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CONTINUOUSLY-PROPELLED AUTOMOBILE TRAINS.*

By Emile Guarini.

One of the greatest attractions and novelties of the last Automobile Show at Paris was undoubtedly the Renard continuously-propelled automobile train.

Low-speed automobiling has, up to the present, attracted but little attention on the part of the public. And yet many localities and many industrial establishments, situated at a distance from a railway and too small to justify the construction of one, would find it to their great advantage to be provided with a means of transportation by highway that would permit of loads of several tons being hauled at speeds of from 10 to 20 miles an hour.

The slight progress made in this line of automobilism is explained by the difficulties of a technical nature that it presents.

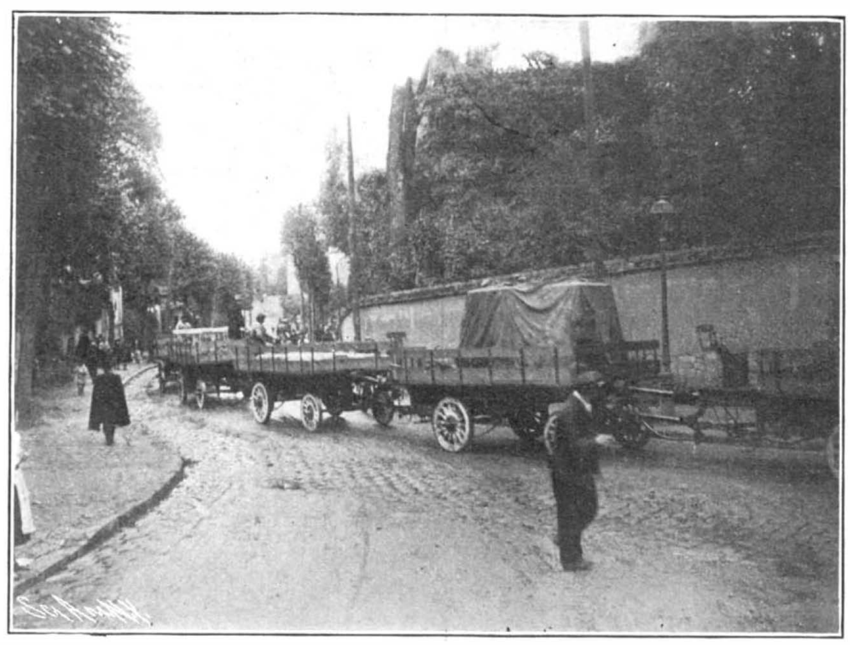
For the solution of the problem, two methods offer themselves. The first, which is expensive and scarcely capable of application on a large scale, consists in the use of automobile trucks. The second, which consists in the use of roadway trains, requires the employment of heavy tractors that damage the roadbed and are not easily manageable. Moreover, if the trains are of some length, they will be incapable of practically running upon any but wide roads having slight curves, on account of the lateral skidding of the cars hauled. In the Renard train, such inconveniences are overcome by the application of two new principles, namely, continuous propulsion and accurate turning. There is no tractor. One only of the vehicles is provided with a motor, and this is powerful enough to haul the entire train. It constitutes a simple movable generator of motive power that can be placed at any part of the train whatever. Owing to the specific lightness of the present motors, this vehicle is no heavier than any of the others of the train. We shall always suppose, in what follows, that the motive power is furnished by this vehicle; but it is needless to say that the energy may be obtained from any external force and be transmitted by trolley or any other process.

The power generated by the motor is distributed by any process to all the vehicles of the train, and each of these is provided with an arrangement by means of which the portion of the energy furnished to it is employed for actuating a pair of wheels, so that each vehicle is a motor one of the same kind as the first, excepting that it receives its energy from another. As each carriage is provided with a pair of driving wheels, it propels itself with as much facility as an isolated automobile. The adhesion is no longer due solely to the weight of the tractor, but to that of the entire train, and is therefore proportional to the force to be overcome, and, wherever sufficient for an isolated vehicle, will likewise suffice for the entire

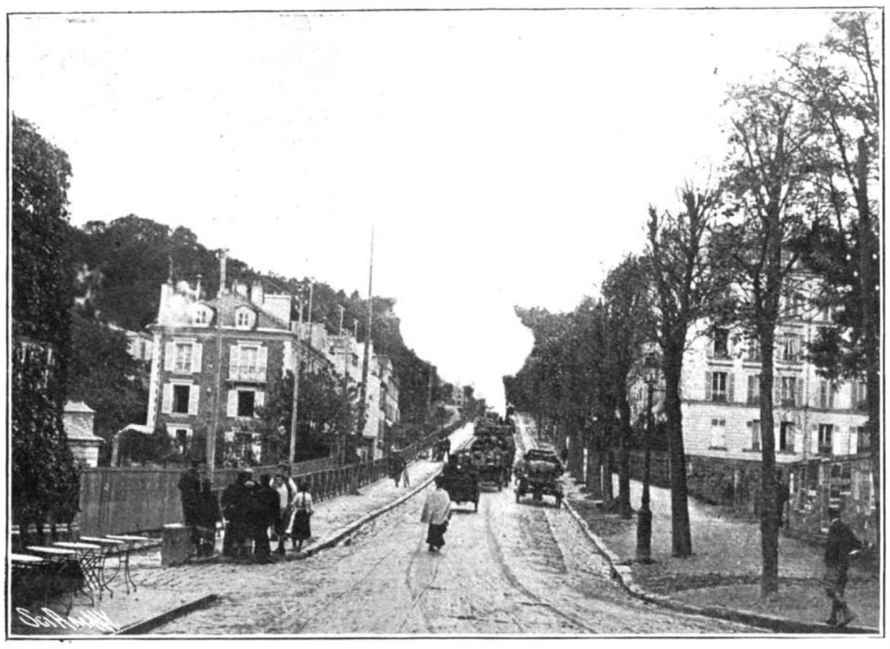
* Specially prepared for the Scientific American Supplement.

THE RENARD TRAIN STARTING OUT, SHOWING ITS CAPABILITY OF MAKING SHARP TURNS.

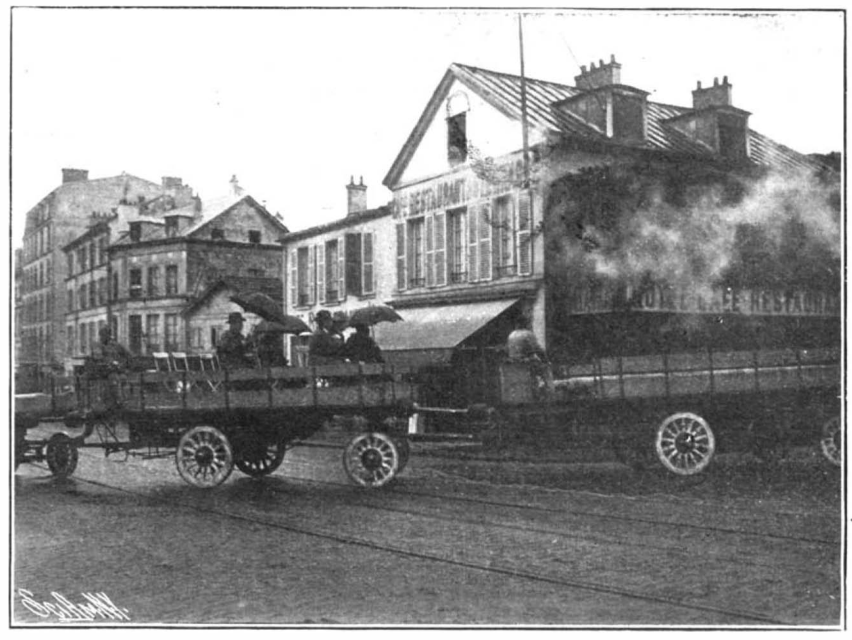
TRAVELING ALONG THE ROAD.



THE TRUCK PART OF THE TRAIN.



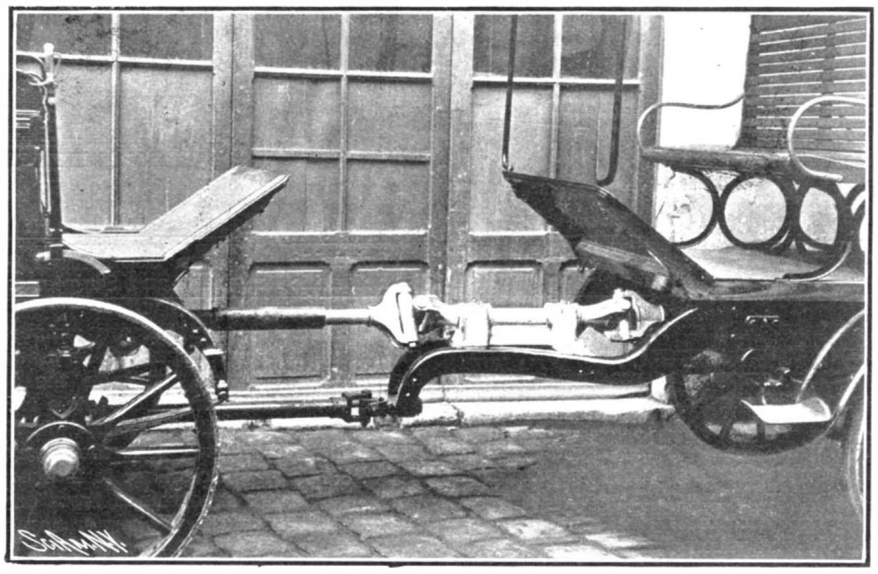
CLIMBING A HILL.



ROUNDING A CORNER BEFORE CLIMBING A HEAVY GRADE.

THE RENARD CONTINUOUSLY-PROPELLED AUTOMOBILE TRAIN.

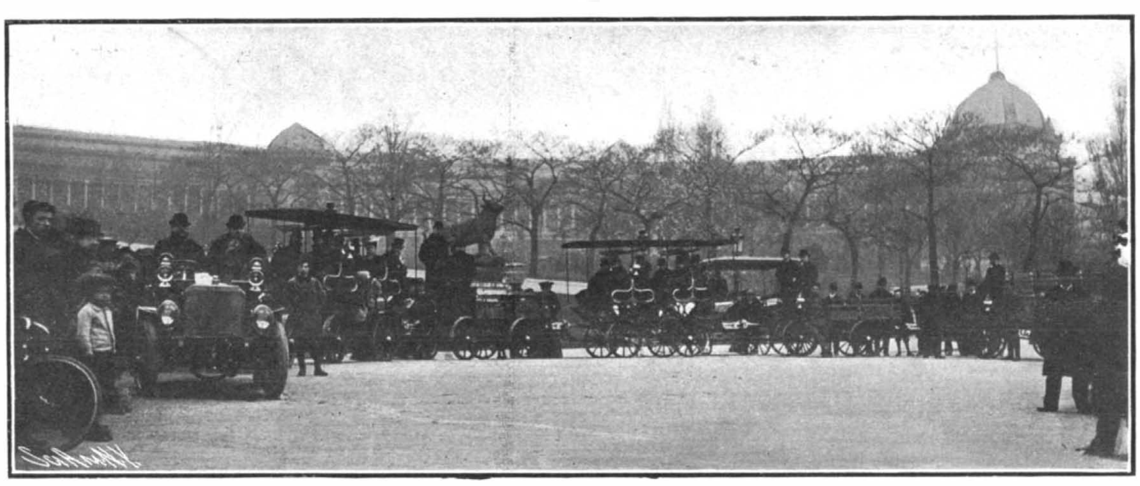
train. Theoretically, there is no limit to the number of the vehicles that make up a continuously-propelled train. On the other hand, the braking is continuous, since in slowing down or arresting the motion of the



VIEW SHOWING THE COUPLER AND UNIVERSALLY-JOINTED DRIVING SHAFT.

longitudinal driving shaft, all the carriages of the train are slowed down or brought to a standstill. The driver of the first car has therefore under his control the propulsion and braking of the whole train, which can be governed with the same facility as an isolated vehicle. Accurate steering of the train is effected through a special arrangement, by means of which each vehicle follows the same trajectory as the preceding one. The first vehicle of the trains describes a circle of a determinate radius around a center of rotation. The following carriage will describe a circle of the same radius around the same center, and, as this effect extends rearward, all the vehicles will follow the circle described by the first, whatever be the radius.

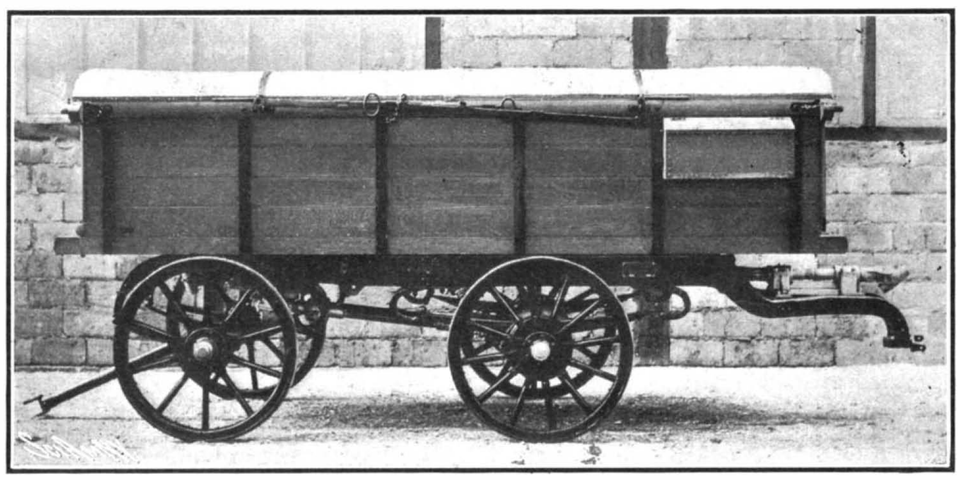
Such a result is obtained through a combination of the lengths of the three following elements: (1) The wheel-base, which is the distance of the centers of the axles of a vehicle; (2) the length of the draft-bar from the front axle to the point where it is jointed to the preceding vehicle; and (3) the tail, which is the distance from the fore part of the draft-bar joint to the center of the axle of the vehicle that precedes it. If these three quantities are properly selected, all the vehicles, when the front one describes a circle of a given radius, will describe the same circle. The property of correct turning is carried out with straight lines or with circles of any radius whatever. With lines of variable curvatures, if the variation is progressive, this property will remain in force with so much the greater approximation to correctness in proportion as the variation in curvature is slighter. In practice, with the usual direction-line of roads, a correct-turning train of from 8 to 10 vehicles adapts itself to the trajectory of the locomotive vehicle at the head



THE COMPLETE RENARD TRAIN.

of the procession with a deviation which, in the most unfavorable cases, does not exceed 12 inches.

Correct turning prevents skidding, which, in ordinary trains, is due to the fact that each vehicle is drawn by the one preceding. In turning a curve, the resultant of the forces that the vehicle considered receives from the contiguous ones will be directed toward the center of the curve and will tend to cause skidding of the vehicle in that direction. Since, in the Renard system, each vehicle propels itself, none is drawn and none draws. There is no longitudinal stress, since each vehicle runs on its own account.



AN UNCOUPLED BAGGAGE WAGON OF THE RENARD TRAIN.

As for the material elaboration of the system, there is adopted a purely kinematic method of transmission consisting of a longitudinal shaft that extends from one end of the train to the other, traversing all the vehicles and the intervening spaces. This shaft is necessarily so jointed as to permit the train to adapt itself to the most complicated trajectories. It is provided with universal joints and various arrangements by means of which the motion given by the motor at one point of the shaft is transmitted to the entire length of the train without any alteration.

The sections of the shaft connecting those carried by the vehicles are dismountable, so as to allow of uniting or separating the different vehicles at will. Gears upon each of them transmit the motion of the longitudinal shaft to a differential analogous to that of all automobiles and which turns the rear wheels of the vehicle by means of a live rear axle. The entire train is operated by the driver of the first machine without any more difficulty than is experienced in the operation of an ordinary automobile.

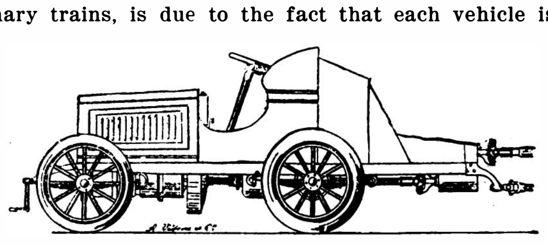
The weight of the first machine is no greater than that of an ordinary car. The stress at the felly of the driving wheels is the same as if each vehicle were isolated, and the road consequently suffers no more damage than it would through the passage of a number of ordinary automobiles equal in weight to the vehicles that make up the train.

The Renard automobile trains exhibit still other peculiar arrangements that improve their operation. A series of elastic transmissions between the longitudinal shaft of the train and the driving wheels of each vehicle permits, without inconvenience, of the passage of each train from a straight to a curved portion of the road, and *vice versa*. These transmissions, in addition, have the advantage of making the starting, stopping, and changes of speed of the train easy.

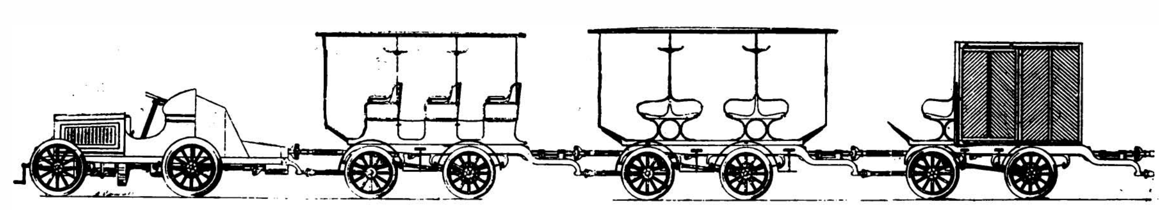
In the automobile train that was exhibited at the Paris Automobile Show, the head machine was an automobile provided with a 50-horse-power gasoline motor and an ordinary change-speed gear. Independently of the latter, it was provided with a special device called a "variator," which is nothing more than a second change-speed gear which is set once for all before the trip, and the effect of which is to reduce, to a determinate degree, the speed of the vehicles according to the position in which it is placed. The modifications of speed obtained by this apparatus do not prevent the ordinary change-speed gear from operating, but the number of speeds that it is capable of giving is reduced, according to the position in which the lever of the variator is placed. When the latter is in, for example, its first position, the change-speed gear allows of making from 10 to 45 miles an hour; when it is in its second, all the speeds are reduced by one half and vary from 5 to 22 miles; and, in the third, they are still further reduced by one half, and are consequently comprised between 2½ and 11 miles an hour.

With the variator arranged for slow speed, the head motor car is capable of hauling from eight to ten vehicles of a weight equal to that of its own at a speed of from 2½ to 11 miles an hour, according to the gradients. With the lever in an intermediate position, a train composed of two to four vehicles can make 5 to 22 miles an hour; while the head car alone may be operated as a high-speed automobile by setting the variator lever properly. The Renard principle is applicable not only to trains such as have just been mentioned, but also to mixed trains composed of continuously-propelled vehicles and a few ordinary ones, and to trains running upon rails. In the latter case the steering apparatus is useless, since the trajectory of the vehicles is determined by the rails.

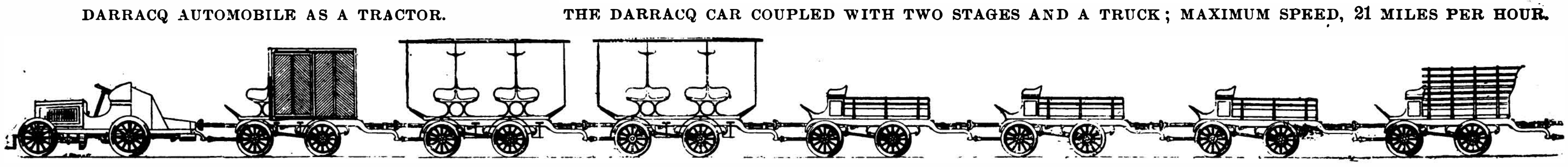
The advantages and applications of the Renard train may be readily seen. The former may be summed up as follows: Vehicles of an excessive weight are done away with; the roads are no longer damaged;



DARRACQ AUTOMOBILE AS A TRACTOR.



THE DARRACQ CAR COUPLED WITH TWO STAGES AND A TRUCK; MAXIMUM SPEED, 21 MILES PER HOUR.



THE DARRACQ CAR HAULING A MIXED TRAIN OF 10 TONS; MAXIMUM SPEED, 10 MILES PER HOUR.

CONTINUOUSLY PROPELLED AUTOMOBILE TRAINS.

the train as a whole is as easily manageable in every respect as in an isolated vehicle, and its flexibility is such that all of its parts follow the trajectory of the leader with absolute certainty, while the number of train hands necessary is greatly reduced.

As for the applications, it may be at once seen that it is possible for a manufacturer or an agriculturist to employ at will the complete or reduced train or the head motor car alone, according to the nature and speed of the transportation to be effected. The use of trains of two or three vehicles running at a speed of more than 20 miles an hour permits of making trips with numerous passengers and considerable baggage under pleasurable conditions. Finally, we may mention public conveyance between localities destitute of railways. The cost of establishment for this purpose would be reduced to that of the rolling stock alone, and it is perhaps in such an application that the Renard train will, in the future, reach its greatest development.

A NOVEL BLOCK OR TELEPHONE SIGNAL SYSTEM.

EDWARD ROWE, of Indiana, Pa., has invented a block or telephone signal system which is independent in itself, and in no way connected with other wires, flags, switches, semaphores, lights, or signaling devices that may be in use. The wires of one station are not even in connection with those of the next, on either side. The regular telegraph or telephone service in general use by railroads is depended on, as is the case now, for all communication between operators, dispatchers, etc. The system may properly be divided into three parts, viz., the office, the line, and the locomotive. The line may also be regarded as being divided into blocks, six miles long, a signal tower or office being located in the center of each block. From this office, a single wire extends three miles each way, but does not connect with the wire of the next office, or with the other wire in the same office. The office equipment for a single track consists of two indicators, one drop annunciator, one telephone, four two-point switches, two open-circuit batteries, the necessary wires, etc., all properly installed. The line equipment consists of a single wire, on poles, extending along the track, three miles in each direction from the office. At distances of one-fourth mile apart along the track, contact rails are attached outside and about 12 inches from the road rail. This contact rail is of wood, 8 or 10 feet long, about 2½ inches thick, and of a width that, when secured to the ties, edge up, it will be about 2½ inches higher than the road rail. This rail is slightly curved, both endwise and crosswise, so its ends, when in position, are only as high as the road rails. An iron or suitable metal cap, curved to fit the wooden rail, is attached to it, extending over its top ¼ inch or more on all sides. To the under side of the cap a suitable underground cable is soldered, which passes down through a hole in the wooden rail, and underground to the nearest pole, at the top of which it is attached to the line. The entire line and system may be made underground if desired. The locomotive equipment consists of two contact brushes, two two-point switches, one telephone, and one alarm bell or whistle. Two contact brushes only are necessary to provide for the turning of the locomotive to run the other way. The contact brush, properly insulated, is located so as to sweep the contact rails through about two feet of travel as the engine passes, and are fitted with dynamo or other suitable brushes.

To remove sleet, a strong steel scraper or brush will temporarily replace those regularly used. A wire leads from the contact brush to the first two-point switch, which is used to send signals when the engine is standing in contact with a rail, and also for cutting the engine entirely out when it is drilling back and forward and not desiring to send signals. From there the wire continues to the second two-point switch, which is used to cut the telephone in, the 'phone being at all other times out of circuit. From this second switch the wire passes through an electro-mechanical bell or whistle alarm, and is grounded on the frame of the engine. The telephone is provided with two brass hooks, which are in circuit with the 'phone. Two other brass studs or pins are attached to the top of the cab. A wire from the second two-point switch is attached to one of these studs, the other having a wire connected from it to the ground stud on the engine frame. When this switch is closed, the 'phone is in circuit.

The indicators in the office, which are simply a dial, a pointer, and the necessary operating mechanism, are set at a light tension, and in such a way that the energy of a small battery of a few cells will easily handle them; they are also provided with a bell that gives one stroke each time they are energized. The gong or whistle alarm in the engine is, on the contrary, set at such a tension as to require twice as much battery to overcome its resistance and cause it to sound. Spring or electrical resistance may be used in the alarm, spring being preferable, owing to its ease of regulation. The batteries in the office are arranged so that the smaller one, the indicators, the line, and the contact rails are normally in circuit. The larger battery and the annunciator, being in a separate circuit, controlled by the lower pair of the four two-point switches, are not in circuit with the line. The batteries are of the open-circuit type; the line and all instruments are, of course, normally open.

As a train enters a block, the brush sweeps the first contact rail, closing the circuit. The indicator is energized, its pointer moves forward one number, its bell makes one stroke. The alarm in the engine, being in the path of this current, is also energized, but as before stated, its tension or resistance being so much greater than the power of the smaller or indicator battery, it is not affected, and remains silent. This action is repeated at every contact rail passed, the pointer continually moving forward another number. The operator is thus notified by the bell of the entrance of a train to his block, the dial showing the progress of the train through it. The indicator on the incoming side ceases working when the train passes the station, and may be set back to zero. The one on the outgoing side acts when the first contact rail is passed, and continues to act until the train leaves the block, when its pointer is set back to zero. At the half-way point between stations, the contact rails are located within a few feet of each other, so that when a train leaves one block, the next is immediately notified of its entrance into it.

If, through mistaken orders or for any reason, a train should get past a station where it should have been held, or should it be necessary to stop a train at any point in the block on either side of the station, the operator shifts the lower two-point switch on that side, which cuts out the smaller and puts the larger battery in circuit. The line is now charged with current of two to three times the strength of that of but a moment before, the annunciator, the line, and the contact rails all being in the path of the increased current.

At the first contact rail swept by the train, the alarm in the locomotive now being sufficiently energized sounds, and the annunciator at the station acts, showing the engine has received its signal. The engineer stops, backs until the brush touches the contact rail, and switches on his telephone. The operator has in the meantime shifted the upper two-point switch on that side, cutting off all battery current and putting his telephone in circuit. It has now become an ordinary telephone line, and conversation may be carried on between them.

A cessation of operation by the indicator before a train has had time to pass out of a block shows the train has stopped, or the line trouble. If the former, no other train is allowed to pass until the first is heard from. Line trouble can be quickly ascertained by communicating with the operator on that side. Irregular or double action of the indicator after a train has passed a station, shows another train has entered the block at the far end. Both must be signaled and stopped, and in such cases both engineers and the operator would be in telephonic communication with one another at the same time.

In cases of trains following each other closely, their progress through the block can be watched on the indicators, and be under full control.

By stopping in contact, train people can call the operator by rapidly moving the lower two-point switch in the cab, causing a like ringing of the indicator bell in the office.

The telephone of a disabled train, which is unable to stop in contact, can be lifted from its hooks in a moment, carried to the nearest contact rail, and quickly attached by spring clips and wires with which the 'phone is provided, one set of clips being placed on the road rail to form the ground. Signals are sent by a contact spring, also on the 'phone. As a further precaution, an extra 'phone should be carried on the rear end of the train for cases in which the engine 'phone may be damaged in a wreck.

At points between the contact rails, extra wires fitted with connecting jacks may be led down the poles, thus affording as many places for communication as may be desired.

THE BEGINNINGS OF THE INCANDESCENT LAMP.*

By THOMAS A. EDISON.

IN response to the kind suggestion of the Electrical World and Engineer that the celebration of its completion of thirty years of existence affords a fitting opportunity to recall the beginnings of the incandescent lamp, I am glad to put on record a brief personal narrative of the details connected with what was to me a very interesting period of electrical development. The occasion is not only a reminder of the rapid flight of time, but of the fact that since 1874—the year of the quadruplex, by the way—all the great modern departments of electrical industry have sprung into vigorous being. We telegraphers have a right to claim this journal also as part of our contribution to the art.

My experiments on carbon began in 1876, when I had the idea of making carbon wire, etc., for various electrical and chemical purposes. Even at that early time Messrs. Charles Batchelor and E. H. Johnson were with me, and we saw quite a business ahead in carbon novelties. I had familiarized myself with the properties of carbon, particularly that made from paper and Bristol board, and this led on very naturally to my work on the carbon telephone or microphonic transmitter, early in 1877. In the fall of that year I was pretty well through with studies and inventions in that line, but had several other ideas that I wanted to work up. One of these was the subdivision of the electric light, and I began experimenting with that purpose. My records and the voluminous testimony in litigation, now happily long past, show that in the fall of 1877, about September, strips of carbonized paper were tried as an incandescent conductor suitable for use in lamps, and the work was followed up until January of 1878, when the general excitement over my invention and exhibition of the phonograph out at old Menlo Park frustrated serious or continuous work for a time, in any other direction. In fact, my health gave way under the strain, and in July I broke away for a western trip as far as California.

Of course my mind was turning the subject over, and when I got back in August we immediately went at it again. Around October and November Batchelor made a great number of paper carbons, at least fifty, from tissue and other kinds of paper, coated over their surface with a mixture of lampblack and tar, rolled them up into the fine long form of a knitting needle, and then carbonized them. These we put into circuit and brought up to incandescence in vacuo, although they would last but an hour or two. We tried a great many experiments with paper carbons, wood carbons, and some made from carbonized broom corn. What we desired at that date, and had settled our minds upon as the only possible solution of the subdivision of the electric light, was that the lamps must have a high resistance and small radiating surface. About December, 1878, I engaged as mathematician Mr. Francis R. Upton, who had lately studied under Helmholtz, in Germany, and he helped me greatly in calculations of the multiple arc problem. Our figures proved that the lamp must have at least 100 ohms resistance to compete successfully with gas; for if the lamps were of low resistance, the cost of the copper main conductors would be so great as to render the system uneconomical and commercially impracticable. In this direction we tried platinum also; and when working on incandescent platinum we had procured a Sprengel mercury pump and had ascertained that we could thus get exceedingly high vacua. It occurred to me that perhaps a "filament" of carbon could be made to stand in the sealed glass vessels or bulbs, which we were using, exhausted to a high vacuum. Separate lamps were made in this way independent of the air pump, and in October, 1879, we made lamps of paper carbon, and with carbons of common sewing thread, placed in a receiver or bulb made entirely of glass, with the leading-in wires sealed in by fusion. The whole thing was exhausted by the Sprengel pump to nearly one-millionth of an atmosphere. These filaments of carbon, although naturally quite fragile owing to their length and small mass, had a smaller radiating surface and higher resistance than we had dared hope. We had virtually reached the position and condition where the carbons were stable. In other words, the incandescent lamp as we still know it to-day, in essentially all its particulars unchanged, had been born.

We began immediately to make vacuum pumps and to produce these paper filament lamps on them. During that November we made perhaps as many as 100 of such lamps, and the same month saw us plunged deep in experiments and inventions on dynamos, regulators, meters, circuits, etc., all just as necessary to the success of the art as the little lamp itself. Some of those paper filament lamps had a remarkably long life. Each yielded from 12 to 16 candle-power and they were burned on chandeliers until they gave out. The average life was about 300 hours. One of them lasted 940 hours and another 1,350 hours, so that commercial success and a new industry were already well in sight.

But I was not quite satified as to paper, or even with the more regular and homogeneous wood fiber filaments, and thus came to take up bamboo. We happened to have a palm-leaf fan on one of the tables. I was then investigating everything with a microscope, so I picked it up and found that it had a rim on the outside, of bamboo, a very long strip cut from the outer edge. We soon had that cut up into blanks and carbonized. On putting these filaments into the lamps we were gratified to see that the lamps were several times better than any we had succeeded in making before. I soon ascertained why and started a man off for Japan on a bamboo hunt. Before I got through I had tested no fewer than 6,000 vegetable growths, and had ransacked the world for the most suitable bamboo. The use of bamboo was maintained for many years until other processes dealing with such material as cellulose had been perfected. We tried even at the earliest moment of success a number of experiments and things afterward taken up again or followed through, as for example, burning the paper filaments in a vacuum charged with inert gas; and a little later, in 1880, we also "flashed" the filaments with gasoline vapor.

The furore that followed the announcements from Menlo Park as to the successful subdivision of the electric light in a commercial incandescent lamp will be well remembered by many of the readers of this. The feasibility of such a thing had been denied by some of the greatest minds in electricity, but here it was; and along lines that have endured to this day. The best story at the time was given to the world by the New York Herald in December, 1879, and on Christmas Day I had already lighted up my laboratory, my offices, two or three houses about one-fifth of a mile from the dynamo plant, and some twenty street lights. On the last day of the year some 3,000 people flocked out to Menlo Park to see it for themselves—and the rest everybody knows.

It is interesting to note that in addition to those mentioned above I had around me other men who ever since have remained active in the field, such as Messrs. Francis Jehl, W. J. Hammer, Martin Force, Ludwig Boehm, not forgetting that good friend and co-worker, the late John Kruesi. They found plenty to do in the various developments of the art, and as I now look back I sometimes wonder how we did so much in so short a time. Early in the spring of 1880 I lighted up for Mr. Villard the Oregon Steam Navigation Company's steamer "Columbia," and it was not long before the Edison plants began to multiply. Meantime lamp making took on large proportions in two factories of mine, one at old Menlo Park and the other

* Electrical World and Engineer.

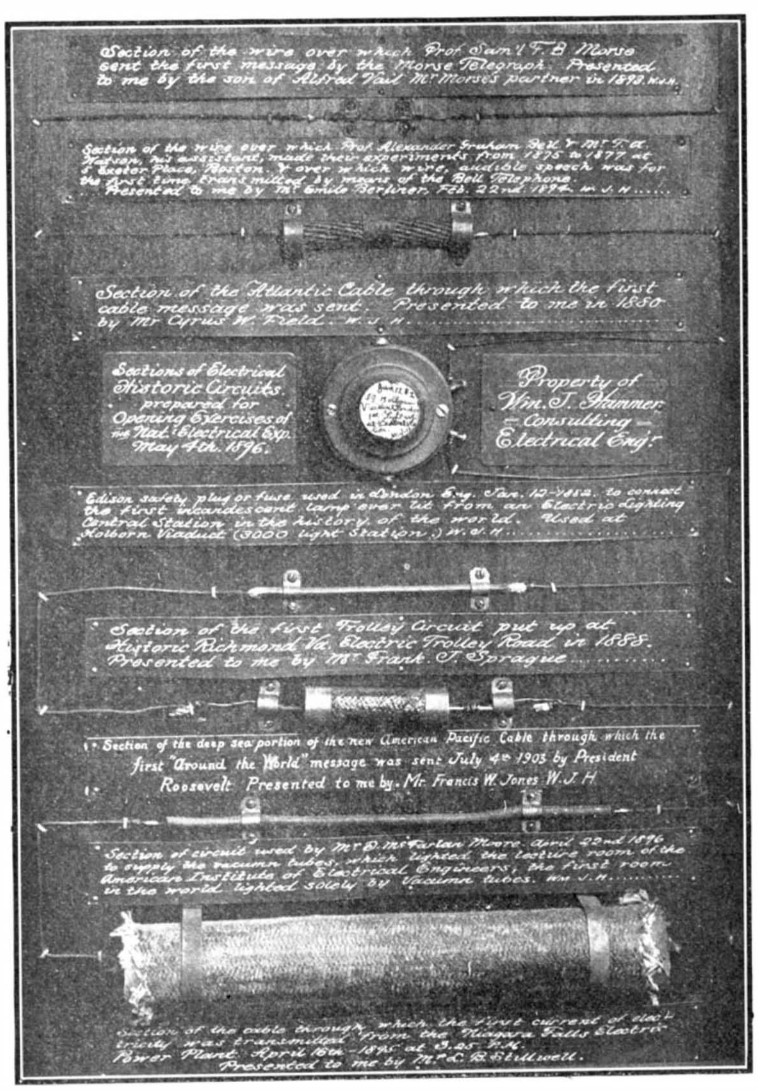
at Newark, and much of my energy was being devoted to cheapening the price of the lamp as well as increasing its life and its candle-power per watt. I am told that upon a moderate computation the production of incandescent lamps in this country since my first success has reached a total of 250,000,000 lamps, or not less than 10,000,000 a year for each of the twenty-five years. Essentially, the lamp has remained structurally the same ever since 1879, in the elements then demonstrated to be essentially vital and necessary to commercial success.

HISTORICAL ELECTRICAL CIRCUITS.

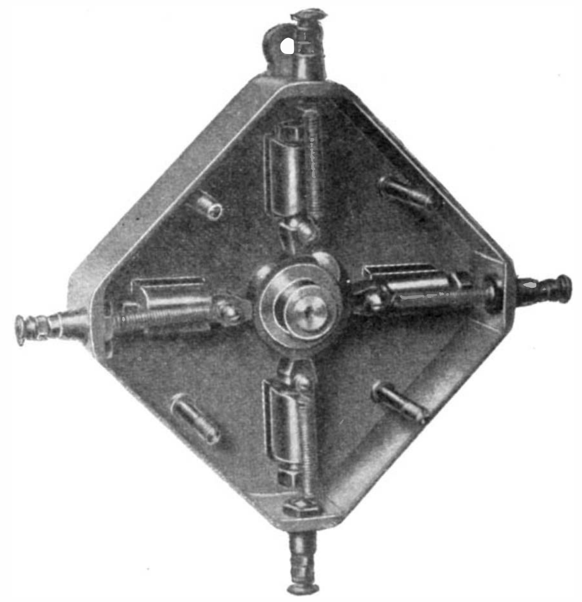
ON the evening of February 11, on the occasion of a dinner given by the American Institute of Electrical Engineers at the Waldorf-Astoria, New York city, in honor of Mr. T. A. Edison's fifty-seventh birthday and of the commemoration of the twenty-fifth anniversary of the invention and commercial development of the incandescent lamp, various sections of wires and cables, which at one time formed parts of electrical circuits famous in the history of electricity, were connected into a continuous circuit and used. The photograph herewith reproduced shows the various sections of wire and cable that were used. They are all the property of Mr. William J. Hammer, New York city. It is rather noteworthy that many of the circuit sections illustrated are in some way connected with electrical industries, such as telegraphy, telephony, electric lighting, electric railways, and power transmission, with which Mr. Edison's name is associated. At the top of the case is a piece of the wire over which Prof. S. F. B. Morse sent the first message by the Morse telegraph. This relic was presented to Mr. Hammer in 1893 by a son of Mr. Alfred Vail, Prof. Morse's old partner. Immediately below it there is a length of a few inches of the wire through which Prof. Alexander Graham Bell and Mr. T. A. Watson, his assistant, made all their early experiments in the transmission of audible speech in the years 1875 to 1877 at No. 5 Exeter Place, Boston, Mass. The first audible speech transmitted by the Bell telephone went through this wire. The authenticity of this fragment is attested by the fact that it was given to its present owner by Mr. Emile Berliner. The third of these historical mementos is a section of the Atlantic cable over which the first successful message was sent between the old and the new worlds. The specimen was presented to Mr. Hammer in 1880 by the late Cyrus W. Field, through whose efforts the cable was laid.

In the center of the photograph will be seen a safety fuse or plug used in London, England, on January 12, 1882, to close the circuit of the first incandescent lamp ever lighted from an electric-lighting central station in the history of electricity. This interesting event took place at the Holborn Viaduct central station, and it was Mr. Hammer himself who made the connection, the lamp being one of 3,000 incandescent lamps of the earliest Edison type. Beneath the fuse is a portion of the first trolley circuit used at the historic plant at Richmond, Va., in 1888. This wire was presented to Mr. Hammer by Mr. Frank J. Sprague. The sixth is perhaps the most interesting of all the relics, being a section of the deep-sea portion of the new American Pacific cable, 8,300 nautical miles in length, over which President Roosevelt on July 4, 1903, sent his memorable message by telegraph around the world. To add to the interest, it should be stated that this historic message passed through all the wires which then constituted Mr. Hammer's collection as displayed in this photograph.

The remaining wires are also of eminent historic interest, although they do not as yet rank among great electrical curiosities. One of them is a section of a circuit used on April 22, 1896, at the American Institute of Electrical Engineers to illuminate the lecture room with Moore vacuum tubes, this being the first time in history that a room was illuminated solely with vacuum tubes. The last specimen is a section of the cable through which electrical power was first transmitted from the Niagara Falls electrical-power plant on April 16, 1895.



SECTIONS OF SOME HISTORIC ELECTRIC CIRCUITS.



THE "P M" CONTACT-MAKER.

AN IMPROVED CONTACT-MAKER FOR GASOLINE ENGINES.

THE make-and-break device for the primary ignition current of engines employing the jump spark, or secondary, system of ignition is the all-important part of the system. If a spark coil without a vibrator is used, everything depends upon the contact-maker; and if this is a perfect-working device, there will be no troubles from irregular ignition.

The "P M" contact-maker, illustrated herewith, was brought out by a French firm, and has been on the market for several years. It consists of a fiber disk having a cam of steel in metallic contact with the motor. The contact box shown has four steel, spring-pressed brushes, which contact with the cam as its disk revolves. Coiled wires in front of the brush holders convey the current from each brush to a separate insulated binding post, and these are connected to the primary terminals of the spark coils. The brushes, of course, are carried in insulated holders. The box is filled with thick oil, and its cover is held tightly in place by four wing nuts. As the apparatus is now constructed, the brushes are fitted with rollers, which have the advantage of causing no appreciable wear. The device is made for one, two, three, or four cylinder motors, and is one of the most positive and certain, as well as one of the simplest, contact-makers made.

CONTEMPORARY ELECTRICAL SCIENCE.*

CAPACITY OF A VACUUM TUBE IN A MAGNETIC FIELD.—E. Lopuchin and A. Afanasieff have, at the request of J. Borgmann, studied the variation of capacity undergone by a vacuum tube in the magnetic field. They found that there is a close correspondence between the luminosity and the capacity. They used Borgmann's method for determination of very small capacities, and compensated the capacity of the vacuum tube by means of two burettes containing mercury. They used a string interrupter, which was kept going at a uniform rate by controlling the note emitted by it. The axis of the tube was placed either parallel or perpendicular to the lines of magnetic force. In the first place, the capacity was perceptibly diminished by exciting the magnetic field, whereas in the second case it was strongly increased. The luminosity changes in a corresponding manner. As long as the tube is not luminous, the capacity of the tube is constant. The capacity of the electrodes alone is then brought into play. The capacity of the tube is a maximum at a pressure of 1 millimeter. At about 0.05 millimeter it suddenly falls, and the luminosity disappears at the same time. The magnetic effect is strongest at pressures at which the cathode rays begin to appear. At a pressure of 0.07 millimeter the magnetic field simply extinguishes the light, if the position of the tube is axial. With an equatorial field, the maximum magnetic effect occurs at a pressure of 5 millimeters. At very high vacua, when the tube remains quite dark, the magnetic field always increases the capacity of the tube.—Lopuchin and Afanasieff, Phys. Zeitschr., November 1, 1903.

CONDUCTIVITY OF SELENIUM.—E. van Aubel has found that, besides being subject to variation by light and by Röntgen rays, the conductivity of selenium is also affected by the rays emitted by hydrogen peroxide, by essence of turpentine, and by certain bodies after they have been exposed to the action of ozone. A highly sensitive selenium cell was placed in the dark over a porcelain dish containing a 30 per cent solution of hydrogen peroxide. In three or four minutes the resistance of the selenium fell from 496,000 ohms to 324,000 ohms. On interposing a brass screen, the original resistance was restored, but very gradually. A similar effect, but somewhat feebler, was observed in the case of essence of turpentine. To test the action of ozone, a leaf of red India rubber was held for 12 seconds in a stream of dry ozone, and then laid into a porcelain dish. In 15 minutes the resistance of the selenium fell from 599,000 ohms to 556,000 ohms. On interposing the brass screen, the resistance recovered to 563,000 ohms in about an hour, and regained its original resistance in about a day. A stronger effect was obtained on substituting camphor for the India rubber. This effect may be compared with the effect exerted upon sensitive plates by the same bodies after exposure to ozone. This was first discovered by J. H. Vincent, and was shown to be due to the fact that bodies so exposed contain a small proportion of hydrogen peroxide. Ozone by itself produces no effect. The effect upon selenium is remarkable on account of the slow recovery and the paramount influence of the temperature.—E. van Aubel, Phys. Zeitschr., November 1, 1903.

ELECTRICITY DIRECT FROM COAL.—R. Lorenz gives a capital summary of the present state of the problem of directly converting the chemical energy of burning carbon into electricity. The slow combustion involved in an electrolytic process such as is exemplified in an ordinary voltaic cell suffers under three disadvantages—viz., the slowness of the reaction between C and O at ordinary temperatures, the impurity of the carbon, which gives rise to complicated hydrocarbons in solution, and the necessity of using the highly-priced conducting forms of carbon instead of ordinary coal. These circumstances led to the adoption of a gaseous "electrode" consisting of carbon monoxide, as in the cells of Bucherer and Borchers. In these, however, the currents obtained cannot be proved to result from the further oxidation of the CO. Indeed, the existence of CO ions has yet to be demonstrated. Another and more indirect way of utilizing the energy of carbon is that suggested by Nernst, in which carbon is used for regenerating other cells, such as Daniell's cell, by the reduction of the zinc sulphate. Another method proposed by Nernst is to heat an accumulator having a negative temperature coefficient until its E. M. F. disappears and then let it cool. Dolezalek has, indeed, obtained an E. M. F. of 0.6 volt between two lead accumulators having a difference of temperature of 90 deg. The problem is theoretically soluble, but will require much detailed work for its final solution.—R. Lorenz, Mitt. Phys. Ges. Zürich, No. 5, 1903.

American Importations into Colombia.—The decree of January 29 has created some talk here, especially among the importers, as it is claimed that in the great majority of cases the articles on which duties have been lowered are wholly or for the greater part imported from the United States. This is true to some extent, as far as sugar, flour, and lard are concerned, but the fact that they must be in the native state, with-

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

out any preparation, counterbalances to a great degree the apparent working of this decree in favor of American goods, as the major part of the articles above named is imported from the United States in some degree of preparation.—Alban G. Snyder, Consul-General, Bogotá, Colombia.

ELECTRICALLY-REGISTERING WIND VANE AND ANEMOMETER FOR SCHOOL USE.*

By H. W. HARMON.

SEVERAL years ago, wishing to organize weather work as part of the work of our students taking the subject of physics, we were met with the difficulty of getting apparatus at moderate expense which would be suitable for student use, in the measuring of the weather factors, wind direction, and wind velocity.

The United States Weather Bureau instruments are very expensive and they record only once in ten minutes. It was found, therefore, necessary to design some inexpensive instruments from which it would be possible to get almost instantaneous readings, possessing a fair degree of accuracy. As a result of experimenting along this line, a number of very successful instruments were developed.

The instruments consist of a wind vane, a windmill, and a cup anemometer. The wind vane (Fig. 1) is 6 feet in total length. The tail is made of thin pine boards, cleated and diagonally braced at two different places, and are spread apart at the extreme end about 9 inches. The advantage of the spreading tail is that it offers a greater lateral pressure to the wind than does a single-planed vane, and therefore will respond to slighter shifts of the wind, and oscillate less.

For an axis sleeve and bearings, a ½-inch gas pipe about 12 inches long, threaded at both ends for joint couplings, is then inserted in place. The coupling for the upper end is fitted with an ordinary ½-inch plug, whose inner end is usually and should be hollow-cone shaped. The coupling for the lower end is run about half full of melted Babbitt metal or solder and drilled out to take a ⅜-inch steel rod which is to serve as the axis. The axis rod, which should be about 36 inches long, should have its upper end filed to a somewhat blunt but very smooth point to swivel in the hollow-cone plug. The lower end of the axis rod has a copper wire contact soldered to it. The axis rod is then snugly mounted in the center of a wooden rod 2 inches in diameter and a foot long. About 15 inches of the upper end of the axis rod is left protruding. This wooden cylinder is in turn fitted into a 2-inch iron pipe 5 feet long, which is later to serve as a support for the wind vane. About 2 inches of the upper end of the wooden cylinder is left exposed to view.

The upright supporting pipe is guyed by four double galvanized iron wires leading to large wooden screw-hooks and tightened up by screwing in the screws, as shown in our illustration.

A wooden disk, drilled to fit on the top of the upright support pipe, carries the four wind-direction arms with sheet-copper letters N, S, E, W, attached.

This completes the mechanical parts of the wind vane, though the vane may still need balancing with lead strips on the arrow point.

Electrical Connections.—For registering electrically the wind directions, a rubber strip or electric tape is wrapped around the protruding end of the wooden cylinder, and a commutator is built up, consisting of four segments of sheet brass, one for each of the four wind directions. To each of the segments is soldered a copper wire leading down on the inside of the upright support pipe to the room below, where the record is to be received. These four wires, together with a fifth leading from the lower end of the steel axis rod, are connected up, as shown in our diagram, with the wind direction keys, making the electric circuit complete through a telephone receiver as follows: From a battery of three or four dry cells or Leclanché cells, connected in series, the current passes up the axis wire to the bearing of the wind vane, and returns through a single commutator brush, which is a fairly stiff spring brass wire soldered to the lower coupling of the axis sleeve and with contact surface equal to about one-third of the width of a single segment. The current then follows down the wire leading from the segment or segments, if it be a half-way wind, to the corresponding key or keys, properly labeled, in the room below. These wind-direction keys are merely short, stiff brass wires fastened side by side on a short board, and extending out over a single wire at right angles to them, and this wire completes the electric circuit through the telephone receiver and back to the battery, whenever the proper key is pressed. The pressing of the proper key (i. e., the key corresponding to the wind-direction at that time) causes the telephone to give a responsive click, and fails to give a clear click on any of the others.

An ordinary windmill properly proportioned for giving wind velocities is mounted on an upright, rising from the wind-vane immediately above its axis. The windmill by its revolutions is arranged to make and break circuit once each revolution. Thus the telephone would respond by a series of rapid clicks, which could be counted and rate noted. The rapidity of these, by a properly-constructed velocity curve, could be reduced to miles per hour.

The windmill is constructed of two straight-grained pine sticks 12 by 1 by 2¼ inches, which are sawed lengthwise so as to form blades for the wind to strike them at an angle of 26¾ deg. or 63¼ deg. with the plane of the wheel. These blades extend to within one-half inch from the center; here the two sticks are cut so as to joint into each other, and when carefully balanced in weight, are glued and nailed together. Through the hub of the wheel thus formed is bored a hole to take snugly a ¼-inch glass tube. This glass tube is about 2¾ inches in length and has both of its ends carefully heated and closed down over a coarse steel knitting needle, which is to be the axis. A bead of solder is deposited close to the end of the axis

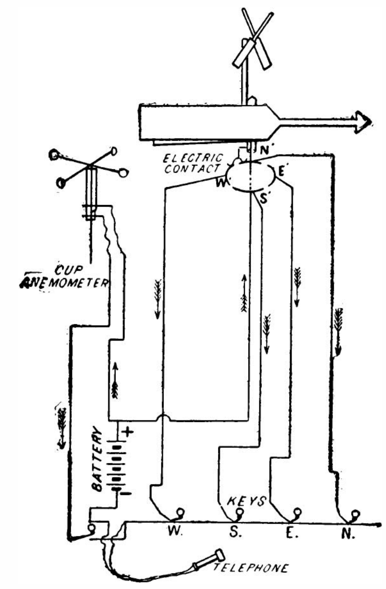


FIG. 2.

needle, to prevent the glass bearing from coming off. A small strip of brass is fastened on the front end of the hub of the wheel, for the end of the needle to bear against. For an electric circuit breaker, a brass tube ⅝ inch in diameter and ⅝ inch long is used, and this for one-half its length is one-half cut away. The tube is then soldered concentric with a piece of sheet copper one inch square. This copper piece has a ¼-inch hole drilled through its center, to allow the glass bearing to pass through it, and it is then nailed to the rear end of the hub of the wheel. Two small spring brass wires are fastened to the upright, supporting the windmill, in such a position that one of them bears upon the contact breaker all of the time, and the other only half of the time during a revolution of the wheel. These two brushes are then connected up on the wind vane circuit, as previously explained. As the windmill revolves, it thus makes and breaks the electric circuit once in each revolution.

The windmill revolves, if the blades make an angle of 26¾ deg. with the wind, one-half as fast as the wind. This is based on the fact that the tangent of the angle 63¼ deg. is 2.0; and the resultant diameter of the wheel is two-thirds of its actual diameter (i. e. 8 inches or two-thirds of 12 inches). For the single blades can be regarded as uniform compound pendulums, whose centers of oscillation, or, in this case, centers of percussion, are two-thirds the distance from the axis. The circumference of this resultant wheel is in round numbers 25 inches, twice which distance would represent the wind's actual movement during the time of one revolution. Winds as high as 20 miles per hour can be registered with accuracy by means of the telephone receiver. The method of determining the velocity is to count the number of telephone clicks in ten seconds, and refer to the velocity curve, plotted on the basis that a mile per hour wind is a wind movement of 1.467 feet per second, and one revolution per second, by the wheel, is caused by a wind traveling at the rate of 2.842 miles per hour.

The cup anemometer, which is used to check the windmill velocities, was made especially to register winds having higher velocities than could be reliably determined with the windmill.

A ⅝-inch brass tube 3½ inches long was drilled through in two adjacent places at right angles to each other, ⅝ inch from one end, with a quarter-inch drill. Through these holes were passed ¼-inch brass rods 18 inches long, centered and soldered. To each of these was soldered a hemispherical cup 4 inches in diameter, its center being 6.72 inches from the center of the axis. (These cups can be obtained from some of the physical apparatus supply companies, as weight pans.) The longer end of the axis tube is one-half cut away for ½ inch to serve as a contact breaker, in the same way as was done for the windmill. When this is done, a steel axis rod 10 inches by ¼ inch is soldered in place in the center of the longer end of the axis tube, and its lower end smoothly rounded off. A half-inch glass tube 7 inches long has its ends heated and drawn down just to size to let the axis rod pass through. The glass tube is to serve as a lateral bearing. It is then snugly fitted into a hole bored lengthwise in the center of a wooden pole to support the anemometer. The lower end of the steel axis rests on a piece of plate glass inserted in an opening in the wooden pole about ½ inch below the lower end of the glass axis sleeve. These glass bearings, kept oiled, allow both the windmill and cup anemometer to revolve in winds having velocity less than one mile per hour. The contact breaker is fitted with small spring brass brushes, the same as the windmill, and is placed on a separate electric circuit from the wind-vane, but both may use the same battery.

The method of determining velocity is the same as used for the windmill, but the velocity curve is based on the fact that the diameter of its circle of revolution is 13.44 inches, and the cups revolve approximately one-third as fast as the wind. Therefore it can be computed that one revolution of the cup anemometer per second is caused by a wind 7.19 miles per hour.

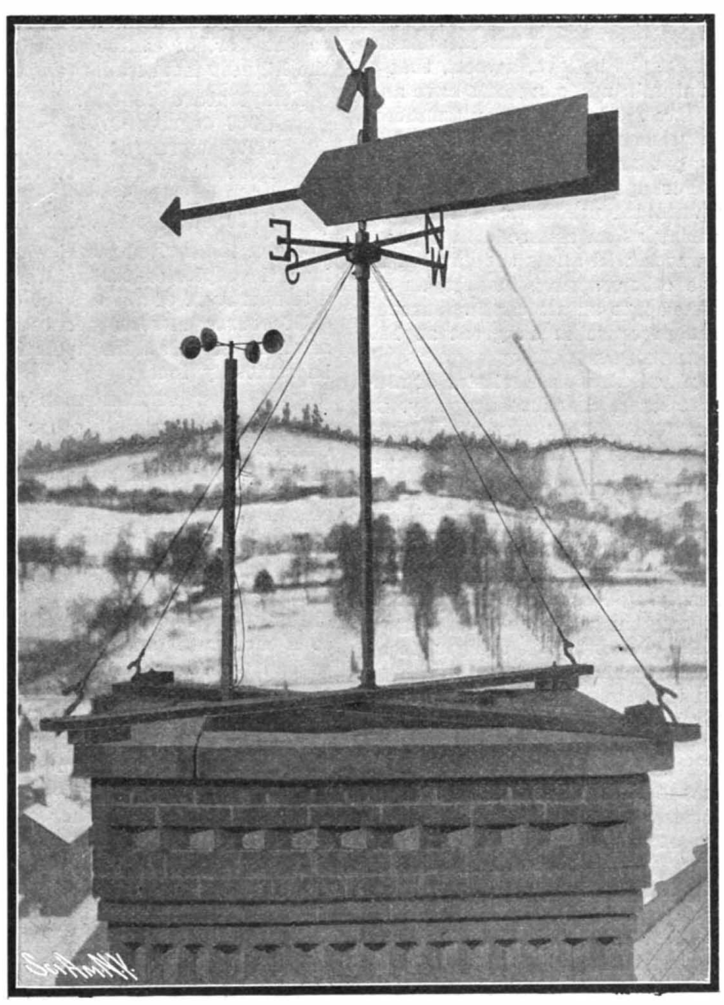


FIG. 1.—ELECTRICALLY-REGISTERING WIND VANE AND ANEMOMETER FOR SCHOOL USE.

THERMIT.*

BEFORE I come to my subject proper, which relates to a material which depends for its peculiar and valuable properties upon the unique characteristics of aluminium, which, however, in some respects, it shares with magnesium, it may be worth while to draw your attention to a number of curious properties of this peculiar metal, in which again magnesium is found to behave similarly to aluminium, either in greater or less degree.

The obvious characteristic of aluminium with which

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

* A paper by C. V. Boys, F. R. S., read before the Society of Arts and published in the Journal of that Society.

we are all familiar, is its lightness; not only is it light in the gross, but chemically it is light also, its atomic weight being only twenty-seven. The low atomic weight carries with it, as is well known, a high specific heat, and this, together with its large latent heat, give rise to the peculiarity that it takes a long time to melt aluminium, even though the melting point is only a little above that of zinc, namely, quite a dull red heat.

According to Richards, it takes more heat to melt aluminium than the same weight of cast iron, two and a half times as much as for platinum, and nearly five times as much as for gold. When melted, at once a new peculiarity is apparent; it appears in the crucible to stand up above the lip, as though it were not fluid. It is sometimes even called pasty, and it seems as if it would be difficult to pour, yet it is perfectly fluid, and is capable of making the most exquisitely fine castings. This capacity for standing up is simply caused by its high capillary constant, as compared with its density. In the workshop, aluminium, when pure, is a disappointing metal, and, in spite of the numerous aluminium solders, it is not so easy to handle where solder is necessary as we should like.

In connection with the difficulty of soldering aluminium, it might be worth while to refer to a further peculiar property of aluminium, namely, its power of adhesion to glass when rubbed upon it.

This property of aluminium is described by M. Margot in the "Archives des Sciences Physiques et Naturelles de Genève" for 1894, but a sufficient account is to be found in that most valuable book, of which the title is "On Laboratory Arts," by Prof. Threlfall. Not only does aluminium adhere to clean glass when rubbed upon it, more especially if the glass has been lightly dusted with rouge, or with alumina, but, strange to say, the very fine aluminium deposit so made can be soldered by means of M. Margot's aluminium solder, of which the proportions are 92 per cent of tin and 8 per cent zinc. It seems extraordinary that it should be possible to solder pieces of glass together through the intervention of a rubbed-on film of aluminium, more especially when we remember how troublesome in the ordinary way aluminium is to solder. Prof. Threlfall and Dr. Watson now solder quartz fibers in instruments by means of aluminium solder.

Aluminium further possesses the unique property of enabling clean metal ingots for plates, between which is interposed a thin sheet of aluminium, to be welded simply by hot rolling. The Compound Metals Company have kindly sent a number of specimens of sheets so made, and of articles made from them—from thick copper-plated steel for ships' plates to quite thin foil, including all kinds of combinations of metals. It is impossible to see any limit to the importance or ultimate scope of this process, and I should strongly urge that a paper dealing with it exhaustively should be arranged for by this society.

Another very curious property of aluminium is its value as a fine hone; its capacity for giving a fine edge to razors, lancets, and other tools requiring a fine and keen edge, seems to me to indicate that, in spite of all the care that may be taken in casting, the oxide which forms upon its surface to a certain extent is diffused throughout the mass. I cannot believe, myself, that a pure soft metal, such as aluminium, can itself have any abrasive action on hard steel. If, however, ultramicroscopic particles of oxide permeated the mass, then it is not difficult to realize that an excessively fine hone would be the result. Perhaps the most remarkable property of all that aluminium possesses, is that discovered by Pollak, of acting as an electrode in a phosphate of soda solution, which will allow the current to go one way, but not the other, acting, in fact, as an electric valve when inserted into an alternating-current circuit, even though the pressure is as great as 180 volts.

However peculiar the physical characteristics of aluminium may be, it possesses a chemical property, in which, together with magnetism, it surpasses all other metals, namely, the production of an enormous quantity of heat on combining with oxygen.

It may be worth while, by means of a simple experiment, to give some evidence of this and of the high temperature evolved in the combustion of aluminium. I have here a small glass jar, in which two or three leaves of aluminium are lying loosely at the bottom. The jar is filled with oxygen gas. On dropping a minute splinter of red-hot charcoal into the jar, it at once sets fire to the metal, and a flash is produced of such dazzling brightness, that those who see it will not see anything clearly for a little time. It may be interesting to state that the oxide bombards the glass with such effect as to apparently enter its substance, so that it can never be made clean and bright again.

The enormous temperature developed by the combustion of aluminium in oxygen, or when mixed with any material containing oxygen, has been made use of recently in an explosive of which I heard for the first time about a year ago, but I am not now able to ascertain what is being done with it. The explosive consists simply of ground aluminium and nitrate of ammonia. Here we have a mechanical mixture in the same sense that gunpowder is a mechanical mixture, as distinct from an explosive compound such as nitroglycerine, yet this mixture can be fired by detonation, when it explodes with the suddenness of a true chemical explosive. This is the more remarkable, as, unlike all recognized explosives, here the product of combustion is not wholly a gas, but largely a solid, so that there are only the residual gases of the nitrate of ammonia to produce the explosive pressure, and this is only rendered operative by reason of the fearfully high temperature. . . .

HEAT OF COMBUSTION OF ALUMINIUM.

Having spoken generally of the great heat of combustion of aluminium, I should next give some figures to make our ideas more precise. Instead of comparing the heat generated by the combustion of one pound or one kilogramme of a material, it is more convenient for the purpose of comparison to choose a number of pounds or kilogrammes that combine with 16 pounds or kilogrammes of oxygen, 16 being the atomic weight of oxygen. Richards, in his great work on aluminium, gives such a table, and the same figures may be deduced from Lupton's handy little table, from which it appears that magnesium heads the list with 145,860 large calories set free by the combustion in oxygen of 24.4 kilogrammes of magnesium. This is followed by aluminium, 18 kilogrammes of which in combining with the same quantity of oxygen, set free 130,500 calories. The metals of the alkalies and of the alkaline earths follow closely. A long way behind come ordinary metals and hydrogen, while carbon, our best fuel, is far behind. Of ordinary metals iron is of special interest to us. Thirty-seven kilogrammes in becoming Fe_2O_3 give out 63,700 calories or absorb this amount of heat in being reduced again. If the reduction is effected by the action of 18 kilogrammes of aluminium, the heat developed will be 130,500 — 63,700 = 66,800 calories. As 71 kilogrammes of material are involved, i. e., as nearly 1,000 calories are set free per kilogramme of mixture, the temperature attained must be several thousand degrees if the mean specific heats of alumina and iron through that great range of temperature and their latent heats of fusion are at all comparable with those of ordinary materials. Another consideration—limiting temperature—is the inability of elements to combine when a certain temperature is exceeded, so that a higher temperature cannot be produced by their combustion. In the case of our ordinary fuels, carbon and hydrogen, it is this rather than lack of heat units that limits the temperature of a furnace fed even with hot oxygen. In the case of aluminium, however, a much higher temperature is possible; while, therefore, the total development of heat of the reaction just described is known pretty accurately, it would be difficult to calculate with precision the temperature reached on account of our imperfect knowledge of the latent heats of alumina and of iron and of the varying specific heats of the materials at these high temperatures.

The temperature could be determined by radiation measures on the principle of the "absolutely black body," which, however, seems a strange way of speaking of such a dazzling blaze, but I am not aware that any measurements of the kind have been made as yet. Wyborgh, however, has made a measurement involving of necessity considerable extrapolation. He placed a small charge of fulminate of mercury in a magnesia tube, and having prepared a number of identical specimens, he subjected them suddenly to known temperatures by casting metals round them at these temperatures, then, when the fulminate reached a certain temperature, it exploded. The times taken between the casting of the metal and the explosion were observed to get less, of course, as the metal was hotter up to the highest measurable temperature, as follows:

Temperature of metal.	Time before explosion.
300 degrees C.	180 seconds
1,900 degrees C.	30 seconds
2,000 degrees C.	29 seconds
2,100 degrees C.	28 seconds
2,250 degrees C.	27 seconds

When the melted metal was replaced by the thermit-iron, the explosion took place in 22 seconds, from which a temperature of about 3,000 deg. C. was deduced.

Of course extreme accuracy must not be looked for after so great an extrapolation, but the result cannot be seriously incorrect.

THERMIT-IRON AND METALS.

Not only iron, but other metals, as already mentioned, may for similar reasons be obtained in a state of great purity and fused by this process. I would specially point out that the iron obtained in this way, though it is fluid, and may be cast in molds, is not "cast iron," but pure metal wrought iron. It may have its softness modified somewhat by the admixture with the thermit of small quantities of manganese, titanium, chromium, or other metal, or it may be carbonized to a moderate extent by adding to the mixture high carbon steel or cast iron. The temperature is in any case so high that it is desirable to reduce it somewhat. This is most advantageously done by the addition of some ten per cent or so of sheet-iron punchings, where the thermit-iron is intended for welding, or even a larger amount where a lower temperature will suffice. This possesses the further advantage that the yield of iron per pound of material is increased. When in future, therefore, I speak of thermit-iron as being used in any welding operation, I do not mean "cast iron," or necessarily pure iron free from carbon, but iron to which, if desired, the required degree of hardness has been given by the addition of one or another of the materials mentioned, but which is always ductile.

HISTORY AND DEVELOPMENT.

The history of thermit dates back to the year 1894, when Claude Vautin, of the city of London, made use of aluminium mixed with metallic oxides, sulphides, chlorides, etc., to effect a corresponding reduction of metals with which oxygen, sulphur, or chlorine might be combined. He found, on mixing aluminium in a finely divided state with these bodies, that the mixture when heated in the crucible to a sufficient temperature would react as already described, and that the mass would attain an intense heat, in virtue of the enormous heat developed by the oxidation of the aluminium. So great was the temperature, that metals ordinarily intractable and infusible, such as chromium, could be reduced and obtained in a compact form. Not only this, but the absence of carbon made it possible for the first time to obtain many such metals with a degree of purity hitherto unknown. One drawback, however, resulted from the very great temperature set up, namely, there was risk of losing a large proportion of the contents of the crucible, which was apt to be more or less violently projected into the air.

The next stage in the development of this subject, as shown by the records of the Patent Office, was made by Vautin a little more than two years later. In his specification of 1896, Mr. Vautin describes his next step. Instead of heating the materials in the crucible up to the point at which reaction begins, he ignites a portion of the cold mixture by the aid either of burning magnesium, or of a special ignition powder, which he there describes, consisting of finely divided peroxide of barium and aluminium. This mixture is specially valuable for creating high temperatures, because the peroxide of barium is quite ready to give up its extra atom of oxygen, and the product—namely, baryta and alumina mixed—is solid, so that there is no loss of temperature owing to the latent heat of a liquid, or still more so of gas. A little of this mixture, which is easily lighted by a match, may be placed upon the mixed oxide of chromium, manganese, or whatever the metal may be, and aluminium, and ignited. The local heat is so intense as to start the reaction in the mixture in immediate contact with it. The heat produced by this is so great as to set up the reaction in surrounding quantities, and so a combustion gradually proceeds through the mass, after which the metal is found at the bottom of the crucible, in a pure melted state, and the alumina, or oxide of aluminium, remains floating on the surface.

So far as the records go, there is no means of telling what Vautin did with his invention; judging by my experience of the way in which invention is looked upon by the majority of our English manufacturers and capitalists, it is likely that Vautin can have found nothing but discouragement wherever he turned. This, however, is pure imagination on my part; I have no direct knowledge that it was so. At any rate about six months later we find that Vautin's mixture began to be turned to account in Germany, where Robert Deissler made use of the heat of the reaction as a convenient way of heating up metal quickly.

DR. GOLDSCHMIDT'S INVENTIONS.

Nearly three years later we find Dr. Hans Goldschmidt coming upon the scene with a further invention for utilizing the heat of the reaction that I have described, for the purpose of welding iron. To Dr. Goldschmidt further, I believe, should be attributed the invention of the word "thermit," a convenient fancy name for the mixture, especially of aluminium and oxide of iron in fine grain, and in chemical proportion. Dr. Goldschmidt has been most active in the last few years in the development of a number of inventions designed to utilize either the heat of the reaction or the product of the reaction, or both. Supposing, for instance, that a butt weld is desired between two bars of iron or steel, or between two pipes or angle-irons, or channel-irons, or iron bars of any other section, two distinctive methods have been devised by Dr. Goldschmidt. From what I have already said, you will understand that a crucible of the mixture which I shall now call thermit, after ignition consists of two layers, iron below, in an amount nearly half the weight of the original thermit, alumina above, both at a temperature approaching 3,000 deg. C., so that it cannot be looked at without risk to the eyes. This double layer may be taken out of the crucible by either of two methods; it may either be poured out of the top, like castor oil over ginger wine, in which case the lighter material goes first and is followed by the heavier; or it may be run out through a small orifice at the bottom of the crucible, in which case the heavy iron will go first, and be followed by the lighter alumina.

PIPE WELDING.

In the case of a weld in a pipe, or in an angle-iron, it is probably desirable that the body of the weld shall, when finished, be identical in section with the rest of the material, so that on no account must any iron produced by the action of the thermit remain adherent. If this is the object, a simple mold is placed round the pipe or bar to be welded, leaving a space which experience has found to be suitable; the two ends are securely held in position by means of clamps, so that when desired a considerable pressure can be exercised between them. Then, when all is ready, the charge of thermit in the crucible, the amount of which for each section is known to a nicety and is tabulated, is ignited, and as soon as the fluid has become quiet, it is poured into the mold. As it is difficult to see the mold in consequence of the glare from the crucible, it is desirable just to splash a little alumina as near as can be judged, into the mold, when at once the glare from this will make the opening into the mold easily seen, and the rest of the mixture can be gently and gradually poured in. Now, in this operation, the alumina going first immediately chills in contact with the cool metal, thus forming a protecting layer, which prevents the iron that follows from damaging or adhering to the bar. The heat of the mixture—again iron below and alumina above—quickly heats up the bar or tube to the welding point; and if the space below, where the iron is, has been properly proportioned, and a proper quantity of thermit has been taken, the temperature of the bar or tube will reach the welding

point, but will not reach the melting point. After a time, varying from one minute to three or four, according to size and thickness, it is merely necessary to exert pressure by means of the clamps, and the weld is complete. Immediately—that is while still white-hot—the mold is removed, and the hot iron and alumina are knocked away, when there is nothing more to be done but to leave it to cool.

The molds for this pipe welding, the dimensions of which have been carefully tabulated by Dr. Goldschmidt, may either be made of two casings of sheet iron with sand between, or sand molds of the right form, such as are used in foundries, may be employed. The crucibles are not of the usual kind adapted to be heated in a fire, but consist of a perforated sheet-iron casing lined with an inch or more of magnesia.

RAIL WELDING.

The second method of making a weld is that which now appears to be, commercially, the more important, namely, to use, not only the heat of the reaction, but to utilize the iron formed by the thermit as well as the heat. Perhaps the most extensive use that has been made of this method of welding, at any rate in this country, has been in the welding of street tram-rails. In this case there is no objection whatever to the thermit iron being allowed to adhere to the rail ends, forming a shoe round the foot and web of the rail. By this means the heat of the reaction is more completely utilized, so that a smaller quantity of thermit is sufficient to raise the ends of the rail to the welding point, and even to melt, to a certain extent, the surface. . .

Tests speak for themselves, and show (1) that the joint is far stiffer than the usual one made with fish and sole plates; (2) that the electrical conductivity is better than that of the unjointed rail; and the conclusion is that there is no more any occasion to subject the rolling stock and the nerves of the passengers to the continual hammering of imperfectly connected rail ends.

Besides Leeds, some fifteen other towns, mostly in the north, have used thermit joints, but up to the present not to the same extent.

Before dismissing the question of the welding of tram-rails, whether the welding is performed by the thermit process or is made electrically, I feel that I must, in spite of having done so many times already, refer to the expansion bogey which seems to scare so many people. I will not now go into all the figures (I have already done this* elsewhere), but the general results may be stated. Tram-rails that are buried in the street, as distinct from rails on our main lines that are exposed over their whole surface to the air, do not go through a large diurnal change of temperature, and even the annual range of temperature is very much less than that of the atmosphere. With a rise of temperature, the rail of course tends to expand, and with a fall, to contract, and the forces set up are, if that expansion or contraction is resisted, pretty considerable; but with the steel used for tram-rails, these forces are insignificant compared with the tensile strength of the steel, being only about 300 pounds of tension to the square inch for every degree that it falls in temperature. Similarly, where there is a curve in the road, the lateral forces due to expansion or contraction become infinitesimal where the radius of curvature is large, and where it is small, an imperceptible movement of the rail, extending over half the year, is sufficient to relieve it of strain. The most serious conditions are those in which a sharp curve in a vertical plane, such as may be found in crossing a narrow bridge, unites two long straight lengths. Such conditions might lead to the actual lifting of the rail and, with it, of the roadbed, in prolonged hot weather; but then there is no necessity to make use of a weld in the very few places which can be found, where a weld is likely to introduce trouble.

There is another point to which I should like to refer, before dismissing the welding of tram-rails: Objection is often taken, that however good the joint, or however perfect the system may be, it must be a terrible undertaking to make any alteration in the rails when they are all welded into a single piece. Of course this objection, so far as it goes, applies equally to electrical and other methods of welding rails, besides that with which we are specially concerned this evening. The objection really is a purely imaginary one. Any one who has used a hack-saw only once or twice, and broken it or hurt his fingers in the attempt, cannot understand what a marvelously efficient instrument the common saw worked by hand is, in the hands of a man who has acquired the knack of using it. The tram-rail has a section of about 10 square inches, and is made of steel of moderate hardness. I was amazed, even though I believe I can use a hack-saw with some effect, to hear that at both Leeds and Liverpool they have a man who can saw through the rail in twenty minutes, and who does not think much of the proceeding. How long it would take to remove fish-plates and sole-plates, held as they are by eighteen or twenty 1-inch or ⅞-inch bolts, well rusted up or covered with pitch, I do not know, but the margin under twenty minutes cannot be so great as to make the sawing, where it really may be required, in any serious degree an objection.

MACHINE REPAIRS.

The thermit weld may be of very great value in a breakdown of machinery, for a piece that is broken away from a steel forging or casting, or even from an iron casting, may be replaced by thermit iron run into a proper-shaped mold; or if a crack has developed this may be enlarged with a chisel, and thermit iron run in and through the space, sufficient in quantity to heat it up so as to make a complete and perfect weld. Owing to the kindness of Mr. J. H. Jurriaanse, of Rotterdam (Wynmalen and Hausmann), I am able to show you a slide of a most interesting repair of this kind. The connecting rod of a large steam engine, driving all the machinery in a wire, nail, and rivet factory in Holland, where five hundred men were employed, broke in the fork in one end, and it was of the utmost importance that this should be repaired immediately, as work was stopped until it was done. The repair of this connecting rod was undertaken by Mr. Jurriaanse, who, having the drawings, prepared the necessary mold, and had it ready when the connecting rod arrived. The photographs show the several stages of the repair, and it may be sufficient to quiet those people who never cease to be afraid of the effects of expansion and contraction, if I tell them that when the joint was cold the connecting pin, which had previously held one side of the fork correctly in position, simply dropped out. The whole of this repair was effected within twenty-four hours.

I should like to express at this step my admiration of the skill and ingenuity with which Mr. Jurriaanse has utilized the powers of thermit. I have seen a number of specimens of experimental joints and of runners made by him, and it is impossible to imagine how they could be improved. Mr. Jurriaanse, whose experience is very great, has told me of one or two little points of detail which are of so much importance that I should like to refer to them. In the first place, he adopts a plan to prevent the sand which is placed at the bottom of the crucible from entering the mold, a plan which would at least surprise any one seeing a thermit joint made for the first time. Having got everything ready for a run, Mr. Jurriaanse places a piece of ¼-inch iron plate over the opening in the mold, and then, when he taps the crucible in the usual way, the first splashing of iron and sand is scattered, but the iron plate is no bar to the entry of the thermit iron that follows, and so the iron enters the mold, but the sand is kept out. Another point of importance—in which the beginner persists in going wrong—is to wait for a time, which in the excitement seems interminable, say half a minute or so after the reaction is complete, before tapping. This allows gas and particles of slag to get well separated from the metal, and a more clean and perfect run is to be expected than any that can be obtained if the tapping of the crucible is effected with undue hurry. There is another point to which he attaches some importance; in order to insure that the crystallization of the metal shall be of fine grain, he gently and continuously taps with a hammer the steel upon which a thermit weld is being made, from the time of the setting of the metal until the crystallization may be considered complete, and finally he pays great attention to a careful preliminary heating and annealing, where that is possible.

As an example of an engineering repair which I fear it would be difficult to get accepted in this country, I am able to show slides of a repair made in Austria, for the Austrian State Railways, to a locomotive driving wheel, from which you will see that in three places, the spokes have had a break satisfactorily repaired.

A question that will very naturally be asked is: To what extent are welds made in this way—really welds, and not mere patches; and if welds, to what extent may the utility of an otherwise sound weld be destroyed by contraction strains? I think the best answer to this is found in the fact that not only have broken teeth been replaced in steel wheels, and stood up to their work, but a far more difficult operation, and one which involves the most severe stresses known in engineering, has been successfully accomplished. I refer to the casting of new steel journals on the ends of the broken rolls of a rolling mill. This is hardly so direct an operation as any that I am describing this evening, and would take too long to describe in detail; but the method was devised by Prof. Matthesius, now appointed professor of metallurgy in the University of Berlin, and has been successfully accomplished. If a thermit-welded roll will stand to its work, it is hardly necessary to discuss the soundness and strength of the weld. I cannot give a better example of the British (it was in Scotland) mode of being interested in the progress of the arts than the answer of one of the engineers of a great steel works, to whom I was describing this process, as I saw a number of broken rolls lying about. He showed his superiority over a mere outsider, and his just appreciation, in the following words: "The thing is ridiculous; the roll cost £300."

SHIP REPAIRS.

The success with which steel of moderate dimensions, such as has already been described, may be welded by the aid of thermit, naturally leads to the inquiry as to how far it would be applicable when the section of the metal, when a weld is desired, is very much greater, say, than 10 square inches. It is difficult, at first, to realize the possibility of heating solid steel with a sectional area of, say, 50 or 100 square inches to the welding point, without at the same time heating the metal through a considerable distance, which would inevitably be the case if the heating were performed by the use of an ordinary forge fire, which would require a greatly increased quantity of heat. The fact that thermit puts into our hands a temperature at least 1,000 deg. C. above that available in the forge, and the fact that the thermit iron carries its heat at a rate enormously greater than that at which hot furnace gas can possibly carry it, simply on account of its far greater density and conductivity, completely alter the usual circumstances; and further, the relatively less conductivity of the solid metal for heat when dimensions are great, as compared with that where the dimensions are small, makes it by no means so prohibitive a process to weld steel of the great dimensions of the propeller shafts or the framings of ships, as at first one would be led to expect.

In the case of a repair to a ship, the stake is so great that there must have been great anxiety when the first repair of the kind was effected. This has now become almost a common operation on the Continent. The importance of the subject is such that it will be worth while to spend a short time describing, by the aid of photographs kindly furnished by Dr. Goldschmidt and Mr. Jurriaanse, some of these repairs. The first of these shows the repair in various stages of the tiller arms of the steamship "Assyria," 6,581 tons, which was welded fourteen months ago. The second shows the repair, in different stages, of a 13-inch crank shaft of one of the Rhine paddle steamers. This is the more interesting, as the position of the fracture is such, where the shaft and the crank web join, that the stresses, twisting and bending combined, are most severe, and the repair could not have lasted had it not been effective. In this case the crack was found extending more than half of the thickness of the shaft. The metal was cut away by means of cross-cut chisels, so as to form a gap about 1¼ inches wide, until the bottom of the crack was reached. The process was carried out in the manner already described, but a ring of thermit iron was left on. The ship has been running ever since, and the result is entirely satisfactory. A certain number of repairs have been made in stern frames of steamships which have been damaged in collision. The photographs of the steamship "Sevilla," 5,135 tons, showing the repair in various stages, are of special interest. The metal at the crack is cut away until a space of 1 or 2 inches is left. A mold, consisting of sand with sufficient clay to make is less friable, is prepared, in two or three sheet-iron boxes, so as to allow of the entrance of the metal at the lower part of the desired cast, and of the overflow of so much metal as would insure the passage of enough thermit iron through the gap to bring the metal up to the welding point, and superficially melt it. In the case of the steamship "Sebenico," in order to avoid any contraction flaws, the stern-post was forced outward by means of a powerful screw-jack before the metal was run, and then, as the cooling began, the jack was gradually released, so as to keep the joint in a state of compression. Of these ships, the "Assyria" and the "Sevilla" belong to the Hamburg-American line, and from the time of the weld to the present, i. e., about fourteen months, they have experienced the usual Atlantic weather, and no trouble has resulted. The "Sebenico" repair was carried out in the floating dock at Trieste, and was also entirely successful.

One of Mr. Jurriaanse's repairs to a dredger is interesting in that the heel just under the rudder frame had been broken away in running aground. In this case, a new piece over 3 feet long was forged to replace the missing corner, but it was purposely made too short, so as to leave a gap at each end. This was welded at both places as described already. The photographs will make the process more intelligible.

LUNKER AND TITAN THERMIT.

Referring back to an early paragraph of this paper you will remember that I showed how not only iron, but other metals may be reduced from their oxides by the aid of aluminium. In this way chromium, manganese, titanium, tungsten, and a number of metals may be obtained, free from carbon, and suitable for the purpose of making alloys, specially of copper or of steel. Specimens of several of these are upon the table. There is, however, a use for thermit containing some of these metals, to which I would refer, namely, the use of small tin boxes containing what Dr. Goldschmidt calls "lunker" thermit or "titan" thermit, which may be plunged at the end of an iron bar into ladles of cast steel or of cast iron, where the reaction sets up such a development of heat and such a churning and mixing of the metal as to make it possible to run thin and extensive castings in steel or in iron which, in the ordinary way, would be impracticable. The British Westinghouse Company have kindly given me permission to state that they are now using lunker thermit with this object, and they have sent me some specimens of castings so made which they found impossible before, of which specimens are upon the table.

The production of heat has been ingeniously made use of to prevent the formation of cavities in steel ingots. A small box of thermit, prepared for the purpose, is pushed into the head of the ingot just as the crust is beginning to form. The heat set up there is so great that, as the metal below gradually solidifies, the cavity which ordinarily is formed, and which spoils the upper third of the ingot, is kept supplied with hot, fluid metal, so that a very much smaller proportion of the ingot is wasted. The same purpose has been served where very extensive steel castings are made, by putting small boxes of special thermit in the risers at the distant parts of the mold. Where hitherto the metal on reaching the riser has become too cool to be able to run back to supply the contracting metal during the process of feeding, the metal in the risers is made so hot, by the use of the thermit, as to get over this difficulty.

ARTIFICIAL EMERY.

Even the slag is useful. This being almost pure alumina, fused and crystalline, is nothing more than emery of unusual purity and sharpness, and emery wheels may be made of it.

* "Proceedings of Civil Engineers," vol. cli., 1902, pp. 102-5.

A MODEL PARISIAN LAUNDRY.

The aphorism, which doubtless dates back to a remote antiquity, recommends us to wash our soiled linen at home; and yet the custom has become general in large cities to intrust this matter to laundries, which, putting together in their tubs the shirts and handkerchiefs of persons belonging to very different centers, do not always perhaps call to their aid all the resources that might be suggested to them by the exigencies of public hygiene. What inconveniences result from this is well known.

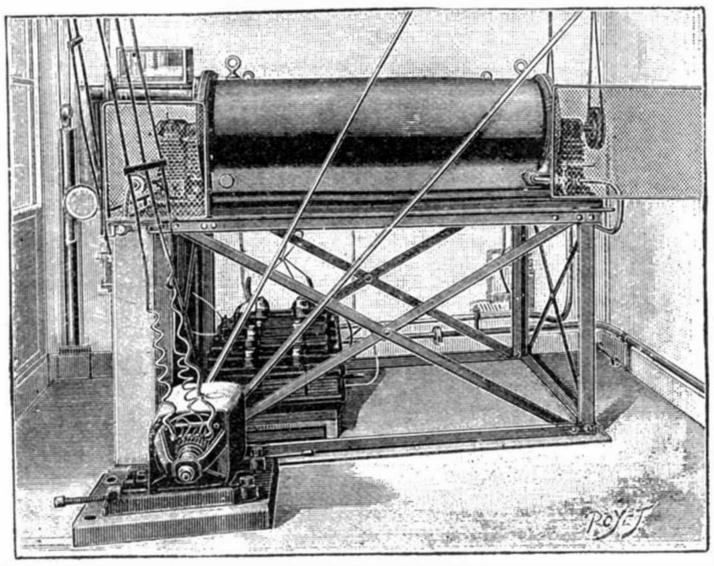


Fig. 1.—MANUFACTURE OF OZONE BY MEANS OF THE OTTO APPARATUS.

Our attention has therefore been attracted by a new laundry that has very recently been installed at Paris by M. Charvet, who, benefiting from the progress of science, endeavored to make his establishment a model of its kind.

Occupying himself in the first place with the question of the contamination that may be communicated by the linen of persons suffering from smallpox, scarlatina, tuberculosis, or other microbian diseases, not only to the linen of other customers, but also to the persons who do the sorting of the articles as they arrive, he has provided for an abundant production of ozone by means of the Otto apparatus, and thus has at his constant disposal one of the most powerful of disinfectants. The ozone apparatus (Fig. 1) are installed in a special room, which is tightly closed in order to prevent the occurrence of any accident from the electricity at a very high tension utilized for the manufacture. The bags that reach the establishment are all numbered and pass at once from the wagons in which they have been brought to large upright drums situated on a level with the street (Fig. 2). As soon as a drum is full, it is closed hermetically and a jet of steam is introduced into it in such a way as to thoroughly saturate all the linen with it. After this, the ozone is introduced through a special pipe, and then twenty minutes are allowed to elapse. At the end of this time, the disinfection is considered as complete, and the drum is opened at the bottom in order to allow the bags to fall into the basement, where they are opened by the hands whose business it is to do the sorting. Each article is provided with a ribbon carrying the same number as the bag, and which remains attached to it during all the successive operations. It is then, according to its nature, sent to the apparatus in which it is to be treated. If it has been previously starched, it is treated with diastase, and then the washing water is chemically tested in order to make sure that every trace of starch has disappeared. This is very important if it is desired that the linen shall not become yellow when it is kept for some little time before being used. The linen afterward passes into a series of washing machines where it is submitted to the action of hot soap-suds, and is then rinsed and dried (Fig. 3). The more delicate pieces are treated by hand (Fig. 4). The drying is effected in a stove-room. The starching and ironing are done by a force of female operatives, and the linen, still provided with its number, is taken to the classifying room, where it is put into baskets in order to be sent to the customer along with the bag designed for the reception of the next lot of articles to be forwarded to the laundry.

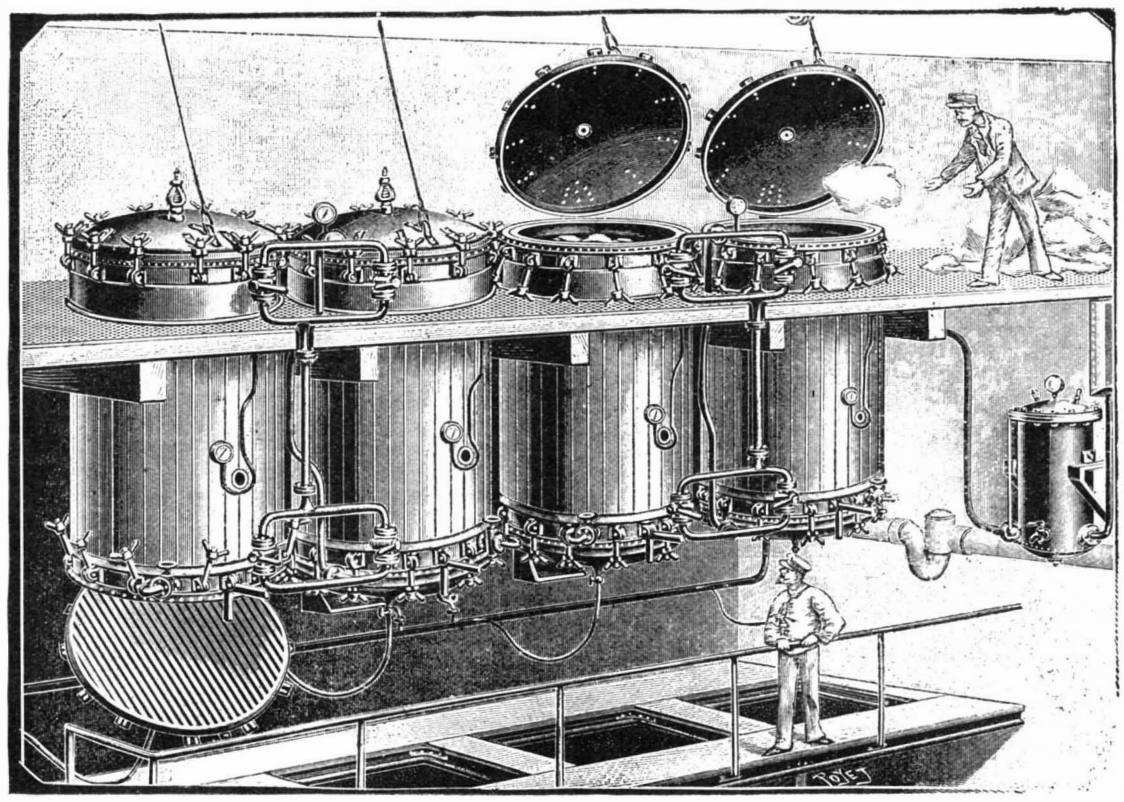


Fig. 2.—DRUMS FOR THE DISINFECTION OF LINEN BY OZONE.

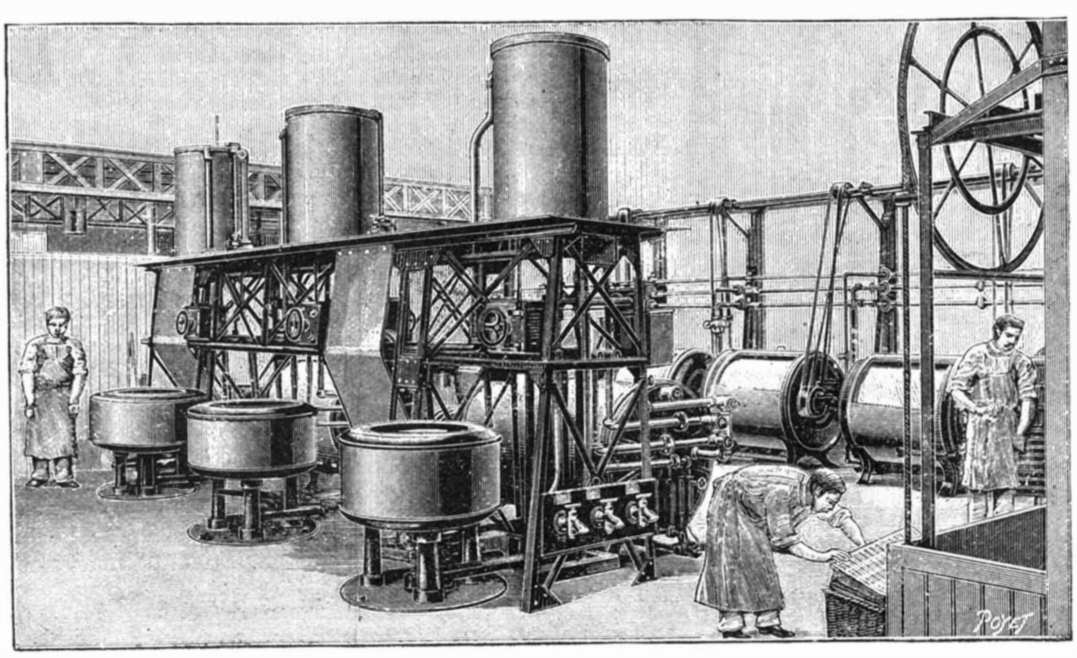


Fig. 3.—A BATTERY OF WASHING AND RINSING MACHINES.

The city of Paris, alive to the importance of facilitating the installation of a laundry that might serve as a model for the hospital or municipal services that are anxious to keep abreast of the progress dictated by the laws of hygiene, largely aided M. Charvet's initiative for the application of his happy idea. The Prefecture of the Seine, in fact, after having had a study made, under the surveillance of the Council of Hygiene, of the processes of disinfection employed by M. Charvet, made a concession of one of the pavilions of the Saint-Honoré market, in the very center of the city, on condition that the entire installation should, at the end of twenty-five years, revert to the city for its municipal services, and that, during this entire period, the establishment might be constantly visited and inspected by delegates from the services of hygiene, for which it might, in a manner, constitute a laboratory for the study of the processes of hygienic laundering.

The installation in the pavilion was made by the architect Gaultier. It is very well elaborated, and the linen passes methodically from one apparatus to another without any loss of time. The electricity designed for lighting, for the ozone apparâtus, and for the transmission of power for the eight motors that actuate the apparatus, is generated in the establishment itself by means of two 55-horse-power steam engines coupled directly with two dynamos of 37 kilowatts each.

As scientific processes are now being introduced everywhere, we must not be astonished to see them advantageously replacing the housewife's wash-tub. The example given by M. Charvet, as regards the preliminary disinfection of linen by the laundryman, should be imitated by hospitals, colleges, and, in general, by all establishments in which promiscuousness may prove the cause of an epidemic or contagion.—Translated for the Scientific American Supplement from La Nature.

PRODUCT REPLACING CAOUTCHOUC AND ITS PREPARATION.

A homogeneous mass is prepared by mixing intimately 50 parts by weight of leather scraps; 35 parts by weight of caoutchouc scraps; 0.5 of scraps of cork; 5 of asbestos; 10 of a solution of caoutchouc dissolved in linseed oil.

The scraps of leather are cut up fine, advantageously scraps of sole leather, with the aid of a machine. To soften the fibers and remove the impurities, they are soaked for a sufficient time and shaken in a mixture composed of barley, yeast, and water; then, in order to produce suppleness for the fibers, the dried mass is immersed for a longer or shorter time in the mixture known by the name of leather oil, and composed of oleic ether, freed of adherent acid by washing, with hot water and train oil.

The fibrous mass thus treated, and the small pieces of cork mixed with the necessary quantity of asbestos and the waste of caoutchouc of the size of a nut, boiled previously with soda, are introduced into agglutinating matter prepared by the known method for the solution of caoutchouc in linseed oil; heated from 40 to 50 deg C. The whole is mingled intimately, and after having produced in the mixture obtained, for instance, with the aid of calenders with heated rollers, the desired form, it is immersed in sulphur proto-chloride, diluted with carbon sulphide for vulcanizing the caoutchouc, which serves as an agglutinant.—From the French in La Revue des Produits Chimiques.

WATER-RESISTING MORTAR.

It very frequently happens that work has to be carried out in the presence of running water, or where water runs through under pressure, as in the case of mines or caves that are situated below the level of a certain sheet of water. In these cases the mortar of cement—even that which sets rapidly—does not fulfill the desired object, for it is necessary to close, almost instantaneously and securely, the openings through which the water runs under high pressure. In these particular cases, Staab proposes the employment of a mixture of cement, sand and wood charcoal, which is

moistened with a solution of sea salt and potash; two parts of cement and one part of sand are taken, or, in the case where high pressure of water is to be resisted, three parts of cement and one part of sand. This is mixed together while dry, some wood charcoal powder being then added to facilitate the adherence of the oil varnish that is to be applied outwardly. Another method which is advocated is to dissolve seventeen grammes of sea-salt (chloride of sodium) in a liter of water, afterward adding fifty grammes of potash lye. The water thus charged with salt is heated to 30 or 40 deg. C., the mixture of cement and sand being then moistened. The paste-like mass which will be obtained should be immediately employed, as it hardens very quickly. If it be desired to coat a wall, a layer of the mass is applied about seven or ten millimeters thick; in the case of closing up large apertures through which water runs under pressure, the opening is first made smaller by applying the mass round the sides of the hole, gradually completely filling up the same. In this case, it is as well to apply, for a short time, a small piece of wood against the repaired portion by way of a support. Scarcely, however, a minute after application, the hardening is almost complete, and so great is the solidity and resistance of the mass that in one case the water forced its way through the gaps in the masonry work and came through the bricks themselves. We are assured that this preparation can also be used for a number of other requirements where a hard and quick setting mortar is required.—Stone Trades Journal.

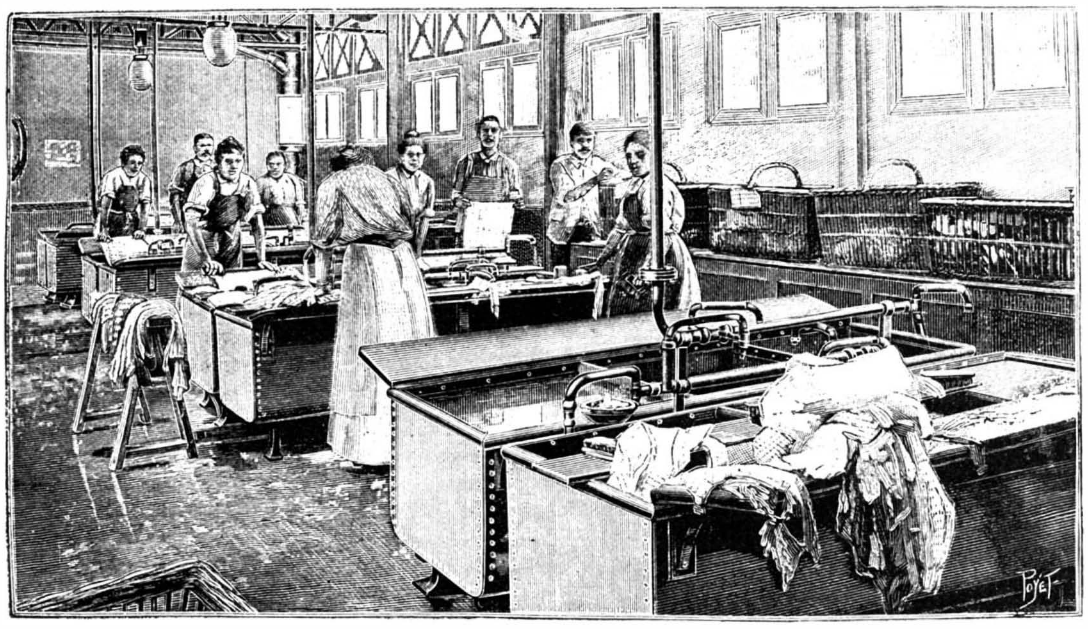


FIG. 4.—WASHING SMALL OBJECTS BY HAND.

ONYX.

THE onyx marbles, owing to their nature, are represented by slabs of varying size, some larger, some smaller, than the standard. The cylindrical and fruit-like forms of the Mexican onyx give the effect of the characteristic bands on carved surfaces. Besides the better known onyx of Mexico, lower California and Arizona, less known localities, such as the stalagmite marble quarries of Utah, are represented. Among other foreign localities Egypt and Syria are represented by travertines of great beauty, the same known as alabaster in Biblical times. A serious endeavor is to be made to place onyx marble on the market in quantities. In the past our supplies have been mainly drawn from Mexico and California. The Mexican quarries produce the finest material, but the quantity shipped is very limited, and the price is almost prohibitive, owing to the fact that the quarries are situated some distance from the seaboard, and transport is exceedingly costly. From the California quarries there is a more steady supply, but the cost of transport has always been a serious bar to the development of the business. A shipment has recently arrived in London from Galveston, of an onyx quarried in Arizona, and this is pronounced by experts to be of a quality unsurpassed by the finest produce of Mexico. Until recently the owners of the Arizona quarries were under the same difficulties as the producers in Mexico and California with regard to transport, for something like seventy miles had to be slowly and painfully traversed by road before the nearest railway could be struck. A new railway has, however, now been built, which passes within 200 yards of the quarries, and this, it is stated, will enable onyx to be placed on the market in London at prices which have been hitherto unattainable. If this should turn out to be the case, the ornamental marbles in ordinary use will have a new and formidable competitor, and future developments will be interesting. The beauty of onyx consists in the marvelous gradations of color which are found in the stone, and the semi-transparency of the material, which makes it peculiarly adapted for decorative purposes. If all that is claimed for the onyx from the Arizona quarries can be realized, there is, without doubt, a great future before it. The origin of onyx is purely chemical. It is, without doubt, an aqueous deposit of carbonate of lime, and similar in this respect to marble; the main difference between onyx and marble being that the latter has been formed under conditions which involve deposition from waters of a high degree of saturation and of considerable pressure at the same time. The Arizona deposits are doubtless those formed by an ancient geyser; in fact, the quarries are on the site of a volcanic eruption of this nature, which must have been one of the most extensive in the world, as they extend over an area of 320 acres. The reports of experts are to the effect that the amount of the deposits runs into millions of tons, so that the supply for all practical purposes is inexhaustible.—Stone Trades Journal.

THE NAVAL BATTLE OFF CHEMULPO.

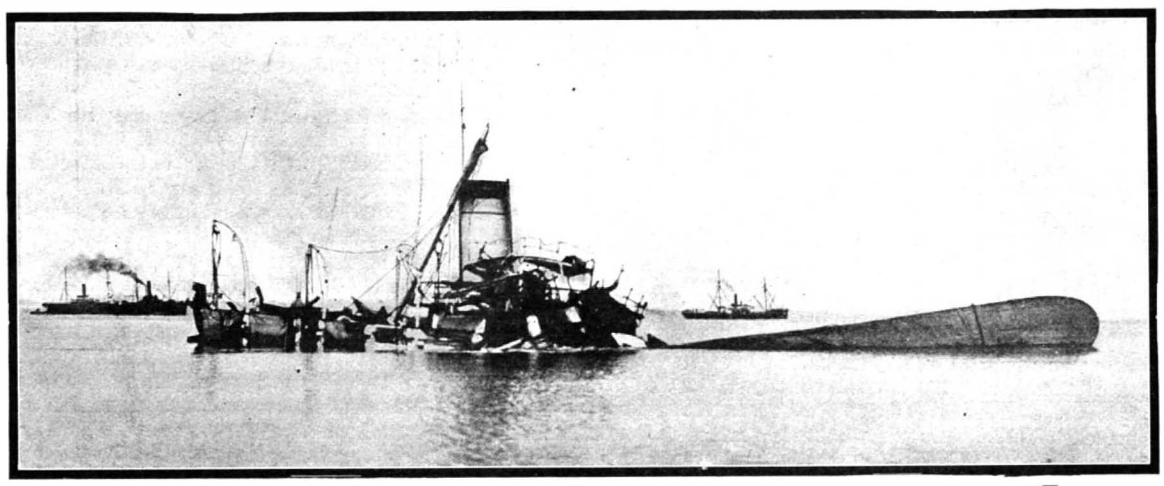
THE Tokio Asahi's Chemulpo correspondent reports that a banquet for the celebration of Japan's victory over Russia was given by the leading Japanese residents at Chemulpo. There were in attendance the captain of the Japanese warship "Chiyoda" and other naval officers. The captain of the "Chiyoda" gave the guests the following account of the naval engagement at Chemulpo on February 9: Shots were first exchanged between the Japanese and Russian squadrons when the latter was passing Rose Island to starboard. The ill-fated "Korietz" and "Variag" were encountered by the "Chiyoda" and "Asama" only, the rest of the Japanese warships playing the part of onlookers at a distance. On one occasion, the enemy's squadron came so near to the Japanese that the distance between the two was only 4,800 meters. The firing from the Russian warships was most intense when the two squadrons in the engagement were separated by 5,400 meters. The captain of the "Variag" was wounded on his left arm, while two bluejackets who were standing on either hand of the Russian captain were fatally wounded by our shells. The Japanese torpedo flotilla also remained quiet. Very few shots were fired from the "Chiyoda" and "Asama" during the engagement. The explosion of the "Variag" was apparently due to the fact that one of the shells fired from the "Asama" struck the vessel in a vital part. The Russian warships both kept their flags flying to the last moment.

The battle lasted less than an hour, with the result shown in the accompanying pictures taken from the King.

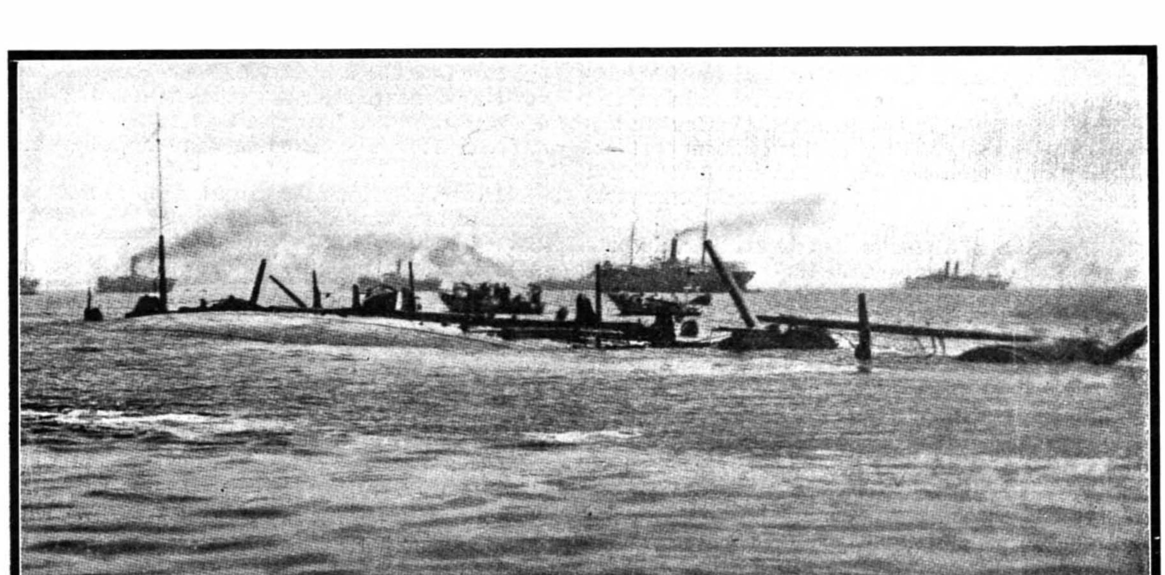
CHINESE WOOD OIL.

WOOD oil is rapidly becoming an important article of export in China, according to L. S. Wilcox, United States consul-general at Hankau, during last season there having been more than $1,890,000 worth of it shipped from that port. Previous to 1899, when the attention of the United States importers was called to its valuable properties, only three small shipments had been made from here to the United States. After the report which called attention thereto was published, inquiries began to be received and orders commenced to come in from the United States. Now two United States firms have located branches here for the purpose of exporting wood oil. One of the firms deals exclusively in this article, and it has shipped nearly 200,000 gallons since last fall. Previous to 1900 the oil was shipped to Europe in considerable quantities. "The value of the oil is due to its astringent and drying qualities, and it is used in varnish for the finer kinds of furniture. There are two kinds of this oil—one yellow, the other a dark color. Only the former has been exported, being considered of a higher quality than the latter. It is also reported that in Europe it is used in making soaps. The price of the yellow variety during the past season has varied from $4.92 to $6.05 per picul (133 1-3 pounds). The oil is brought to Hankau in bamboo baskets lined with oiled paper, each basket containing about one picul of oil. The great difficulty of obtaining barrels to export the oil in is a serious drawback, as no barrels are manufactured in any of the provinces where the oil tree grows. For this reason an American firm at Hankau has imported from New York shooks for 5,000 barrels and machinery for setting them up. Last year a request was received from California for 1,000 seeds of the oil tree. They are planted and are growing finely. The same parties last fall requested 4,000 more seeds, and arrangements have been made to secure and ship them. As the oil finds a ready market, the introduction of these trees into various parts of the United States will be a source of revenue to their owners."

Market for American Fruits in Canada.—American fruits are sold in this district, but only to a very limited extent. The purchases are mostly made through commission houses at Montreal. There appears to be no particular objection to present methods of packing. The terms of payment are cash or on thirty days' time. Deliveries are made with satisfactory promptness. Trade might be increased by agents, as it is more satisfactory to buy from them than through correspondence.—E. S. Hotchkiss, Consul at Brockville, Canada.



THE WRECK OF THE "KORIETZ."



THE LAST OF THE "VARIAG."

THE USE OF LIGHT AND OTHER RADIATIONS IN THE TREATMENT OF DISEASE.

ONE of the most interesting fields of medical research at present is the investigation of the therapeutic properties of various rays, and although much has been accomplished in a few years, there is promise of a still greater future for this development of the healing art. Any advance in medical science is of the greatest moment to the general public, and cannot be too widely known, and in this respect this branch of therapeutics has had a measure of publicity which is probably unique, but which is not altogether free from harm. The discussion of purely medical details, and the description of "cures" of apparently hopeless cases in the columns of the lay press, have unfortunately led to misconception and to terrible disappointment to many sufferers.

The fact that certain rays of light possess special physiological properties has been long known, and valuable papers on the subject were presented to the Royal Society as far back as 1872 by Downes and Blunt. But the credit of rendering the knowledge obtained by these and other observers of practical value in the treatment of disease belongs to Finsen, of Copenhagen. His first work was to show that the chemical rays of light, the violet and ultra-violet rays of the solar spectrum, have a deleterious influence upon the eruption of smallpox, and this led him to introduce the red light treatment for this disease. The patient is confined to an apartment from which the chemical rays are excluded by means of red curtains. For the treatment to be successful, the curtains must be thick enough to exclude the chemical rays as completely as they are excluded by the photographer from his plates and films. In a patient under these conditions the ordinary course of the smallpox eruption is modified, the fever of the second stage is lessened, and the scarring is infinitesimal. It is not claimed that the mortality from this terrible disease is materially diminished by the light treatment, for in a certain proportion of cases there is no hope from the first, but in a large majority suffering is diminished, convalescence is easier, and disfigurement is slight.

Finsen's next work was the development of the light treatment for lupus. Lupus vulgaris is a very chronic destructive disease of the skin and mucous membranes caused by the bacillus of tubercle, the microbe which attacks and destroys the lungs in consumption. The chemical or actinic rays are here the therapeutic agents used. These rays have a definite germicidal power, and they are also capable of setting up a peculiar form of inflammation. They are the cause of sunburns and of pigmentation of the skin from exposure to the sun's rays. In the treatment of lupus the rays of the sun, or, more conveniently in northern climates, those of a powerful electric arc light, are concentrated by means of lenses upon the diseased area. For the lenses rock-crystal must be used, because ordinary glass obstructs the passage of a considerable proportion of the rays in the ultra-violet part of the spectrum. When the sun's rays are used, a light filter is employed to cut out as far as possible the heat rays at the red and yellow end of the spectrum. The light filter is a hollow lens filled with a solution of methylene blue or an ammoniated solution of the sulphate of copper. If the electric light is used the light filter is now dispensed with, as the proportion of heat rays is much less than in the rays of the sun. Even with the light filter a certain proportion of heat rays pass, and in using either the sun or the arc light it is found necessary to cool the surface under treatment. This is effected by placing in contact with the area treated an apparatus through which a current of cold water is constantly passing, and, when the electric light is used, by also passing the rays through a cylinder containing distilled water, which is kept cool by a water jacket, similar to that used in the Maxim gun. Another point of importance is that the area under treatment should be rendered bloodless, for the red coloring matter of the blood prevents the passage of the chemical rays to the deeper parts of the skin. This was shown by a simple little experiment of Finsen. If a piece of sensitized paper be placed behind the lobule of the ear and a powerful light be concentrated upon it, so that the rays have to pass through the ear, the paper will not be blackened at the end of some minutes; but if the ear be compressed by two glass slides, so as to render it bloodless, and the light be concentrated as before, the sensitized paper is blackened at the end of twenty seconds. In practice the apparatus which is used to cool the surface is used to compress the area under treatment, and it is held in position by an attendant. Various means have been tried to do away with this constant personal attention, but no mechanical means yet devised can replace it, for the parts treated must be kept in accurate focus.

The light is applied for an hour at a time, and six to twelve hours after treatment the part becomes red and inflamed, and a blister commonly forms. The inflamed, blistered area heals under simple dressings. It will be noticed that the effect of light is very different from that of heat. The application of intense heat to the skin causes an immediate inflammation, a burn, while the inflammatory reaction to light does not appear for some hours. As a result of the inflammation set up, and also of the specific germicidal action of the actinic rays, the bacilli in the tissue are killed, and after successive treatments the diseased area is replaced by a pale, soft, supple scar. The cosmetic results of this treatment are unequaled. The process is essentially a conservative one. All other methods of treatment, such as removal by the knife, scraping or cauterizing, are destructive and tend to produce grave disfigurement, an important point, as the disease commonly attacks the face. The disadvantages are, however, serious. In the first place, the length of time required for the satisfactory treatment of even small areas is considerable. Secondly, the apparatus is expensive, and each patient requires constant skilled attention, and this is an important item in the cost. Lastly, it is often impossible to reach the disease when it involves the interior of cavities such as the nose and mouth. In some cases also of long standing, the area involved is so extensive that the method is too slow to keep pace with the spread of the disease. With early cases a cure can be completed in a few weeks, but in some instances a cure cannot be effected in less than a year or two. A large number of cases are now on record in which patients have been free from the disease for five years and upward, and many unfortunates who were debarred from obtaining work by their disfigurement are now in regular employment.

Certain other affections of the skin of parasitic origin can also be treated successfully by Finsen's method, notably a form of baldness; and some superficial nævi have been removed.

The use of light baths has many advocates. As commonly applied, the whole body or an affected limb is subjected to the radiations from a number of incandescent electric lamps in a closed chamber. This produces local or general perspiration, and the effect is that of a Turkish or Russian vapor bath. By another method the patient is exposed to the light from powerful arc lamps, and these appear to influence nutrition by their powerful stimulation of the skin.

To Prof. Röntgen's brilliant discovery medical science owes an incalculable debt of gratitude, for not only are the Röntgen rays of the greatest value in the diagnosis of injuries and diseases of the bones, in the localization of foreign bodies, such as needles, bullets, etc., in the tissues, and in the demonstration of calculi, and even of diseases of the lungs and great blood vessels, but they have been found to possess therapeutic properties of immense value. In the early days of X-ray work operators and patients occasionally suffered from a peculiar form of inflammation, a so-called burn, occurring days and sometimes weeks after exposure to their action. This power has been turned to practical account in treatment. Schiff and Freund, of Vienna, showed that certain cases of lupus could be cured, at any rate temporarily, by their means, and other superficial diseases of the skin have also been found to be benefited. The results are not so certain or so permanent as those achieved by Finsen's method, but in some cases, as already indicated, the latter is inapplicable.

Not long after Schiff and Freund's discovery the rays were applied to cases of rodent ulcer, a locally malignant disease, starting in the skin and often destroying deeper structures, and even bone. Rodent ulcer usually attacks the face, and its treatment by older methods was so frequently unsatisfactory that it had received the name of *noli me tangere*. It was demonstrated that the peculiar cells of the rodent growth are destroyed by the Röntgen rays, and that they are replaced by healthy scar tissue. Recurrences do happen after apparent cure by the rays, but such recurrences are as a rule easily removed by a further application. The rays are applied to the diseased tissue for ten to twenty minutes at a time. There is little or no discomfort to the patient, and in most cases improvement is at once manifest.

The success which attended the X-ray treatment of rodent ulcer led to the hope that in it would be found the cure for cancer. But there are essential differences between rodent ulcer and cancer. Rodent ulcer is peculiarly a local disease, while the characteristic of cancer is the spread of the disease to and the involvement first of the glands and then of internal organs. The Röntgen rays have an undoubted influence upon many cancerous growths. Superficial tumors have disappeared when exposed to their action, ulceration heals, and pain is relieved, but not by any means in all cases; in some, even when the growth appears to be localized, the glands and internal organs are already involved, and there is no hope of a cure by such a purely local measure. One thing is certain, and that is that where it is possible to remove a cancer by operation that procedure should be adopted in preference to ray treatment; but where operation is out of the question suffering may be relieved by the application of the rays, and possibly the cancerous development may be checked, but cure is not to be expected. Some surgeons are now applying the rays after operation, so that any outlying cancer cells which have not been removed may be destroyed. It is as yet too early to say how far such measures are likely to prove successful.

Another therapeutic application of the X-rays demands a few words. The rays have the power of removing hair, and for this purpose are used in certain diseases where the hairs are attacked by parasites. One such disease is ringworm. The difficulty in treating this and similar diseases lies in the difficulty in thorough epilation. The rays do not kill the parasites, but they remove the infected hairs, and in that way hasten a cure. If applied for a short period only, the roots of the hairs are not destroyed, and after a time the area treated is covered with new healthy hair. The removal of superfluous hair, which is so often a disfigurement, by the X-rays is not to be recommended, for the effect is not permanent unless the application is made for so long a time and so often as to run a risk of exciting a severe inflammation, with the possibility of causing greater disfigurement than the original hirsuties. Moreover, there are other more satisfactory means which are quite safe.

Radium is the latest addition to the therapeutic armamentarium. The romance of its discovery, the mystery of its radiations and emanation, its relation to some important scientific theories, and, above all, the possibility of its being the long-desired cure of cancer, have fixed upon M. and Mme. Curie's discovery the attention of the world. The element in the form of a bromide, and other compounds more or less pure, is now under trial in various diseases. Rodent ulcers, and some superficial cancers, react to it with very similar results to those obtained by the X-rays. There is no doubt that it is an agent of great value, but further observations are necessary to estimate its position. It can certainly be applied to disease in regions which it is now impossible to reach by the X-rays, but that its field in the treatment of cancer is limited is obvious. Its effect is local, so far as present observation has shown, and the remarks made above upon the influence of the X-rays in cancer apply equally here. Radium has to be used with great care, for it is powerful for evil as well as for good. If too long applied it causes destruction of tissue, and such destruction may take months to heal.

It will be gathered that rapid strides have been made in this field, and it would appear that we are but on the threshold of further developments. The latest discovery, the mysterious *n*-rays which are said to be produced by nervous and muscular action, does not appear to possess therapeutic importance, and whether it is likely to be of value in diagnosis is at present purely problematical.—Nature.

DETERMINATION OF THE TOTAL PHOSPHORIC ACID IN THE THOMAS SLAG.

From the German of Prof. C. ASCHMANN in the Chemiker Zeitung.

THE following solutions may be employed:

1. Nitro-sulphuric acid.—Mix 420 grammes of nitric acid, of density 1.2, and 50 grammes of concentrated sulphuric acid, with ordinary water, so as to make 10 liters of solution.

2. Citric acid.—Dissolve 500 grammes of crystallized citric acid in distilled water, making up one liter.

3. Magnesian mixture.—Dissolve 100 grammes of crystallized magnesium chloride, 140 grammes of ammonium chloride, and 700 grammes of ammonia (density 0.967 = 8 p. c) in 1,300 cubic centimeters of distilled water. In a few days filter the solution.

Method of Determination.—5 grammes of Thomas slag, finely pulverized, are put in a half-liter bottle, and a few cubic centimeters of alcohol added; then the bottle is filled to the mark with nitro-sulphuric acid. The mouth is closed with a good rubber stopper, and the bottle placed in a Wagner shaking apparatus, which is kept in movement for 30 or 40 minutes. The speed of rotation should not exceed 40 or 45 turns a minute, in order that the air below the level of the liquid may have time to pass. It is filtered, and 50 cubic centimeters measured, to which 10 c. c. of citric acid are added. Then a piece of litmus paper is introduced, and ammonia slowly added until the color is blue. After cooling, the solution having become completely liquid, 20 c. c. of the magnesium mixture is introduced and mingled for 40 minutes; before filtering, it is well to leave the precipitate to deposit for one or two hours.

It happens at times that, at the moment of neutralization with ammonia, the liquid suddenly blackens, or the blackening may appear only during the shaking. Prolonged shaking will cause it to disappear.

In other cases, the neutralization may give rise to a precipitate of silicic acid, and then the method above described cannot be employed. This inconvenience occurs but rarely. The writer has noticed it but twice in 615 determinations which he has made.

The mixing apparatus is put in movement by means of a motor. This process has the advantage in the laboratory of avoiding the formation of acid vapors, and is attended with a saving of lighting gas, since all the operations, except the drying of the ammoniaco-magnesian precipitate are conducted cold.

Finally, it may be remarked that the solution of slag in the nitro-sulphuric acid does not keep long after filtration. In a certain time the crystallization of gypsum occurs. This may be avoided by adding to 50 c. c. of the solution, immediately after filtration, 10 c. c. of citric acid. This mixture can be preserved indefinitely, and a precipitation of ammoniaco-magnesian phosphate determined after any time.

The saving of time that is sometimes effected at one stroke by the introduction of a machine into some class of work is something quite wonderful. An example in point is the rotary bevel shear which has come into use in boiler shops for shearing, splitting, beveling, and forming the edges of boiler plates. Formerly it was necessary to shape the edges of all flanged parts such as domes, heads, furnace mouths, etc., by the slow and laborious hammer-and-chisel process. With the rotary shear, however, such parts are beveled and shaped in a small fraction of the time required by the hand process. The machine is adapted to work complicated shapes, and the action of the rotary cutters both feeds and cuts the stock. It is said that such machines will trim stock at the rate of from 400 to 500 feet per hour. In railroad shops it has been found, for example, that a door sheet, which required 420 minutes to shape by hand, can be shaped and beveled with the machine in ten minutes. Other characteristic work is done with a proportional saving of time.—Machinery.

THE IRON ELECTRIC ARC IN PHOTOTHERAPY.

OF all the recent methods of treatment proposed for combating lupus—that invading cutaneous manifestation of tuberculosis—there is none that has met with more success than that of phototherapy, which, as is well known, utilizes the bactericidal action of light, and the inflammatory reaction that it brings about, for destroying tuberculosis bacilli in ulcerated tissues converted into cicatricial sclerous ores. This method was recommended for the first time by Prof. Finsen, of Copenhagen. In order to obtain such therapeutic effects, Prof. Finsen devised an apparatus, which we have already illustrated in the SCIENTIFIC AMERICAN, and which may be described briefly as follows: A large lens formed of a plate of plane quartz, and another and convex one mounted in a metallic ring, the space between the two being filled with an ammoniacal solution of copper sulphate designed to arrest the ultra-violet rays. This lens concentrates upon the ailing region (previously rendered anæmic by compression) either the light of the sun or that of an electric arc produced by a powerful continuous current of from 60 to 80 amperes. The excellence of the results obtained by this treatment could not fail to lead numerous specialists to make researches as to the best methods of applying it. So, in recent years, a certain number of new arrangements have been proposed for the application of light-cure, and of these there is one in particular that deserves especial mention. We have reference to an apparatus devised by M. André Broca and Alfred Chatin, consisting of a quartz lens mounted in an apparatus devised by them for the use of an electric arc using metallic electrodes unaccompanied by any cooling arrangement.* The iron arc, which was employed for the first time in 1901 by Bang, presents the peculiarity of being considerably richer in violet and ultra-violet rays than the carbon one; and this is an important property. In some experiments, in fact, carefully performed by MM. Chatin and Nicolau, these gentlemen found that the iron arc, owing especially to the large number of chemical rays that it contains, possesses a bactericidal power much greater than that of the ordinary carbon arc. The immediate and very advantageous practical consequence of this peculiarity is the possibility of utilizing, with the iron electrodes, arcs of less intensity, which consume less current and produce less heat than do those produced between carbons. Thus MM. Broca and Chatin, for the treatment of tuberculous complaints, make use of arcs obtained with currents of between 12 and 35 amperes, under a tension varying from 25 to 45 volts, the first of these figures being obtained when the electrode is sufficiently warm to allow the iron alone to burn in the arc. Under such circumstances the heat radiated is not very great, while, on the contrary, the actinic power has greatly increased. By reason of these two peculiarities, the inventors of the new arrangement have been able to greatly simplify their apparatus, since they do not have to take the precautions necessary with other systems for keeping it cool. They employ merely a metallic device adjusted to the head of the patient, who, after the compression has been well performed, can, without any inconvenience and without any heating of the completely anæmic tissues, remain within two or three inches of the voltaic arc. Naturally, some accessory arrangements are provided for preventing the light of the iron arc from striking the assistants and for preserving them from the erythemas that would soon be produced.

With this apparatus of MM. Broca and Chatin it seems that the rays, owing to the excellent compression effected, penetrate the innermost parts of the tissue. Its efficacy, however, has recently been questioned by Prof. Finsen, according to whom the essential condition of success in phototherapic treatment is to employ a light of as an intense a blue as possible. For obtaining such a light, Prof. Finsen says that it is necessary to employ 60 to 80 ampere arc lamps having carbon electrodes, and not lamps provided with metallic electrodes, which produce a large number of ultra-violet rays, but give no penetrating ones.

There is no doubt that new experiments in the near future will tell us whether this opinion of the initiator of the method is fully justified or whether, on the contrary, conformably to the hopes of MM. Broca and Chatin, it will be possible successfully to use iron arc apparatus, which are of easier installation, less costly,

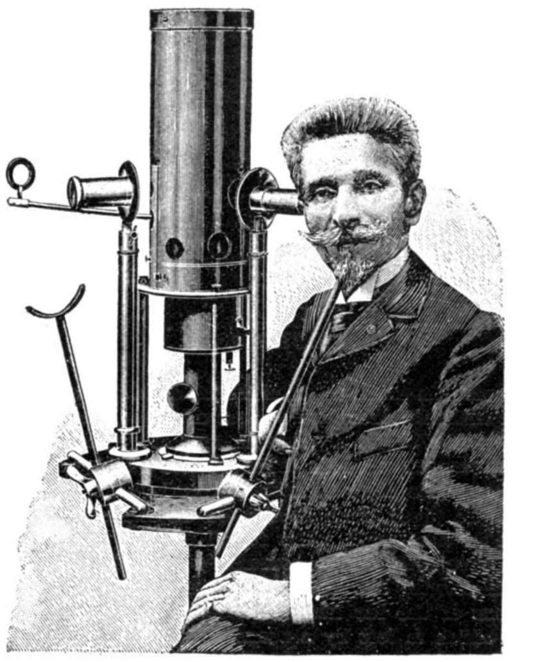


FIG. 1.—TREATMENT OF A PATIENT BY MEANS OF THE BROCA-CHATIN APPARATUS.

and much more conveniently operated.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

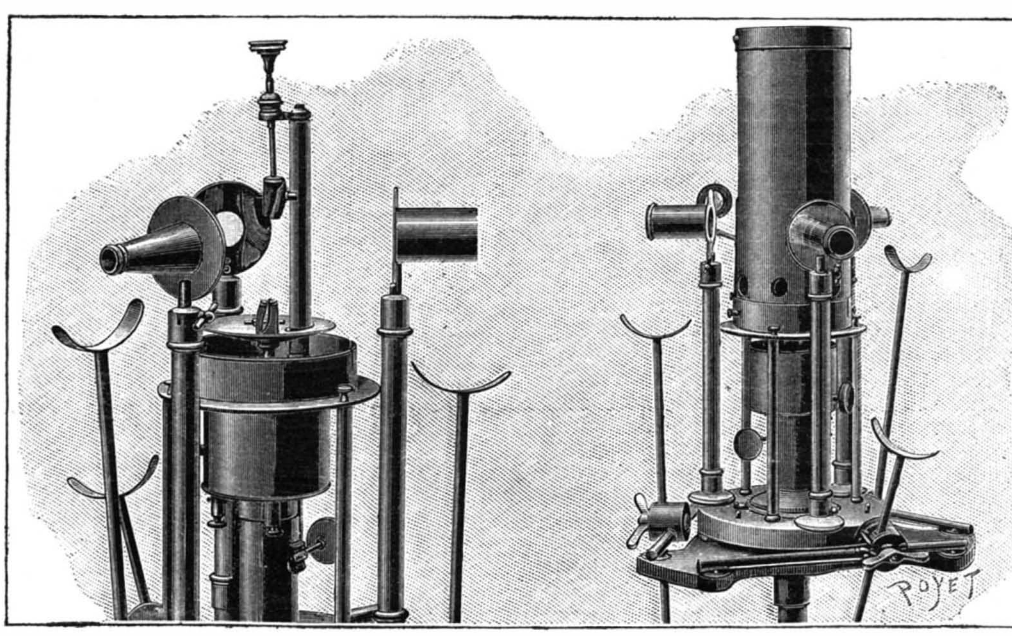


FIG. 2.—THE BROCA-CHATIN APPARATUS FOR THE PRODUCTION OF AN IRON ELECTRIC ARC.

* The Broca-Chatin electrodes are not of pure iron, but of an iron alloy.

A FEW NOTES ON THE STEAM TURBINE.*

By HON. G. L. PARSONS.

THE early turbines were governed by a lantern type of throttle valve worked by the movement of a leather diaphragm, which the suction of a fan on the shaft tended to close against a spring. The admission of air to the diaphragm was controlled by an electrical governor. On the top of the magnet yoke there was a small iron bar pivoted on a vertical spindle and carefully balanced. This was moved round by the alteration of the magnet yoke against a spiral spring. A double finger or arm was keyed on the same vertical spindle; the end of each finger was flat, and when opposite to the inlet of the air-pipe, closed it. The spiral spring was so adjusted by a movable head that the greater the voltage the more was the air inlet closed by one of the fingers. When the inlet was open the air rushed along the pipe and partially neutralized the suction of the fan, allowed the diaphragm to extend, and thus opened the throttle valve. If the dynamo was demagnetized the needle turned the other way, and the safety finger closed the air inlet and thus cut off steam. This type of governor was very sensitive, and kept the voltage steady within 1 per cent. The steam consumption of a 32-kilowatt plant of this type running non-condensing was about 48 pounds per electrical horse-power hour with a boiler pressure of 61 pounds, and about 42 pounds per electrical horse-power hour with a boiler pressure of 92 pounds.

In 1899, owing to temporary loss of patterns, the radial-flow type of turbine had to be adopted. This consisted of a series of fixed annular disks with rings of blades, between which another series of disks keyed to a shaft rotated. The guide blades were secured to the faces of the stationary disks, and nearly touched the rotating disks, while the moving blades nearly touched the fixed disks. The steam passed outward through the successive rings of blades, then inward along the back of the first moving disk, and again outward through the next ring of blades until it finally reached the exhaust. In 1892 this type of turbine was first tried condensing with a vacuum of 27 inches. With slightly superheated steam at a pressure of 100 pounds the consumption at the normal full load of 100 kilowatts, was 27 pounds per kilowatt hour.

In 1894, however, the parallel flow type was again adopted with considerable improvements. The turbine was made single-ended, with the steam passing in one direction only, the second series of rings being replaced by three rotating pistons, or dummies, by which the end pressure of the steam along the shaft was balanced. Each of the pistons corresponded in size to the part of the turbine it balanced, and to which it was connected by a pipe. Grooves were turned in these pistons, between which the corresponding fixed collars of the cylinder projected, and, being almost in contact, reduced the leakage of steam to less than 2 per cent; the amount of clearance could also be regulated by the thrust bearing at the end of the turbine shaft.

The governor can be of the mechanical type, which keeps the speed constant, or of the electrical solenoid type, which maintains a constant pressure at the terminals of the dynamo by raising the speed of the turbine to meet the fall in voltage due to the increase of the load. The electrical governor is now seldom fitted except on the smaller continuous current plants. A small pump supplies oil under pressure to all the bearings, the oil being then returned to the tank to be used over and over again, resulting in a great saving as compared with reciprocating engines. Inside the cylinder itself no lubrication is required, since no parts are touching; the two end packing glands being of similar construction to the balancing pistons, also run clear, hence no oil can possibly find its way into the exhaust. Turbines are running in breweries and chemical works, where the exhaust is led straight into the vats or liquids which require to be heated, and at Heaton part of the turbine exhaust steam is especially condensed to be used as distilled water for delicate chemical processes. The cost of oil for a large turbine works out at about 0.002d. per kilowatt hour. The single-cylinder type of turbine has again been adopted for the large as well as for the smaller sizes, being found cheaper as well as more efficient, besides requiring a shorter engine room. Plants up to 10,000 I. H. P. are now being constructed with a single cylinder. As a high vacuum is most important for obtaining the best results in steam economy, ample space is allowed at the end of the turbine for the exhaust steam, and the condenser is generally placed in a pit straight under the turbine, so that the drop in vacuum may be as small as possible between the machine and the condenser, while the length of piping required is greatly reduced. The following table shows the effect of variation of vacuum on the consumption of steam in the case of a 1,500-kilowatt set. For the smaller sizes the variation is not so marked:

Vacuum bar = 30 in. Inches.	Difference in steam consumption per 1 in. of vacuum. Per cent.
29	6
28	5
27	4
26	3½
24	3
22	2¼
16	2

As regards the cost of obtaining these high vacua, a little investigation will show that the extra power required to maintain a higher vacuum in a given condenser (and the cooling surface need not be larger than usual) is very small in comparison with the saving of steam in the main turbine with a good vacuum. Three sets of 300 kilowatts each have just been completed for the corporation of Derby. They run at 3,000 revolutions per minute, and are intended to supply current for traction and lighting. Curves were taken on a Horn tachograph showing the variation of speed when the main circuit was made and broken on a load of 350 kilowatts. The temporary variation did not exceed 4½ per cent, and the permanent 2½ per cent. The dynamo was tested by throwing 350 kilowatts off and on when running both as a shunt machine and as a compound, no movement being found necessary for the brushes, which were of brass wire. The following table shows the variation of voltage under different conditions:

	Kilowatts.	Voltage.	Speed.
Compounding in use..........	0	505	3,075
Compounding in use...........	336	565	3,000
Shunt only	300	500	3,000
	0	543	3,075
	0	520	3,000
(Constant excitation)	0	518	3,000

*Abstract of a paper read before the Newcastle (Eng.) Local Section of the Institution of Electrical Engineers, March 21, 1904.

Vochting has made certain researches into the formation of tubers, for the purpose of studying the effect of external conditions on the development of potatoes. The French variety of potato, known as "marjolin," was considered to be the most suitable. With regard to temperature it was found that an optimum temperature of 25 deg. C. caused a rapid development of roots, and later, leafy shoots from the tuber, while at a low temperature, about 6 deg. C., the roots formed were few and weak, and no leafy shoots were produced, but only secondary tubers. Similar results were obtained when the amount of water in the soil

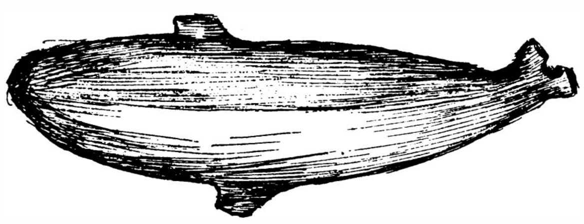
was varied. When water was plentiful roots and leafy shoots were formed, but if the quantity was so small that the plant was enabled to retain it in spite of the osmotic attraction of the sap in the root hairs, then tubers were developed. Also experiments were made with dry and moist conditions of the air while the soil was kept wet. In dry air the shoots crept along the surface of the ground, that is they were hydrotropic, and the leaves were reduced to scales. The author offers an explanation of his results based on the heat of combustion of dextrose, starch, and cellulose.

SKILL AND INVENTIVE ABILITY OF THE ABORIGINES OF SOUTHERN CALIFORNIA.*

By ELIZABETH MILLS-STETSON.

IN nearly all of the archæological excavations that have been made in California, and more especially along the coast, there have been found among the relics of the Indians many pieces that were of European manufacture. All of these pieces, metal, glass beads, and such articles, are conclusive evidence of the mingling of the two races in trade.

They show that the Indians were brought in contact with the civilized world, that they received impressions from that source, and that they were thereby affected to a large extent in mind and in morals. They determine, in addition to all of this, the date at which these people were living whose remains are now being unearthed. They show that the tribes whose graves



WHALE.

are thus filled were not a race that lived previous to the time of a civilized invasion. The date may by such means be approximately fixed, and the time of their inhabitancy determined.

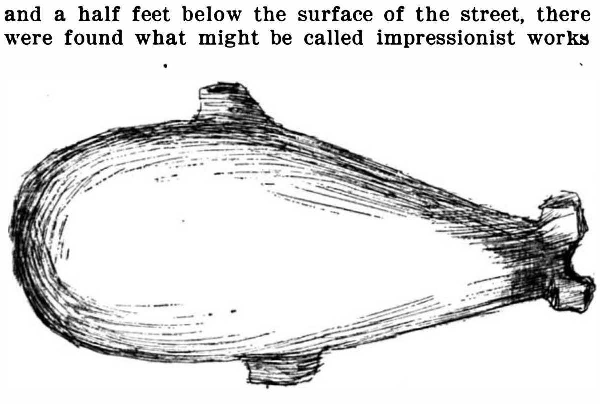
To these tribes no special merit can be ascribed, for indeed the knowledge of their native ability can hardly be ascertained. It would be a difficult matter to determine just how far that ability had been affected by the stronger foreign influence.

There were, however, some Indian graveyards unearthed recently at Redondo, a small seaside resort in Los Angeles County, California, of a very unusual character. These contained none of the distinguishing marks of invasion. There were no pieces of metal, not even a single glass bead; no trace of the slightest interference with the works of utility or art, was there shown. It was aboriginal work that was laid bare in all its unique and interesting features, a very ancient and remarkable burying ground, and a valuable archæological discovery.

It was while laying the water mains for a street in the town of Redondo that the find was made. Such occurrences are generally by chance, although many scientists have searched this territory, and, in fact, even in the outskirts of the town, for old burial places; yet the chance finding is not at all uncommon. The coast line was a prominent place for building sites and graveyards; villages sprang up here in great numbers, for reasons of trade, and for the easy means that the sea furnished of obtaining a living.

When the skeletons were taken from the Redondo burying ground, they fell to pieces almost as soon as they came in contact with the air. The smallest bones were not in existence at all. They had all gone to dust; not one of them was to be seen. There were a great many of the large bones, making in all several hundred bodies. None of these have been preserved, owing to their great age and crumbly state of decomposition.

In the tomb, which was probably not more than four and a half feet below the surface of the street, there were found what might be called impressionist works

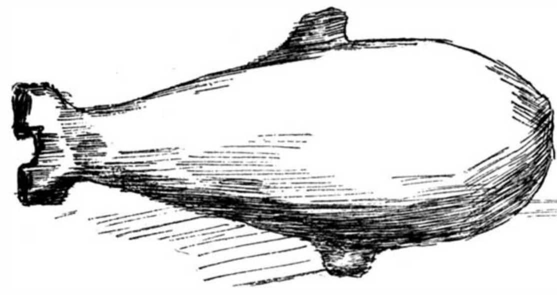


WHALE.

in stone carving. The most remarkable of these pieces were the animal figures, which were cut mostly in the round. There was an old bear with rather stiff legs, but a splendid delineation of head and face. It was as if the aborigine spoke through this image to his admiring observers in this wise:

"He is a beast with a head! His head comes first, it bites, it howls, it makes known his wants and satisfies them; likewise it makes known his presence to man. This is his most important feature, so will I make it complete, regular, symmetrical, and natural"; and so he did.

A short tail was given to the animal, which gave him his usual bunty appearance. A dear little cub image was also found in the collection, with all the cunning suggestions of his nature shown in his chubby little figure. The wildcat was perhaps as well depicted as

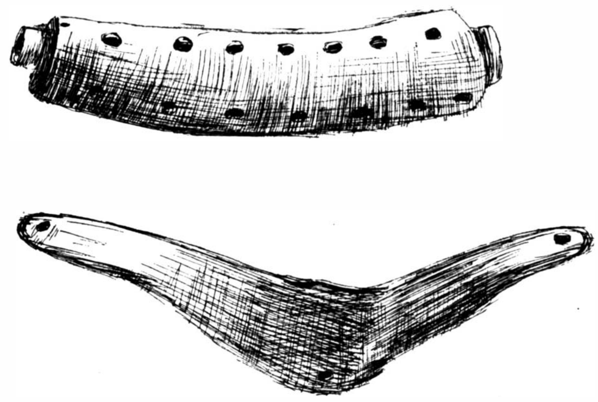


PORPOISE.

any, with its thick tail and tufted ears. In addition to these animals, there were a set of fishes, among which were two whales, a porpoise, and a dolphin. All of these were carved with sufficient and distinguishing details to make their identity perfectly well known.

Unique pipes, such as can be duplicated in no museum in the world, were found there. The bore and stem were unlike those commonly found in other places in California, but more like the work done by the Indians of the far East. There was no striation like that which is left by a stone drill; the bore was perfectly circular in section, and of uniform diameter throughout. Such skill, such patience, such mechanical ability, as were here shown by the aborigines! The marvel is how they ever did this work with so few and imperfect implements for manufacture.

With little or no inclination from the straight line of the stem, were nearly all of the other pipes of the early California Indians made. A few have been found, but they are exceedingly rare and valuable, that have a slight bend about two-thirds of the way down the stem. Among those found at Redondo there were several with the bowl and stem placed at approximately right angles. This most unusual arrangement in the manufacture of the Indian pipe is what renders it



CEREMONIAL OBJECTS.

of such a unique and valuable character. The like has never been seen in any of the very old relics, they are not found in any of the museums, and cannot be duplicated. Their value is, therefore, hardly to be reckoned in common currency.

It is not a little strange that these people, who were, so to speak, alone and unaided, should have made such a contrivance. They seem to have realized the same necessity for the angle in the stem of a pipe that the civilized man found. They were not long in settling the question of how this should be accomplished. The aboriginal mind was perfectly capable of grasping a situation, and of making all the arrangement necessary for its contiguous circumstances. They made the device to fit the requirement. Uninfluenced as they were by other and more enlightened nations, the invention does credit to their native ability and skill.

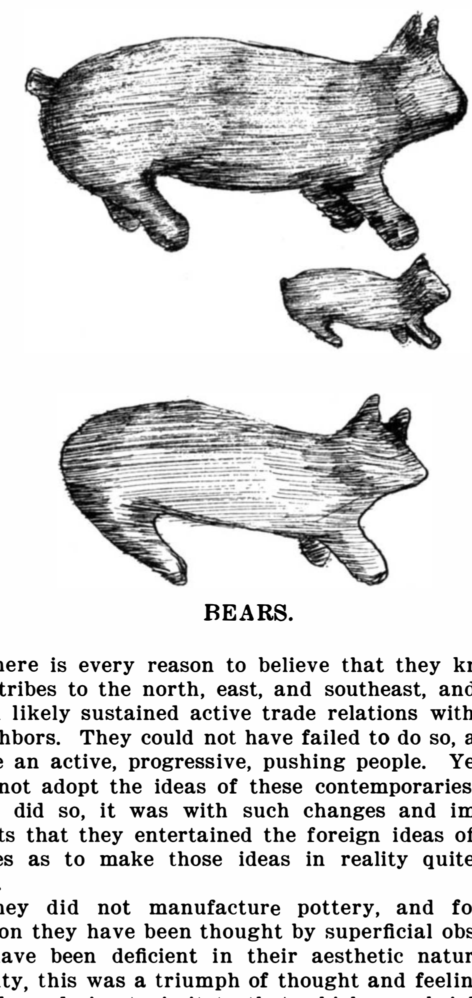
Such credit as this cannot be given to the Indians whose burial places disclose trade relations with the people of foreign nations. These people are forever tainted with the suggestion of plagiarism in art and imitation in handicraft. They can never satisfy a skeptical world that they originated even the smallest part of their belongings. Side by side with all that they possessed are the telltale remnants of the works of others; and how far their own work was changed or made better by reason of the foreign inventions, can never be entirely determined.

In this unique collection there were found no less than fifteen well-carved boats. These were not very large, but the same rigid care and excellent skill were displayed in preserving the exact proportion, such perfect proportion as is displayed in few of the larger specimens that were intended for their own actual use. The little boats were perfect in every way, and not without a considerable amount of decoration and detail. They were a most interesting part of the collection.

There were also some very curious-looking carved objects, for which no use could be determined. They were hook-shaped, spike and spoon-shaped pieces, and of rather peculiar manufacture. Their surfaces were not worn by handling, showing that they had not been exposed to a common or familiar use; evidently they were used only on ceremonious occasions. More than likely they were objects set aside for private and sacred uses only, and of a votive character.

The tools with which these wonderful pieces of invention were made were of a different character from those commonly used in this section. They were made more like those of the far North, of Oregon and Washington, and resembled the chipped stone implements. The fineness of their work was thus enhanced, and the power to make accurate estimates of figure and exact proportions of space was thus given its fullest scope. It was not necessary to remove large pieces from the stone; bit by bit it was chipped away, until at last the perfected piece was created from the rude stone.

With these crude instruments the Indians worked better than they could have done with finely polished steel tools. The crumbly stone with which they fashioned their pieces would have been crushed with the metal implements. Wood can be carved better with steel than stone, and it was probably for this reason that we find no wooden images left by the aborigines. They saw the inferiority of the work which they had tried to accomplish by working with stone upon wood, and gave up the effort as futile. They seem to have scorned any creation that was not adapted to a perfect execution. Neither were they given to imitation.

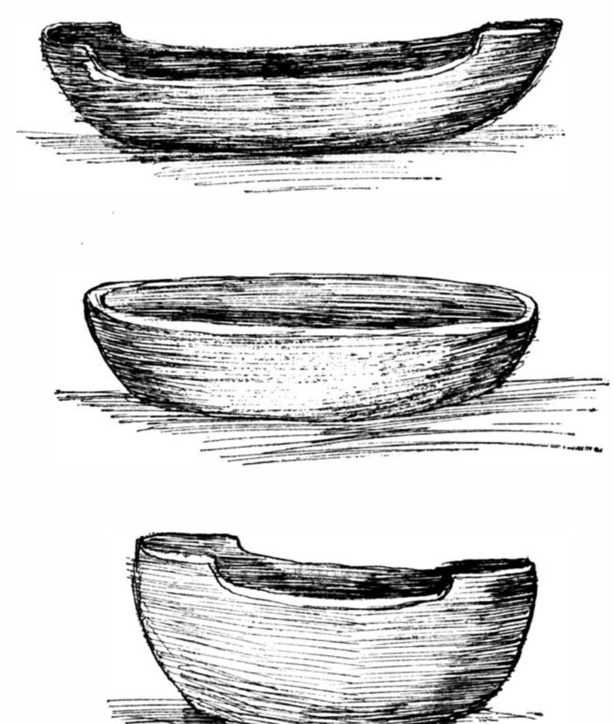


BEARS.

There is every reason to believe that they knew of the tribes to the north, east, and southeast, and more than likely sustained active trade relations with these neighbors. They could not have failed to do so, as they were an active, progressive, pushing people. Yet they did not adopt the ideas of these contemporaries, or if they did so, it was with such changes and improvements that they entertained the foreign ideas of other tribes as to make those ideas in reality quite their own.

They did not manufacture pottery, and for this reason they have been thought by superficial observers to have been deficient in their aesthetic nature. In reality, this was a triumph of thought and feeling over the base desire to imitate that which was bright and pleasing to the eye. There was clay in abundance and close at hand, which they could have worked up into pottery no doubt with superior skill and finish. They could have made pottery, doubtless, that would have far outrivaled that of their neighbors; but they did not do so because they had something that was better.

Soapstone, or steatite, was a better material than

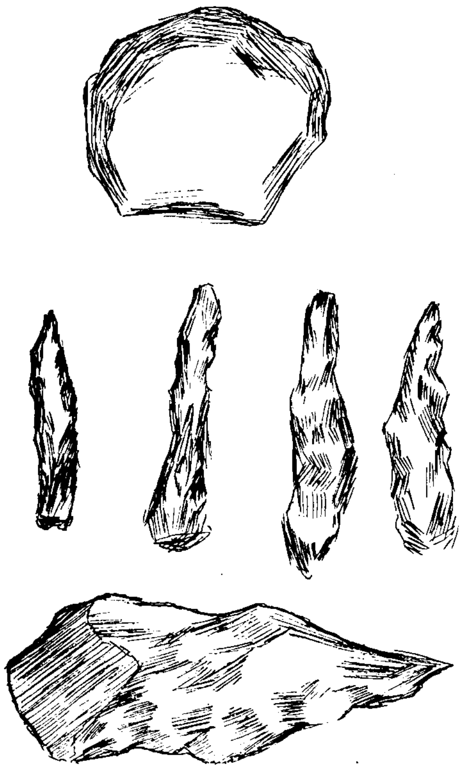


BOATS.

clay; it was less perishable, could be placed in smoke and fire without injury, was not easily cracked or marred, and was altogether better than pottery. On this they lavished their attention, putting all their skill to the task of making beautiful, different-colored,

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

and highly decorated pieces. With this material they could make not only the cooking utensils and other household and utility articles, but also the many beautiful carved images of animals, fishes, and other objects. It is this steadfastness that has rendered their relics a most valuable find to the students of ethnology. They seemed to have scorned change where unnecessary, and to have remained untainted to the last by



SAW, PICKS, AND CHISEL.

any outside influences, from whatever source and of whatever character. There was to them no call so loud as the call of their own imagination, and no faith so deep as that founded in their own powers of invention.

They used the flat "*metates*," somewhat like those used later in Mexico, except for the three legs. They used no heavy cooking pots or clumsy sandstone mortars and pestles. Instead of such ugly utensils, used by the Indians of the North and East, these people had shallow serpentine vessels, finely wrought, well polished, and light of weight. The essence of refinement is thus shown in the works that surrounded them in their daily and menial labor. It was not only in the finely-worked carvings for votive and decorative uses that these people showed their æsthetic and inventive nature; they were naturally artistic and skillful, and these tendencies found expression in everything that they did.

The most of these relics are now in the Los Angeles Chamber of Commerce, with the famous collection of Palmer antiquities. They are, indeed, a part of that collection, very properly so, and were purchased and placed there by Dr. F. M. Palmer, of Los Angeles, Cal., who spent the greater part of seventeen years in making the original collection.

Some of the things that have been said of this collection by eminent archæologists are indeed most eulogistic. Prof. Holmes, of the Smithsonian Institution, said: "No museum on earth can duplicate it, and the scientific accuracy of its classification is such, that I accept Dr. Palmer's opinions as conclusive."

Prof. Lumholtz, employed by the United States government in archæological research, said: "It is the most perfect collection of the artifects of a primitive people ever made by any collector or scientific institution in the world."

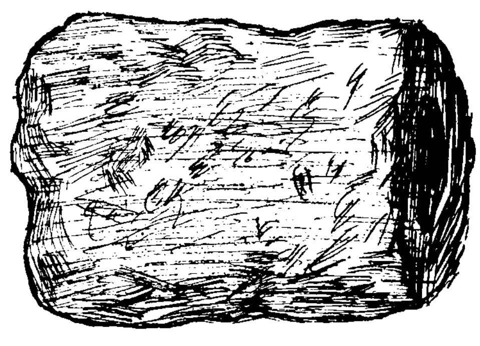
Prof. F. W. Kelsey, secretary of the American Archæological Institute, said: "There is no collection in America that equals it; no waste material, a concrete, scientific whole. In order to find any parallel for the work Dr. Palmer has done, you must go to some of the local museums of European states, where the collection and preservation of archæological objects has been carried on for generations or centuries by the government. I can only express my amazement that with a foundation so grand as this collection, there should be no museum in Los Angeles."

Prof. Wilcomb, of the Golden Gate Park Museum, San Francisco, said: "It was the greatest disappointment of my life that I failed to secure this collection for the museum in San Francisco."

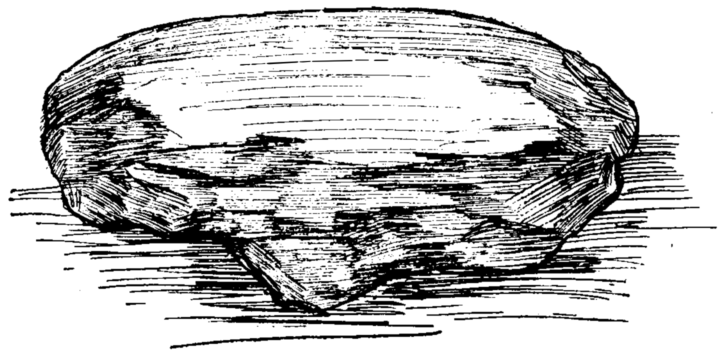
No articles with reference to the collection have ever been published in any scientific journals, though Dr. Palmer has often been importuned to prepare and have published the data in his possession. He has, however, steadfastly refused, preferring that such publication should be officially made by the museum that he has always believed would be eventually established in Los Angeles.

Dr. Palmer has spent many years in investigating the territory in and about Redondo, and has made many valuable collections from these excavations. It is a rich archæological section, and one well worth the research and investigation. He was the first archæologist to get to the spot when this latest and most valuable discovery was made.

The work of excavating lasted about ten days. The men who were engaged in digging the water mains, being the discoverers, were, of course, entitled to dispose of the relics. They realized seven or eight hundred dollars, a small sum when considering the great value that these pieces are to both ethnologists and archæologists. The most of them went to Dr. Palmer; the balance, which were duplicates and pieces less valuable from a scientific standpoint, were bought by curio dealers and private collectors. Of these there were some fifteen or twenty present.



HAMMER.



CHISEL.

It is greatly to be regretted that any of these unique and interesting pieces were ever given over to the charge of any but curators of museums. They are too valuable as historic relics to sacrifice to private uses. The public and the men of advanced learning and science should, by all means, have access to any such relics as these, that have so direct a bearing upon the history of the whole continent.

UNEXPLORED ALASKA.

THE Geological Survey has just published the story of the pioneer journey through Central Alaska between the Yukon basin and the Arctic Ocean. This journey of 535 miles was recently made by Messrs. Schrader and Peters, of the survey, with their assistants, and nearly all the way it was a revelation of the unknown.

In the extreme east and west, Alaska has been crossed from south to north, but no one knew what might be found through the north central part of the country. There remain now only two large regions in Alaska, in the northeast and northwest, that are still wholly unexplored.

The volume is beautifully illustrated with photographic reproductions showing the typical features of the region. We knew the John River where it joins the Koyukuk, but Schrader and Peters ascended it through its valley, across the Rocky Mountains; and

PIPES.

the pictures show it a broad, placid stream even among majestic mountains that rise far above it. Here we see stretches of underbrush and stunted firs along one bank, while the other is a broad beach strewn with rock *débris.*

Not a glacier appears in the fine mountain views, but we see patches of snow and long lines of it filling the narrow scars that wrinkle the steep slopes. Apparently there are no flat surfaces of sufficient extent to afford a gathering ground for the quantity of snow required to nourish important glaciers.

North of the mountains another series of river views of entirely different character were taken. They are pictures along the Anaktuvuk, tributary of the Colville, and on the Colville River; and here we see long stretches of flat-topped bluffs bordering one side of the valley, while on the other side stony river plains frequently extend far away from the river. The Colville and its tributary draining to the Arctic Ocean are not nearly so large as the John, which, in its wider reaches, is majestic in appearance.

Other views show the Indians and in the far north the Esquimaux, who hunt along these rivers. Then there are views of the flat, moss-covered tundra which borders the Arctic Ocean, and the small waves of that sea are seen breaking on the flat shore. The pictures are particularly interesting because they so graphically depict a part of our domain which no explorer has ever seen before.

The party ascended the Koyukuk River to the mouth of the John, where an abundance of supplies had been stored for them. This is on the edge of the great Koyukuk River placer mining region, where miners are now washing out over $700,000 worth of gold dust in a year.

In April, before the John River opened, Mr. Peters made a reconnoissance up the river, traveling on the ice. For several days his party followed the trail of a solitary person, four of whose camps they passed.

The person was overtaken at last and was found to be a native Indian woman who was traveling alone and subsisting on rabbits which she caught in primitive traps. Thirty natives were seen on the journey.

It is their custom to ascend the John and other tributaries of the Koyukuk in winter to hunt. They find enough caribou to supply them with food, and as they never go beyond the timber line, they are able to build fires to cook their food and warm their camps. They collect skins and furs, and when the rivers thaw they build rafts and float down to Bergman on the Koyukuk, where they trade the skins for blankets and other commodities.

It was not till June that the canoe voyage up the John River began. Briefly stated, the explorers passed through three distinct varieties of country. The most southern was the Koyukuk region, rich in gold, a rolling or hilly land, whose hills rise to elevations of from only 1,000 to 3,000 feet above the sea, while the main valley floors are approximately 600 feet above sea level.

The second region is the mountain province which is regarded as the northwestern continuation of the Rocky Mountains. Above the Arctic Circle this great mountain system turns abruptly to the west and trends nearly westward across northern Alaska.

Our explorers passed through the mountains from south to north. They form a jumble, with few well-defined ranges. The width of the mountain belt is about 100 miles and the average elevation is about 6,000 feet. Their sides are scored with the glacial marks of the ice age.

Passing out of the mountains the canoes were carried over a short portage to a lake from which flows the Anaktuvuk, tributary to the Colville. They were now in the Arctic coast province.

The two rivers took them north and they floated down stream instead of paddling against the current, as in the John River. For eighty miles north of the mountains extends a gently rolling plateau country, sloping northward, its elevation gradually lowering from 2,500 to 800 feet.

Here the plateau gives way to the nearly flat tundra country or coastal plain which extends about eighty miles northward, and descends in this distance practically to sea level, with a slope so gentle as to be inappreciable to the naked eye.

The explorers have proposed the name of Arctic

Coastal Plain for this tundra country. Its flat surface is dotted here and there with shallow ponds and lakelets which in most instances have no outlet.

Arriving at the coast they mapped the delta of the Colville River and secured passage in boats paddled by Esquimaux along the ocean edge westward to Point Barrow. Thus the entire journey was made by water; and it was not a very uncomfortable trip, excepting for the plague of mosquitoes.

Coal detritus, suggesting the probable occurrence of coal of economic value, was found in the John River gravels among the mountains. It may be called a good grade of bituminous.

Coal was also found at several points on the Arctic slope, notably on the Anaktuvuk and Colville rivers. On the Colville coal is abundant and conspicuous. It may not, however, prove suitable for export or steaming purposes. No other minerals of importance were discovered.

EXCAVATIONS IN THE ORIENT.

SINCE his visit to Palestine, some four years ago, the German Emperor has evinced a keen interest in Oriental research. The Sultan, on his side, has recognized the archæological interest of his imperial brother by concessions and gifts of a most unusual character. Of these perhaps the most noteworthy was the concession at Baalbek, where the Germans have excavated and renovated the ancient temples, the expedition at the same time conducting further studies, not only in the neighboring region, but also at Palmyra, in the Hauran, and at Gerash, Amman and Mesheytta. This last remarkable ruin, which has been visited by but few, on account of its inaccessible position in old Moab, east of the Jordan, beyond the present pilgrim route to Mecca, in the desert, was presented outright to the German Emperor. Under the direction of Dr. Schumacher the remarkable carved stone façade of the great inclosure of the khan or palace, whichever it may be, has been taken down, boxed, and sent to Berlin, where it is to form one of the adornments of the new Friedrich Museum, which will be opened this spring. The carved stones of this façade filled 462 boxes. The imperial participation has done much to stimulate German interest in Oriental research. A school has been established in Jerusalem for practical Biblical study, and the German Orient-Gesellschaft, of which the Emperor is a member, and to whose work he is one of the largest contributors, in conjunction with the German Palaestina Verein, commenced last spring excavations at Mutesellim, supposed to be the site of ancient Megiddo, on the southern edge of the plain of Esdraelon and at the neighboring Lejjun, the site of the important town Legio, of the Roman period. These excavations were resumed last autumn, after an intermission during the heat of the summer months, but up to the present time have yielded no important returns. An account of these excavations, so far as the results of the work last spring are concerned, is contained in the Mitteilungen der Deutschen Orient Gesellschaft for December, 1903 (No. 20 of the series). The Orient-Gesellschaft is to be commended for the promptness with which it publishes preliminary reports of the work done, as this naturally tends to retain and stimulate the interest of subscribers. The extent of that interest is manifest from the fact that according to the fifth annual report, just published, the income of the society for the last fiscal year was some $60,000. Besides the excavations in Palestine, successful excavations have been conducted by this society at various points in Egypt and Babylonia. It is in the latter region that the principal work of excavation has been and is being accomplished. This work consists, first of all, in a systematic excavation of the ruins of Babylon, which has now been in progress for five years, with minor excavations and explorations at other sites, Borsippa, the sister city of Babylon, Fara and Abu Hatab, two very ancient sites about three days south of Babylon, between the Tigris and Euphrates. The current number of the Mitteilungen contains an account of the commencement of excavations at Kal' at Shirgat, the ancient Ashur, the original capital of Assyria. Up to the time of the discovery of the Code of Hammurabi, by the French at Susa, in 1901-02, it was supposed that the city of Ashur, and hence the country of Assyria, was founded not earlier than about 1800 B. C.; but the mention of Ashur in that document proved that it was already a famous and important city in the twenty-third century B. C. The discoveries of the Germans up to the present time have shown that the city retained its importance also to a much later date than had been heretofore supposed. Hitherto historians have assumed that, with the construction of Calah and the removal thither of the seat of Assyrian empire, about 1300 B. C., Ashur lost its importance. A succession of palaces has now been found, showing that Ashur continued to be occupied as a residence city by the Assyrian kings into the seventh century B. C., and probably until the time of the downfall of the Assyrian empire; that, in fact, during the whole period of the existence of that empire it remained a city of great importance, at least from the official and religious standpoint. Further excavations at this point seem likely to contribute valuable material for the history of Assyria.—N. Y. Evening Post.

If it is not practicable to accomplish a result mechanically in one way it may often be done in another way equally as good and with great simplicity. The history of labor-saving appliances is full of examples. Not many machines duplicate the motions of the human hand, because it is possible to accomplish the same results in a far simpler manner. A case in point is a machine for opening letters that was recently patented by Mr. Henry C. Zenke, New York. A machine that would insert a knife under the flap of the envelope and rip it open, would be entirely too costly and complicated for ordinary use, and it is quite doubtful if it could be made operative. This machine, however, simply saws the edges off the envelopes, thereby releasing the contents. The saw is mounted on the shaft of an electric motor and is of the end-cutting type, being made in the shape of a hollow cylinder or tube with the teeth on the end. In other words, the saw is of the same type used by coopers for sawing out staves. The envelopes are gathered together in a bunch with the top edges even and in this position they are passed before the saw. The saw is protected by a shield carrying a ledge on which the envelopes are laid and above which is a narrow slot where the saw is exposed.—Machinery.

SCIENCE NOTES.

Sir Norman Lockyer and his son have communicated to the Royal Society a paper in which they show a connection between solar prominences and terrestrial magnetism. The occurrence of magnetic "storms" on the earth is proved to depend on some cause that also affects the frequency of solar prominences. Such storms are also connected with the solar spots—but may take place when no large spots are visible, being also dependent on prominences. The prominences themselves are often, but by no means always, associated with large solar spots. The magnitude of the storms appears to vary with the solar latitude of the prominences connected with it. "The nearer the poles (either north or south) the prominence occurs, the greater the magnetic storm" is Sir Norman's conclusion. On this it may be remarked that a small prominence that is seen near the sun's pole may be merely the upper part of a large prominence that has its root in a lower latitude. From the researches of Prof. Bigelow, of the United States Weather Bureau, it is certain that some kind of synchronism between prominences and variations in the horizontal component of terrestrial magnetism exists. The remote cause of all this is yet to be uncovered.

The main course of the line at which dates change in the Pacific is correctly marked on every good map. There is, however, considerable difficulty in determining whether the date at any particular one of the smaller islands is counted like the dates to the eastward or like those to the westward. The following paragraphs are an abstract of a useful semi-official note from the United States Hydrographic Office. Magellan approached the Philippines from the eastward and up to 1845 the American date prevailed there. The commerce of the islands was chiefly with Mexico. Celebes is in the same east longitude as Luzon—120 deg.—and has the Asiatic date. The Manila authorities dropped December 31, 1844, from the calendar, by order, and named the day following December 30 the first of January, 1845, thus adopting the Asiatic date, which now prevails throughout the islands. Prior to the purchase of Alaska in 1867, the Asiatic date was adopted throughout the group. At the present time the American date is employed in Alaska. St. Lawrence Island, all the Aleutian Islands, as well as in Morell Island, Phœnix Islands, and in the Samoan group. The change in Samoa was made July 4, 1892. The Asiatic date—one day earlier than the American; that is the first of our month is the second of the Asiatic month—prevails in Siberia, Kamchatka, Copper Island, Komandorski Island, Marshall, Gilbert, Ellice, and Fiji Islands, New Zealand and Chatham Island. Most vessels change their dates at 180 deg. from Greenwich, but the French make the change at 180 deg. from Paris (177 deg. 40 min. west of Greenwich), and the Spanish at 180 deg. from San Fernando (173 deg. 46 min. East).

Luppo-Cramer has confirmed Russel's result as to the action of hydro-peroxide in producing the chemical reversal of the latent photographic image. When strips cut from dry plates were partially immersed in perfect darkness in weak solutions of peroxide for two hours at 20 deg. C., the phenomena observed resembled those given by exposures increasing in length up to the solarization (reversing) point. With solutions between 0.03 and 0.1 per cent in strength, the wetted and the non-wetted parts of the films developed up to the same degree of blackness, the density increasing as the concentration of the peroxide increased; but when the bath contained 3 per cent of hydrogen peroxide, the wetted portion remained quite white, while the dry part turned black when the developer was subsequently applied. These phenomena cannot be explained by a variation in the speed of diffusion of the developer into the wetted and the non-wetted film; because during the final employment of "hypo," fixation proceeded with uniform rapidity all over the plates. More probably the peroxide acts upon the gelatin to produce a body which reduces traces of the silver bromide, but which, in presence of stronger solutions, again destroys the latent image by oxidation. In similar concentrations ammonium persulphate acts identically, but more slowly; and even sulphuric acid has an analogous action. In the last case, however, an impurity, perhaps hydrogen peroxide, may be present in the acid, which causes it to behave in this fashion. No reversal could be obtained with nitric or citric acid; for in concentrations exceeding 1 per cent, the gelatin was completely dissolved before the maximum of density was produced.

ELECTRICAL NOTES.

In erecting a large generator having a bed-plate to which the bearing pedestals were bolted, it was found that the shaft had no end play. The erecting engineer accordingly had the bearings taken out and faced off to give the shaft the proper amount of end play, and reported to the factory that the machine had been shipped defective in this respect. An investigation brought to light the fact that the middle of the bed-plate had not been properly supported by the foundations, and the bed-plate had sagged, tilting the two bearings and bringing them nearer together, so that the space originally allowed on the shaft for end play was taken up. The bearings were of the self-alining type, so that this tilting had not interfered with the alinement of the bearings.—Electric Club Journal.

The first main-line electric trains on a steam railway were put in regular service on March 29 between the Central Station and Benton, on the North-Eastern Railway, and this company has thus won in its race with the Lancashire & Yorkshire Railway for this honor. The North-Eastern Railway buys its current from the Newcastle-on-Tyne Electric Supply Company. The original voltage is 6,000 volts, which is reduced at substations to 600 volts for the third-rail conductors. The section of road to be operated electrically is 37 miles long, with double and quadruple tracks, and when everything is working smoothly it is expected that the run from Newcastle to Tynemouth will be reduced from 35 to 23 minutes for local trains, and to 15 minutes for express service. Three-car trains are now in use on the Central Station-Benton section, a distance of four miles, and the running time is eleven minutes, including several stops.

To the Physical Review Messrs. Harley R. Willard and L. Elmer Woodman contribute a lengthy article describing the results of a study of the radiations emitted by a Righi vibrator. The experiments were undertaken for the purpose of determining, first, the nature of the radiation emitted by a Righi vibrator, and, secondly, the dependence of the length of a linear receiver upon the wave-length with which it is in resonance. This problem, however, resolved itself into (1) the measurement of the energy received from the same vibrator by resonators of different lengths, and (2) the measurement of the wave-lengths obtained from different resonators. These experiments were successful in bringing out several useful points. In the first instance, the measurement of energy with a linear receiver of definite length showed the existence of a fundamental and upper partials; secondly, that the relations of the receiver lengths f-r fundamental and the successive upper partials stand in the relation 1, 2, 3; and, thirdly, that the wave-length and receiver length are connected by the relation indicated in the formula $\lambda = K (l + a)$. Again, the interference curves show that the damping in a Righi vibrator is less than the theoretical value computed by Thomson for the radiation from a single sphere. Another point brought out was that the grating space of the separating surface does not affect the wave-length measured. The character of the emission of a Righi vibrator, as shown by the experiments, may be accounted for by a modified statement of Sarasin and De la Rive's hypothesis, but is more rationally explained, in the opinion of the authors, on the basis of the hypothesis of Bjerkness and Poincaré. The results of the present experiments are, however, too limited in extent and too uncertain to give conclusive evidence in favor of either view.

Mr. J. J. Taudin Chabot (Physikal. Zeitschrift) some time ago experimented to find whether selenium in its modification as a conductor, being sensitive to light, may give rise to radio-active phenomena. To this end he used a selenium cell of the Shelford Bidwell type, the effective mass of which was uniformly distributed on the surface of a platinum wire. After having been in the dark for many weeks, the platinum-selenium surface was covered under a red light with a sheet of silver bromide jelly, to which an ingredient absorbing the yellow and green rays was added. An aluminium strip bent at right angles was interposed between the wire and sheet. After the whole system had been kept in the dark for another 48 hours the same experiment was repeated, using a fresh silver bromide film, while a current of about 110 micro-amperes traversed the selenium. Now the following results were observed on the developed films. In the first case some bright spots, corresponding apparently to the outline of the aluminium strip, were noted on a dark background; whereas, in the second case, a dark silhouette of the whole of the bent strip was reproduced on a bright background, some brighter narrow transverse lines being visible at the same time. These bands were produced more clearly in the case of repeated exposures, thus showing that they are due either to the parallel platinum wires or to the selenium interposed between each two of these, or, finally, to the points of contact between the platinum and selenium, where the Peltier effect must give rise to an evolution of heat either positive or negative on the passage of the current. On continuing these experiments, Mr. Chabot noted the fact that the back of the plate bearing the platinum-selenium wire was equally capable of affecting the silver bromide film, dark silhouettes on a bright background being then obtained. As to the question whether these results are an evidence of the existence of some novel radiation, or else an emanation from the surface of conductors, the author hopes to publish in due course some further investigations allowing of more definite conclusions being drawn.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

American Boots and Shoes in New Zealand.—I have frequently called attention to the rapid growth of our boot and shoe trade in this colony, and trust that another reference to it will not be unwelcome to those interested in the subject in the United States. An Auckland member of the lower House of Parliament, now in session at Wellington, recently asked the government whether it would ascertain if the statements in a copy of the Auckland Star were correct, which, succinctly stated, were that the boot and shoe making industry in New Zealand had been slowly declining for the last eight or ten years, and was at the present time in a very bad state, and that many of the factories were shortening the working week by three hours and naturally lowering the wages in consequence thereof; that this decline was mainly due to the quantities of prison-made work from America which were being shipped into the colonial market and capturing New Zealand's trade. The speaker said it was high time that the government took some notice of this condition of affairs and used its influence to alleviate the strain. The speaker stated that the work which was being showered on the colony was practically debarred in America in consequence of a law which forbade the sale of all prison-made work in the States; that if the government did not step in and do something in regard to the present condition of affairs, next winter would see much suffering in this particular branch of trade, and the output, which should find a good local market, would be practically killed. The Commissioner of Trade and Customs replied that upon inquiry made in Wellington no confirmation could be obtained of the alleged large importations of prison-made boots and shoes from the United States. He stated that the evidence was in fact to the contrary; that the invoices submitted throughout the colony were nearly all those of manufacturers. There were, however, one or two cases where New York agents had forwarded their own invoices to customers in the colony, and therefore it was the intention of the commissioner's department to require manufacturers' invoices to be produced in these cases, as it was only possible for prison-made goods to come through these agents.

The commissioner further stated that it would thus be seen that, considering the large importation, the proportion of prison-made goods was very small indeed, if any. Further, that the department had reliable information that only the heavier class of "nugget" boots is produced in prison, whereas it is well known that numerous factories produce daily thousands of pairs of boots at such prices as astonish all who see them. He called attention to the fact that a line of men's light boots produced in these factories is invoiced in America at 3s. 1d. (74 cents) per pair and retailed in New Zealand at 5s. 11d. ($1.44) per pair. Apart from the question of prison labor, therefore, there is a very serious competition, as the commissioner stated, for the New Zealand manufacturers to meet.—F. Dillingham, Consul-General at Auckland, New Zealand.

American Optical Goods in Germany.—In the opinion of parties interested in the manufacture and sale of optical goods there exists a good market in Germany, Austria, and other European countries for American gold-filled wire, nickel wire, and steel wire. It is claimed that the American manufactures in these lines are distinctly superior to those of Europe and are also somewhat cheaper. Americans have not attempted to compete in these lines abroad, and, as far as can be ascertained, only one agent in Berlin imports American wire for optical purposes, and that on a small scale. A good example of the superior quality of American workmanship is furnished by the fact that an advertisement for the manufacture of gold-filled wire bearing the stamp R. A. was inserted in the Optician, a technical paper of Berlin, for eight months, as the wire in question was of American make. It is estimated by a manufacturer of optical goods that $75,000 is a minimum annual valuation for the amount of gold-filled wire consumed in Germany, it being likely that the consumption is much greater. The value of nickel and steel wire used is very much greater than that of gold-filled wire, but there are no statistics on this subject and it is not possible to obtain even approximate figures. The forms desired are the same as those used in the United States—the half frame, the cornered, and the flat—so there is no necessity on the part of American manufacturers to make any change in their products to meet the requirements of the European market.

There is quite an important trade done in India rubber and celluloid plate for the manufacture of eyeglass and spectacle frames, the principal importer being the Hamburg-American Celluloid Manufacturing Company, which imports large quantities of plates from the United States for use in the manufacture of frames and for other purposes. No plates are manufactured of celluloid or India rubber for eyeglass and spectacle frames in Germany, but a French syndicate carries on an active competition in them. It is believed that the American exports to Germany in these lines can be increased by pushing the sale of the goods. The thicknesses of the plates are, as a rule, 4 millimeters (0.157 inch), but plates of 5 and 6 millimeters (0.197 and 0.236 inch) are used, and for certain manufactures plates of 10 millimeters (0.394 inch) are required.

A large amount of gold-filled chains for optical and other purposes are exported from the United States to Germany, and this line of goods is deservedly popular in this country.

Parties are known at this consulate who are ready to exploit or introduce these articles among German manufacturers, and it would appear that in the sale of wire for optical purposes there exists a new and heretofore undeveloped field for American enterprise that certainly deserves investigation.—Dean B. Mason, Vice and Deputy Consul-General at Berlin, Germany.

Russian and American Petroleum in Germany.—Export, a German trade paper, in its issue of September 24, 1903, says:

"The taxation of Russian petroleum according to measure instead of weight and the general increase of the test point have been advocated. The fact that Russian oil is heavier than American oil causes the former to pay a higher duty per gallon than the latter under a weight tariff. The duty on raw and refined petroleum in Germany is $1.43 per 220 pounds; while on lubricating oil it is $2.38 per 220 pounds, including the weight of the wrapper. In the former commercial treaty with Russia the duty on refined petroleum has been levied according to both measure and weight. It is stipulated in the protocol to this treaty that petroleum for lighting purposes shall be taxed, not according to weight, but according to volume, and that 125 liters (33 gallons) at 15 deg. Cel. shall equal 100 kilogrammes (220 pounds). This decision has found favor in the new tariff, so that it will not come under the influence of the commercial treaty, but will be employed independently. The specific gravity of oil on which there is a duty of $2.38 according to weight must be 0.8. American petroleum meets this requirement, while the specific gravity of Russian petroleum is 0.82. Two hundred and twenty pounds of American oil amount to 33 gallons, while the same amount of Russian oil will measure 32.25 gallons. The duty on three gallons is about 4½ cents. The taxation according to volume is very important as far as Russia is concerned. During the period 1897-1902, the amount of petroleum imported (into Germany) from Russia rose from 9,037,482 gallons, valued at $357,000, to 41,763,565 gallons, valued at $1,886,400; while imports of American oil fell from 255,161,072 gallons to 229,825,125 gallons. In the last year imports of Russian petroleum reached the value of $4,545,800, of which sum $2,558,500 was for lubricating oil; American petroleum was imported to the value of $15,898,400, of which amount $5,367,800 was for lubricating oil. A reduction of the tariff on Russian petroleum was opposed in 1893 by the German government on financial grounds. We do not know whether they take the same view now or not. The figures given above show that the import of Russian petroleum can be assisted by other means than by a reduction of the tariff. At any rate the decreased tariff would only aid the imports of petroleum for lighting purposes, but lubricating oil and crude petroleum, which is imported in considerable amounts for purposes of refining, would not be affected thereby. When the new tariff is discussed in the Reichstag, the question will be considered as to what the effect will be of different duties for raw and refined oil on the creation of a great German refining industry. The beginnings of such an industry are already at hand, as the comparatively successful development of a few refineries in the last few years has shown. Their further extension is hindered by the fact that raw petroleum pays the same duty as the refined product."

American Boots and Shoes in Great Britain.—Nearly all the boot shops handle American boots and shoes to a greater or less extent, and other articles of American import carried by dealers generally throughout Scotland are usually to be had in the shops here.

While American boots and shoes are as popular as ever, and continue to hold the prominent place gained in the British market, it is likely to be but a question of time when the imports of boots and shoes from the United States must necessarily fall off, as British manufacturers are now turning out a class of boots and shoes in style, finish, and quality like American-made boots and shoes. Retail boot shops, even in the smaller towns, are advertising boots made to order on American lasts. The new machinery and American lasts, which the British manufacturers were once so slow to adopt, are now enabling them to turn out an easy-fitting ready-made boot, in a variety of sizes, that in every way satisfies the wants of the trade.

A well-known extensive boot and shoe dealer in Scotland is credited with saying that out of $6,000,000* worth of footwear exported from the United States in 1902, $2,000,000 worth came to the United Kingdom, $1,000,000 worth went to Australasia, and $500,000 worth to Canada.

Ten years ago Great Britain took only $2,169 worth of boots and shoes from the United States; last year she took $2,013,890 worth.—J. N. McCunn, Consul at Dunfermline, Scotland.

Agricultural Implements and Condensed Eggs in South Africa.—The Welthandel (World's Commerce) states that Mr. Henry Birchenough, who was sent to South Africa as commissioner by the British Board of Trade, calls attention to the favorable opportunity in the Orange and Transvaal colonies for the sale of agricultural implements and cheap farm utensils.

The agricultural development of these colonies will be tremendous as soon as the projected railroads are completed, and, as the colonies have to start over again, there is now and will be a great demand for light plows, harrows, creamery utensils, etc.

The Americans and Canadians, says Mr. Birchenough, have recognized this already and are trying hard to secure as large a share as possible of this commerce.

The commercial agent for Canada in Johannesburg, Mr. James G. Jardine, has already sent a report to his superiors and refers to the report of Mr. Birchenough. He also states that South Africa is a good market for condensed eggs, as fresh eggs are from 3s. 6d. to 7s. 6d. (85 cents to $1.82) per dozen. Condensed eggs are prepared from ordinary eggs by depriving them of their superfluous water and adding sugar. When being prepared for use, some water is added and the mixture quickly beaten; it can then hardly be distinguished from fresh eggs.

These condensed eggs are put up for the South African market in hermetically closed boxes, each containing from 1 pound to several pounds. A 1-pound box contains about 15 eggs.—Richard Guenther, Consul-General at Frankfort, Germany.

Transportation as a Factor in Foreign Trade.—As an illustration of the important rôle which the item of transportation plays in foreign trade, it may be stated that a few days ago there came to Germany a merchant from one of the northwestern Pacific States who has acted as purchasing agent of rails and general iron and steel supplies for the western section of one of the Pacific railway systems. He stated that he had bought during the past year, through an English broker, several million dollars' worth of rails, etc., that had come from Antwerp and Rotterdam in grain ships returning to the Pacific coast, and which were glad to take rails and heavy machinery at nominal freight rates as ballast. This they did on such favorable terms that railroad supplies made in Westphalia or the Saarbruck district and floated down to tide water on Rhine barges could be delivered at Puget Sound at a cost for transportation with which Pittsburg, Cleveland, and Chicago, with a transcontinental railroad haul, were wholly unable to compete. He had noticed that the rails, bars, and machinery imported last year bore the marks of German makers, and he had therefore come to obtain further supplies from the ultimate source of production.—Frank H. Mason, Consul-General at Berlin, Germany.

American Trade Opportunities in Spain.—In his annual report, which will be printed in Commercial Relations for 1903, United States Consular Agent Faustino Odriozola, of Santander, Spain, October 16, 1903, says:

Most of the Spanish railways need the immediate renewal of their rolling stock—locomotives, passenger and freight cars, etc. Some of them—the Santander-Bilboa Railway, for instance—have made satisfactory arrangements for such renewal with American manufacturers, but the most of them draw their supplies from the north of Europe. The establishment in Spain, especially in the north of Spain, of agencies of American manufacturers, which would not only profit by opportunities constantly offering for trade, but which would make those opportunities, is the one thing needed to enable us to win our full share of Spanish trade now held by European manufacturers simply because they are on the ground ready to meet all the wants of the consumers.

American Sulphate of Copper in Austria.—The demand for sulphate of copper is decreasing and the receipts fell from about 36 metric tons in 1901 to 22.4 tons in 1902. The imports from the United States constitute about 70 per cent of the whole, viz., 15.4 tons. American packing of sulphate of copper has improved, but is still far from being as satisfactory as the British. I believe it would pay our exporters to adopt for foreign shipments the hard-wood barrel. Such barrels would not only be much less likely to burst open during the voyage, but would sell in Austria, when emptied, for more than their cost, while soft-wood barrels can be used only for kindling. It might, at the same time, be advisable to reduce the size of the barrel. For shipments to the interior Trieste importers are compelled to repack the American article, using for this purpose a barrel containing only 550 pounds, on account of the greater convenience in loading and unloading.—Fredk. W. Hossfeld, Consul, Trieste, Austria.

American Car Couplers in Bavaria.—The Bavarian railways have been for some time making experiments with American couplers. In the summer of 1903 trials were given in Nuremberg, and experiments were made anew on special trains on Wednesday, January 27. The report is most favorable. The main point was what change could be made from the present screw coupling to the self-acting coupler.—James H. Worman, Consul-General, Munich, Germany.

* The exact figures for 1902 were, as per the official publication of the Bureau of Statistics: Total exports, $6,182,088; to the United Kingdom, $2,013,890; Australasia, $955,230; Canada, $523.624. The exports of boots and shoes to the United Kingdom during the past six years were: In 1897, $300,978; 1898, $352,755; 1899, $525,242; 1900, $950,267; 1901, $1,552,628; and 1902, $2,013,890.

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ENGINEERING NOTES.

The United States Consul at Birmingham, England, says in Consular Report No. 1899 that an English firm is introducing a light and handy explosion motor for boats that is known as the "universal transferable steering propulsor," the invention of a French firm. The great advantage of this steering propulsor is that it can be readily applied to any existing boat, converting the same into a petrol (gasoline) launch, without the necessity of boring a hole through the stern post and supplying a permanent propeller shaft and stuffing box. It can be attached to a boat and removed from same without any modification of the boat itself. Any one taking this "steering propulsor" to a lake, river, or the seaside may attach it to any boat he finds there that is within its range of power. A rudder is unnecessary, the boat being steered by varying the angle the axis of the propeller makes with the keel. As the propeller can be completely turned around, a reverse action is given. It is authoritatively stated that a number of these transferable propulsors have been adopted by the navies of France, Russia, and Japan, and that a 12-horse-power propulsor has been successfully applied to a launch, which towed a 300-ton canal barge with a load of 150 tons of sand.

Mr. Gehricke, a German railroad official, has patented a preventive appliance against the derailment of railroad trains. It is claimed that this invention will considerably decrease the dangers and damages in all cases of derailments, also those resulting from broken axles or tires. A rail is adjusted to the truck of the car parallel with the axle, so that it is in a position across, and about an inch above, the rails. Should a derailment of the wheels take place these cross rails will lie upon the rails of the track without letting the wheels touch the ground. The car will then drag along upon the cross rails and slowly stop the whole train. In order to break the force of the settling of the car as much as possible, the cross rails are so adjusted that they are as near as possible to the rails of the track and are, in addition, supplied with springs. The cross rails are also supplied with projections underneath for the purpose of preventing the car from leaving the track. The advantages expected are that a derailed car will not be suddenly stopped, will not fall with undiminished force upon the rails of the track or upon the ties, and will not be dragged with the wheels upon the latter, but will be stopped slowly, the cross rails acting as brakes.

The combustion of one pound of coal in a well-designed boiler furnace will evaporate from 8 to 10 pounds of water, which is considered a fair commercial rating. But in the purification of bad water or sea water by distillation the fuel cost of the direct process is practically prohibitive. By using distillers built on the so-called Yaryan multiple-effect system it is possible and practicable, however, to more than quadruple the evaporative power of a pound of coal, or rather to more than quadruple the product of distilled water. The steam from the main boiler is led into what to all purposes is another boiler, and by its condensation it evaporates the water containing impurities, the steam from which passes into another so-called boiler and repeats the operation. The result is that each drum acts both as an evaporator and as a condenser. The successive evaporations are made possible by maintaining a successively decreased pressure in each boiler. A Scottish firm, Mirrlees, Watson & Co., Glasgow, recently built two sextuple-effect distillers for the Egyptian government which yield about 45 pounds of distilled water for each pound of coal. Each plant consists of six horizontal cylinders arranged vertically, one over the other, the total height being something like 39 feet. The pressure in each shell is graduated, being less in each successive effect than in the preceding one, which makes it possible to boil the water in one by absorbing the heat of the steam in the preceding effect. The apparatus, of course, includes steam pumps for maintaining the circulation.—Machinery.

"Professions are not mines of wealth; those who have embraced them are not paid in proportion to their merits, anomalous as it may seem. Men have grown gray in the services of colleges without receiving more than a very small salary. Be this as it may, the shopman has by no means a poor outlook in comparison with many of the so-called learned professions—lawyers, physicians, and even clergymen. He can command now $3 per day, and much more if he is a skilled man; on piece and contract work he can make 'good money,' as the saying is. Few professional men make $3 per day in the early years of their careers, and there is nothing in the calling of any workman to debar him from civic or national honors if he seeks them. The only thing which prevents more young American men from taking up trades is the fancied stigma which attaches to a mechanic, so called, among a certain class—one, by the way, whose verdict is of no importance from any aspect. If I had a life to live over I should devote five years to learning a trade first. I would go into a shop without giving any one a hint as to my intentions later, and would take what came, keeping an open eye and receptive mind for all within my field of vision. After such an experience I would go to a scientific school (if not outlawed by an age limit) and absorb knowledge as a sponge does water. As one benefit from this course, I would have a sound mind in a sound body, enabling me to study hard and to appreciate more readily the teachings of science. I could see exactly where it agreed or conflicted with practice."—Egbert P. Watson in Engineering Magazine.

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