thorough screening and mixing of the dust prepare it for immediate contact with the bonding agent. There is a wide experimental use of bonding agents for iron flue dust, and different compositions of lime, soda ash, and salt and other ingredients are employed. Most of the bonds used are patented, and are kept secret by the briquetting companies. The first of the bonding agents put in a tank above the flue-dust bins consists of a certain proportion of salt and soda ash. After this mixture has been boiled, lime is poured in and allowed to slake, and the whole stirred continually for some time. This bonding agent must be made of the right thickness and consistency, and the success of the operation depends largely on the skill of the operator in securing the desired result in this direction.

The flue dust and the bonding mixture are allowed to flow together in a conveyor mixer, where through machine manipulation the two become a mass of stiff, sticky substance. Machinery then rolls, stirs, plows, and twists around this mixture of flue dust and bonding material until it is woven and mixed evenly throughout. It is absolutely necessary that the bonding agent should be manipulated so thoroughly that it is worked into every part of the flue dust, and this can be accomplished only through fine machinery invented for this purpose. After mixing it in this way, the machinery catches up the material and passes it through rolls under a pressure of 6,000 pounds. Once more it is stirred and plowed up, and passed through rollers again.

When it finally emerges from the last set of rollers, it is deposited in the big press pan, and then conducted as needed to the big presses. The material is cut up and pressed into molds by heavy pressure and then carried on a conveyor belt to the cars or storage yard beyond. The drying ovens are located not far off, and the green briquets are carried to them on specially prepared cars or by conveyor belts. The drying ovens are sometimes heated by the waste furnace gases, which are employed with considerable economy in this way. After the briquets are dried, they are ready for immediate use, and they are carried direct to the furnace. The machinery for conveying them to the furnace and loading them on transfer elevators for feeding the fires, is all of the ordinary type, and represents nothing new in the way of invention.

Briquetting fine flue dust is a peculiarly difficult work unless carefully handled. It is so fine that it will blow out of the hoppers or conveyor belts with the least gust of wind, and consequently it has to be protected continually throughout its entire course. The dust is hard and grinding, and its effect on machinery is much like powdered emery. The machinery made for handling it must consequently be of the best, and designed for the particular purpose. The mechanical points involved in the manufacture of the dust briquets can be better solved as more experimental works are established and operated for the commercial manufacture of the product. Where the blast-furnace mills are large, and their capacity sufficient to warrant the erection of a briquetting plant, the saving is quite important. The larger the tonnage of the plant the less expense is involved in the process of manufacture.

As in coal briquetting, the binder is the most expensive material used, and the question of reducing this cost to the lowest medium is now in course of investigation. It is essential that the brick should be hard and compact enough to stand transportation and avoid rapid disintegration. When the right proportion of lime and salt is used the briquets are hard and solid, and break with a clean cleavage; but when lime alone is employed, or a large excess of salt, the briquets tend to break apart and crumble in dust, thus destroying their chief value. The salt must be added in sufficient quantity to prevent this crumbling.

In drying the dust briquets, the surface must be hardened by a gradual application of heat, or otherwise the outside shell hardens, and the inside remains more or less green and soft. If thoroughly and properly dried in the ovens, they can be stored indefinitely for use, and though the outside gets a coating of rust, no harm is done to them. This rust is due to the action of the air and salt in combination with the iron in the briquets. Briquets completely coated with this rust can be used without any apparent change in their general usefulness.

The value of all fuel briquets must be ascertained by actual tests in furnishing a steady and continuous heat in the ordinary furnace. Experimental tests which do not take into account the modern furnace conditions of mills and factories are of little practical value. The use of briquets only in specially-prepared furnaces will hardly prove of sufficient importance to warrant their commercial manufacture. The briquets must be able to take the place of coal or other fuel, so that a change from one to the other will not presuppose a change in the burning apparatus. In the case of oil fuel, the changes demanded in the grates are imperative, and are necessary to the proper use of this liquid as fuel; but the plant which has once had its grates fixed for oil burning can easily change back to coal within a short time. This installation of coal and oil burning grates marks one of the changes of the day, and tends to give plants a better assurance of sufficient fuel in the event of strikes or delays in transportation of oil fuel. It would hardly be considered economical to make any further changes in the burning apparatus to suit another fuel, and briquets of any kind must therefore accommodate themselves to the conditions of the present grates. This they seem to be able to do, and the various plants are gradually increasing their output and the quality of their briquets.

## LEATHER FROM WALRUS SKINS.*

By Charles H. Stevenson.

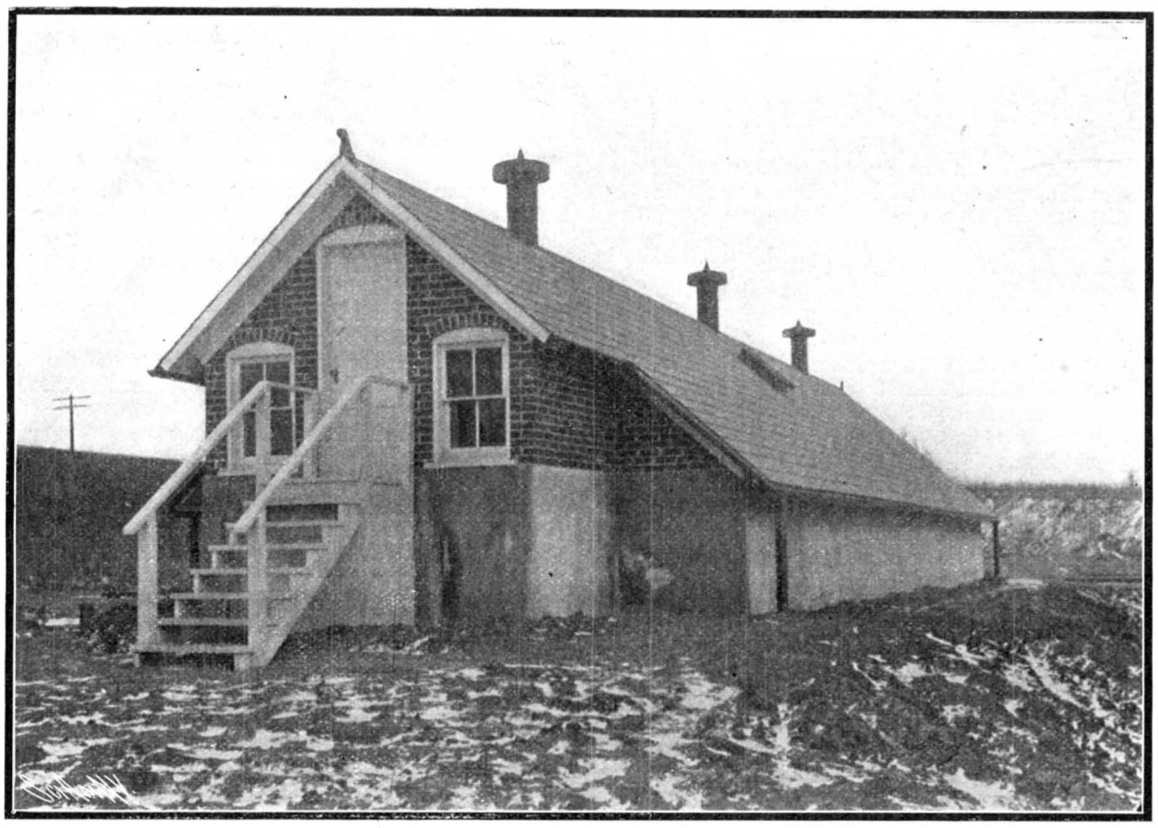
Formerly the principal use of walrus hides in Europe was for the rigging of vessels, for which it is especially adapted. For many years nearly all the rigging of vessels on the north coast of Norway and Russia was made of this article. The skins were also employed for protecting the rigging of vessels from chafing. Later came their use in northern Europe for manufacture into harness and sole leather.

Then the thick, heavy leather was adopted by silversmiths and other manufacturers of bright metal objects, for removing mars and scratches and to polish fine metal surfaces. The hide is particularly desirable for this purpose because of its peculiarly tough grain. It is usually cut into circular shape, forming a wheel of solid leather, but sometimes a ring of leather is cemented to a wooden center by which it may be attached to a revolving head or mandril. Other than that made from bull-neck, buffalo, or sea-lion hides, there is no satisfactory substitute for walrus leather for these purposes. The thickest parts of the hide are the most valuable, and the demand at the present time is quite large, the principal silver works of the United States and Europe making use of it. The London value of an average hide suitable for polishing purposes is in excess of $100.

About 30,000 pounds of tanned walrus hides are imported into the United States annually. The import value is about $25,000 and the selling value after it is cut in the form of wheels is from $40,000 to $50,000. The quantity used in Europe is probably double the amount of the importations into this country. A small quantity of walrus hide has been tanned on the Pacific coast of the United States, but the quality of the output is reported as inferior to that prepared in Great Britain. As shipped from the tanneries, the "sides" weigh from 30 to 200 pounds. The cub sides weigh from 30 to 40 pounds, measure from ¼ to ½ inch in thickness, and are worth about 30 cents per pound. The largest sides weigh from 180 to 200 pounds each, are 1½ to 2 inches thick, and sell for $1 to $1.25 per pound. The average sides weigh 80 or 90 pounds, are ⅞ to 1 inch thick, and sell for 60 to 70 cents per pound. Of course, when cut into circular shape these are sold at very much higher prices. The average price paid by metal-workers in this country is probably between $1 and $2 per pound, and for the very thick hides as much as $5 per pound has been paid.

Another use to which tanned walrus hide is put is as covering for the rollers used in ginning long-staple cotton, such as Sea Island or Egyptian. This is a comparatively recent use, yet probably 6,000 pounds are consumed in the United States annually in this manner. The tanned hide is cut into thin strips and attached to the surface of the roller, entirely covering

* Extracted from United States Fish Commission Report for 1902.



BUILDING OVER SEPTIC TANK.

that portion that comes in contact with the cotton. It is peculiarly adapted to this use and much more satisfactory than bull-neck leather or any other material formerly employed.

Formerly the light or thin hides of walrus were little used, as they were not suitable for polishing purposes, and therefore they were of small value. But during the last few years the leather made from these thin hides has become quite fashionable for such articles as card-cases, pocketbooks, belts, etc. For this purpose the leather is split and so tanned that the grain has a remarkably smooth, velvety appearance.

The process of tanning walrus hides depends on the purpose for which the finished material is designed. If intended for polishing purposes the hide should be tanned as thick and heavy as possible, with a hard, tough texture. The tanning of the heavy leather consumes from six months to one year or more when properly done. Acceleration of the process is likely to result in uneven texture, with the interior fibers imperfectly tanned. It is claimed that the best of the heavy hides are English tanned.

For thin, pliable fancy leather, the skins are tanned in precisely the same manner as seal skins, except the changes and the greater length of time due to the superior thickness of the leather. It is proper to state, however, that the greater portion, indeed possibly 90 per cent, of the so-called "walrus leather" manufactured into card-cases and other fancy articles is nothing more than seal leather with a walrus grain, which is easily given to it in the process of currying. The walrus skins are so difficult to obtain and are so frequently cut and damaged that they can not be economically used for fancy articles. The seal leather is equally durable, and when properly grained and finished the sustitution can be detected by comparatively few persons.

## SEWAGE PURIFICATION.*

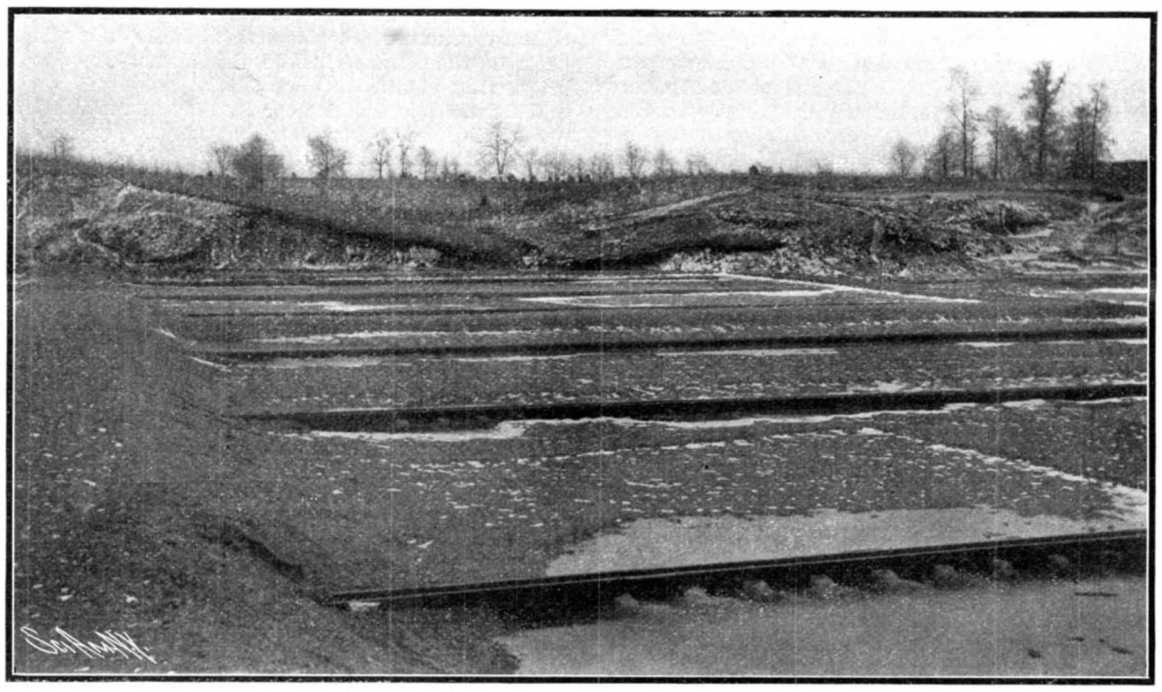
By C. M. GINTHER.

AT the Eastern Indiana Hospital for the Insane there was installed in November, 1903, a sewage purification plant, the successful working of which has attracted the attention of scientists in many parts of the country. This plant was built under the direction of Prof. R. L. Sackett, of Earlham College, Richmond, Indiana.

The Eastern Indiana Hospital for the Insane contains more than seven hundred people. For ten years all of the sewage from this institution had been disposed of by running it into Clear Creek, a small stream adjacent. Property owners and residents along this stream below the mouth of the sewer complained of the stench and menace to health, and the hospital authorities were forced to provide other means of disposal. Prof. Sackett submitted plans for a purification process which would dispose of the sewage by purifying it.

Various methods have been employed to dispose of the sewage from communities. Primitive peoples migrated from a spot when it became polluted beyond sufferance. The Jews had the first authentic sanitary code and their rigorous practice of it for centuries may in a measure account for the hardiness of the race. In the twelfth century filth stood a yard deep about St. Paul's churchyard, London. The death rate was 80 per 1,000; now it is 20. Unsanitary conditions of city life caused the black plague which caused the death of 40,000,000 people. In the fourteenth century it swept away one-third the population of Scotland, and one-half the inhabitants of England. With the revival of learning and the increase of urban population attention was directed to the sanitary requirements of large bodies of people. Water was brought from distant points, subterranean pipes were laid to carry off the sewage, streets were cleaned and habits of personal cleanliness were enjoined. The rapid increase in the size and number of cities in England and on the Continent soon made it imperative that processes of sewage purification be employed, as the streams were at once sewer and source of water supply. It was not enough that sewage be conducted in pipes from a city and deposited in a stream, for only a few miles below another city drew its water supply from the same stream and discharged its own sewage into it farther down its course. It was required that the sewage be disposed of in some other manner than any then in use and scientists set about discovering a way to do it.

Chemical precipitation was introduced, but as this was not properly a purifying, but only a separating process, a concentrated sludge remained which had to be carted away, while the effluent, biologically unchanged, was run into the stream which it was sought to keep pure. In addition, this process involved constant and considerable expense.



FILTRATION BEDS.

Irrigation was found to be an ideal method, but serious practical difficulties attended this treatment which prevented its general adoption. Large areas are required which must necessarily be at some distance from centers of population, which increases cost of mains, labor, maintenance, etc. Only porous soils are adapted and these work best with concentrated sewage.

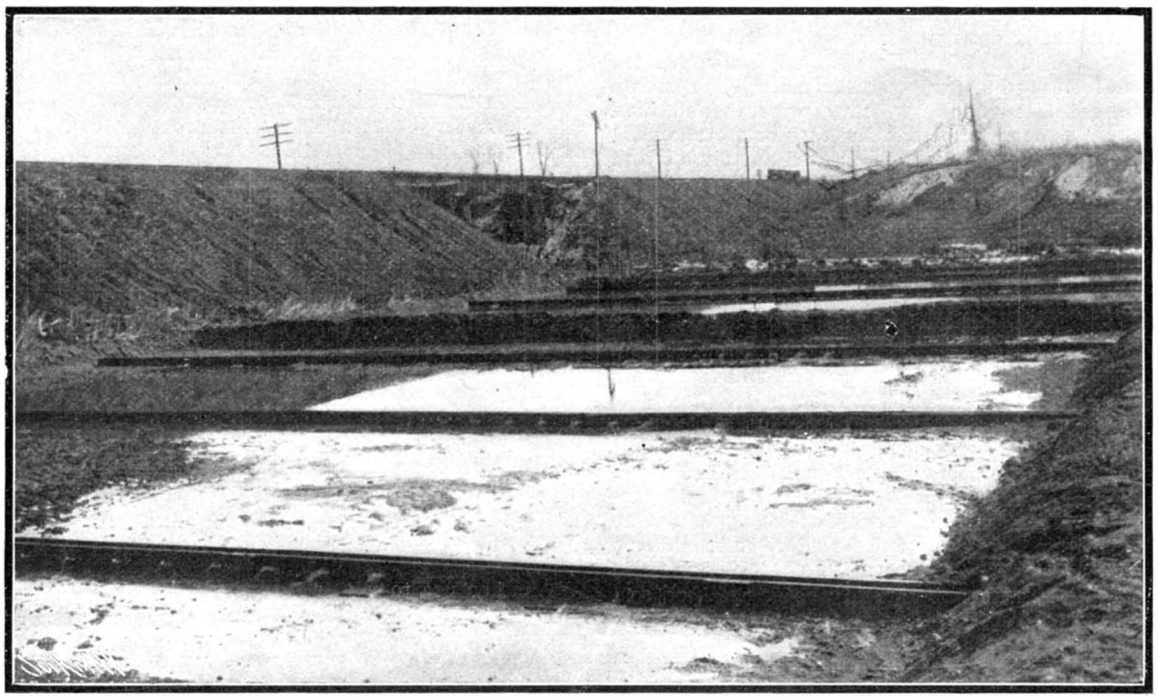
Several methods of sand filtration have been and are employed, but crude sewage requires large areas which frequently clog and require considerable attention and expense to maintain the desired capacity and efficiency. Besides the above, there are the more recent bacteriological processes known as the septic tank, single and double contact beds.

England was the pioneer in the use of the septic tank and contact beds. In 1891 Scott-Moncrieff liquified the sewage from a household of ten persons by means of contact beds composed of coarse flints.

In 1896 the first septic tank was installed at Exeter, England. Air and light were excluded, under the belief that liquefaction was carried on by organisms which propagated best in the dark and without ventilation.

The cities of Leeds and Manchester carried on a series of experiments to test the efficiency of contact beds and tanks in liquefying sewage. The conclusion was that whatever the subsequent treatment, the septic tank is important. It was found to increase the capacity and life of the contact beds or filters in which the process is completed. The question of whether the closed tank had advantages over the open tank was also subjected to thorough tests at Manchester with the result that the open tank produced an effluent

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.



THE FILTRATION BEDS.

SEWAGE PURIFICATION.

containing less solids. As there is a better supply of oxygen in the open tank nitrification takes place then to a greater degree than in the closed tank.

Sewage is composed of liquid waste carrying considerable quantities of solid matter from the kitchen, laundry, and closets. The principal ingredients are vegetable and animal matter, suds, grease, oil from the human skin, and excreta. There are also livery, brewery, abattoir, and manufacturing wastes.

The septic tank proper consists of a water-tight chamber in which the sewage stands from 6 to 8 feet deep. Here it remains as quiet as possible for from 6 to 48 hours, while bacterial action takes place, the period depending on freshness, uniformity in composition and peculiar circumstances, such as the accelerating or retarding effect of certain trade wastes. This bacterial action is a fermentation and the microorganisms causing it are of the same general character as those which produce vinegar from cider. In consequence the solid matter is reduced to gaseous compounds such as marsh gas and carbon dioxide. The temperature rises in the tank and the gases released by disturbing the surface scum may be ignited.

The tank averages the composition of the sewage, removes the suspended matter and reduces some of that in solution. It decreases the amount of sludge and renders the effluent more susceptible to the nitrifying bacterial action in the filter beds. The amount of organic matter removed, as determined by the albuminoid ammonia, ranges from 17½ per cent, according to Dibden at Exeter, to 46 per cent given by Rideal.

It is not quite clear why some tanks cause little or no odor and others are quite offensive. It is probable that sewage that is subjected to the septic action too long begins to stale, and that odors do not rise if the proper period is not exceeded.

The subsequent process must be of such a character that oxygen is supplied in such manner and quantity that the nitrifying operation goes on rapidly. The air and sewage must be brought into intimate mixture in order that the bacteria involved may act as rapidly as possible. The organic matter in solution is reduced to nitrous and nitric acids from which it readily returns to the harmless mineral salts from which it originally came to make plant life.

Intermittent filtration consists in flowing the sewage over the beds at intervals. The sewage seeps through, dragging air after it and driving air before it. In this manner oxygen is supplied the nitrifying organisms and these oxidizing agents complete the process begun in the septic tank.

After a period of rest, which is really one of activity, the bed is flooded again and the operation repeated again and again.

English methods sometimes employ continuous filtration, the sewage being sprayed into the air and the oxygen entrained by the falling drops and dragged through the pores of the bed. In the latter case the flow is continuous and the beds have no rest period. In the former case automatic apparatus is used to control the intermittent operation. Apparatus of this description is installed at the purification plant at the Eastern Indiana Hospital for the Insane. Five hundred or 1,000 gallons of septic sewage is discharged at intervals upon filtration beds adjacent, the fluid flowing through buried pipes to valves which discharge the effluent into wooden sluiceways pierced at intervals with waste ways which permit practically even distribution over the filtration beds.

The entire success of this purification plant is evidenced by the composition of the flow from the filtration beds. This flow is as clear as spring water and almost chemically pure. The past severe winter, when the thermometer frequently fell to 28 below zero, was an extreme test of the practicability of the plant. The bacteriological action in the septic tank served to increase the temperature of the sewage until the interior of the building containing the tank was uncomfortably warm. The heat generation continued after the tank was emptied and the sewage spread over the filtration beds. At no time during the winter was the filtration bed frozen over, and Clear Creek, into which the purified sewage was discharged, remained open and free from ice for several hundred feet below. This purification plant is operated without the use of any chemicals whatever, without any person in attendance, and has performed all of its intended functions without hitch or stoppage from the first day it was started until the present.

## A GASOLINE-ELECTRIC AUTOMOBILE.

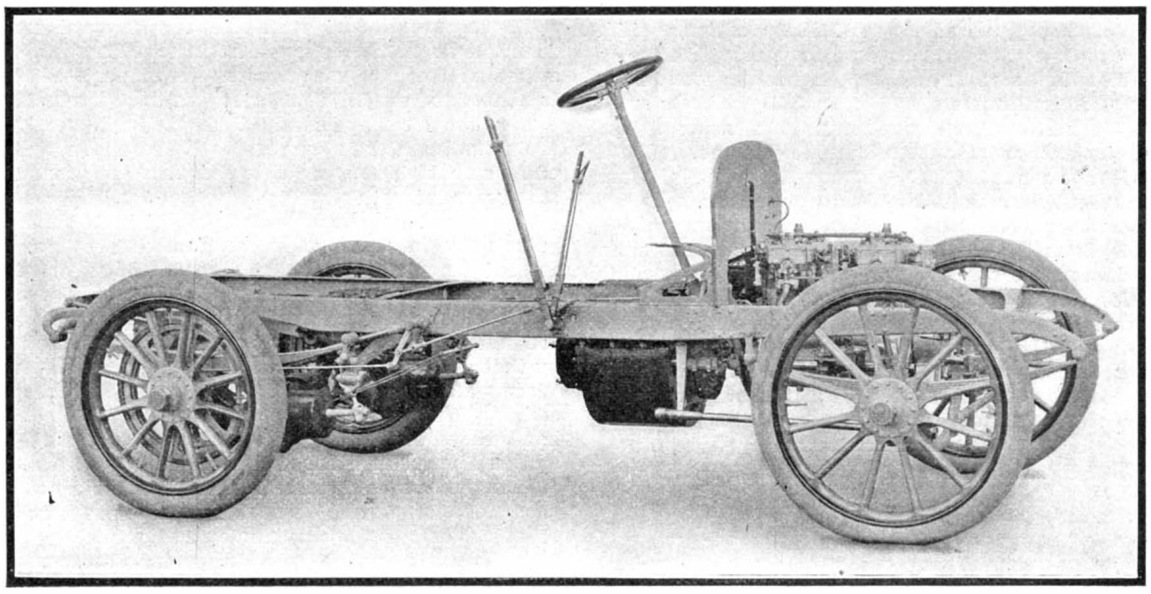
By Emile Guarini.

The gasoline automobile with electric transmission, which has recently been constructed by the Compagnie Parisienne des Voitures Electriques, of Paris, consists of a gasoline motor, an electric generator, and two electric motors, while storage batteries are not necessarily employed. The energy developed by the gasoline motor is transmitted to the driving wheels, not mechanically, but electrically. The motor drives directly a dynamo which supplies current to the two electric motors that are connected through spur gears to the rear driving wheels.

The chassis proper is composed of two longitudinal pressed steel members connected by cross members of the same material, thus forming an exceedingly rigid frame of great lightness, which rests upon five springs —two in front and three at the rear—the last of which is a transverse spring connecting the front ends of the two rear springs. The front axle is provided with ball-bearing steering knuckles, which assures the maximum solidity and great ease of steering. The rear axle, of nickel steel, has near each end, one on each side of the springs, two rounded places, which carry the brackets of the motors. The latter, suspended on their front sides from the ends of the transverse spring, drive directly, by means of a pinion, gear rings attached to the hubs of the rear wheels. All four wheels are mounted on ball bearings. These special bearings are, it appears, unadjustable, without any cones or retainers. An under frame of tubing attached at one end to the generating dynamo and at the other end to the front of the chassis by two hangers, supports the gasoline motor.

The explosive motor can be run on either gasoline or alcohol. It is of the vertical, balanced, four-cylinder type, with mechanically-operated valves and unregulatable ignition by magneto. It develops 20 horsepower at 1,200 revolutions per minute. It is direct-connected, by means of an elastic sleeve, to the armature of a dynamo which serves as a flywheel and is placed in line with the motor crank shaft, thus constituting the electric generating group. The generator, attached firmly to the chassis, braces this strongly. The power developed by this generating group is integrally distributed to the two motors, which drive independently the two rear wheels; and by this arrangement the ease of operation is greatly improved, as all the delicate parts of the ordinary gasoline car, such as the transmission gear, the differential, and various universal joints, are done away with. An aluminium casing entirely protects the electric generating group from mud and dust. The radiator, which is placed at the front end of the chassis and which also serves as the water tank, has a very large cooling surface; the circulation of the water is maintained on the thermo-siphon principle, thus doing away with the pump, which is a troublesome part of most automobiles. Immediately back of the radiator and in front of the motor is located a powerful fan, which makes a strong forced draft through the tubes of the radiator.

The operating levers are reduced to the minimum and have very simple movements. At the right of the driver are located two levers. The first lever operates a very powerful differential brake acting on the interior of the gear drums attached to the hubs of the rear wheels, and this brake permits of stopping the machine very quickly, no matter in which direction it is moving. The second lever can be moved to five different positions on a sector having corresponding notches which give the following results: (1) Reverse; (2) starting the motor by the dynamo; (3) off position; (4) coupling of the electric motors in series, the position utilized for steep hills; (5) coupling of the motors in parallel for normal running. On the steering wheel there are also two buttons, as follows: (1) A special button which throttles the gas to the motor and permits of varying the speed of the machine on a level road from 10 to 75 kilometers (6¼ to 46½ miles) an hour without operating any other lever; (2) another button controls the shunt-generator regulator which makes possible the easy starting of the electric generating group and the concordance of the powers of the gasoline motor and the generator by varying the self-regulation of the group.

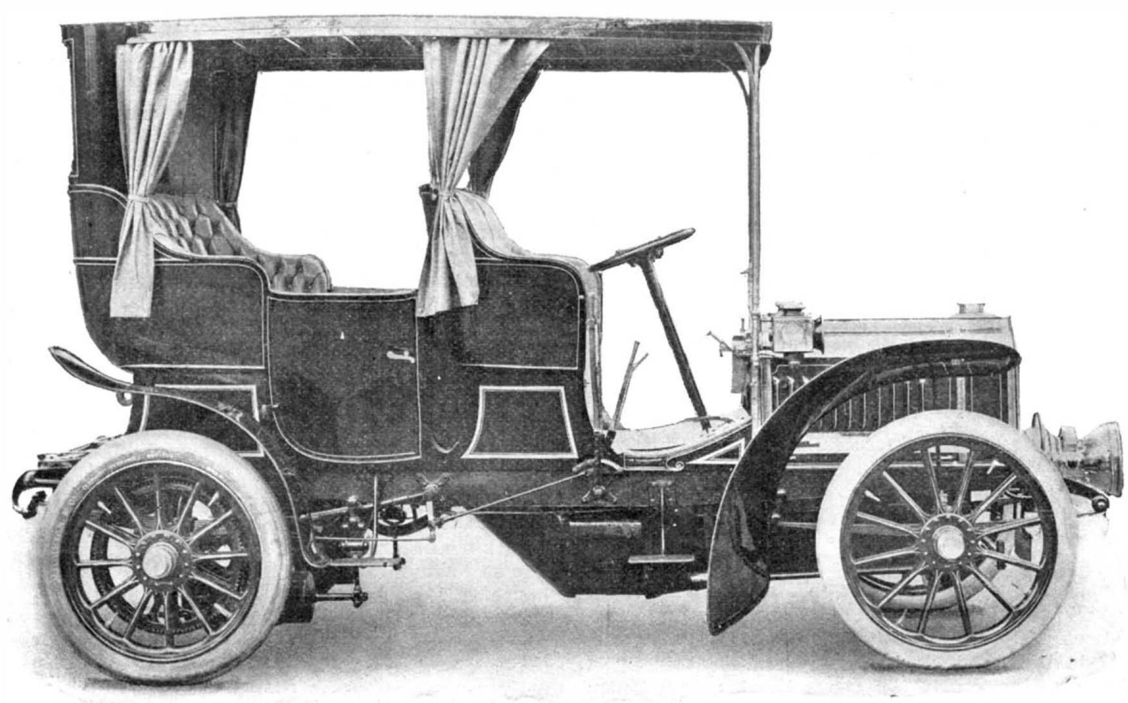


CHASSIS OF THE KRIEGER 20-HORSE-POWER GASOLINE ELECTRIC AUTOMOBILE.

The driver operates, by means of a pedal at his left, a second electric brake which progressively short-circuits the motors through resistances. Moreover, this pedal, at the start of its movement, cuts off the current by means of a special switch. Another pedal, on the right of the driver, acts on a balanced mechanical brake placed on the prolongation of the armature shafts of the motors. The operation of these two mechanical brakes does not cut off the current from the motors, and thus permits of slowing down the car with a minimum chance of side-slip.

The controller is placed on a cross-piece directly behind the generator and fastened to the side bars of the chassis. This apparatus serves to change the speeds and to couple the motors in series or parallel, corresponding to the different positions of the second lever. From the controller are run the various wires that distribute the energy produced by the generating group to the two motors driving the rear wheels.

A small storage battery weighing about 25 kilogrammes (55 pounds), serves for starting the generating group without the use of a starting crank. This battery is placed under the seat. It also serves for the independent excitation of the generator, and it is continually recharged by current from the latter, so that it is practically never discharged and always serves as a constant exciter of the generator. There is therefore nothing to worry about with respect to the charging of this battery or its maintenance.



LATEST MODEL KRIEGER SIDE-ENTRANCE TONNEAU.

The lubrication of the gasoline motor and the bearings of the generator is accomplished automatically by a force-feed oiler connected to the exhaust, which starts to feed as soon as the motor starts, and ceases as soon as it stops.

On the dashboard of the vehicle is located a volt-ammeter which indicates the voltage of the generator and the number of amperes supplied by it to the motors. The driver can therefore always verify the power developed by the generating group and regulate the gas and the shunt in such a manner as to obtain continually the maximum power possible from the gasoline motor. Another volt-meter, placed below the one just mentioned, indicates the voltage of the storage battery which is used for starting.

The maintenance is reduced to that of the commutators and the brushes.

The principal dimensions of the vehicle are as follows: Wheel base, 2.6 meters (8.53 feet); track, 1.4 meters (4.59 feet); total length of the chassis with pump handles for the springs, 3.85 meters (12.63 feet); width of chassis 0.8 meters (2.62 feet); extreme width from end to end of the chassis, 1.6 meters (5.24 feet); length of the body, 2.45 meters (8.03 feet); front tires, 910 by 90 millimeters (35.82 x 3.54 inches); rear tires, 920 x 120 millimeters (36.22 x 3.72 inches). The total weight is about 1,000 kilogrammes (2,204 pounds), or about 150 kilogrammes (330 pounds) more than an ordinary chassis of the same power.

M. Krieger places at 80 per cent the efficiency of his vehicle, from the crank shaft of the gasoline motor to the rim of the wheels, while in ordinary gasoline vehicles having the usual gear transmission, the efficiency scarcely ever reaches 60 per cent. At the same speed, the Krieger car should therefore consume 20 per cent less fuel than a car of the same weight having a gear transmission. With the same consumption, it should run at a 20 per cent greater speed.

## USEFULNESS OF THE AMERICAN TOAD.*

By A. H. Kirkland, M.S.

The heavy tax levied by insects on nearly all agricultural crops is well known to farmers. Nearly as well known, thanks to Agricultural Experiment Station experts and others, are the principal remedies for combating these pests. But in the long run nature provides the most efficient checks on insect increase, and these often are but little understood or appreciated. While the value of birds as destroyers of noxious insects is now becoming generally recognized, the silent, inconspicuous work of insect parasites and certain predaceous animals receives but slight recognition even from those who are most directly benefited. Thus the common toad, nocturnal, of quiet habit and appearance, renders notable service to farmers and gardeners throughout the entire growing season; yet to many its worth is unknown, while to others it is even an object of disgust, if not of fear. It must be admitted that to some the toad can never be an attractive animal. Nature has denied it the gay colors of bird life or even the sinuous beauty of some of its reptilian relatives. Yet, judged by the standard of good works, the toad does not suffer by comparison with any of the lower animals.

The toad has always borne the burden of false and even ludicrous misrepresentations. We have adopted in their entirety the principal European traditions concerning the toad as set forth by the early writers on natural history. These ancient savants, who did so much to establish the study of nature, had the failing, not confined to that age, of confounding fancy with fact. Thus the popular superstitions of that time are curiously interwoven with their statements concerning the life history and habits of the toad. The early writings on this subject teem with vague and ludicrous fancies of the toad's venomous qualities, its medicinal virtues, and more commonly of the valuable toadstone or jewel to be found in its head. All these traditions are to be met with even in this era of progress, and coupled with them we hear of the equally surprising ability of the toad to produce warts on the hands; to poison infants by its breath; to bring good fortune to the house in whose new-made cellar it takes up its abode; and, finally, to cause bloody milk in cows if killed by accident or design. The writer well recalls the shock his credulity received when in the inquisitive stage of boyhood he faithfully tested several of these superstitions with only negative results. When so much that is false has been written about the toad it may not be amiss to increase the scanty literature of facts concerning this humble servant of man as determined by a somewhat intimate acquaintance extending over a decade or more.

The toad is of direct service to man by reason of the noxious insects which it destroys. Should it feed on beneficial insects, it would be to that extent an injurious animal. There is only one way to determine accurately to what extent an insectivorous animal is beneficial or injurious, and that is by a careful examination of the contents of a sufficiently large number of stomachs collected at different dates and over a suitable range of territory. While field observations furnish important circumstantial evidence and aid to an understanding of the kind and condition of food found, the stomach examinations, as Prof. F. E. L. Beal has so aptly put it, "constitute the court of final appeal." Patience, strategy, and good eyesight will enable one to study the feeding habits of such animals, but the absolute identification of the kind and quantity of their food cannot be made at long range. For accurate results the material devoured must be available for careful analysis, often under a microscope.

The writer a few years ago collected and examined 149 toads' stomachs, particular effort being made to secure representatives from different sections and from a wide range of places, i. e., gardens, fields, hills, woodlands, city streets, etc., during every month of the feeding season. This number is doubtless too small to show the exact status of the toad in the region covered, yet it is sufficient to afford interesting data for some general conclusions. With the exception of a few stomachs preserved in formalin, all were examined while fresh, the stomachs being split along the outer curvature and the contents carefully washed into a glass dish. The material thus obtained was separated into its proper groups, identified, and its percentage of the entire bulk estimated and noted. The number of stomachs examined, by months, was as follows: April, 7; May, 30; June, 66; July, 29; August, 10; September, 7; total, 149.

The nature of the vegetable and mineral matter found in the stomachs needs no further mention. The animal matter recognized constitutes 93 per cent of the total food, of which 77 per cent was insects and 16 per cent other forms. As might be expected, nearly all the animal matter is composed of terrestrial species or of forms which at some time frequent the ground for shelter or migration.

The common angleworm was present in 14 stomachs, principally in toads taken soon after showers, and formed 1 per cent of the total food. Rains drive the worms to the surface, where they fall easy victims to a particularly hungry toad. From studying toads in confinement, it appears that worms are not preferred by that animal as an article of diet, but may be eaten. Worms are of great service in tilling and aerating the soil, as Darwin has so well shown. On the other hand, they often cause great annoyance in greenhouses and in flower beds out of doors. Since the toad frequents the abodes of man, it seems probable that the good done by worms in such localities may well be offset by their damage as above mentioned.

Snails are a serious pest in greenhouses and gardens, where their depredations on lettuce and other succulent plants are well known. Several of the large naked snails common in gardens were found in the stomachs, while, in the case of the shell-bearing snails, it was found that the acid stomach juices of the toad were sufficient to dissolve the shell in a short time. It seems a little strange that such slow-moving animals should attract the attention of the toad, yet it is apparent that the animal finds them suitable articles of food, as shown by their constituting 1 per cent of the total stomach contents.

Sow Bugs.—These small creatures were most numerous in stomachs taken in the late summer, and made up 2 per cent of the food for the season. Their damage to roots of orchids, violets, pansies, roses, etc., has been frequently noted by florists. By destroying them the toad renders a distinct service.

Thousand-legged worms form a constant article of diet, as many as 77 having been found in a stomach. Ten per cent of the food of the toad was of this class. They are frequently called "wire-worms," although this name belongs properly to the young of the "click beetles." Farmers often find the attacks of these myriapods on potatoes a serious matter. The late Dr. J. A. Lintner has recorded an instance where for two years in succession a potato crop was severely injured by these "worms." Many cases of injury to newly-planted potatoes have come to the writer's attention, while others have recorded the partial destruction of cucumbers, tomatoes, etc., from this cause.

It is not strange that such active creatures as spiders form 2 per cent of the toad's food. Naturally most of the spiders were of terrestrial species. How much good spiders accomplish is an open question, but since they destroy large numbers of flies we have included them in the column of beneficial insects. It should be noted, however, that the spider's web often catches those active parasitic flies which would otherwise serve man through the destruction of injurious caterpillars. Perhaps a fair statement would be that the harm the toad may do by including 2 per cent of spiders in its menu is offset by the 13 per cent of snails, sow bugs, and "thousand legs" which it destroys. This brings us, then, with a clean balance sheet to a consideration of its insect food in the strict sense of the term.

Grasshoppers, crickets, etc., were found to make up 3 per cent of the food of the toad, and included several of the common species of the hay field, as well as house crickets, tree crickets, and cockroaches. The damage to grass and grain crops by grasshoppers is too well known to require more than mere mention. The black house cricket is often a nuisance, while the cockroaches and water bugs are even worse. The small roach or water bug was often found in stomachs of toads taken on city streets. The toad is entitled to unstinted praise for its work in destroying these insects.

We come on debatable ground when we take up the economic importance of ants. The writer for the purposes of this paper has regarded them as of neutral value. Most entomological writers regard lightly the shortcomings of these industrious and highly intelligent creatures. Certainly one cannot observe their systematic domestic arrangements and evident reasoning powers without a feeling of sincere admiration. During the season of their activities they destroy a certain number of soft-bodied insects and carry off more dead ones as a provision against future need. On the other hand, they care for and distribute plant lice and certain other related insects, infest lawns, walks, and dwellings, attack cooked food, and often make of themselves an unmitigated nuisance, as many a perplexed housekeeper can attest.

Ants constituted 19 per cent of the total contents of the stomachs examined. The greatest number was found in the May examinations, when they were present in 70 per cent of the stomachs and formed 23 per cent of the food for that month. Aside from ants a few allied insects—such as bumble bees, honey bees, wasps, and hornets—and two ichneumon flies were noted in the examinations. The latter insects are beneficial as parasites on certain caterpillars. Beekeepers have informed the writer of cases where toads had taken position at the entrance of hives, and thus destroyed a large number of bees. This loss might have been avoided by raising the hives above surface of the ground. Since the toads feed principally at night, such cases are probably of rare occurrence.

There is a certain family of active black or metallic ground beetles, which are usually present in gardens, fields, or woodlands, feeding for the most part on soft-bodied insects, and occasionally varying their diet by attacking low-growing fruits. These ground beetles undoubtedly are beneficial, as a whole, although the damage to strawberries by certain species has caused considerable loss at times. The most serious charge to be laid against the toad is the destruction of these ground beetles, which make up 8 per cent of the total food.

On the other hand, the members of the May-beetle and click-beetle families are commonly present, and furnish 6 and 5 per cent, respectively. The May-beetle, or June bug, is unfavorably known as the parent of the white grub, which, in certain years, destroys large areas of grass land and lawns, and also works havoc on the potato crop. Promiscuous shooting of crows has removed one of the principal checks on this insect; hence the service of the toad in this connection is of especial value. The "rose bug," or rose-chafer, was found in several stomachs.

The common wireworms, which attack newly planted corn, are the progeny of the click-beetles, and these insects were present in large numbers in the stomachs examined. Wireworms also attack potatoes, lettuce, cabbage, and other garden crops.

Snout-beetles, or weevils, make up 5 per cent of the toad's food. These insects, of which the plum curculio is a good type, are among the most difficult pests to combat. Nearly all have the habit of dropping to the ground and feigning death when disturbed, thus giving the toad a chance to capture them. Among the species found in the stomachs were two specimens of the plum curculio, and many which bore in standing timber and shade trees.

Potato bugs, cucumber beetles, and their allies amounted to 1 per cent of the total food. The injurious habits of these species need no comment. Of equal rank were the carrion beetles (1 per cent) of possibly beneficial habits, and miscellaneous beetles (1 per cent). The latter, aside from an occasional ladybug (beneficial), are of no special importance. The sole value of the carrion beetles lies in their habit of burying or devouring dead animal matter which might otherwise become offensive.

The young or larvæ of moths formed 28 per cent of the total food; cutworms forming 16 per cent, tent caterpillars 9 per cent, and miscellaneous caterpillars 3 per cent. The destruction of cutworms is of special importance. These insects feed by night, and the grower only learns of their presence through the loss of his lettuce, cabbage, and other plants. Hand labor offers the most practical remedy, and this is ably assisted by the efforts of the toad. To appreciate fully the number of cutworms a full-grown toad may consume, one should watch these animals in a field infested by army worms, which are members of the cutworm family. Three toads taken under such conditions contained, respectively, 9, 11, and 55 army worms. These soft-bodied insects are quickly digested, and the toad's capacity for cutworms seems only limited by the supply.

The insects consumed by the toad are chiefly those of terrestrial habit. Yet the good work of the toad is not confined to insects of this class. There are a large number of caterpillars which feed ordinarily on trees, yet seek the ground when ready to transform, and these fall easy victims to the toad. The common tent caterpillar of the wild cherry and apple well illustrates this point. These caterpillars when full grown often travel considerable distances in search of suitable places for cocoon making.

In May these insects formed 18 per cent of the food, and for the season 9 per cent. This insect is a pest of the first rank on apple trees and occasionally works on cherry, plum, and peach. It is much preyed upon by the cuckoo and oriole, while the toad secures a fair proportion of those that escape the birds. From 15 to 20 were often found in the stomachs, 37 being the largest number noted. The writer once saw a black-billed cuckoo eat 35 of these insects at one meal. That bird is well protected by wise laws. The toad has equally as good a record, but receives no legal protection from wanton cruelty.

Among miscellaneous caterpillars, which formed 3 per cent of the food, were noted such injurious species as the gypsy moth, canker-worm, Vanessa, grape and celery caterpillars, tomato worms, cabbage worms, etc. An abundance of active gypsy-moth caterpillars in certain Massachusetts localities often proves sufficient to tempt the toad from retirement even at midday. Three of the toads' stomachs examined contained, respectively, 7, 15, and 65 gypsy caterpillars. As a means of checking the increase of such a serious pest the value of the toad is small, but the case is of interest as showing that tree-infesting caterpillars are often captured by this animal.

* Abstract from Farmers' Bulletin 196, issued by U. S. Dept. of Agriculture.

It would seem that such heavily armored insects as the spiny Vanessa caterpillars would escape the toad, yet in spite of their natural protection they are gathered in without apparent discomfort. The damage caused to the elm, willow, and apple by these insects is a matter of common knowledge.

Elsewhere mention has been made of the capture by the toad of the winged brown-tail moths as they fall partially stunned from the street lamps. The lamps have a strong attraction for the moths, and the toad makes sure that few if any escape. This imported European pest has now become well established in several New England States, particularly in residential districts. It is here that the toad is most valuable as a destroyer of the moths. Four toads taken under electric lamps contained 10, 11, 15, and 17 moths, respectively. The caterpillars of this insect are but little more fortunate than the moths. Six toads taken in infested orchards contained, respectively 3, 3, 5, 7, 8, and 12 caterpillars. When we consider that the hair with which these insects are clothed produces a most intense irritation whenever it comes in contact with the human flesh, it would seem that the toad is practically immune from injuries of this class, and that few if any caterpillars are well enough protected to escape its rapacious appetite once they come within its reach.

ECONOMIC STATUS OF INSECTS DESTROYED BY THE TOAD.

In the following table an attempt is made to strike a balance between the good accomplished by the toad through its ravages on injurious species and the harm it does by destroying beneficial species:

Insect Food of the Toad Classified as Regards Economic Status.

| | Beneficial. Per cent. | Neutral. Per cent. | Injurious. Per cent. |
|---|---|---|---|
| Cutworms, caterpillars, etc. | | | 28 |
| Ants | | 19 | |
| Injurious beetles | | | 18 |
| Sow bugs, myriapods, snails, etc. | | | 13 |
| Ground beetles | 8 | | |
| Grasshoppers, etc. | | | 3 |
| Spiders | 2 | | |
| Carrion beetles | 1 | | |
| Worms | | 1 | |
| Vegetable matter | | 1 | |
| Mineral matter | | 1 | |
| Total* | 11 | 22 | 62 |

To summarize: Against the toad must be reckoned the destruction of many beneficial ground beetles, a few spiders, an occasional carrion beetle, ladybird, and ichneumon fly, forming as a whole 11 per cent of its food.

To the credit of the toad we must place the destruction of a remarkably large number of particularly injurious insects, such as cutworms, army worms, caterpillars, gypsy moths, brown-tail moths, May beetles, rose-chafers, wireworms, cucumber and potato beetles; also snails, thousand-legged worms, and sow bugs. The quantity of injurious species destroyed forms 62 per cent of its total food. Should ants be included as injurious, as many housekeepers would think proper, this figure would be increased to 81 per cent. These figures derived from careful examination, show the toad to be a highly beneficial animal and well entitled to man's protection in every possible way.

The amount of food consumed by the toad is remarkable. Elsewhere records have been given of finding 77 thousand-legged worms in one stomach, 37 tent caterpillars in another, 65 gypsy moth caterpillars in a third, and 55 army worms in a fourth. Under the writer's direction, 24 medium-sized gypsy moth caterpillars were fed to a toad under observation before its appetite was appeased, while Mr. F. H. Mosher fed over 30 full-grown celery caterpillars to another in less than three hours. Doctor Hodge has seen a toad "snap up 86 house flies in less than ten minutes," while he has also published an interesting observation by Ellen M. Foskett, Worcester, Mass., who fed 90 rose bugs to a toad without satisfying its appetite.

The number of insects a toad consumes in a season is conjectural. The writer is satisfied that the amount of food taken in twenty-four hours amounts to about four times the stomach capacity. In cold weather this figure would be lower, while in midsummer, when insect life is at its height, the quantity would probably be larger. A typical stomach examination as taken from the writer's notes is given below.

Specimen 43, taken 9 P. M. May 11, 1896:

| | Per cent by bulk. |
|---|---|
| 6 cutworms | 50 |
| 5 thousand-legged worms | 20 |
| 6 sow bugs | 20 |
| 9 ants | 6 |
| 1 weevil | 2 |
| 1 ground beetle | 2 |

On the basis of the above data the amount of food consumed in certain periods would stand as follows:

Number of Insects which One Toad May Destroy.

| Period. | Cutworms. | Myriapods. | Sow bugs. | Ants. | Weevils. | Ground beetles. |
|---|---|---|---|---|---|---|
| 24 hours | 24 | 20 | 24 | 36 | 4 | 4 |
| 30 days | 720 | 600 | 720 | 1,080 | 120 | 120 |
| 90 days | 2,160 | 1,800 | 2.160 | 3,240 | 360 | 360 |

In ninety days (a period selected because May, June, and July represent the time of the toad's greatest activity) it would destroy 360 beneficial insects (ground beetles) and 9,720 injurious or noxious insects. Take the single item of cutworms. These insects are preyed upon by ground beetles. Let us assume that the ground beetles, if spared, would have succeeded in capturing 10 per cent of the cutworms. This would leave a net balance of 1,944 cutworms to the toad's credit. Many gardeners give their children one cent apiece for each cutworm found and destroyed, considering this a low estimate of the damage caused by the insects. Even at this nominal figure, without considering the importance of the destruction of other injurious insects, the toad's services on this one item would figure $19.44.

* The 5 per cent unidentified has been excluded from this classification.

The toad suffers from enemies both natural and unnatural. Of those provided by Nature a few internal parasites are sometimes found, while hawks, owls, crows, snakes, and skunks yearly destroy large numbers. The marsh hawk kills a great many toads during the spawning season, while hens, ducks, geese, and guinea fowls feed on the young toads as they migrate from the breeding pools.

It is perhaps the irony of fate that large numbers of the toad should be killed annually by man, the one most benefited by its life. Lawn mowers work great slaughter among them, while the practice of burning over lawns and fields kills more. The killing of toads in this way is largely unnecessary and the extra labor involved in protecting their lives will be more than repaid by their services.

The heaviest charge of wrongdoing must be entered against the small boy, ubiquitous, inquisitive, and often thoughtlessly cruel. In a case coming under the writer's notice two boys in one afternoon established the disreputable record of 17 dead and mutilated toads captured at a breeding pool. Such a wanton and expensive exhibition of cruelty may be unique, but it is certain that thousands of toads are killed in this way annually, and this practice will continue until our boys are taught to recognize the value of the toad and to respect its rights. Laws protect our insectivorous birds as well as others whose worth to man is, to say the least, a debatable question. The toad's worth is an established fact. Should it not receive a similar protection?

Elsewhere reference has been made to the strong homing instinct of the toad. This makes it difficult to establish toad colonies unless the animals are brought from a considerable distance. It is said that English gardeners often pay as high as $25 per hundred for toads for colonizing purposes. That such a procedure is sometimes successful is shown by the experience of the well-known authoress, Celia Thaxter, who at one time found her beautiful gardens at the Isles of Shoals overrun by insects and snails. A considerable number of toads were imported from the mainland, with the result that in a short time the pests were suppressed and the flowers preserved from harm.

A better plan is to provide a breeding place for toads and carry them to it at the mating time, so that later in the season the young toads leaving the water may establish themselves in the locality. A shallow pool having a small but constant water supply is all that is needed. Stagnant rather than running water is desirable, since the growths in which the tadpoles feed do not develop so well where there is a current. Further, the stagnant pools usually have a higher temperature, thus favoring the growth of the tadpoles. Against this plan may be urged the breeding of mosquitoes in such pools, and under some circumstances this objection may prove an important one. It is entirely possible, however, that the tadpoles would keep down the mosquito larvæ, and in any case the young toads will leave the water by mid-summer or before the mosquitoes become abundant, when the pools may be drained.

It is always well to provide artificial shelters for toads in gardens. These are easily made by digging shallow holes and partially covering them with a board or flat stone. Toads will use these shelters for weeks, sallying forth by night and returning at daybreak. Greenhouse owners will find toads particularly useful as destroyers of snails, sow bugs, weevils, and other injurious forms of animal life. The well-known entomologist, Dr. Ritzema Bos, writes: "In the research garden of the Rouen entomological laboratory the snails were entirely exterminated in 1891 as a result of introducing 100 toads and 90 frogs." At Malden, Mass., a collection of valuable orchids was severely injured through the attacks of myriapods and sow bugs. On the writer's advice a number of toads were introduced and all damage from this cause soon ceased. Many other cases where the toad may be made useful will suggest themselves. The common greenhouse rose weevil (Fuller's beetle) can doubtless be controlled in greenhouses by aid of toads, particularly if the beetles be jarred from the bushes at occasional intervals.

"Go to the ant, thou sluggard," was Solomon's dictum. One may find profit and pleasure in studying any of the common forms of animal life, but few offer a more attractive field than the subject of this paper. Abundant everywhere, harmless, easy to obtain and rear, the toad is one of the best objects for class-room work in nature study. A small aquarium and a pair of toads or a mass of toad's eggs are all that are required. Let the aquarium be of glass, earthenware, or wood, shallow, and supplied with plenty of water plants, a few fresh-water clams or mussels to keep the water in circulation, and a small quantity of dog biscuit or chopped fresh meat if needed when the tadpoles are half grown. Care must be taken not to supply more meat than they will devour, since otherwise the water may become fouled. Such an aquarium makes an object of unfailing interest in the schoolroom or home, and by summer will yield hundreds of small toads for colonizing gardens and farms. The value of such a study to the children can not be overestimated.

## THE "GLOBE" CURTIS LETTER ON THE MOST VALUABLE SOURCE OF WEALTH IN THE PHILIPPINES.

You will remember that I told you some time ago how Uncle Sam might make a big profit by treating the expansion policy as a real estate speculation, for, by the treaty of Paris, he acquired more than $20,000,000 worth of valuable city real estate appraised at its auction value. And if you will look around over here you will soon be convinced that he got a great deal more for his money. A native poet has described the Philippines as "a magnificent rosary of glowing islands that nature has hung upon the heaving bosom of the warm Pacific." I do not quarrel with that proposition, but it is a mighty big rosary to hang on any kind of a bosom, if rosaries ever were so familiar. Measured by figures, the Philippines have 128,000 square miles of available public land, and are 7,000 square miles larger than the United Kingdom, and about the same area as Spain. Luzon alone is equal to Denmark, Belgium, and Holland combined. Compared with the United States, the Philippines are as large as New York, New Jersey, Pennsylvania, and Delaware combined, and nearly twice as large as all New England. Our jurisdiction extends over more than 700,000 square miles of water, which, by the way, is very deep, if that is any advantage. Within the three-mile limit of some of the islands the water is 12,000 and some places 18,000 feet deep. But that is nothing to brag of, nor is it an available asset.

The most valuable source of wealth is found in the forests, which cover an area of 51,537,243 acres, according to the official Spanish statistics, and about 50,000,000 acres belonged to the crown of Spain and became the property of the United States by the treaty of Paris. The annual growth of pine, cedar, mahogany, and hundreds of other varieties of hard wood is estimated at 1,400,000,000 cubic feet, which is about three times the annual cut of the United States. Ninety-nine per cent of this annual growth is going to waste because there is no one to cut it or use it, and no transportation facilities by which it can be taken to market.

It is actually cheaper to bring pine from Oregon to build Fort William McKinley than to cut it in forests within sight of the post. That is one reason why railroads are needed over here, and some of the lines that have been surveyed will make this timber accessible. Within a few years, doubtless, you will find sawmills scattered all over the archipelago, but foresters say that it will take 1,000 years at the present extravagant rate of consumption in the United States to exhaust the supply to be found here without considering possibilities of renewing the forests as they are cut down.

The destruction of our forests at home has been the cause of much concern to economists, and the measures that have been taken to protect and preserve them were begun none too early and it is a satisfaction to know where we can get more lumber and timber and cabinet woods when we need them. The island of Mindanao is almost entirely covered with forests. The population is living along the coast. The interior has never been explored, but it is safe to say that there are not less than 10,000,000 acres of virgin forest there, and every tree will yield commercial lumber. In the southwestern islands it is estimated that there are more than 4,000,000 acres of virgin forest, extending from the sea beach to the summit of mountains. Much of it is "narra," the Philippine mahogany, and "calantas," the Philippine cedar, two of the most valuable varieties of timber for building and cabinet work known to botanists.

The trees grow to enormous size, with trunks clear for eighty feet up to the first limb and from four to eight feet in diameter, as straight and regular as a pillar of the Parthenon. The officials of the forestry bureau tell me that they have listed 665 species of native trees, including 200 of which they know nothing more than their names.

They established a timber laboratory where the native woods to the number of 300 species are now being tested by various methods in order to ascertain their strength, durability, adaptability for various purposes, and the very important question of their ability to resist the ravages of the white ants that eat up everything in these islands. Cabinet makers from the United States are in charge of the laboratory with native assistants, including several expert carvers and woodworkers, who are familiar with the different classes of timber, and the uses which have already been found for them.

The Pullman Palace Car Company sent an expert down here from Chicago to make an investigation, who took home with him at no little expense forty-eight logs of as many different varieties of timber. Although no formal report has yet been received from him, private letters intimate that the collection contained some of the best varieties of cabinet woods that were ever brought into the Pullman shops.

After 375 years of Spanish domination not more than 5,000,000 acres of all kinds of land have ever been utilized. The Spaniards and the Filipinos have allowed all this wealth to remain untouched.

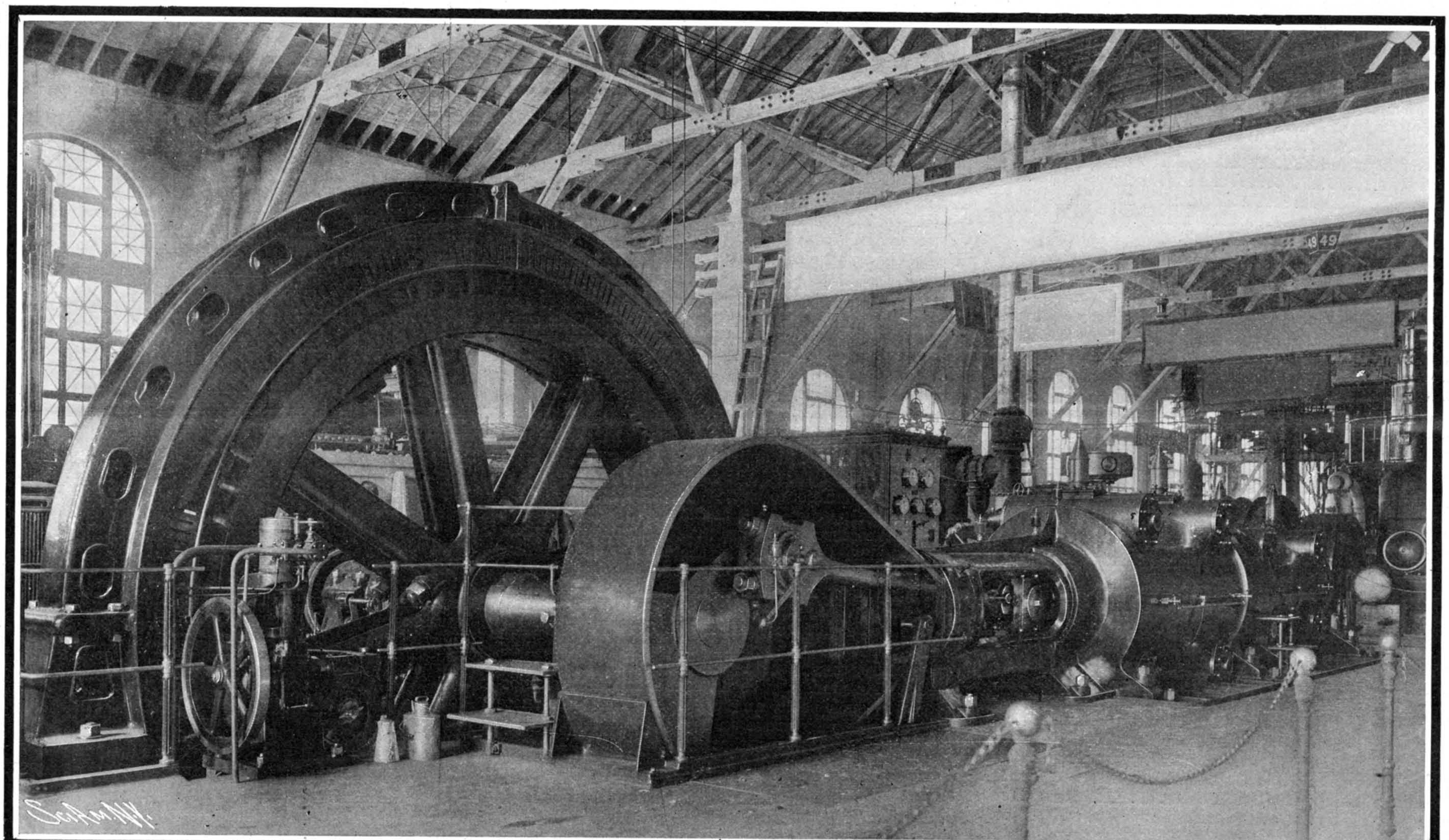
The Philippines have a magnificent river system, with at least four rivers in Luzon alone that are navigable for nearly the entire length of the island, but these streams have been a disadvantage rather than an advantage, because the development of the country has been limited to a narrow fringe along their banks and along the harbors of the coast. Had it not been for this fact railroads might have been constructed and the development of the interior might have been more rapid. All of these rivers can be utilized more or less by the timber industry.

No spot on the earth contains more luxuriant vegetation or a greater variety of plants than the Philippine archipelago. Already the botanists have identified 4,500 species representing 151 families and 1,100 genera, and they predict that a thorough exploration will disclose at least 10,000 species of plants. Only the Island of Luzon has been partially explored, and frequently between 200 and 300 different species have been found on areas not exceeding one square mile.—The New York Globe.

## A 1,000-HORSE-POWER COMPOUND FRENCH ENGINE AND DYNAMO.

By the St. Louis Correspondent of the SCIENTIFIC AMERICAN.

THE excellence and beauty of the French designs of stationary engines have long been recognized, and these characteristics are conspicuous in a handsome 1,000-horse-power, horizontal, tandem compound engine which stands near the western entrance to the Machinery Building at the St. Louis Fair. This engine is direct-connected to a three-phase 60-cycle alternator of a maximum capacity of 800 kilowatts and a voltage of 2,300. The high and low pressure cylinders are placed in tandem with the low-pressure forward of the high-pressure. The guides are carried in, and form part of, the engine-frame casting, the form and construction being of the well-known type. The beauty of the engine lies in the fine proportion of the parts, the excellence and truth of the castings, and the careful attention to detail that characterizes the whole design. The engine is of 1,000 horse-power, and steam is supplied at a pressure of 180 pounds to the square inch. It is admitted by transverse piston valves carried above the cylinders, a pair to each cylinder, one at either end. These are operated by eccentrics, one eccentric serving to operate both the steam admission and the exhaust. The engine was built by the Société Alsacienne de Constructions Mecaniques, of Belfort.



A 1,000-HORSE-POWER FRENCH HORIZONTAL COMPOUND ENGINE AND DYNAMO AT THE LOUISIANA PURCHASE EXPOSITION.

## ANTI-FOULING COMPOSITIONS.

HOLZAPFEL, who has devoted years of study to paints for under-water uses, says concerning the same: The best anti-fouling compounds are those made of poisonous enamel colors which combine with their powers of resisting submarine growths also the qualities of drying quickly, forming smooth surfaces, and do not peel off. In order to avoid a composition that scales it is necessary to apply to the object a mass that does not penetrate the whole body to be protected at once, which, at all events, means that each individual coat should be thoroughly dried on and also that the union of dissimilar layers with incongruous binding material be strictly avoided. Copper, particularly the sulphates and oxides, form new combinations with the sea-water surrounding them, and are little by little eaten away and come off in scales. There are still other materials besides copper which are subject to this peeling propensity.

Holzapfel lays great stress upon the notion that the compositions should be adapted to the waters through which the ship is to pass, because no single compound is suitable for all waters. The harder the covering composition, the longer will its coating last, and an enamel which possesses this property is especially adapted to voyages in the Atlantic, whereas softer compounds and those which are more inclined to scale are more suitable to the impure waters of the Indian ocean.

A ship that is confined to cruising in the Atlantic does not need so much poison in the compound, nor does it require to be painted so often as one whose business keeps it constantly in the Indian waters.

Ph. Schwarz expresses it as his opinion concerning submarine paints, that they should be insoluble in water, they should possess a certain elasticity, so as not to become cracked, and above all they should be of a hardness capable of offering a sufficient resistance to mechanical injury. These demands are best met by a layer of rosin. Varnishes of prime quality consisting of volatile oils or alcohol in which rosin has been dissolved are eminently suitable. During the volatilization, or, perhaps better said, evaporation, a thin elastic layer is formed upon the iron. It dries almost under the brush, and consequently requires little time for the application. Coal tar in which solid and fluid carbureted by hydrogen are present, together with resinous particles has, when free from acid to the highest possible degree, proven itself also a good covering for ships' bottoms, though it is more likely to décompose and disappear in sea water than the varnish paints.

Schwarz also maintains that the best protection against marine growths is a sheathing of copper which oxidizes evenly over the whole surface. The copper combinations are of so loose a character that the motion of the ship through the water causes them to be torn away or washed out, whereby the growths which have attached themselves to the bottom are compelled to let go their hold.

Hummel, who has occupied himself with a thorough investigation of the covering for the bottoms of ships, expresses himself thus:

"The solution of shellac in spirit as produced by Rathjen must be acknowledged as an important step forward in the matter of protecting the hulls of ships. This solution was mixed with iron oxide and a small portion of linseed oil added in order to lend the mixture elasticity. Paints of this description are characterized by their durability, because the salts contained in sea water have little or no effect upon shellac; from the quicksilver contained in the second coat there is slowly formed, under the influence of the sea water, a mercuric chloride, which destroys the tiny organisms."

Rathjen's paints dry quickly, so that from two to three coats may be applied in a day.

It is impossible to combine mercury in large quantities with these paints because the shellac solution would be destroyed thereby. Moreover, the solubility of shellac is very small, so that the effectiveness of the paint is, as a consequence, considerably lessened. As poisons, zinc white and copper claim attention. Other antiseptic remedies also are available. For example, hydrazine has been tried, yet copper and quicksilver have proven most effective. Cheapness is the most sturdy advocate for the application of copper, and yet for other reasons its use is less to be countenanced, for if the insulating layers become damaged to any great extent such a large quantity of copper in contact with the sea water is liable to set up a corrosive action upon the iron. Paints applied to the bottoms of ships produce the desired result of keeping the bottom clean, either by peeling off and carrying with the scales the barnacles or other growths which have attached themselves to the hull, or by means of their poisonous constituents—copper, arsenic, or salts of quicksilver—kill the animalculæ and cause them to release their hold.

These last-named salts for the most part attack and destroy the priming coat which protects the iron from rusting, and thereafter they attack the iron itself. Nor are we as yet fully convinced that these salts remove the marine growths by killing them. For this reason scaling compositions are preferably used. Of course, the painting must be done every year, and as a consequence it is not suitable for ships which cruise for lengthened periods in tropical waters. Among the fundamental conditions for the practicability of a paint for iron ships, Hummel sets forth the following axioms: 1. The composition must protect the ship's hull from corrosive influences. 2. It must form a smooth surface in order to reduce the friction. 3. It must dry quickly, so that the bottom may be cleaned and two coats of paint be applied in one day.

Like all coverings of iron, the chief requisite in painting the bottoms of ships is the first coat, which shall not, as is the case with wood, by sinking into the pores, form a mechanical union with the foundation, but must stick fast to the outside and compose a water-proof film or layer. This priming-coat, which is applied to the vessel still upon the launching ways, need not dry so very quickly, but it must take a firm hold upon the metal, and not be dislodged by a jar or shock. It must become hard and may not soften under water and after loosening fall off, as happens often with many oil-colors. Holzapfel maintains that satisfactory results in the preservation of a ship's hull may not be expected so long as the loose color on an already painted ship has not been removed; every rust spot must be most carefully cleaned; then, and only then, may a priming be applied and other coats be painted on. If tallow, minium (red lead), or any other coating have been applied to the ship's bottom just before, then only very thin coats of certain compositions may be put on, because otherwise the first coat will be dissolved in the binding material of the second. Many anti-fouling compositions bond well with an old coat of zinc-white and form a hard, compact covering that gives satisfactory results. Zinc-white is also the only one of the ordinary pigments

which will seize and hold fast upon the bottoms of new ships. White lead is also used in dockyards, and deserves attention. It would doubtless be more extensively employed were its higher price not an obstacle.

The lead which covers the ship's walls is attacked by the salt water, and the salt of lead thus formed kills the animalculæ which attach themselves by suction. Ships that have been coated during construction or shortly after never turn out well at first; the covering loosens and falls off gradually, carrying whatever coats may have been subsequently applied with it.

We give here some new compositions. The anti-fouling compound invented by Hansen, under an English patent, No. 1458, in 1901, consists of a mixture of spermaceti, rosin, and beeswax, and must be applied hot. Peter Jebel, of Hamburg, in a German patent, holds as follows: The sheathing consists of thin sheets of copper or similar metal, the back side of which has been coated with gutta-percha, pitch, and shellac formed into an insulating medium. This latter compound may be applied to the copper sheets either with a brush in the form of a paint or forced upon them by pressure. These sheets are prepared for shipment most conveniently when cut in long strips of a suitable width and rolled up. The following procedure is best adapted for fastening these strips to the ship's sides and bottom: After the under body has been cleansed it proves of advantage to coat the walls at first with a varnish which combines with the rust particles and prevents further oxidation. Then the metallic strips, with the insulated side next to the ship, are applied by pressing them against the ship with hot iron rollers or other heated tools. The shellac and pitch combination is thus warmed and in consequence of its great tenacity hold with extraordinary power. The formation of air bubbles under the sheathing must, of course, be avoided—not a difficult matter if the work begins at one end and proceeds carefully toward the other. So soft are the metal strips that they may be easily pressed into all the cracks, elevations, and depressions that occur, and thus form airtight joints. Again the layer of insulating material may be applied independently of the metal strips in the form of a thin, soft rubber layer by means of a glue formed of pitch and shellac, or any other sticky substance or cement, and afterward this layer may receive the metal strips, attached by means of a cement, being rolled or pressed upon it, as above indicated.

W. Briggs, of Dundee, prepares a patented compound of bitumen or pitch, lime, fine sand or Portland cement and flaky mica. These component parts are melted together and applied hot. The surface is, of course, first well cleansed and then coated with an ordinary solution of bitumen or pigment. According to Coleman, in an English patent, No. 11,962, granted 1901, the metallic surface is covered with a layer of paint, which consists preferably of a mixture of linseed oil and Australian damar or other varnish resins, as well as oil of turpentine or any other thinning medium. Then comes an insulating layer, of sand, for instance, which is applied before the first coat is completely dry. Upon this is painted another coat of the paint, and finally a layer of large, thin sheets of copper. The copper parts are rolled, hammered, or pressed against the side until they form a part of the insulating material, and until the whole coating presents a smooth surface. Instead of mineral or inorganic substances, vegetable matter, such as sawdust, tow, and so forth, may be employed as insulating media.

Manfred Ruyg, of Vienna, in a German patent, No. 110,395, gives us the following: For paints destined to cover the bottoms of ships and as a poisonous ingredient it is proposed to add a mixture of a cuprous oxide containing a molecule of cyanogen, cuprous cyanide, or cuprous rhodanide, for example. Up to the present only combinations of copper with acids have been employed for painting ships' bottoms. The application of hemioxide of copper in the form of a free base, as actually occurs in the German patent, 14,428, although the endeavor is to use it in the shape of a phenate, does not offer the advantage of the process before us, because in the latter the cuprous rhodanide combined with two molecules of sodium chloride is decomposed by sea water, whereas in the German patent No. 14,428 only cuprous oxide goes in solution with common salt. According to an English patent, No. 23,294, in 1896, potassium cyanide is used. The formation of copper cyanide is also excluded because of the simultaneous employment of sulphuric acid. Either the cuprous cyanide or the cuprous rhodanide may be used in combination with one of the primers which are applied warm, or even cold, being applied as an alcohol, oil, or rosin paint. The cyanides may be used either alone, in combination with each other, or combined with one of the already known additions to the anti-fouling compounds, such as arsenic, quicksilver, or the cuprous combinations.

J. Kühlich, of Magdeburg, according to a German patent, No. 137,937, employs metallic quicksilver as an addition to his paint and in the following quantities: Thirty-two parts of metallic mercury, 1 part of sulphurized turpentine, 60 parts of lard and mutton tallow, and 20 parts of litharge which had been previously ground in oil. To effect this combination he proceeds thus: The quicksilver, which, as we know, does not mix readily nor completely with fat, is first triturated with the sulphurized oil of turpentine until an intimate mixture has been accomplished, only a few minutes being required for its completion. Now this mixture may be worked into a homogeneous mass with the lard and tallow and the triturated oil and litharge added.

By a copious addition of linseed-oil varnish, which is only to be stirred in a little at a time, the product may be reduced to a state ready for the brush, which, after the addition of about 3 per cent of peroxide of manganese, dries easily. The compound may be given any desired color; it prevents the attachment of snails, barnacles, or any other form of living organisms to the bottom of the ship.

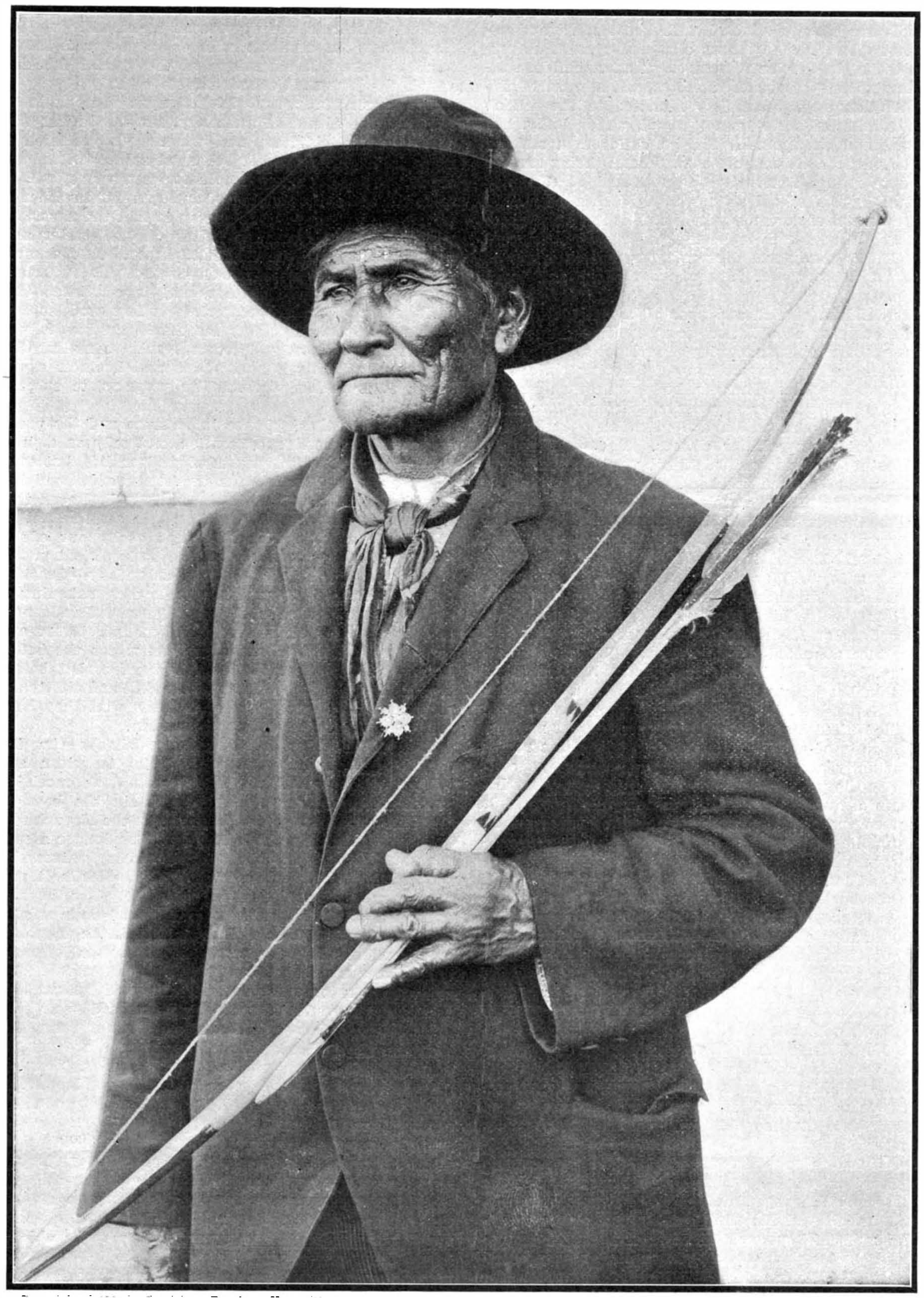
Here is another coating for the same purpose: Ten parts by weight of tallow, 2 parts of rosin, 2 parts of vitreous sand, ¼ part of arsenic melted and well mixed together.

According to a German patent, No. 107,227, granted to H. Alexander, heavy metal xanthogenates, particularly methyl-ethyl, or amylxanthogenates of copper or zinc, are added in the usual way to these ship paints, either as solids or dissolved in carbonic disulphide. These xanthogenates differ from other additions to the compounds in that besides their poisonous effects they carry with them at the same time coloring properties.—Farben Zeitung.

## GERONIMO AT THE WORLD'S FAIR.

By the St. Louis Correspondent of the SCIENTIFIC AMERICAN.

GERONIMO, the once bloodthirsty Apache chief, who spread terror throughout the Southwest until he was finally captured by Gen. Nelson A. Miles, is one of the striking features of the Indian exhibit at the World's Fair. Geronimo regards himself as still a great chief, on the ground that he resisted the American government longer than any other Indian. He is seventy years old and, while revered by all Apaches, is not considered as a ruling chieftain on account of his extreme age. When Gen. Miles first made Geronimo captive, the old Indian was sent to Florida, but in a short while he was returned to the prison at Fort Sill. Geronimo is nominally free at the World's Fair, but practically a prisoner of war. He was accompanied to the exposition by Capt. Sayre, of the United States army, under whose charge the old Indian has been since his stay at Fort Sill. Geronimo spends the day in the Indian Building at the World's Fair, and as a pastime writes his autograph for visitors. He has a special teepee in the Apache village and makes his home with his tribe at night. Of all the tribes that roamed America's forests, the Apaches were the most cruel and treacherous. And of all the Apaches, Geronimo was the most vicious. He fought desperately when escape was possible by no other means; but slaughter from ambush and the slaying of the defenseless were the more to his choosing. Long years of captivity have broken his spirit, but he is still warlike, proud, and erect, the true representative of a once powerful race.



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GERONIMO AT THE FAIR.

## MOSELY EDUCATIONAL COMMISSION.*

THE object of our visit to America was to study American education, and so far as the time would permit to inquire as to the direct influence of education on the progress of American industry. The various members of the commission had each his own special department in which he was more particularly interested. The writer was chiefly concerned with the education of engineers, and it is to this side of the work that his attention was chiefly directed.

In looking at American education as a whole, there was no mistaking the fact that a very strong and keen interest is felt in the subject by the whole community. The education of the people appeared to be the one topic upon which all were agreed, and from the President of the United States downward all seemed enthusiastic in helping forward the great work. President Roosevelt, in his kind and courteous reception of the members of the commission at Washington, when addressing the company, said, "I say not that

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education has *made* America, but I say that without education America is lost."

In addressing the members of the commission at Chicago, Dr. Edward J. James said, "No matter whether our education in the past is good or bad, in the future we are determined to have all grades as perfect as they can be made." He said, "We work for this end, not only because a great nation should have great schools, but from the conviction that great schools will make a great nation."

The education of the United States is divided into four grades, the common school, the secondary or high school, the college, and the university. The common school is free and compulsory up to the age of 14. The secondary school is free, but not compulsory, and is attended by pupils from 14 to 18, and boys and girls attend the same school. The college provides a degree course of study in arts from 18 to 22, and is intended to equip the student with such general culture and accomplishment as shall place him in the rank of educated men. The last course is taken at the professional school of the university, where students receive a special training from 22 to 26 (or from 18 to 22 if the college course has been omitted) for the vocation he is intended to follow. In many cases the student omits the college course and proceeds direct from the high school to the professional course.

Common Schools—To this portion of the subject more attention was paid by other members of the commission, and little need be said here except that these schools are being conducted with great spirit and enthusiasm, but in many cases also under great difficulties, owing to the large number of alien children attending them, who often cannot speak a word of the English language when first admitted to the school. The training of the common school, undoubtedly, has a wonderful effect on the foreign children in making loyal American citizens of them, though their presence tends to reduce somewhat the standard of efficiency reached by the school as a whole. It has been said of the American common school that it has done more than anything else to make the American nation, and to weld the many and diverse types and interests of which it is composed into one contented and loyal people.

The children of rich and poor alike sit side by side in the common school, and there is thus a freedom of intercourse and community of interest set up which engenders mutual respect not only during childhood, but far on into life. There is, however, a considerable growth in the number of private schools where high fees are paid, and which are attended only by the children of the wealthier classes. The most noticeable feature of the common school was the great preponderance of women teachers. In many schools the whole of the teachers were women, and it is doubtful whether this is a satisfactory arrangement for the training of older boys. In justice to the women teachers it should be said that the discipline and attention of the pupils was generally excellent. It was stated that the salaries offered were not sufficient to attract men into the teaching profession.

Secondary or High Schools.—The secondary schools of America attracted the special attention of the commission, because it is in this direction that English education has been allowed to drop so far behind and to remain so defective right down to the present time.

In the United States secondary education has reached a high state of efficiency, and it has become as really and actually a part of the American system of education as the primary school. It is said that every little town of over 1,000 inhabitants demands that a high school course shall be provided for the senior pupils of its public schools. The city high schools are prominent everywhere. They are architecturally fine structures, and internally well fitted and equipped with all modern school requirements. In a comparatively small town such as Scranton, Pa., of 110,000 inhabitants, the high school is a handsome building with a large and spacious entrance, with an assembly hall, excellently furnished, capable of accommodating over 1,000 pupils, and with a large and well-appointed gymnasium. There were 1,000 pupils in attendance at this school, boys and girls together, and the age of the pupils was from 14 to 18. This is an average and not an exceptional town. In Pittsburg, a city of 600,000 inhabitants, there were over 1,000 pupils in attendance at private secondary schools, over 2,000 pupils over 14 years of age in attendance at the public schools, and 1,180 pupils attending business and commercial schools and colleges. In addition, there were 775 Pittsburg students out of a total of 814 students attending the Western University of Pennsylvania, which is situated at Pittsburg. In Philadelphia the Central High School is attended by 1,584 boys over 14 years of age. The assembly hall of the school seats 1,750 pupils, and the building cost £300,000 to erect. Taking the statistics for the whole of the States, it may be said with close approximation to the truth that 1 per cent. of the population are pupils between the ages of 14 and 18 in attendance at secondary or high schools. In parts of the Eastern States the proportion is said to be as high as 2 per cent. The attendance at secondary schools in America is increasing, according to President Murray Butler, at a rate five times as fast as the rate of increase of the population.

One is regretfully compelled to ask where are the towns and cities of England with 1 per cent of their population in attendance at high schools, over 14 years of age. Steps are being taken, it is true, to improve the condition of our secondary education, but it will be a long time before we can hope to reach the numerical standard of the American high schools. For quality of work, the work done in the best British secondary schools is unsurpassed in the States, but we have too few first-rate secondary schools, and even the powers conferred by the recent Education Act with respect to secondary education will avail but little, unless the pressure of a strong public opinion, based on a real demand for improved education, is brought to bear upon the question.

In the possession of so complete and general a system of secondary schools, the youth of America have at present an immense advantage over the youth of England. In America the system of keeping boys at the high school till they are 18, and soundly drilling them in the elements of a good general education before admitting them to technical schools and colleges, is producing very superior results, and the technical institutions are able with such boys to do the work for which they are intended, viz., to give a sound training in the subjects of applied science.

In England boys enter the technical schools too early and too ill-prepared, and the result is that the technical schools that have been provided in so many centers of our country have in most cases been compelled, and are still compelled, to fulfill the functions of an ordinary secondary school pure and simple, and to provide just those elements of a general education that are necessary to the student before he can even commence the study of applied science. The technical schools are unable to proceed with their special work until at least the second year of the student's course, and these schools are at present impatiently waiting the time when students will come prepared beforehand to take full advantage of the special facilities which the technical school has to offer.

The American parent insists upon the provision, by the local education authority, for the higher education of his children, and when such provision is made he is willing to keep them at school till the age of 18. Though many English parents are willing to do the same, the number of such parents in America is very much larger. One reason is that the American parent is on the average better off and better able to afford it than the English parent. But a more powerful and effective reason is that the American parent believes in education, and is convinced that it is essential to the material welfare and success of his children. Further, the American boy is precociously ambitious, and seems keenly to realize that his school training is part of his real business equipment; it is to him the road to progress, to success, to wealth.

Considering the immense importance and the pressing need of secondary education, not only as a preparation for the requirements of modern life, but especially as a preparation for the study of the higher branches of learning, it is sincerely to be hoped that the powers now conferred by the Education Act of 1902 will be taken full advantage of by our educational authorities, and that ample and efficient means will be provided for improved secondary education throughout the country. As regards the awakening of public interest, one of the most powerful influences in this direction will arise when manufacturers and employers begin to show a preference for the better educated class of youths, and to require that before boys shall enter departments where skill and ability are necessary, they shall be able to show that they have received a sound secondary education.

Manual Training in Secondary Schools.—An important department of the work in American secondary schools, and one which has done much to popularize these schools and to retain the boys to the end of a four-years' course, is the department of manual training. This subject is no longer a new one, but is well established and almost universally adopted in the American high school. While it prepares for no particular industry, it gives boys a command of their hands as well as of their minds, and is essential to a full training of the faculties. It engenders not only a respect for but a keen interest in manual employment, with the result that many boys enter constructive trades and become successful who would otherwise have missed their way in some clerical or professional employment for which they were less fitted. These departments are usually extremely well equipped with tools and appliances; they are taught by enthusiastic, capable, and practical teachers, and the course of instruction is productive of excellent results.

Business and Commercial Departments.—In many of the high schools a further addition to the curriculum is made for the training of pupils in commercial subjects. It is the aim of these departments to give as thorough a training as possible in business and commercial methods so that the student may be able to keep books, make out bills, and write business correspondence, as well as possess a general knowledge of business laws and customs. In many of the schools rooms are fitted up with an elaborate business office equipment, including a large number of typewriting machines, and although such a department seemed somewhat strange and novel, it left the impression that the work was being done very thoroughly and that it had a very serious and real meaning to the pupils and to the teachers.

College Education.—On leaving the high school the student must select his course from one of four alternatives:—(1) He may go direct to business or to work; (2) he may proceed to a college for a four-years' course of training in the subjects of a general literary education and then go to business; (3) he may omit the college course and proceed direct to a professional or technical school and receive a four-years' course of scientific and special training for his future professional career; or, (4) he may proceed from the high school first to the college for a four-years' course of general education, and afterward for a four-years' course of professional or technical training. If the last of these proposals is adopted the programme is a very long one, but it was surprising to find how many young men were going through this long course of training, and how strongly such a course was recommended by men whose opinions deserve the highest respect as practical men of the world.

In the United States at the beginning of the century there were 30 colleges with 3,000 students. To-day there are 472 collegiate institutions with 155,000 students all over 18 years of age. The colleges devote themselves to general literary studies, and they award the bachelor's degree to those who complete a four-years' course. What is the explanation of the very large attendance of students at college at an age when, in the estimation of many persons, they would be better at business? The question is not easy for the English observer to answer.

Causes of the Keenness for Education.—The first cause is the ambition of the student himself. He is keen to come to the top. It is not enough for him that only a few can be leaders. He means to be one of the few. He believes an advanced education is the way to reach it, and he is willing to stake his time, his money, and his work on the issue. He knows, it is true, that there are men who fill high positions who have not received a college training in their youth, but he knows also that they generally regret the fact, that they are anxious that their own sons shall receive the best possible education, and that they frequently show their appreciation of its value by leaving large sums of money for the endowment of educational institutions. He will tell you also that the competition of the future will be a very different thing from the competition of the past, and that the new conditions brought about by modern science, organization, and method will require the highest possible skill in every department of work. He, therefore, feels justified in devoting the time required to the laying of a sound educational foundation upon which to build his future career.

In this view he is encouraged by many distinguished employers. For example, Mr. W. Barclay Parsons, engineer of the New York Rapid Transit Railway, which employs an executive staff of about 200 engineers and assistants, in the course of an interview, said: "I do recommend most strongly an advanced education, including a literary training, for my assistants. Though the value of the training may not appear immediately, the trained man is soon able to show the result of it, and he rises rapidly, much more so than the untrained man. He has more self-reliance, especially when faced with a change of conditions. He knows where to look for new information on the subject, and how to make use of it when he has got it. Why do so many of our men take a double course (that is, the arts and professional course)? Because they are ambitious. I do not want any man here as assistant to me who is content to remain a subordinate. That is the difference between the trained and the untrained man. The trained man is ambitious, capable, pushing, resourceful; he has more strings to his bow. He is a man of broader views and wider interests. The untrained man is contented to be a subordinate, he is dependent, and, in general, without resource."

Mr. George S. Morison, a distinguished American engineer, says the young engineer is the man of the future. It is such qualifications as he possesses that will be most in demand in future. Great business concerns are like a great machine, and they need the engineering type of mind to control and manage them. The young engineer who means to make his way in the world must, therefore, receive a broad and liberal education and not only a merely professional one. His education must be broad enough to enable him to hold his own among other educated men, and to fit him to fill any position, even the highest when the opportunity is presented to him. He says further that the omission of a literary training may not impair his professional efficiency, and is right enough if he is satisfied to be employed rather than to be an employer, but it will deprive him of the power and authority which a broad education gives, and will decrease his chances of filling the highest positions.

Dr. James H. Canfield states that 1 per cent of the entire population of America has received a higher education in her colleges and universities, and that this 1 per cent holds more than 40 per cent of all the positions of confidence, of trust, and of profit which it is in the power of American people to grant, and, further, that as these positions rise in the scale of importance and emolument the percentage of college men still further increases.

The second cause of the keenness for education in America is the freedom of opportunity which awaits all American citizens who have the ability to rise and are willing to pay the price in industry and training. Every youth, be he the son of the President or the son of the laborer, knows that there is nothing to hinder his advancement to the highest positions in public, professional, or commercial life, except his own personal merit and ability. To attain to these qualities he believes an advanced education is essential, and he is willing, therefore, to do anything to obtain it. When at college, his education is a very real and serious thing to him, and he is old enough and keen enough to know that the use he makes of his

opportunities makes all the difference between success and failure in life. As one American college puts it, "This institution is a place for men to work, not for boys to play."

There are no scholarships given in America. They say, "We don't believe in the scholarship system. We expect the students who can't afford to pay to do something for their instruction, to take some duty in the college, or to earn their privilege in some other way."

As an example of the willingness of the poorer class of student to make sacrifices for his education, the following is taken from a New York newspaper of October last, showing how students earn their way through college in the vacations:—"Reuben A. Meyers, secretary of the Student Employment Committee at Columbia, has issued his report for the past summer. The 192 students who reported their earnings made £6,286. One man earned £90 as a lecturer in psychology and another £40 as a lecturer in English. By tutoring one student made £170 and a life insurance agent earned £150. A night watchman made £20 and all expenses, a printer earned £35, and a street car conductor £34. One man made £10 as a harvester in wheat fields, while a 'checker' on the Great Lakes steamships earned £35. Among the other forms of employment which the students turned to during the summer vacation were newspaper correspondent, bank clerk, teacher in vacation playgrounds, civil service examination monitors, tourist's guide, architectural draughtsman, and factory superintendent."

Dr. James H. Canfield, speaking to young men, says, "If the applicant is reasonably sure that he may profitably take a college course there is no better undertaking for which to borrow money, nor is there any better investment of borrowed money—nothing which pays a larger interest nor makes a more sure return. Borrowing should be a last resort, but if the choice be made between entering upon life in the bonds of ignorance or in the bonds of debt, the latter is to be chosen."

Said a fine old Scotch resident to the writer: "The one great concern in America is the education of its young men, and I am sorry I can't make you Britishers understand this." Such advice as Dr. Canfield gives seems to fully confirm this statement.

Attendance at the Technical Colleges.—According to statistics prepared in 1900, there were at that time 89 institutions in America giving professional courses of instruction in engineering of college grade. During the decade 1889 to 1899 the numbers of students increased from 3,043 to 9,679. The course of instruction in these institutions is in all cases for four years, and the students are all over 18 years of age.

With regard to the numbers of students given above, it may be well to call attention to statistics recently gathered by the Association of Technical Institutions of Great Britain. These returns included the engineering students in attendance at all the universities, university colleges, and technical schools of England, Scotland, Ireland, and Wales for the year 1900. It was there shown that the total number of students in attendance was 2,259, made up of 1,141 first-year students, 719 second-year students, 347 third-year students, and 52 who had attended more than three years. But these numbers are obtained by counting students who begin their studies at the immature age of 15, and they are the majority. From the above numbers, therefore, a very large proportion of the first and second-year students must be omitted, which leaves a very small number to the credit of the English engineering college. On the other hand, it should be noted that these returns do not include the educational work done by the British Admiralty at the various Government dockyards and at the Royal Naval College at Greenwich, a work which has been productive of more men of mark and distinction in shipbuilding and marine engineering than that of any other institution in the world.

The curriculum of the American technical college consists of about 10 per cent English and modern foreign languages, 30 to 40 per cent pure science and technical drawing, and 50 to 60 per cent technical subjects. The fees vary from £6 to £7 a year in the State colleges to £50 a year in such institutions as the Massachusetts Institute of Technology.

The most noticeable features of the various technical institutions visited were the extent of the laboratories, and the excellence, one might say the magnificence, of their equipment in mechanical, electrical, and physical appliances, the liberal scale upon which these departments were staffed with men of distinction in their various departments of study, and the large numbers of students of an older type than it is usual to see in our own country.

The students come from all classes and conditions of life and from all parts of the United States. In one college we were told several of the students were sons of farmers from the West. They sometimes come and apply for admission with only a few dollars in their pocket, but they work their way up through the college by acting as waiters at boarding houses, attending to heating apparatus, lighting street lamps, selling newspapers, or acting as car drivers and conductors. It must be said that these students are not despised on account of filling such positions, but are rather respected by their fellow students, and they often turn out among the very best men of their year.

The effect of the presence of such students upon the colleges is worthy of notice. It is certain that the student who earns his tuition so hardly, and makes so many sacrifices, will want his money's worth out of the college, and he will make himself very much heard if he does not get it. He will not readily put up with incompetent or second-rate teaching, or neglect, or inefficiency of any kind which will prevent his getting full advantage out of the resources of the college. This is an important point, as every influence which tends to develop the efficiency of the college and to insure that the fullest use shall be made of its equipment and appliances for the benefit of the student is to be welcomed. The presence of such students, therefore, must be a distinct advantage to the college. A further point is that such students would not persist with their studies under such difficulties for so long a period as four years without good and sufficient prospects that the result of their work will be profitable to them.

(To be continued.)

## AGRICULTURE IN JAPAN.

ONLY 14,995,272 acres, or 15.7 per cent of the whole area of Japan, exclusive of Formosa, consists of arable land, and 55 per cent of the agricultural families cultivate less than 2 acres each; 30 per cent cultivate 2 acres or more up to 1½ cho, or a little less than 3¾ acres, leaving 15 per cent of the farmers who cultivate farms of 3¾ acres or more. A comparison of the whole area under cultivation with the number of farm workers shows that, on an average, one man cares for a little less than an acre.

An American farmer will naturally wonder how the Japanese farmer can support his family from the produce of so small a farm, and how he employs his time on it. The Japanese standard of living is far below the American, and the income of the Japanese farmer is usually increased by his engaging in some subsidiary industry, such as rearing silkworms, reeling silk, or spinning, and by working for wages in the intervals of farm work. In his work on the farm he seldom uses a horse or other draft animal, and his tools are of a very primitive character. He fertilizes and cultivates very thoroughly, and is thus enabled to secure a more abundant harvest, besides often raising two or more crops a year on the same field. In the warmer latitudes of Japan barley, indigo, beans, and rape are grown successively on one plat of ground within the space of a year.

There are no reliable data respecting the proportion of independent and tenant farmers, the latest published estimates being based on returns made fifteen years ago. According to these estimates, a little more than half the cultivated land was leased to tenant farmers, the remainder being worked by the owners. The lot of the tenant farmer is far from easy, the high price of land forcing him to lease on terms which leave him a very small return for his labor after he has paid for the necessary fertilizers. These conditions tend to retard the advancement of agriculture by preventing the purchase of new tools and hindering any effort the farmer may make to adopt improved methods.

The government has attempted to aid the progress of agriculture by laws respecting irrigation, the protection of forests so as to control the flow of rivers in the interest of the farmer, the formation of farmers' guilds, the rearrangement of farm boundaries, and the improvement of drainage systems. Small as the farms are, their parts are usually separated so that a farm of 2 acres may consist of several non-adjacent lots, the average size of a lot being about one-eighth of an acre. A law which went into force in 1900 provides for the rearrangement of boundaries by farmers exchanging fields for those owned by others so as to make the farms more compact and enlarge the fields to permit the use of horses and machinery, at the same time increasing the tillable area by straightening some boundaries and removing others. About 20,000 acres have already come under the operation of this law.

For the purpose of further promoting agricultural interests the government maintains a State experimental farm and nine branch farms. The work at these farms is largely theoretical, and is divided into eight departments, viz., seed, saplings, agricultural chemistry, entomology, vegetable physiology, tobacco, horticulture, and general affairs. The results of the investigations are submitted to thirty-eight experimental farms, created and carried on by the provinces with the help of a subsidy from the general government, and theories are here subjected to the test of practical application before general publication. Among the results already accomplished by this method are improvement in the quality and quantity of crops through more careful selection of seeds and better understanding of the varieties suited to the conditions in different localities; more efficient modes of destroying injurious insects; ability to minimize the injury from plant diseases, such as smut, mildew, pear cluster-cups, etc.; increased skill in the application of fertilizers, and the discovery of indigenous grasses suitable for meadows, all meadow grasses having formerly been imported.

The general government aids the local treasuries to maintain six local agricultural schools for the instruction of farmers' sons in the general principles of agriculture, surveying, veterinary science, and related subjects. The government also carries on an experimental tea farm, on which is a curing workshop; a laboratory for investigating the diseases of cattle and poultry; a cattle-breeding pasture for improving the native breeds of cattle for meat and dairy purposes, and two horse-breeding pastures for promoting the introduction of better horses.

Efforts have been made to introduce sheep raising and swine raising, but with only partial success. It is claimed that the conditions of climate and food supply present no serious obstacles to the success of sheep farming, but the statistics of 1901 showed only 2,545 sheep in the country. Swine raising has succeeded better, but can not yet be spoken of as an established industry of much importance, the number of swine having remained in the vicinity of 200,000 for several years.

Besides the encouragement and assistance to agriculture furnished through the agricultural schools and experimental farms and laboratories, the government aids and promotes the development of agricultural interests by means of the hypothec banks. Recognizing that many operations necessary to the prosperity of agriculture require a heavy investment which will not yield immediate returns, and that farmers are therefore not able to pay the high interest or accept the conditions of short-time commercial loans, the government has established the hypothec banks for the special accommodation of this class of borrowers. These banks are under the direct supervision of the finance minister, subject to strict regulation, and, in return, receive a certain degree of support from the government. They are permitted to make loans only for the following purposes: (1) Reclamation of land, irrigation, drainage, and improvement of the fertility of the soil; (2) construction and improvement of farm roads; (3) settlement in newly reclaimed places; (4) purchase of seed, young plants, manure, and other materials required in agricultural and industry; (5) purchase of implements and machines, boats, wagons, or beasts for use in farming and manufacture; (6) construction or repair of buildings for use in farming and manufacture; (7) improvements in farming and manufacture not included in the foregoing clauses; (8) rearrangement of farm boundaries; (9) undertakings by credit guilds, purchase guilds, and produce guilds of unlimited liability and organized under the industrial-guilds law.

The credit guilds are organizations of the farmers for the promotion of their common interests, and in some respects resemble the co-operative home-building associations of the United States. When organized in conformity with prescribed conditions, they are permitted to borrow money from the hypothec banks on very favorable terms, and the members may often obtain loans which the circumstances would prevent them from securing except through the guild. These guilds also undertake works for the common benefit, especially such as concern control of the course and volume of rivers, irrigation and drainage systems, road building, reclamation of uncultivated land, measures for protection against insect pests, and similar enterprises.

Stable manure and night soil have been used as fertilizers by the farmers of Japan from time immemorial, but in recent years the supply of these has been found wholly inadequate to the needs of the land, and artificial manures have come into general use. As the farmers were liable to be imposed upon by the venders of these, the government in 1901 enacted a law for controlling fertilizers. This law requires those who manufacture or deal in fertilizers to procure a license, to submit samples of their goods to the proper officers for inspection, and to guarantee the alleged composition. The government has distributed 116 fertilizer inspectors among different districts and has appointed twenty chemists at the State experimental farms to take charge of the analysis of fertilizers. In 1902, 3,697 applications for analysis of fertilizers were made to the farms and 7,685 analytical tables were prepared. Lecturers sent out from the agricultural schools and laboratories have explained to the farmers the primary essentials of fertilizers and the different requirements of different crops, so that the farmers have become generally intelligent on these matters. In 1901 the artificial fertilizer manufacturing companies of Japan produced 62,400 tons; 151,000 tons of fish fertilizers were produced, and 83,967 tons of Chinese bean cakes were imported for use as fertilizers. Artificial fertilizers are also imported from Great Britain, fish guano from Siberia, animal bone from China, and other fertilizing materials from different countries.

The principal agricultural products, named in the order of their acreage, are rice, rye, barley, wheat, beans, mulberries, sweet potatoes, millet, buckwheat, rape, red beans, Italian millet, tea, indigo leaves, potatoes, sorghum, tobacco leaves, cotton, and hemp. The area devoted to rice cultivation constitutes a little more than two-fifths of the total area of arable land. The greater part of the rice fields are in low-lying land, which can be easily flooded, but some upland rice is raised. Mulberry trees and tea plants are usually planted on land not suitable for more important crops, such as the slopes of hills, sand dunes, and similar places. In the warmer parts of the empire barley and rape are often raised as a second crop after rice has been harvested, but farther north the excess of moisture required for rice leaves the land too cold for another crop the same year.

Stock raising is still in its infancy in Japan, and is not likely to become an important industry, owing to the high price of land and the coarseness of the native grasses, most of which are not fit for food for cattle or horses. Oats and maize as food for farm animals are practically unknown, and what passes for hay is a kind of straw, which is chopped fine before it is fed to horses. A little less than one-sixth of the arable land consists of plains and pastures, and to this about two-fifths belong to the state and the imperial household, the remainder being owned by private stock raisers, who raise stock principally for tillage and draft animals. The natives are not accustomed to the use of butter or milk, and do not usually like the taste of them, and their religious prejudices have hitherto prevented the general use of meat of any kind, although

they now seem to be developing a taste for all these kinds of food.

Farmers do not engage in poultry raising to a sufficient extent to provide the eggs needed for home consumption, these being imported from China to the value of over $500,000 per year. Fruit raising, under the stimulus of government encouragement, has advanced considerably, but it is not yet an important branch of farming in this country. Bee culture is engaged in to a limited extent, but the industry is still in a primitive condition.—E. C. Bellows, Consul-General, Yokohama, Japan.

## SOME NEW EXPERIMENTS WITH CATHODE RAYS.

Mr. A. Broca a short time ago stated that in a powerful field there are produced simultaneously both ordinary cathode rays, around the field according to well-known laws, and another kind of rays following the lines of force. These phenomena have likewise been investigated by Mr. Pellat, who accounted for them on the hypothesis of an anisotropical friction the cathode ray particles undergo in the magnetic field.

The existence of two kinds of rays, as pointed out by P. Villard in a paper recently presented to the French Academy of Sciences, may be easily shown by means of an apparatus similar to that used by Broca. To the same effect a narrow cylindrical bulb may be used, placed obliquely in a field either uniform or convergent. The beam directed along the lines of force and the fluorescent spots produced on the wall by the deflected ordinary rays will then be seen simultaneously. The simplest means is to observe the rays in pure oxygen, which shows a brilliant yellow illumination. The helicoidal beam of the ordinary rays and the beam shaped like a tube of force will then be clearly distinguished.

The so-called magneto-cathode rays, being those of the second kind, are produced under otherwise equal conditions with potential differences smaller than ordinary rays. Their production will set up a tension fall at the electrode and accordingly a noticeable weakening or even a complete disappearance of the cathode rays proper.

The main properties of the two kinds of rays are strictly different. With respect to magneto-cathode rays the field exerts in addition to the directing effect a motive action. In fact, if the emission of these rays be counteracted by placing in the neighborhood of the cathode a diaphragm with a small opening, an emission of rays through this opening is found to take place on the field when increased sufficiently. Similarly, the fluorescence excited on the glass, and especially the luminescence of the gas traversed by the rays will augment in intensity with the field. Magneto-cathode rays are not found to be electrified.

In fact, the shadow of a wire will not be broadened as the wire is charged negatively (Perrin's experiment). The wire may easily be connected with the cathode without broadening the shadow or causing a disappearance of the rays passing near the wire.

The method of the Faraday cylinder which since Perrin's investigation has become classical, renders it possible to confirm this non-electrification directly. It would be necessary only to avoid a mixture of the rays by placing in front of the cathode a diaphragm with a small opening. Under the conditions, no field being produced, no rays will reach the cylinder, and if the apparatus be electrically tight, the electroscope will not show any charge. There may then be directed into the cylinder either ordinary rays, by means of a small magnet, or else magneto-cathode rays, by giving the bulb a convenient orientation in a powerful field. Some fluorescent powder, being laid on the cylinder jacket, will facilitate regulation. Now, the arrival of ordinary rays in the cylinder will result instantaneously in a divergence of the gold leaves, corresponding to some hundreds of volts, whereas the divergence is absolutely nil in the case of magneto-cathode rays. The electric charge of the latter, provided there be any, is accordingly quite insignificant as against the one of ordinary rays. Most likely, however, this charge is nil and the rays are non-electrified. In fact, if a thin beam of magneto-cathode rays be allowed to enter an electric field, a deflection will be observed, but in opposition to the case of ordinary cathode rays, this deflection will be perpendicular to the lines of electric force. The direction, moreover, changes along with that of the electric or magnetic field; the latter being directed from the right to the left, an observer inspecting in the direction of the electric force will see the rays wind themselves up in the direction of the hands of a clock. The magnitude of the electric deflection is the higher as the generated magnetic field is smaller, this being analogous to the magnetic deviation of ordinary cathode rays.

The properties of the magneto-cathode rays are accordingly quite the opposite of those of Hittorf rays; electric fields acting on the former as magnetic fields on the latter and *vice versa*. This by the way seems to be the first instance of an action of an electric force according to Laplace's law.

## MAGNETIC ALLOYS OF NON-MAGNETIC METALS.

While investigating manganese bronzes in the Isabellenhütte at Dillenburg, near Wiesbaden, Fr. Heusler noticed that a piece of an alloy of manganese, tin, and copper adhered to a tool which had accidentally become magnetized. The further study of this fact by Fr. Heusler, in conjunction with W. Starck, E. Haupt, and F. Richarz, has led to results which, though not apparently of direct practical importance, are scientifically of high interest. The original bronze with which Heusler had started consisted of copper with 30 per cent of manganese. As this alloy was, in itself, non-magnetic, even when containing 1.2 per cent of iron, the magnetism could only be due to the further presence of tin, and it was interesting to inquire whether tin alone conferred magnetic properties on this alloy. It was found that while carbon, silicon, and phosphorus could not call forth magnetism, arsenic, antimony, bismuth—all three diamagnetic metals, it will be remembered—did so, and aluminium to a higher degree. As the alloys with antimony and bismuth were difficult to work with, the investigators have studied copper-manganese-aluminium were applied in atomic proportions. The induction B increased for the same strength of magnetic field $H = 100$, from 3,200 for a copper alloy containing 28.8 per cent of MnAl to $B = 5{,}300$ for 39.7 per cent of MnAl. Higher alloys with manganese and aluminium proved too brittle.

Another curious point is that the addition of small quantities of lead increased the magnetic induction from 5,600 to 6,500 in an alloy containing 36 per cent of MnAl, while additions of other metals generally proved injurious. The addition of lead further has a remarkable influence on the critical temperature above which magnetic properties vanish. We know that iron loses its magnetism at red-heat. For the 39 per cent alloys of MnAl, the critical temperature is about 300 deg. C. But when a little lead is added to a 24 per cent alloy (i. e., copper with 24 per cent of MnAl), the critical temperature drops from 160 deg. C. down to 60 deg. or 70 deg. C. Thus a piece of this alloy will be magnetic when placed in cold water, in a test tube; when the water is heated, the magnetism disappears before the water boils, and reappears as the water cools. Too high temperatures destroy the magnetism more or less permanently; but annealing at 110 deg. C. (boiling point of toluol) restores it partially in many of the alloys investigated. Careful tests made at the Reichsanstalt demonstrate that while the permeability of the manganese alloys is high for weak fields ($H = 1.6$, $\mu = 700$; $H = 5$, $\mu = 570$), in fields of 150 cast iron shows already a greater permeability, and consequently higher inductions than the new alloys ($B = 5550$—e. g., for $H = 147$ in the alloy, against $B = 9900$ for $H = 154$ in cast iron), so that dynamo-makers would find these rather expensive alloys, inferior even to cast iron. But the high ohmic resistance which promises low Foucault currents and the limited temperature range of the alloys might be utilized. On the other hand, the observations imply a caution that we need not always look for iron alone in alloys which seem to be magnetic against all expectation. The chief interest, however, lies in the fact that these alloys will help to bridge over the gap which now separates ordinary magnetic or paramagnetic bodies—iron, nickel, cobalt, and, to a very slight degree, manganese, platinum, palladium, etc.—which place themselves along the lines of a magnetic field, from the very feebly diamagnetic bodies—bismuth, antimony, zinc, tin, lead, silver, arsenic, etc.—which place themselves at right angles to the lines of force of a magnetic field. The diamagnetic effects can only be shown in very powerful fields, while the magnetic alloys occupy an intermediate position. It is rather surprising that these discoveries should not have been made before. In 1892 T. W. Hogg presented magnetic alloys of aluminium and ferro-manganese to the British Association meeting at Edinburgh. It was known then that 12 per cent of manganese rendered iron practically non-magnetic, and he showed that an addition of 20 per cent of aluminium also deprived iron of its magnetic properties, but that alloys containing about 11 per cent of iron, 55 per cent of manganese, and 25 per cent of aluminium, or 3 per cent of Al to 15 per cent of Fe, were highly magnetic. Mr. Hogg does not appear to have carried his researches, of which Mr. Heusler became aware during his work, much further, however.—Engineering.

## THE JANUS TELEPHONE SYSTEM.*

By Dr. Alfred Gradenwitz.

The Janus telephone system, designed by the Mix & Genest Actien Gesellschaft, of Berlin, Germany, enables each telephone of a private network to be used simultaneously with those belonging to the system of the telephone company (that is, in Germany, of the State telephone lines), the private network being identified completely with the circuits of the latter lines. This arrangement warrants an efficient supervision on the part of the State company, eliminates the risk of unlawful connections, and makes the private lines the last continuation and ramification of the company's telephone system. By using the same telephone apparatus for both interior and exterior communications, any desired connection, either in the private or public telephone systems, may be readily effected from the working place. Moreover, in the case of a telephonic inquiry in the interior service becoming necessary during the course of a conversation with the public telephone, this will be possible by a short interruption of the conversation and by simply switching the Janus telephone on to the interior circuit. The conversation may be resumed again immediately after the telephone has been switched back. The safety of operation, which is susceptible of any desired supervision, is insured by means of fixed switches conveniently arranged, instead of by loose plug switches. With these so-called Janus switches any unlawful connections would be possible only by considerably damaging the apparatus, which would of course be readily noticed by the supervising official.

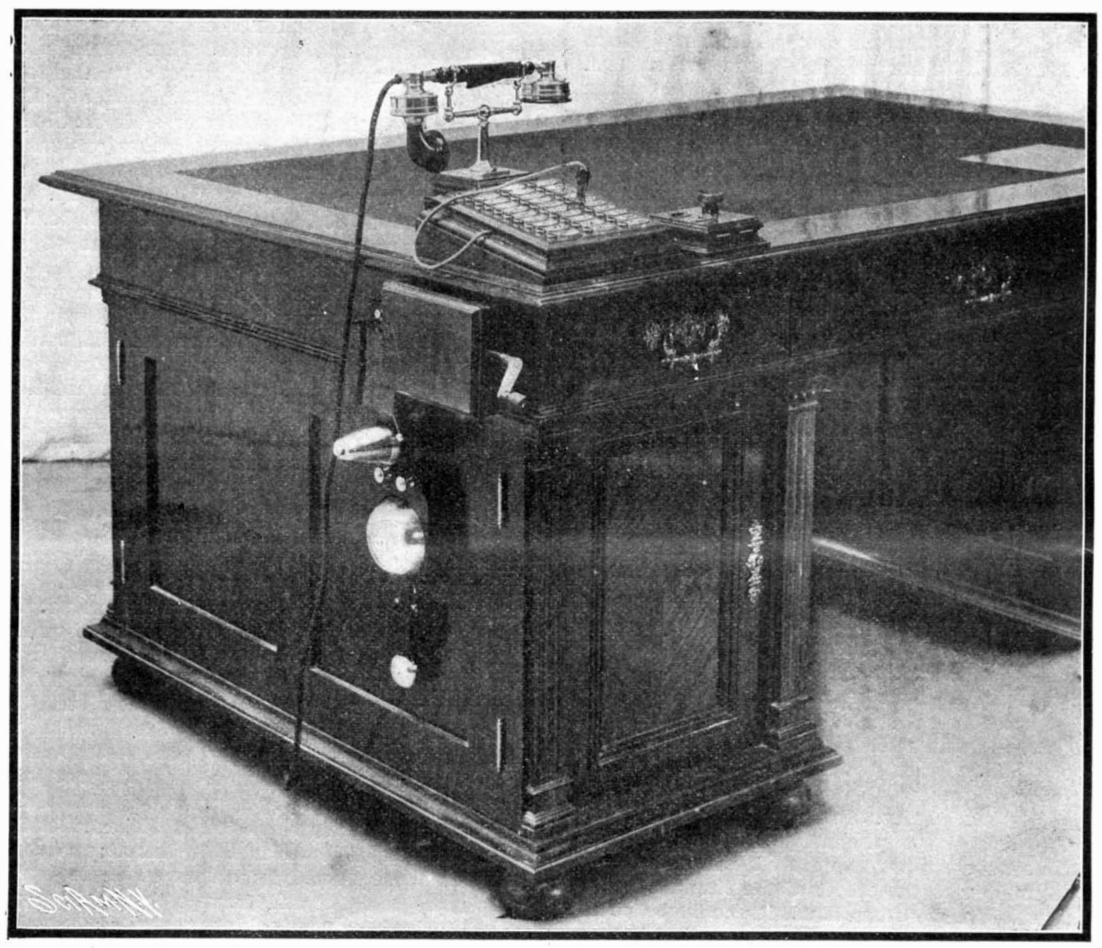


**Fig. 1.**—THE JANUS TELEPHONE APPARATUS, SHOWING DISTRIBUTING SWITCH ("LINE SELECTER"), JANUS SWITCH, MAGNETO, AND CALL BELLS.

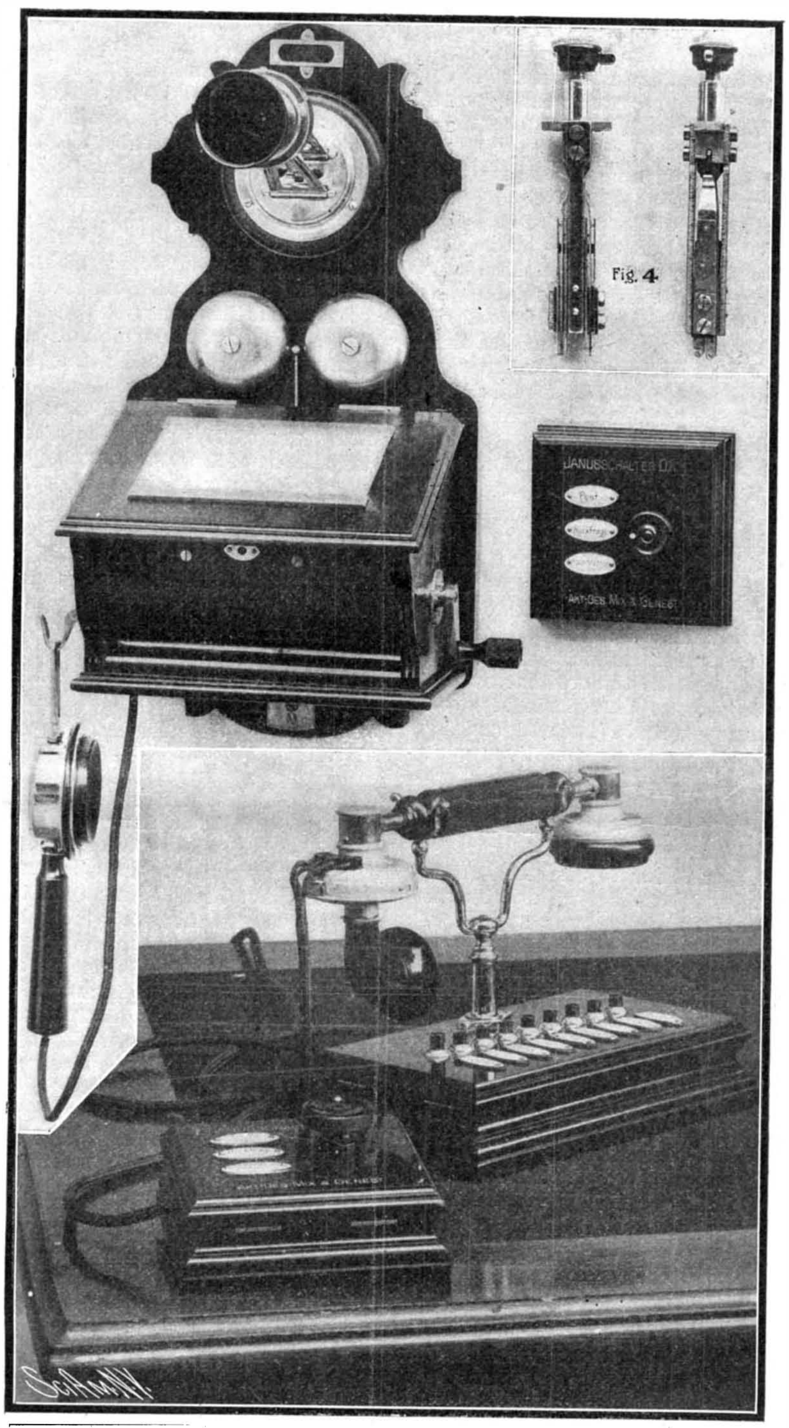
The principle of the Janus system is represented in Fig. 5, where I*ab* and II*ab* are two lines leading to the exchange, the private lines (1*ab*, 2*ab*, and 3*ab*) being led transversally to the exchange wire. Switching is effected by the double Morse keys called Janus switches, represented in Fig. 4, and consisting of two contact springs arranged to be lifted from the arrest contacts and applied to the working contacts in front, by means of pressure exerted on a button. A short rotation will then place the keys in position. These Janus switches are represented in Fig. 6 by *A, B, C, D, E, F*.

The connection with an exchange line is made as follows: If the Janus switch, *B*, be pressed down, the levers are removed from their points of rest and applied to the working contact, the *a* wire of the exchange circuit I, being thus connected to the *a* wire of the private circuit, 2, while 1*b* is connected with 2*b*. Both circuits, 1 and 2, will now be connected, while the catch corresponding to the circuit, 2, is switched off. It thus becomes impossible to effect any connec-

* Specially prepared for the Scientific American Supplement.

tion of the private station with any other public circuit by means of a plug.

The calling apparatus is intended for effecting the calling of the exchange as well as of the public subscriber's station and of private telephones. In order to eliminate any possibility of inadmissible connections by means of the calling plug, the latter, during a conversation on a public line, has to be switched off the private system. Janus switches of the same construction as those represented in Fig. 4 will also serve for this purpose, the connection of the calling apparatus with these switches being represented in Fig. 5. I*ab* and II*ab* are also the public lines, being branched off in parallel from the line represented in Fig. 5. The wires of the calling apparatus lead to the levers of the first Janus switch, thence to the levers of the second switch, and so on. The plug wires are first connected to the "off" contact of the last switch, the *a* wires of the apparatus being always placed in front of the *a* wire of the public line and terminating in the top of the switch, while the *b* wire terminates in the neck of the latter. In the case of a Janus switch being pressed down, the levers are taken off the rest contacts, that is to say, off the connections leading to the switch, and applied to the exchange line, the calling apparatus thus being placed in parallel with the latter.




Figs. 2, 3, and 4.—THE JANUS TELEPHONE APPARATUS.

## CONTEMPORARY ELECTRICAL SCIENCE.*

Bending of Magnetometer Bars.—C. Chree deals with the source of error found in the bending of magnetometer deflection-bars. In magnetometer measurements, the deflecting magnet is carried by the deflection-bar at an appreciable height above the center of gravity of the cross-section, and the bending of the bar when in use, under its own weight and that of the magnet with its carriage, results in an increase of the distance between the deflecting and the deflected magnets. To keep the instrument properly level, there ought to be a counterpoise on the other arm of the deflection-bar, at the same distance as the deflecting magnet from the center. In the absence of such a counterpoise, supposing the instrument originally level, the weight of the magnet and carriage causes a slight tilting. In consequence of this, the point of suspension of the deflected magnet moves toward the deflecting magnet, thus reducing the horizontal distance between them. Measurements of the bending effect have been made on over 20 magnetometers at the National Physical Laboratory, and it is now the regular practice to take the effect into account in framing the certificates. The author fully describes the testing method.—C. Chree, Phil. Mag., January, 1904.

Rotation of Lines of Force.—The question as to whether the lines of force of a magnet revolve with it has been answered by Hoppe in the affirmative. He found that the lines of force show a slight drag in the direction of rotation. K. Düsing has endeavored to reply to the further question as to whether the lines of force revolve with a rotating armature when the magnets remain fixed. Here, also, he found a slight drag. He laid a flat iron ring between the poles of a permanent magnet, covered it with paper, and dusted iron filings upon it. With a proper field-strength he obtained a slight tracing of the lines of force within the ring, in spite of its shielding action. He then substituted a piece of photographic paper for the ordinary paper, and made the ring revolve about its own axis. The tracing of the lines of force obtained during the rotation was fixed by holding a lighted match over the paper. The tracing showed a distinct but slight inclination of the lines of force both within the ring and outside it in the direction of the rotation. The ring must, therefore, have dragged the lines of force with it to some extent.—K. Düsing, Ann. der Physik, No. 13, 1903.

An Oscillator with Variable Capacity.—The measurements hitherto made on the constants of electric oscillations have shown that the dielectric constant and the damping ratio depend not only upon the medium in which the oscillations are produced and transmitted, but also upon the principal wave-length emitted by the oscillator, which in turn depends upon the arrangement and dimensions of its various parts. E. Castelli has designed an oscillator in which the various systems of electric oscillations can be produced, and their wave-lengths varied continuously within wide limits. The primary and secondary plates consist of sheets of tinfoil suspended by pulleys and counterpoised, so that they are in equilibrium at any level. They can also be slid forward or backward, so that their distance apart and the amount of surface in direct opposition can be varied at will. In the course of his measurements with this oscillator, the author made an observation which he believes to be new. If a vacuum tube is used for discovering the nodes, and is gradually shifted beyond the node, it remains alight even in places where it would not light up if it approached it from the outside. The author compares this result with the fact that the distance between the carbons in an electric arc can be increased while the arc is playing to lengths at which an arc cannot be ordinarily formed.—E. Castelli, Nuovo Cimento, July-August, 1903.

Calorimetry with Platinum Thermometers.—In the course of their previous determination of the water value of a Berthelot combustion calorimeter in electrical units, W. Jaegers and H. von Steinwehr obtained a limit of error of 0.1 or 0.2 per cent. On that occasion they used mercury thermometers, and they expressed the hope that with platinum thermometers it would be found possible to reach a far higher degree of accuracy. This expectation has been fulfilled, and they now report upon the method adopted. The platinum thermometer owes its advantage chiefly to the fact that it is possible to operate with intervals of temperature as small as 1 or 2 deg., which means that it is possible to use large quantities of water and that Newton's law of cooling is strictly fulfilled. A point to be considered is that the thermometer must have as large a cooling

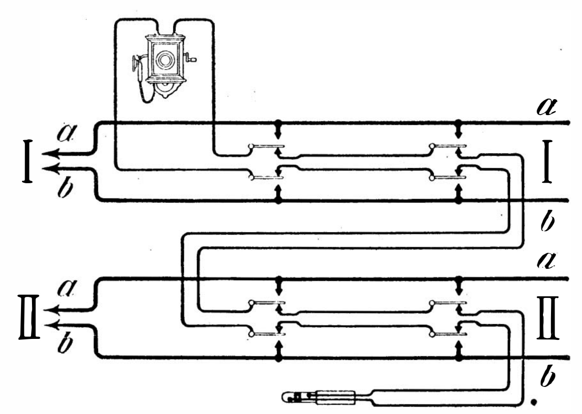



Fig. 5.—CIRCUITS OF THE CONTROLLING KEYS.

constant as possible, in order to render the heating due to the measuring current harmless. The authors used a platinum wire 30 centimeters long and 0.01 millimeter in diameter, drawn through a capillary glass tube bent into a straight loop, the two ends being fastened side by side in a block of ebonite. The loop was surrounded by a guard of wire netting. The temperature inertia was only about one-twentieth of that of a mercury thermometer. The authors used 10 kilogrammes of water, so that the water value of the metallic masses was only one per cent of the total, and only had to be known to within one per cent. The electric energy introduced was about 250 watts per second. The results did not differ among themselves by more than one part in 5,000.—Jaegers and von Steinwehr, Verh. d. Physik. Ges., May 20, 1903.

Magnetism of Volcanic Rocks.—P. David gives some further results of his observations on the per-

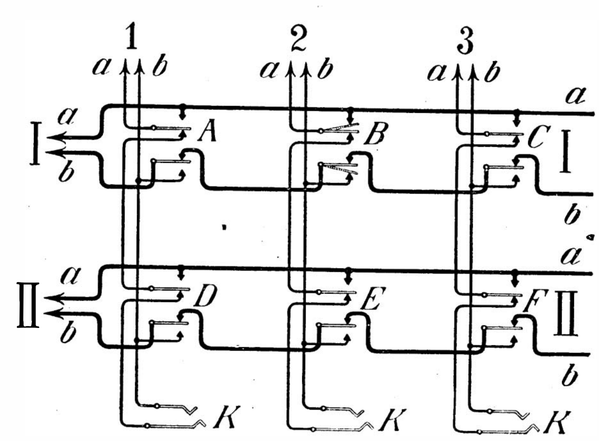



Fig. 6.—CIRCUITS OF THE JANUS TELEPHONE.

manence of the magnetism of volcanic rocks, and on the inferences which may be drawn therefrom. He studied various building materials dating from the Gallo-Roman epoch, which had been in their places for two thousand years. They showed all kinds of magnetizations, thus showing that the long period during which they had been under the influence of the earth's magnetic field since they were put in their places, had not sufficed to give them a uniform magnetization. It was, of course, impossible to deduce anything from their magnetization as to the magnetic conditions which obtained at the epoch of their formation, since their original situation was quite unknown. The author, therefore, turned his attention to some flagstones in the ancient Temple of Mercury on the summit of the Puy-de-Dôme, which also dates from the Gallo-Roman epoch. He had some cubes cut out of the flagstones and determined their direction of magnetization. He found that the declination was different in every stone, but the dip had the same numerical value, though positive in one case and negative in two cases. The obvious explanation of this is that the flagstones all had the same magnetization, but that on laying them down they were oriented in various directions horizontally. But vertically, they could only be laid in one direction, though they might be inverted and thus produce the inversion of the sign. The dip observed was about 55 deg. The author hopes that these observations will shed some light on the quarry from

* Compiled by E. E. Fournier d'Albe in the Electrician.

which these enormous stones were cut.—P. David, Comptes Rendus, January 4, 1904.

Physiological N-rays.—A. Charpentier has discovered some remarkable differences between the various kinds of rays given out by the human body according to their muscular or nervous origin. The rays emitted by the nerves have the remarkable property of being intercepted to a greater extent by aluminium than by lead. "A thickness of half a millimeter," says the author, "suffices to appreciably obscure the beam emitted by a point of the brain. As regards the portion which traverses the plate, it is not absorbed by further thicknesses of aluminium, even of 2 centimeters or 3 centimeters. It, therefore, consists of pure N-rays proper." On the other hand, the rays emitted by the heart, by the diaphragm, and by the muscles generally are hardly appreciably affected by the interposition of aluminium, and what minute effect there is may be attributed to the nerve-endings embedded in the muscles. Another difference between nerve-rays and muscle-rays is that the former are greatly increased by the slightest compression. Yet another distinct mark of the nerve-rays is found in their pronounced action upon phosphorescent sulphide heated to 40 or 45 deg. C. In reply to the complaints as to the difficulty of discovering the rays, the author gives some practical directions. He spreads a quantity of phosphorescent sulphide on black cardboard, in amount sufficient to give a very thin surface 2 centimeters in diameter, and fixes it with collodion. It is exposed for a short time to sunlight and observed in a moderately darkened room. The plate must be observed by indirect vision and without strained attention. It should be remembered especially that the increase in luminosity after the impact of the new rays is gradual. But the observations are by no means difficult.—A. Charpentier, Comptes Rendus, January 4, 1904.

## A PEA-CANNERS' PROBLEM SOLVED.*

By F. H. Hall.

Most classes of foodstuffs are subject to changes which impair or destroy their value as edibles. Fruits rot, milk sours, meat spoils and canned goods work, to the annoyance and loss of the housekeeper or the handler, and often to the perplexity of the one who has spent time and care in the effort to preserve the goods in wholesome condition. Yet these diverse changes are only manifestations of vital forces, very similar to those which have produced the foods themselves.

The decay of most animal and vegetable products is due to the activity of lower forms of life. The ordinary rots of fruit, mustiness in flour, mold on bread and cheese, and a few other troubles of food are caused by small plants. the molds, yeasts, fungi, etc.; but most of the fermentation, souring and spoiling of food is due to even simpler organisms, also classed as plants, each consisting of a single cell. These last are all bacteria, but they differ in species just as do higher plants, and manifest their presence in diverse activities so that they can be classified and studied.

It is usually their development that causes decay in foods, and thus brings trouble to the housekeeper, canner and provision preparer.

The preservation of food products, then, depends upon the control of these minute plants, and this may be accomplished in several ways: (1) The organisms which are present in the material and which would cause decay may be killed by heat and precautions taken to exclude other living germs; (2) the food may be kept at so low a temperature that growth of the little plants is checked; (3) the substance may be dried so that the water necessary to support the life of bacteria is driven off; (4) liquids containing sugar may be boiled down, or more sugar may be added, until the syrup becomes so concentrated that the bacteria cannot live upon the sugar, although this is one of the favorite foods of many common species; (5) some material may be added that is detrimental to the bacteria and prevents or checks their activity.

All these methods are in common use, as in canning fruit, keeping milk, drying beef, "boiling down" cider, and salting pork, respectively; and against none but the last is there any valid objection on the score of wholesomeness, and none against that except when such materials are added as have, or are thought to have, some injurious effect upon the human system. The knowledge, however, that salicylic and boracic acids, formalin, etc., have been used as preservatives has caused a widespread distrust of the use of chemicals in putting up foods, although many substances, like salt and saltpeter, are fatal to bacterial activity while harmless to the consumer as ordinarily used. This distrust of chemicals in food makes it advisable in all cases, where it is possible, to use some other means of preserving materials to be used as food.

Heat is one of the best agents, as it is the most common one, for sterilization of food products, since heating adds to the palatability of many foods, as well as causes the death of decay-inducing bacteria. Therefore, where it can be used without injury to the quality of the material, canning is the favored method for preserving foods; since proper heating kills the germs and sealing the cans excludes living ones.

But the conditions for securing perfect sterilization of different classes of foods are quite diverse. The intensity and length of heating which would prevent the spoiling of fruit are much less than those necessary to insure the keeping of vegetables; and the same fruit or vegetable may contain in some seasons the spores of certain decay-inducing bacteria which would survive the heating that destroys the germs ordinarily present. The germs that cause certain fermentations or decays, of very similar appearance, may themselves be of widely-separated species and different in many characteristics, including the ability to withstand such heat.

These methods and factors all had to be considered in the solution of a pea-canners' problem that was brought to the attention of the Station in 1902. It was evident that this problem was well worth attention, for the value of peas canned in New York each year is about $1,500,000, and the trouble is one which often causes great loss. It was also considered that the investigation came well within the scope of Station activity, since the canning factories, like creameries and cheese factories, take, directly, large quantities of farm products and often stand in a semi-co-operative relationship to the farmers of the State. Consequently the bacteriologist began work upon the problem and has solved it satisfactorily.

The trouble referred to is the swelling of the cans of peas while they are in the store-room of the factory, upon the shelves of the dealer or in the hands of the consumer. Such swelled cans present the appearance of having the ends rounded or "bulged" as though pressed almost to bursting by some force within the can. Such, indeed, is the case, and the pressure sometimes becomes so great that the tops are blown off or the side seams split, scattering the contents far and wide. In such cases the contents of the cans emit a most vile odor, the peas themselves are mushy, and their skins inflated with gas like little balloons.

These outward manifestations indicate the work of bacteria; and after a long and rigid examination this has been proven to be the case and a particular species of bacteria identified as the cause of the trouble. In general terms, this species is rod-like in form, with one end of the rod swollen slightly.

The steps in proving the guilt of this particular species were as follows: Suspicion was cast upon it by finding this form present in large numbers in those swelled cans which on opening emitted the characteristic disagreeable odor; the liquor of these cans, after heating to destroy less resistant germs, was used to inoculate dishes of culture medium and colonies of this particular bacterium, free from all other species, obtained; from these pure cultures, material was taken to inoculate cans of sound peas and the original trouble was reproduced; then from cans thus made to swell by inoculation, the germ was again isolated and by comparing its behavior under various conditions with the behavior of the original species, the two were proven identical.

From experience at the factory it was found that the germ, whatever species it might be, could survive heating the cans to 230 deg. F. for 30 minutes. After the identity of the germ had been determined by the steps given above, the additional test was applied of subjecting cans artificially inoculated with pure cultures of the bacterium in question to the same degree and length of heating. The cans still swelled, showing that this germ, like the one causing the original trouble was not destroyed by such heating. This gave additional proof of the identity of the species.

In preliminary work, various temperatures and times of heating were tested to ascertain how resistant the spores of this bacteria were. The factory where the outbreak occurred had been "processing" peas in 2-pound cans at 230 deg. F. for 30 minutes with good success for several seasons; but with the advent of this species of bacteria the number of swelled cans became so great as to threaten the loss of almost the entire output. The cans in stock after the discovery of trouble were reheated at 238 deg. F. for 35 minutes, which checked the swelling; and this temperature was used with good success throughout the season. Some loss occurred, however, so arrangements were made to continue the investigation on a large scale. Accordingly in the season of 1903, through the courtesy of the Geneva Preserving Company, whose factory was conveniently located, the Station was enabled to can a ton of peas, under various conditions. From replies to a circular letter sent to canners throughout the State it was found that 240 deg. was the most generally used temperature for processing. This was adopted as the degree of heat to be used, and lots of 150 cans each, of different kinds and sizes of peas, previously inoculated with pure cultures of the decay-producing bacteria, were subjected to this temperature for periods varying, by 5 minute increases, from 10 minutes to 45 minutes. When the heating was continued less than 30 minutes, the percentage of swelled cans was too large to count the processing successful; but heated 30 minutes, only one can out of 150 swelled and none swelled that were heated longer than this. It is not enough, however, to know that a certain heating will destroy the germs—it must do this without so affecting the quality of the goods as to hurt their sale. To test this point, competent judges were asked to sample the treated cans immediately after cooling and at the end of eight months. These examinations proved that heating the cans at 240 deg. for 30 minutes left the peas in good condition. Heating 40 or 45 minutes caused a slight darkening of the color, especially in cans of large peas, and in some instances a slight scorched taste. These defects, however, while noticeable at the first examination, had greatly diminished at the end of eight months, although the liquor in the cans of large peas was still somewhat dark. It is thought that this darkening might have been largely prevented by more thorough blenching before the peas were put in the cans.

It seems safe, then, to recommend heating peas to 240 deg. for 30 minutes, since this temperature and time suffice to destroy the spores of this particular germ, the most resistant so far known in pea canning, and do not effect the quality of the goods enough to hurt their sale.

* This is a brief review of Bulletin No. 249 of the N. Y. State Agricultural Experiment Station on A Swelling of Canned Peas Accompanied by a Malodorous Decomposition, by H. A. Harding and J. F. Nicholson.

## A NEW PROCESS OF MANUFACTURING SILICATE-OF-LIME STONE FROM SAND.

By the English Correspondent of the Scientific American.

Although sand is found and easily obtainable, its utilization for building purposes has hitherto been strictly limited to its forming the principal ingredient for the adhesive compound for binding other structural material into a homogeneous whole. Now, however, a process has been devised and protected in Great Britain and this country for the manufacture of sand into solid blocks or slabs, as hard and as durable as quarried stone, for building purposes. The inventor is Mr. L. P. Ford, of Gresford (England), and the process consists essentially of making a silicate-of-lime stone from sand and fat lime.

The invention is the result of five years' ceaseless experiments during which time the inventor expended over $170,000 in his quest. The story of the discovery is in many respects romantic. Several years ago Mr. Ford advanced the money for the development of a silica sand quarry for the production of the silica sand for glass manufacture. Unfortunately, however, the scheme failed owing to its inability to withstand the severe Belgian competition. Mr. Ford, however, having advanced the money on the security of the quarry, was requested by the exploiters of the scheme to take the latter over, as all his money had been sunk in the venture.

Although the lessee had absolutely no use for the quarry, yet at this time the manufacture of a stone from silicate-of-lime in Germany came into vogue, and learning his quarry produced exceptionally pure silica he resolved to turn it to profitable account. A plant was erected and manufacture commenced. Some ten tons of stone were produced daily. Now a great difficulty presented itself. The stone was produced, but from 50 to 70 per cent of it was found to be useless owing to the numerous cracks and flaws. Simultaneously the German company exploiting the process encountered the same trouble and finally relinquished the idea of making large slabs, and confined their energies to the production of small stone bricks.

Mr. Ford abandoned his manufacturing process and set to work experimenting to discover a system of making the stone in perfect blocks of unlimited size and weight. His efforts after five years' work have been crowned with perfect success and stone blocks up to 10 tons in weight can now be produced.

The most noticeable feature of his process is its simplicity. First the sand is thoroughly cleaned and dried in pans. Then the lime is added, the proportion varying according to the degree of hardness and texture of the stone required and the nature of the sand which is used. For regulating the correct proportions of lime and sand in the mixing apparatus the inventor has devised an ingenious device.

When the two constituents have been placed in the mixer and thoroughly incorporated the mass is then packed or compressed. This operation is the most crucial in the whole process and a special apparatus has been devised for the operation—in fact, comprises the most salient part of the invention.

The compressor comprises a specially constructed steel cylinder. The steel is of special preparation of immense strength and thickness, so as to withstand heavy pressures. The cylinder is perforated at frequent intervals with holes. The compound is rammed into this cylinder with tremendous pressure, the rammer having a rotary movement similar to the boring of an auger. This ramming compresses the compound into a solid mass and in this condition the steel cylinder, together with its charge, is inserted in a chamber. The air is withdrawn from this chamber until it is almost a vacuum, boiling water is then admitted into the chamber, which being almost a vacuum, causes the water to rush in under tremendous pressure. The water percolates through the perforations in the steel cylinder, and, acting upon the lime mixed with the sand, slakes it. Owing to the pressure exerted upon the boiling water it can force its way right through the solid charge within the cylinder so that no portion of the charge escapes. The expansion of the lime under the action of slaking exerts terrific pressure, which, if the steel were not sufficiently strong, would burst it, but the force, unable to escape reacts upon the sand and lime, which is now in a very heated condition, welding it into one solid mass. As a matter of fact the action of the slaking of the lime under such conditions as these is practically an explosion of every particle.

This part of the operation is maintained for eight hours, at the end of which the manufacture of the stone is complete and it can be worked up. The stone when withdrawn is in the form of a huge core or column of the same texture and strength throughout.

For the preparation of square or rectangular blocks perforated division plates are inserted into the steel cylinder before the packing operation is carried out, thereby dividing the cylinder into sections with the central one of a square formation. The whole cylinder is then packed in the ordinary way and the process

continued as above. The perforations in the dividing sectional plates are necessary, since it is by this provision that an equal pressure is exerted on all sides. If this were not so the block of stone would be flawed, the defects being caused through unequal pressures.

The utilization of the steel cylinder is practically the secret of the success of the invention. Former experimenters have employed cubical or rectangular boxes for the compressing operation. The result was that it was impossible to obtain uniform pressure all round the charge either internally or externally. The stone was weaker where the least pressure was exerted and when withdrawn was found to be flawed at these points.

The stone produced by this process has been found under test to be stronger and more durable than many of the natural quarried stones. Its cohesion of the particles of silica and lime is perfect. This is conclusively demonstrated when submitting the product to the acid test. When Portland stone and Bath stone are immersed in acid, disintegration sets up, the action of the acid upon the constituents of the stone causing them to effervesce. The Ford stone is absolutely unaffected, there being no appreciable difference.

Of course, owing to the uniformity of the pressure upon the compound while in the compression chamber, the stone is of the same even texture throughout. This renders it especially easy and safe to work with the chisel. There is no liability of the stone working irregularly through the presence of veinings.

With regard to its durability the inventor has some specimens which have been subjected to the severest atmospheric and other influences for six years. Although these are the product of his first experiments they do not display the slightest sign of decay or disintegration. The severe weather changes—such as frost and rain, have not exercised the slightest ill effects.

Another feature of the invention is the cheapness with which the stone can be produced. In England the inventor can manufacture the stone at the rate of six cents per foot, about 75 per cent cheaper than that for which the cheapest quality of natural quarried stone can be produced. Then again there is no waste through flaws or cracks developing in the course of working it. It is about three times stronger than the ordinary qualities and descriptions of stone generally employed for building operations, and is about 60 per cent as strong as granite. Even if the stone is produced as bricks it compares favorably with the cost of the ordinary type of brick, production being from 40 to 50 per cent cheaper.

From this it will be observed that this discovery opens up a new field in the supply of building material. Practical tests of similarly prepared stone which has been used to a small extent in buildings erected over half a century ago, have emphasized its durability, and now that it can be produced cheaper than any other materials employed for building operations, it promises to be extensively used for this purpose.

## ELECTRICAL NOTES.

**How far can power be transmitted electrically?** What is the cost of transmitting electric power? What per cent loss takes place in transmission? These will be recognized by any electrical engineer as typical of the questions that are continually being asked by the investor in electrical enterprises, by the users of electric power, and by the interested layman in general. The crucial question in any commercial enterprise—and an electrical transmission scheme is always a commercial enterprise—is, Will it pay? There is no real limit beyond which it is impossible to deliver electric power, provided no limit be put upon the amount of money to be spent. The engineer could easily be found who would undertake to deliver Niagara power in South Africa. The difficulty would be to find the financier to put up the necessary cash. The law of supply and demand operates no less in the realm of power transmission than in any other department of commercial enterprise. If the price that could be demanded for power in South Africa were sufficient—say a million times its present cost—the idea of delivering Niagara power to that region would not seem the absurdity that it is under present conditions. In fact, there are in operation to-day dozens of transmission lines exceeding 3,000 miles in length that have been for years transmitting power successfully, both from an engineering and from a financial standpoint. The success of these enterprises is simply a question of the price which can be successfully demanded for the power delivered. In the case to which reference is made, this price is perhaps one billion times that for which Niagara power is sold in Buffalo, or say $25,000,000,000 per kilowatt per year. The writer refers to the transmission of energy in the Atlantic cables. The motion of the siphon recorder at the end of the cable is just as truly the result of power transmission as the running of a printing press or the driving of a factory. The same laws of transmission apply, whether the power transmitted be used for operating the siphon recorder or the factory. It is in the value of power transmitted that the great difference lies. If the power for driving factories were worth as much as that for operating a siphon recorder, Niagara power would, perhaps, have been sold in the markets of Europe or South Africa long before this. The distance, therefore, to which power can be successfully transmitted by electricity depends almost entirely upon the price which can be successfully demanded for such power. The price is regulated by the law of supply and demand. The power user will buy power where he can get it cheapest and will install his own steam plant, unless the power transmission company can sell him power as cheaply as he can generate it. The most important single item in the cost of steam power is the cost of fuel. An electric transmission scheme which might fail utterly among the coal fields of a country, with coal at say $1 a ton, might succeed brilliantly in places where coal costs $10, or in South Africa, for example, with coal at say $50 a ton.—Paul M. Lincoln, in Cassier's Magazine.

## ENGINEERING NOTES.

**The wreck of the Thebes Bridge traveler,** used on the erection of the new bridge across the Mississippi River at Thebes, Ill., was due to wind. The falsework had been completed on the Illinois side somewhat beyond the second pier and the traveler was completed and mounted on its track. The accident occurred on July 8, while moving the traveler out to the second pier to place the bed-plate on the latter and erect the bottom chord members of the first span. When within 30 feet of the second pier a heavy rain squall forced the traveler backward over the blocks used as chocks, and, parting some lines which were being used to handle it, drove the traveler backward along the track to within about 100 feet of the first pier. At this point were two hoisting engines and a derrick car. The traveler collided with these and toppled over to the southward, carrying one hoisting engine and the derrick car with it to the tracks of the Chicago & Eastern Illinois Railroad, about 70 feet below. The traveler, which was constructed of wood, was completely destroyed and three men were killed. The engineer, Mr. Ralph Mojeski, estimates that it will require about three weeks to replace the damaged equipment, but that the final date of completion of the bridge will not be delayed.—Engineering Record.

**The wood-lagged drum,** used in connection with hoisting machinery, is now generally relegated to the older days of the mining industry in this country. Such drums are at present seldom built, except when it is necessary to use some extremely cheap arrangement, or when an old-time engine provided with such a drum is considered too good to be condemned to go to the scrap heap. It likewise often happens, from the peculiar construction of such drums, that it is about impossible to exchange one of them for a modern metal, grooved drum without practically renewing shaft, drum, and spur wheel, which it is not often desirable to do when an old engine is being used; so the old machine is allowed to run on as it was originally built until its days of usefulness are over. Drums of this character were often used in connection with gravity planes, where the full car descending pulled the empty one up. In this case both ropes were fastened independently to the drum, and as one unwound in descending, the other was wrapped on the drum in ascending. This arrangement required an extremely long drum or one of large diameter in case the plane was of any considerable length, as it required a capacity for holding an amount of rope equal to double the length of the plane; although but one of these ropes was on the drum at a time, the one rope being reeled on one end as the other rope reeled off of the opposite end. The modern metal drum, with grooves cut in its surface and used in pairs, set side by side, obviates the necessity of such a long drum, as only a sufficient number of coils of rope are required around a pair of metal drums to create sufficient frictional resistance to hold the rope from slipping; and the rope is then coiled on and off of the drums as the cars ascend and descend the plane.—Mines and Minerals.

**It will be a matter of surprise** to most people to learn that there are no less than 250 separately constituted railway companies in Great Britain, between whose ownership are divided the 22,150 miles of our railway system. The properties of about 100 of these companies, however, are what are known as "leased" or "worked" lines. In both these cases the working of traffic is carried on by a company owning an adjacent railway. The basis of a lease is usually the payment of a guaranteed dividend by the working to the owning company, whereas a simple working arrangement is usually based on a percentage division of the gross receipts between the two. There are also about 25 companies included in the total whose capital has not yet been issued, and whose lines are therefore unmade, while several small lines have been allowed by their owners to become derelict.—Mechanical Engineer.

**It is hard to realize** that eighty years ago there was not a single specimen in England of a metal railway bridge. The first one which was made spanned a tributary of the Wear. It consisted of a cast-iron and wrought-iron combination, and is said to have been the only one of its kind. The piers were cast-iron columns, and the spans measured about 12½ feet. The ends of the top and bottom members had bosses cast round them, and spigots were made to fit into the top of the column. The bridge was not used very long for the main-line traffic, but the design of it was so very curious that it is to be hoped that a model of it will be kept. It was built to carry Stephenson's No. 1 engine, which weighed when in working order, 6½ tons. Some of the modern mineral locomotives on the North-Eastern weigh approximately 100 tons. The first "suspension" bridge was built across the Tees near Stockton. A train weighing nearly 40 tons, in passing over this bridge, caused it to deflect 2¼ inches, and consequently it was not very long before it was replaced by a stronger one.—The Mechanical Engineer.

## SELECTED FORMULÆ.

**Dressing for Russet Leather.**—The following formulas are said to yield efficient preparations that are at once detersive and polishing, thus rendering the use of an extra cleaning liquid unnecessary:

| | | |
|---|---|---|
| (1) | Soft soap | 2 parts |
| | Linseed oil | 3 parts |
| | Annatto solution (in oil) | 8 parts |
| | Beeswax | 3 parts |
| | Turpentine | 8 parts |
| | Water | 8 parts |

Dissolve the soap in the water, and add the annatto; melt the wax in the oil and turpentine, and gradually stir in the soap solution, stirring until cold.

| | | |
|---|---|---|
| (2) | Palm oil | 16 parts |
| | Common soap | 48 parts |
| | Oleic acid | 32 parts |
| | Glycerine | 10 parts |
| | Tannic acid | 1 part |

Melt the soap and palm oil together at a gentle heat, and add the oleic acid; dissolve the tannic acid in the glycerine, add to the hot soap and oil mixture, and stir until perfectly cold.

| | | |
|---|---|---|
| (3) | Oil turpentine | 20 parts |
| | Yellow wax | 9 parts |
| | Common soap | 1 part |
| | Boiling water | 20 parts |

Dissolve the wax in the oil with the aid of the water-bath and the soap in the water, mix the two solutions in a hot mortar and stir until cold.—Farben Zeitung.

**Stain-Removing Soaps.**—These are prepared in two ways, either by making a special soap, or by mixing ordinary soap with special detergents. A good recipe for the special soap is as follows:

| | |
|---|---|
| Ceylon cocoanut or palm-seed oil | 320 pounds |
| Caustic soda lye, 38 deg. B. | 160 pounds |
| Carbonate of potash, 20 deg. B. | 56 pounds |
| Oil of turpentine | 9 pounds |
| Finely-powdered kieselguhr | 280 pounds |
| Brilliant green | 2 pounds |

The oil having been fused, the dye is mixed with some of it and stirred into the contents of the pan. The kieselguhr is then crutched in from a sieve, then the lye, and then the carbonate of potash. These liquids are poured in in a thin stream. When the soap begins to thicken, add the turpentine, mold, and cover up the molds.

The following are two recipes for ordinary soap, plus detergents:

| | | |
|---|---|---|
| (1) | Rosin grain soap | 1,000 pounds |
| | Talc (made to a paste with weak carbonate of potash) | 100 pounds |
| | Oil of turpentine | 4 pounds |
| | Benzine | 3 pounds |

Mix the talc and soap by heat and when cool enough add the turpentine and benzine, and mold.

| | | |
|---|---|---|
| (2) | Cocoanut oil | 600 pounds |
| | Tallow | 400 pounds |
| | Caustic soda lye | 500 pounds |
| | Fresh ox gall | 200 pounds |
| | Oil of turpentine | 12 pounds |
| | Ammonia (S. G. 0'91) | 6 pounds |
| | Benzine | 5 pounds |

Saponify by heat, cool, add the gall and the volatile liquids, and mold.—Seifensieder Zeitung.

**Brown Varnish for Metals.**—An excellent and quickly-drying brown varnish for metals is made by dissolving 20 ounces of gum kino and 5 ounces of gum benjamin in 60 ounces of the best cold alcohol; 20 ounces of common shellac and 2 ounces of thick turpentine in 36 ounces of alcohol also give a very good varnish. If the brown is to have a reddish tint dissolve 50 ounces of ruby shellac, 5 ounces balsam of copaiba, and 2 to 5 ounces of aniline brown, with or without ½ to 1 ounce of aniline violet in 150 ounces of alcohol.—Die Werkstatt.

**Gold Ink.**—The best gold ink is made by rubbing up gold leaf as thoroughly as possible with a little honey. The honey is then washed away with water, and the finely-powdered gold leaf left is mixed to the consistency of a writing ink with weak gum water. Everything depends upon the fineness of the gold powder, i. e., upon the diligence with which it has been worked with the honey. Precipitated gold is finer than can be got by any rubbing, but its color is wrong, being dark brown. The above gold ink should be used with a quill pen.—Fundgrube.

**Coloring Metals.**—To redden copper, hang it for from a few minutes to an hour, according to the shade wanted, in a 5 to 10 per cent solution of ferrocyanide of potassium in water. By adding a little hydrochloric acid to the solution the color given to the copper may be made to assume a purple shade. On removing the copper dry it in the air or in fine sawdust, rinse, and polish with a brush or chamois leather, after drying it again. To redden brass dip in solution of five ounces of sulphate of copper and six to seven ounces of permanganate of potash in 500 ounces of water.

To blue copper or brass any one of the following recipes may be used:

(1) Dip the article in a solution of 2 ounces of liver of sulphur and 2 ounces of chlorate soda in 1,000 ounces of water.

(2) Dip the article in a solution of ferrocyanide of potassium very strongly acidulated with hydrochloric acid.

(3) Stir the article about constantly in a solution of liver of sulphur in 50 times its weight of water.—Hannoversches Gewerbeblatt.

## TRADE NOTES AND RECIPES.

**How to Make Perfume of Pine for the Room.**—With 90 parts of the finest oil of white pine mix 4 parts each of the oils of bergamot and lemon, 2 parts of the tincture of vanilla, and dissolve the whole in 1,000 parts of alcohol 95 per cent proof. The above ethereal oils must all be of the best quality if the product is to be of exceeding fineness. A cheaper preparation may be compounded, according to the Drogisten Zeitung, as follows: With 70 parts of fir-needle oil, 5 parts each of templin oil and oil of juniper berries, mix 3 parts each of the oils of rosemary, lemon, and lavender, to which add 70 parts of sweet woodruff, and dissolve the whole in 1,000 parts of pure alcohol.—Der Techniker.

**A Leather Cement.**—A good and durable cement for use on leather goods may be cheaply compounded after the following formula: Dissolve 20 grammes of gutta percha in 50 grammes of bisulphide of carbon and 10 parts of the oil of turpentine; this requires considerable time. To this add 20 grammes of powdered Syrian asphalt and allow it to stand several days. The preparation should have the consistency of honey; if it be too thin, a few hours in an open vessel, but not over any heat, will suffice to thicken it. The parts of leather to be cemented together should first be washed with benzine.—Der Techniker.

**The Preparation of Milk of Glycerine.**—For the preparation of glycerine milk the following formula has proven itself very satisfactory. Rub up well 80.0 of starch with 1150.0 of glycerine and heat it over a water bath with constant stirring until it comes to a gelatinous consistency. When this is finished add 80.0 more of starch and stir in thoroughly 400.0 of distilled water. The tricture of gum benzoin, 20.0, will serve as a pleasing perfume.—Pharmazeutische Zeitung.

**Dry Bottles and Flasks.**—For substances which are inclined to absorb moisture from the air, dry extracts and such like, the bottles and flasks now quite generally used, which are closed with a hollow glass stopper, in the cavity of which caustic lime crystals are placed and held in position by a wad of cotton or asbestos, have proven themselves very serviceable indeed. Care must be taken in one particular, however, that the cavity in the hollow stopper be not more than half filled with the caustic lime, for as this takes up the moisture and slakes, that is, becomes converted into calcium hydroxide, it expands materially, and if sufficient room be not left the stopper will crack.—Der Techniker.

**How to Use Hard Solder on a Ring Set with Stones of Pearls.**—The ability to use hard solder on rings or other ornaments without injuring settings of stones or pearls near the points to be joined is circumscribed within very narrow limits. It is an important part of the goldsmith's business to be able to determine how far the heat necessary to solder a joint will extend from the point of attack to the rest of the material. With a thin ring the heat will not spread so widely as with a thick one. The weaker or thinner the part to be joined [illegible] with that portion containing the setting, the less the risk of injury. This principle once thoroughly comprehended there remains only the expedient of increasing the thickness of the endangered parts. This is most advantageously accomplished by surrounding the threatened parts by a material which absorbs the heat readily. Inclose the setting in moist clay or the like, for example. An old trick is to split a potato and press the setting in the meat between the two halves. In our opinion, however, the asbestos plate seems more effective, particularly when this is fixed over a vessel containing water. The Journal der Goldschmiedekunst says that the setting of the ring should be inserted in a small hole in the asbestos plate and extend so far through the plate that it may reach the water. A more rapid heating of the points to be soldered may be effected by cutting a suitable bit of charcoal and running it through the ring at the points in question. The newest preservative and also highly recommended by the same authority, is the mixture of plaster of Paris and alum. Though the packing in clay is very practical this latter has an advantage, since both the gypsum and alum take up much water and readily absorb heat to drive it off again. Mix the gypsum and alum into a thick paste and pack the menaced setting carefully in it. A real pearl may not be heated beyond 190 deg. C. Now it has been determined by experiment that all the water in the above mixture of gypsum and alum is driven off when a temperature of 163 deg. C. has been reached. As soon then as the operator remarks that no more steam arises from the packing he may take warning that the limit of heat is fast approaching and the danger very near. The use of gypsum instead of clay has the further advantage that the liquid running under the pearl does not discolor it, but rather tends to heighten its brilliancy. The soldering once accomplished, all speed should be made to cool off the whole by pouring water over it, beginning, of course, on the enveloped portion.—Neueste Erfindungen und Erfahrungen.

**Safe Explosives.**—According to a patent taken out by A. Cracken, of New Zealand, a very safe and effective explosive may be compounded by dissolving picric acid in glycerine, neutralized with ammonium carbonate; add to this fossil meal (infusorial earth), and after this an aqueous solution of a potassium nitrate solution, boil the mixture and add a small quantity of sulphur. The compound must now be thoroughly dried.—Neueste Erfindungen und Erfahrungen.

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