SCIENTIFIC AMERICAN SUPPLEMENT No 605

Scientific American Supplement, Vol. XXIV., No. 605.
Scientific American, established 1845.

NEW YORK, AUGUST 6, 1887.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

EXPERIMENTS ON AERIAL VORTICES AND REVOLVING SPHERES.

THE reason that marine waterspouts and aerial vortices have not hitherto been clearly and accurately explained is that these are phenomena which we do

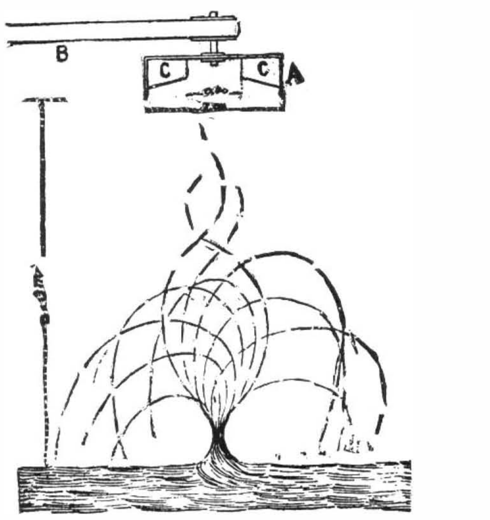


FIG. 1.—WATERSPOUT IN OPEN AIR.

not often have a chance to see, or, to be more accurate, it is because the observation of them has not been made in such a way as to derive advantage from all the details of the phenomenon in order to develop a theory from them. The most extravagant stories have often been told about these matters by sailors or explorers; and by how many fabulous points are they not surrounded? It will be seen, then, that it is not with such data that our scientists have been enabled to solve these complex problems.

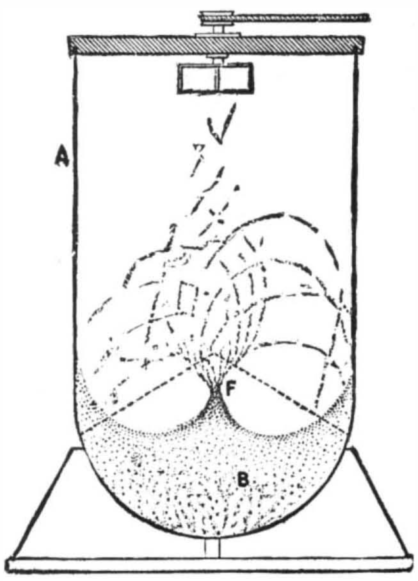


FIG. 2.—EXPERIMENT WITH OATMEAL.

The reproduction of waterspouts and vortices on a small scale was the only thing capable of introducing a genuine progress into so arduous a research. This was understood by Mr. Chas. Weyher, who, aided by a profound knowledge of mechanics, has taken up the problem synthetically, and succeeded in reproducing on a small scale all the principal varieties of waterspouts and vortices. Hereafter, it will be easy to study all the features that accompany them, and, although the opinion of scientists is still divided upon some points, repeated observation will soon furnish an exact theory on the subject.

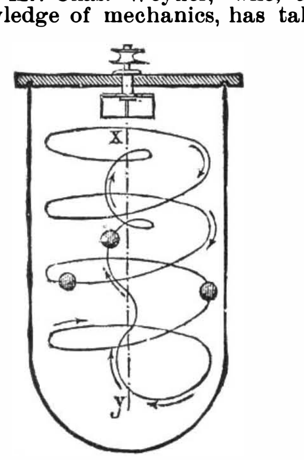


FIG. 3.—EXPERIMENT WITH BALLOONS.

We shall now describe the experiments which we witnessed in the shop of Messrs. Weyher & Richemond, at Pantin.

Waterspout in the Open Air.—This phenomenon is reproduced by means of the apparatus shown in Fig. 1. A drum, A, 3 feet in diameter, is mounted upon a vertical shaft, actuated by a belt, B. This drum is provided with a dozen radiating vanes, C, and is open beneath. The number of revolutions is regulated in such a way that the velocity at the circumference shall be from 100 to 130 feet per second. The apparatus is placed about 10 feet above the surface of the water contained in a large reservoir. When the drum is revolved, spirals are seen to form upon the surface of the water, and all of them to converge toward the same center, at which point the water rises in a large cone, about 8 inches in diameter at the base and from 3½ to 4 inches in height. This first cone becomes surmounted by a second and inverted one, formed of numerous drops that rise to a height of from 3 to 5 feet, and fall all around at distances varying from 3 to 10 feet. The finest drops ascend as far as to the drum.

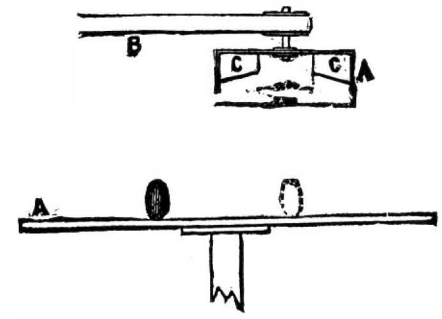


FIG. 4.—EXPERIMENT WITH A COIN.

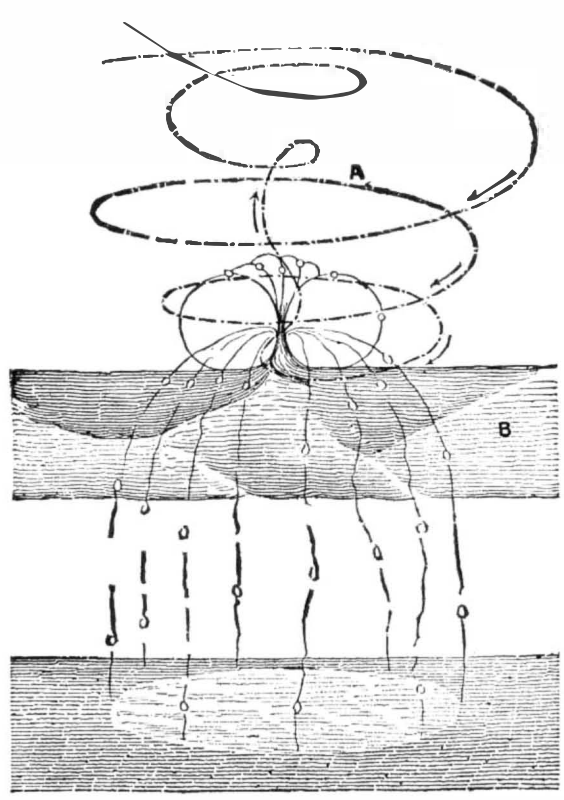


FIG. 5.—FORMATION OF HAIL.

If straw be placed upon the water, it will be brought together and form a genuine cord, which will rise like a corkscrew in the axis of the vortex.

If the water in the reservoir be heated until it gives off a little steam, we shall have the marine waterspout complete, with its clearly defined tube attached to the water below and to the center of the drum above.

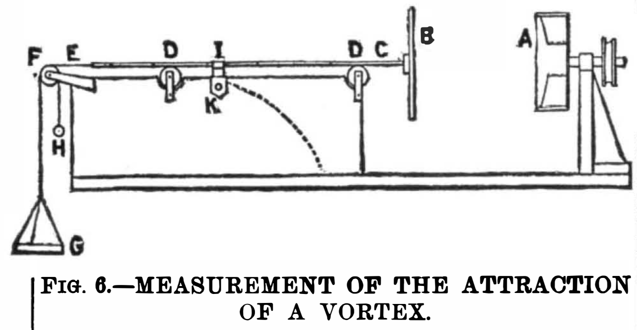


FIG. 6.—MEASUREMENT OF THE ATTRACTION OF A VORTEX.

In the interior of the tube, and on the very axis, we perceive a more rarefied nucleus of an absolutely geometrical form. It is a very elongated cone, whose point is below in the center of the base.

If a wet board be placed upon the water, the vortex will form a focus thereon of a diameter of ¾ inch and of a whitish appearance, and will make a peculiar whistling noise, as if the board contained an aperture through which a mixture of air and water was rushing from beneath. It is remarkable that the vortex contracts thus to a diameter of but ¾ of an inch, considering that the free space in the center of the drum is 15¾ inches. The air descends in external spirals and rises in internal ones. A depression forms in the axis, as necessarily happens when any fluid is rotated. By reason of centrifugal force, the molecules tend to get away from the axis of revolution.

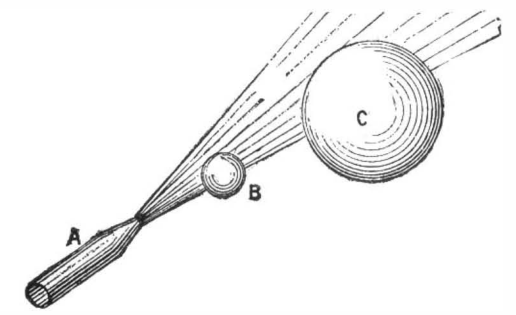


FIG. 7.—ATTRACTION OF A JET OF STEAM.

It is easy to demonstrate that the artificial vortex created by the drum exhibits exactly the same characters as the stem or base of an atmospheric vortex descending from the heights above to the surface of the water.

As this experiment is performed in the open air, the focus shifts under the action of the least wind or eddy due to walls or neighboring obstacles, and it is quite difficult to study it well. The experiment is therefore performed on a smaller scale and in a closed vessel; but the open air experiment shows that the closed vessel is not the cause of the formation of the focus. It has no other effect than that of permitting of fixing the axis of the vortex at about the same point.

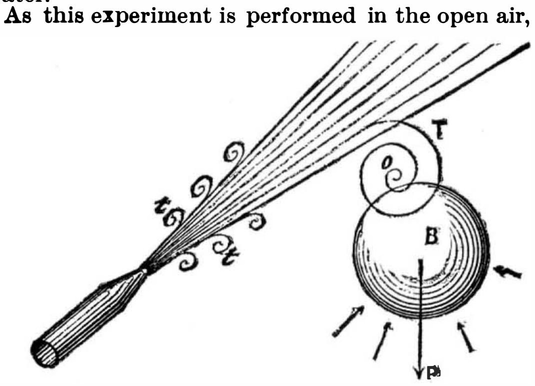


FIG. 8.—STEAM VORTICES.

The apparatus (Fig. 2) consists of a glass cylinder, about 15 inches in diameter and 28 inches in length. The cover contains an aperture through which passes an axle provided at the extremity with one or two cardboard vanes. The cylinder, A, contains sawdust, or, what is better, oatmeal, B. If the latter be first arranged in the form of a cone, and the axle be revolved, we shall see a little tromp form at the apex of the cone at *f*. The mass of oatmeal will gradually hollow out into a hemisphere in the direction shown by the shading. The material will run continuously in spirals from the circumference to the center, where it will first form a cone, and then another and inverted one, whose particles of oatmeal will describe spirals running from the center to the circumference. The system, as a

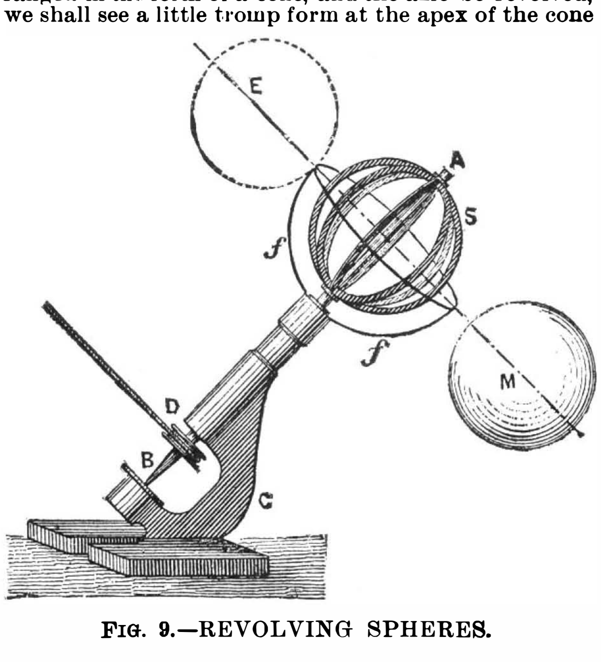


FIG. 9.—REVOLVING SPHERES.

whole, will take the form of a general sphere whose focus, F (where the two cones meet), will be put more or less out of center by terrestrial gravity.

If we make an observation from above, we shall remark a hollow funnel on the axis. It is here that the air is most rarefied by rotation, and it is hither, too, that come the finest particles.

Let us substitute some small, light, air-inflated balloons for the oatmeal, and follow the general motion (Fig. 3). When the balloons are in the external circumferences, they descend in slow spirals; and when they reach the circumferences nearest the axis of rotation, X*y*, they quickly rise on a helix of very elongated pitch.

Upon the whole, the experiment shows that a mass of air being given, if we give it a rotary motion around an axis, it will constantly descend through the external circumferences in order to rise through the inner ones, and the entire volume will continuously pass through the focus of the vortex, carrying along in its motion such particles as may be immersed in it. By the way, in order to show the analogy that exists between this experiment and the natural phenomenon, we shall mention an observation made by Mr. Colladon, and narrated in his work, "Contributions to the Study of Hail and Waterspouts."

"One fine day in July, and in very calm weather," says he, "I was passing along the Coulouvreniere Boulevard, in Geneva, near a gravelly place upon which a number of pieces of linen, of various sizes, were lying exposed to the sun. All at once a whirlwind with vertical axis two or three yards in diameter, and made very visible by the rotation of a cloud of dust, passed over the surface covered with linen, set a portion of the latter in revolution, and carried it up with terrific speed to a great height above the roofs of the city, and caused the pieces to describe continuous spirals that became more and more divergent. Finally, at an elevation of at least 2,000 or 2,200 feet, the objects separated and dispersed in various directions."

In Mr. Weyher's experiment, the balloons rise through the interior spirals, but in keeping at a certain distance from the axis of rotation, for upon the latter is formed the funnel mentioned above; and the finest materials descend through this central funnel, just as in a whirlpool the air descends into the gaping aperture.

So, too, in a marine waterspout, when the aerial vortex has reached the surface of the sea, the water rises through the center and falls back all around, while the minute particles rise through the central funnel to meet the aqueous vapor of the upper cloud, which latter descends through this same central tube; and we are in the presence of what at first sight seems a paradox, but what experiment sheds a clear light upon, to wit, that there is a simultaneous ascending and descending motion. Of course, these two motions occur in different spirals, but spirals that may be very approximate if the waterspout is very contracted.

Fig. 4 shows the apparatus for another experiment in this line. A glass plate, A, or a well planed board, is placed under an arm, B, provided with vanes. When this device is set in motion, a coin, C, is set spinning upon the plate. The aerial vortex will continue to make the coin revolve like a top, and will hold it absolutely captive in its radius of action. The coin in its revolution engenders a sphere, and the following experiment will show that, under these circumstances, such sphere constitutes a center of attraction. A sphere rapidly revolving upon a spindle is covered with a slightly sticky varnish. Then some dust is sprinkled through the surrounding air. This dust will be observed to adhere chiefly to the poles or to the surface in the vicinity thereof. The experiment is still more striking when performed with a sphere formed of a few circular pieces of cardboard.

Formation of Hail.—The above experiments allow us to understand how hail is formed.

If an aerial vortex descends from the heights above (Fig. 5), it is necessarily formed of air at a temperature of less than 0° Its base enters a cloud, B, formed of relatively warm vapor. As soon as the molecules of vapor are congealed and brought to the center of the vortex, and that, too, over the entire active circle of the base of the vortex, the particles of snow thus formed come into contact in the focus of the vortex, and, as the phenomenon occurs principally in summer, the snow becomes agglomerated, and the first nuclei form then in the passage to the focus. Moreover, the reciprocal shock may lead to heat enough to effect a union.

Each little nucleus can remain but an instant in the narrow neck of the funnel, and continues its movement in the upper cone to reach the external circumferences. On descending, it is taken up by the vortex, which makes it pass to the focus again. But it has already, on its first passage, been set in revolution (like the coin in a preceding experiment). If the wind of the vortex has a velocity of say 200 feet per second, and if the nucleus of a hailstone in the course of formation is $\frac{1}{6}$ inch in diameter, it will make about 2,000 revolutions per second It then becomes a center of attraction, and in its progress attracts to its poles all the particles of snow that chance to be in the immediate vicinity of it. The poles therefore elongate, the axis of revolution shifts direction, the particles adhere to the new poles, and the resulting sphere continues to grow.

This sphere, then, when it again enters the focus of the vortex, comes into contact with other similar ones coming from all directions. These hailstones clash against each other, and roll over and over, and the snow of which they are composed passes to the state of ice. The phenomenon continuing, there comes a moment at which the vortex is no longer powerful enough to keep them captive around its focus, and they then escape and fall to the earth over a diameter varying with the intensity of the vortex. The prevailing wind carries the entire system in a horizontal direction.

Measurement of the Attraction produced by a Vortex.—A (Fig. 6) is a revolving device analogous to those that precede; B is a cardboard disk affixed to the end of a rod, C, that revolves upon two pulleys, DD. A thread, E, runs over a pulley, F, and carries a scale pan, G, which is balanced by a weight, H; I is a stop fixed upon the rod, C; K is a traveler provided with a fork that allows I to have a slight longitudinal play.

The drum, A, is revolved with a uniform motion. By means of weights put into the scale pan, G, and by finding the corresponding positions of equilibrium with the traveler, it is ascertained that the attractions on the disk, B, are in inverse ratio of the square of the distances. The same apparatus permits also of ascertaining the lateral attraction of the vortex.

Attraction produced by a Jet of Air, etc.—(Fig. 7). A is the nozzle of a blowpipe from which is escaping a jet of air or steam. This jet holds captive the globes, B and C, and may be inclined 45° with respect to the horizon without the balls falling.

The balls are held in equilibrium whether they are revolving or whether they are not. On putting the hand into the jet, in front of C, the spheres will approach each other and the nozzle. The densest spheres are the ones that are in equilibrium nearest the nozzle. In the experiment, B is a cork ball and C is a rubber balloon inflated with air.

Every one has noticed that on the sides of a jet of steam there form small vortices due to the friction of the steam against the sides of the pipe or against the stationary air. If, in imagination, we increase one of these vortices, T, it will be observed under the form of steam revolving around an axis, O. As, in all vortices, the pressure near and around this axis is weaker than in the regions situated farther off, it follows that if we put a balloon, B, in connection, the pressure will be diminished for it on all the parts licked by the fluid, so that the constant external atmospheric pressure balances the weight, P, of the balloon.

A Free Sphere held in Equilibrium in the Air.—(Fig. 9). A spindle, AB, revolves in a support, C, and motion is communicated to it by means of a pulley, D. Upon the spindle there is mounted a sphere, S, composed of eight or ten rings or disks. The spindle may occupy any position whatever with respect to the horizon. In the experiment it is inclined 45°, but it may be horizontal or vertical. The 45° position is selected as appearing to offer the greatest difficulty in the way of the success of the experiment, and in order that the latter shall be more conclusive.

When the sphere is rapidly revolved, and the hand is placed near it, a strong breeze is felt escaping from it all around the equator, and fragments of paper put into this breeze are blown to a distance. Nevertheless, if a balloon, M, be placed in the vicinity it will be strongly attracted toward the sphere and will describe orbits around it in the plane, EE, of the equator. As this experiment is performed in a room where there are obstacles that produce eddies, and as, too, force of gravity has a great influence owing to the proximity of the earth, it is very difficult to have things operate regularly. The balloon easily comes into contact with the revolving sphere, and is then sent by the shock to too great a distance to be caught again by the sphere's attraction. For this reason recourse is had to a wire guard, which is made to encircle the sphere, and which is fixed to the support by three wires, *f*.

The balloon will now revolve indefinitely around the sphere, and even leave the guard in the lower part under the action of gravity.—*Le Genie Civil.*

APROPOS OF HYGROMETERS.

A Torsion Hygrometer.—A writer in *La Nature* gives the following directions for making a hygrometer which, while being simple and very easily constructed, is very sensitive, and gives as accurate indications as does the instrument of Saussure. It is based upon the principle that the strands of hemp, flax, and cotton cord undergo a variable torsion, according to the dryness or humidity of the atmosphere.

Into any support, say the crosspiece connecting two wooden uprights, insert a screw provided with a ring, and through the latter pass a hemp cord so that it shall be suspended by the center. Then attach a round copper bar weighing a pound and a half to the extremities of the cord, so that the ends shall be eight inches apart, and the center of the bar be three feet distant from the suspension ring. Lastly, one of the extremities of the bar should be provided with a copper needle for indicating the variations in the torsion of the cord. The amplitude of the oscillations may be modified by varying the weight of the bar.

The apparatus may be simplified by substituting a thin piece of wood for the copper bar, and loading it at the center with a one and a half pound weight.

A Sponge Hygrometer.—Take a small and very sensitive scale beam, and from one end suspend a small sponge prepared as directed further along, and to the other affix a weight to keep the beam horizontal in an atmosphere that is neither very dry nor very moist.

When the air becomes moist, the sponge will absorb water, and, increasing in weight, will depress the beam, the central needle of which passes over the degrees of a graduated circle. If, on the contrary, the air becomes dry, the sponge will lose weight, and the opposite will happen.

In order to prepare the sponge, it is to be thoroughly washed in water, and, when dry, to be washed anew in a solution of sal ammoniac or salt of tartar in vinegar, and again dried.—*La Science en Famille.*

The Locomotive as a Hygrometer.—An English observer, after numerous observations, thus establishes the relations that exist between the behavior of steam escaping from a locomotive and the hygrometric state of the atmosphere: "If the steam remains suspended in the air, as if it hesitated in or to know whether it ought to disappear or not, it is because the point of saturation is approaching. If, on the contrary, it quickly disappears, as if it were swallowed up, so to speak, the weather is dry, and there is little prospect of rain. These rules are the result of long observations. On a warm summer day, I have seen a passenger train ascending a gradient under full pressure without giving the least sign of its motion, and without allowing the least trace of steam to escape. At other times the cloud of steam was ten or twelve feet in length; in certain cases it was as long as the train itself; and in very damp weather it extended way beyond the rear of the train." The author of these observations recommends this cheap hygrometer to farmers who live in the vicinity of railroads.

FROM LA NATURE.

WE give this week from *La Nature* the following illustrations and descriptions:

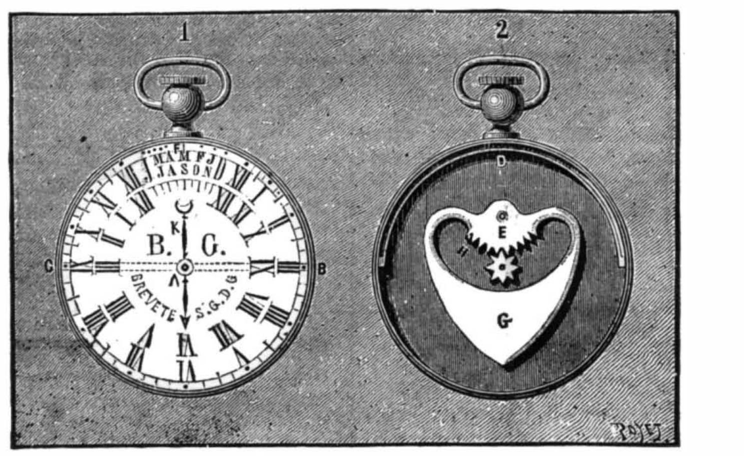
The Bijou Panorama; Solar Watch; Curiosities of Aerostation; Electric Vender; Dog Racing at Brussels.

A SOLAR WATCH.

THE small watch represented herewith was invented by Mr. Bralet. It gives the time by the height of the sun, and it seems to us to be a simple and ingenious little apparatus that cannot fail to interest our readers as much as it has interested us.

In order to use this watch, it is held vertically between the fingers, and, the eye being placed at B, the apparatus is so inclined that that organ may receive a solar ray passing through the aperture, C, diametrically opposite B. These two apertures are formed in a rim projecting from the watch. It is evident that the inclination of the latter must be so much the greater in proportion as the sun is higher. When the observer's eye, the line, C D, and the sun are situated in the same straight line, the hand will indicate the hour. There are two rows of hours for reading. The inner of these, having the figures colored blue, gives the morning hours, and the outer, with red figures, the evening ones.

Before the observation is made, the dial must be regulated according to the season. To this effect the



BRALET'S SOLAR WATCH.

dial plate is actuated by the crown, and moves with slight friction in the rim that contains the apertures, B and C, and that carries the needle, F. The letters figured under this latter, at the top of the dial, indicate, in the first row, the initial letters of the months from January to June, and, in the second, those of the months from July to December. The needle is brought over the proper month, and the observation is then made as just stated. If it is the 15th of the month, the needle should be midway between the two corresponding months.

Fig. 2 gives a view of the internal mechanism, which is extremely simple. The motion of the hand, as may be seen from the engraving, is brought about through a metallic piece, G, which revolves around an axis when the watch is inclined. This piece carries along the hand through the intermedium of a rack, E. When the watch has the proper inclination, as the luminous ray has to pass through the apertures, B C, to reach the observer's eye, it is necessary to make the reading with great precaution in order that the weight, G, may not be moved. The reading may be done by a second observer standing alongside of the first. If the observer is alone, it will suffice to turn the watch slightly in order to get a glimpse of the dial without disturbing the weight.

This little watch is made of thin copper, its mechanism is made of an alloy of lead and tin, and the dial is of paper. Its net cost is, therefore, very small, and this will permit of its coming into common use. But in order to use it, it is necessary that the sun shall be shining, and as the orb of day is not always visible in the dark days of December, the watch is a fine-weather one.

THE ECCENTRICITIES AND INCLINATIONS OF THE ASTEROIDAL ORBITS.*

By DANIEL KIRKWOOD.

THE average eccentricity of the 265 asteroids whose orbits have been calculated is 0·1574. This is about equal to the mean eccentricity of Mercury, and exceeds the maximum of any other major planet. An inspection of the table of elements shows that while but one orbit is less eccentric than the earth's, sixty-nine depart more from the circular form than the orbit of Mercury. These large eccentricities seem to indicate that the forms of the asteroidal orbits were influenced by special causes. It may be worthy of remark that the eccentricity does not appear to vary with the distance

* Extracted from an unpublished work on the minor planets.

from the sun; being nearly the same for the interior members of the zone as for the exterior.

The inclinations of the orbits are thus distributed:

From 0° to 4°	69
4° to 8°	82
8° to 12°	59
12° to 16°	31
16° to 20°	8
20° to 24°	8
24° to 28°	7
28° to 32°	0
Above 32°	1

One hundred and fifty-two—considerably more than half—have inclinations between 3° and 11°, and the mean of the whole number is about 8°—slightly greater than the inclination of Mercury, or that of the sun's equator. The smallest inclination, that of Massalia, is 41', and the largest, that of Pallas, is about 35°. Sixteen minor planets, or six per cent. of the whole number, have inclinations exceeding 20°. Does any relation obtain between high inclinations and great eccentricities? These elements in the cases named above are as follows:

Asteroid.	Inclination.	Eccentricity.
Pallas	34° 42'	0·238
Istria	26° 30'	0·353
Euphrosyne	26° 29'	0·228
Anna	25° 24'	0·263
Gallia	25° 21'	0·185
Æthra	25° 0'	0·380
Eukrate	24° 57'	0·236
Eva	24° 25'	0·347
Niobe	23° 19'	0·173
Eunice	23° 17'	0·129
Electra	22° 57'	0·208
Idunna	22° 31'	0·164
Phocea	21° 35'	0·255
Artemis	21° 31'	0·175
Bertha	20° 59'	0·085
Henrietta	20° 47'	0·260

This comparison shows the most inclined orbits to be also very eccentric; Bertha and Eunice being the only exceptions in the foregoing list. On the other hand, however, we find over fifty asteroids with eccentricities exceeding 0·20 whose inclinations are not extraordinary. The dependence of the phenomena on a common cause can therefore hardly be admitted. At least the forces which produced the great eccentricity failed in a majority of cases to cause high inclinations. —*Sidereal Messenger.*

HENRY'S MACRO-MICROMETER.

THE apparatus represented herewith is designed for the measurement of photographic pictures of the stars, and is called a macro-micrometer. It was constructed by Mr. Gautier, according to directions furnished by Messrs. Paul and Prosper Henry, of the Paris Observatory.

It consists of a carriage that slides upon two horizontal rails, one of which is of triangular section, while the other is flat. This carriage is moved by a screw 10 inches in length, with a pitch of 0·4 inch. As the focus of the photographic telescope is 11¼ feet, it follows that one revolution of the screw is very nearly equivalent to an interval of 1'. The head of the screw is divided into 600 parts, thus giving 0·1" as the value of each division, and, as it is easy to estimate $\frac{1}{10}$ of a division, the readings can be made to about 0·01". In addition, the carriage is provided with a scale divided into millimeters, that serves for counting the revolutions of the screw.

The movable part is provided with a revolving disk, upon which may be fixed the photographs that are to

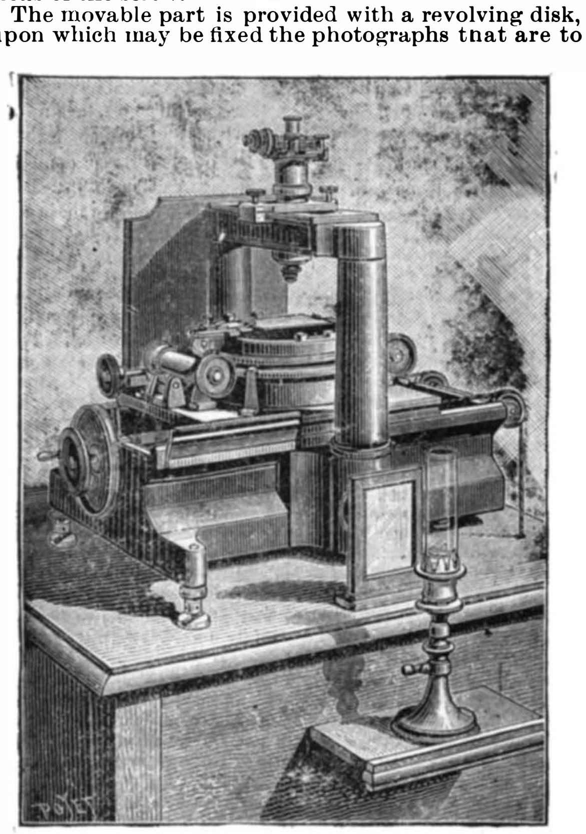


FIG. 1.—HENRY'S MACRO-MICROMETER.

be measured. In the center of this disk there is an aperture 7 inches in diameter, which, through the intermedium of a small mirror placed beneath, permits of illuminating the plate throughout its entire extent. This disk is designed for the measurement of the angle of position of the stars photographed.

As sufficient accuracy could not have been obtained by means of a divided circle and of verniers, and as the use of microscopes designed to divide the divisions of the circles into fractions would have been hardly practical, the following arrangement was adopted: The circumference of the disk is provided with 720 teeth, with which engage the threads of two tangent screws, placed perpendicularly to the two extremities of the same diameter. These two screws are actuated simul-

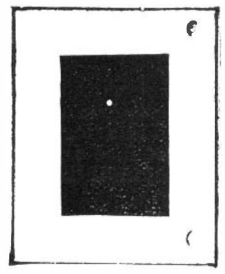


FIG. 2.

taneously through gear wheels by means of a single rod provided with a milled head, which is turned by hand. They are both provided with a head divided into 180 parts, each equal to 10", and, as $\frac{1}{10}$ can be easily estimated, the reading of the angle of position can be done directly to within 1".

The microscope that serves for measuring is 8 inches in length. It is provided with a micrometer and a position circle. The micrometer screw has a pitch of 0·02 of an inch, and is provided with a head divided into 100 parts. Each division of the head corresponds upon the photograph to $\frac{1}{500}$ of a millimeter, or $\frac{1}{10}$ of a second of an arc. The circle of position is graduated in degrees; the tenths are given by a vernier. The microscope objective consists of an achromatic lens of 20 inch focal distance, and produces upon the plane of the micrometer reticule an image of the photograph magnified three diameters. The eye-piece magnifies ten times.

The microscope may be placed horizontally in a direction at right angles with the motion of the carriage. During an observation, it is fixed by means of two clamps.

The precision of the measurements of double stars made by means of this apparatus is truly remarkable. Thus, with ζ of Ursa Major, for example, the mean error in the measurement of a simple pair of images is equal to 0·077" for the distance, and the mean error of the angle of position is 0·55°.

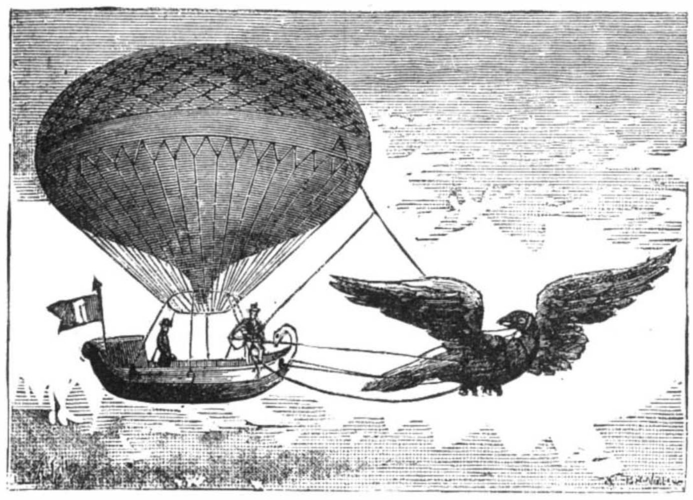
The Messrs. Henry have pursued their splendid labors in celestial photography with great perseverance and rare success. They have obtained remarkable results with the satellites of Jupiter, Saturn's ring, and photographs of the moon. Their processes of investigation occasionally permit them to discover nebulæ on the photographs that they obtain, and we shall ere long return to the subject of the discoveries that they have recently made in this line.

We would just now make especial mention of the photographs of stars with which they have enriched astronomy. In their photograph of the constellation of Cassiope more than 4,800 stars have been counted, and some idea of the importance of such work may be had by a glance at Fig. 2, where is given the same region of the heavens as seen by the naked eye. Finally, we may obtain an idea of how infinite the worlds are, when we learn that, in order to represent the entire sky visible from the surface of our globe, it would take no less than ten thousand photographs similar to the one just alluded to, and that the entire heavens visible from the earth are but a point in immensity.—*La Nature.*

CURIOSITIES OF AEROSTATION.

WE could not believe what innumerable whims the problem of aerial navigation has given rise to since the discovery of balloons up to our day had we no knowledge of the books, pamphlets, memoirs, articles in journals, engravings, etc., that have been published upon this subject for a century past. In the very year (1783) of the memorable experiment of the Montgolfier Brothers at Annonay, the Academy of Sciences received no less than 140 different projects for steering balloons. Among these there were some very remarkable ones—that of Bisson, a member of the Academy, and that of General Meusnier, who magisterially studied the construction of an elongated balloon with an air pocket and revolving oars or helices. But the majority of the other projects are absolutely laughable, and some of them most whimsical. A few months after the discovery, one inventor conceived the idea of directing balloons by harnessing trained birds to them. He wrote a letter on this subject, which was printed in the *Journal de Paris.*

Among the projects that have been addressed to us for several years past, we may cite those of some inventors who have submitted analogous systems to us, thinking that they had at least the merit of priority.

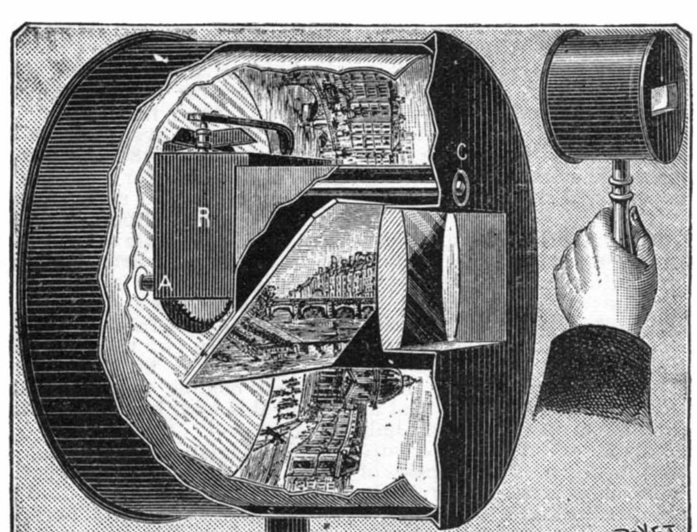


MADAME TESSIORE'S PROJECT FOR DIRECTING BALLOONS.

Not only does the idea date back to more than a century, but it was seriously studied in 1845 by a female aeronaut, Madame Tessiore, *nee* Vitalis. This lady published a pamphlet on this subject, which is now very rare, and in which she developed her project of directing a balloon by means of a griffin harnessed thereto. In addition to this, she exhibited at the printsellers' shops a large lithographed poster, which we herewith reproduce on a very small scale. Is it necessary to make objections to so puerile a system? They offer themselves of their own accord. It will suffice to bring the picture back to its exact proportions. A balloon capable of raising two men must be at least nine yards in diameter. A griffin with outspread wings would necessarily be about five times smaller than the diameter of the balloon, and it is unnecessary to say that, under such circumstances, its muscular efforts would be entirely inadequate to haul this wide surfaced mass. Madame Tessiore has figured a gigantic bird such as exists only in the Arabian Nights, and it has appeared to us of interest to reproduce a specimen by way of curiosity.

THE BIJOU PANORAMA.

MR. P. BENOIT, an artist, has recently presented to the *Societe d'Encouragement* a novel little panorama, which we represent in the accompanying figure. Upon putting the eye to the aperture shown at the extremity of the box, the observer beholds a little moving pano-



THE BIJOU PANORAMA.

rama. The latter is revolved through the action of a clockwork movement. The internal mechanism is shown in the larger of the two figures.

The apparatus consists of a panoramic image supported by a glass cylinder, which, while it allows the light to pass, communicates to it a rotary motion which it receives from clockwork, R, to which it is fixed, and which is wound up through the aperture, C. The glass

is supported by partitions that are attached to that part of the device that faces the observer.

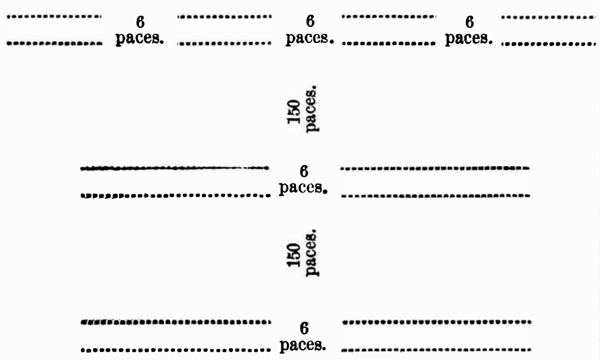
This same face carries a lens, which is placed in the axis of the apparatus and permits one to see in the prolongation thereof a false image (resulting from the real image) in a mirror inclined at an angle of 45°.

It is unnecessary to say that, as this image is seen by reflection, the original should be reversed.

The whole is inclosed in a cylindrical box, closed at the back with a glass of such a nature as to admit diffused light only. The panoramic image revolves around the central axis figured at A.

ATTACK FORMATIONS.

WE have expressed an opinion that the officers of our army in general do not place much faith in any of the numerous "attack formations" which have been presented for their consideration—that is, in any form of attack which necessitates the loosening of the ranks and inevitably introduces confusion. Still there are a good many officers in the army whose minds are busy on the preplexing problem how, in days of shelter trenches and repeating rifles, infantry is to be brought up to the attack of a determined enemy with any prospect of success. It is, of course, very easy to say that frontal attacks are impossible, and that turning movements will have to be adopted. But if an enemy is occupying a chosen position, he will have made the same preparation for flank attacks that he has made for direct ones, and the attacking force will be presented with the same perplexing problem that we have indicated above. It has been shown, moreover, that under the conditions of the great range of modern artillery, and even of small arms fire, turning attacks will have to be made on so great an orbit as to quite destroy their efficacy. The defending force moving on interior lines will be able at any point to present an overwhelming fire. And even supposing turning attacks presented less difficulty than they are likely to do, unless the enemy is held in firm grip by a determined frontal attack, the mass of the defending force will simply change position to meet the turning attack. Therefore we think that determined frontal attacks will *still have to be made and pressed to the utmost.* We have presented to our readers at various times a great many propositions coming from officers of the regular army and auxiliary forces for carrying out the modern attack, and the last that we have received is from Lieutenant S. M. Schneider, of the Prince of Wales' Own Grenadiers, Bombay Infantry. The writer says in his preface that his proposed formation has been prepared after careful study of the criticisms by the representatives of the German army at the Delhi maneuvers on our present system. Lieutenant Schneider would have our infantry battalion consist of six companies, and advance to the attack in three lines 150 paces apart, each line consisting of two extended companies. The lines would be in double rank, with four paces intervals between the files. There would be six paces interval between each half company in the first line and six paces interval between the complete companies in the rear lines. The general appearance would be as follows:



Lieutenant Schneider does not give the strength of the companies, but we may assume them to consist of 160 men each for a battalion on war strength. This would give eighty files, and, when extended, the firing line would occupy a front of 770 paces. The captain of each company would have a front of 385 paces to look after. Now it is a question whether a captain *could* efficiently command this front when in action. Lieutenant Schneider does not inform us how the reenforcement is to take place—whether, as losses occur in the firing line, the remainder are to close in to the center, and the re-enforcements are to come up on the outer flank, or whether they are to insert themselves in the gaps caused by the losses. We may mention here that such a battalion in line would only occupy 390 paces; whereas it seems to us that the firing line should only occupy the ground which is required for the force of which it is the unit, so that at the final moment every yard of ground should be occupied by as many rifles as can fire effectively.

The formation that Lieutenant Schneider proposes would take place from quarter column, the leading company advancing and extending from its left, No. 2 doing ditto from its right. The remainder would lie down until the firing line had got 150 paces to the front, when three and four would advance and extend in the same way as Nos. 1 and 2. Nos. 5 and 6 would do the same when 3 and 4 had got its proper interval. Lieutenant Schneider's instructions proceed to say that as soon as the fighting line is able to open fire it will halt and lie down and fire section volleys. The lines of supports and reserves would also lie down. For purposes of drill it is necessary of course to show how a line is checked in its advance by the enemy's fire and what measures it should take to overcome it, but it should be clearly taught that it is the duty of the firing line to advance *as far and as long* as possible without firing, and it is only when it is unable to advance without overwhelming loss that it should take up the fire. It seems to us that no amount of firing will gain the victory, that it is the "shock," and the shock only, that settles the business, and the firing is only the means on the one side of keeping the shock off, and on the other of getting at the enemy to deliver it.

Lieutenant Schneider goes on to say that, firing having commenced, the entire firing line will advance by rushes at the double, the rushes at the earlier stages being about 100 yards each, but becoming shorter as the position is approached. From another part of his instructions we find that a major is to be in command of the firing line, and we presume the rush would have to be made under his orders. But, as we have pointed out in our calculation, the firing line would have a front of 770 paces, and a single company a front of 385. How, therefore, could a major, who would probably have to be on foot, give an impetus to such a long line, or how could a captain even get his company to make a simultaneous rush of 100 yards? Again, supposing a company spread over a front of 385 paces making a rush of 100 yards, would not there be a very strong tendency to converge and huddle together? Lieutenant Schneider claims for his plan simplicity, which we admit. But the fact is, there is no mystery about any attack formation if it is only thoroughly taken up.

He claims also that the supports and reserves in rear, being extended, are less vulnerable. Now we think the extension of the supports and reserves in rear, or, as some call it, the "wave system," has the advantage that, if the front line is checked, the next line comes up to it and impels it forward. But it should always be understood that for the final rush there must be a strong and compact body to deliver the shock, with a strong reserve behind to secure the victory or cover defeat. But as regards the comparative vulnerability of supports and reserves in extended order or closed in the ordinary two deep formation, we think it would be difficult to decide.

If it depends on unaimed fire, people will tell you that fifty people will get just as wet in a storm of rain when scattered about as they would if they stood close together. And if the supports and reserves were exposed to aimed fire, a wide extended line would be more easily hit than a close one. We are glad, however, to see these things discussed and to aid in their discussion. What we fear is the danger that we may be involved in a European war, or in a war with a European power, and our soldiers have to evolve on the battle field a system of attack, because they have never been thoroughly taught one during peace.—*Broad Arrow.*

DOG RACING AT BRUSSELS.

THE dog, as well known, is the only domestic animal of the Esquimaux, who use it for drawing their sleds, often to the number of thirty per team.

In this way they are enabled to traverse immense frozen, snow covered areas, and that too with very great rapidity.

Among civilized nations, the dog was long used by nail makers for turning the wheel that actuated the bellows of their little forge; but since the works of Charleville, and even those of Sweden, have killed this humble industry, the dog has been almost exclusively used in hunting, for guarding houses and cattle, or as a pet animal, and is no longer of any industrial use.

Among our neighbors, the Belgians, we find the dog used on a large scale as a draught animal by peasants of the environs of Brussels or by the smaller tradesmen of the city, and it is a very curious spectacle for a stranger who has arrived in the evening to see in the morning innumerable little carts loaded with vegetables and fruit on their way to the market, and drawn by dogs. It is not only the kitchen gardeners and peasants coming to the market that make use of the dog in this way, but also the milkmen, the bakers, and the butchers.

The Belgian draught dog has been rendered celebrated by Stevens' picture entitled the Sand Merchant.

The dog which is thus used at Brussels and in its environs for drawing small carts is a strong, broad backed mastiff, of smaller stature than the large Danish or German dogs, of varying shades of dull fawn color, or black, and having a short, coarse haired coat. The Brabant peasants do not seem to stick to any very uniform type as regards conformation and color; provided that their fanged and clawed steed is strong, and energetic, that is all they ask. These dogs display great zeal in the service demanded of them, and perform their duty with as much pleasure as hunting dogs do in following the track of game.

One of the exercises that brings their qualities into prominence and shows the spirit of emulation with which they are endowed is that of racing, which frequently takes place as the result of challenges offered by their owners. We represent one of these races in the accompanying cut, which is from an engraving that is old, but is still of great interest.

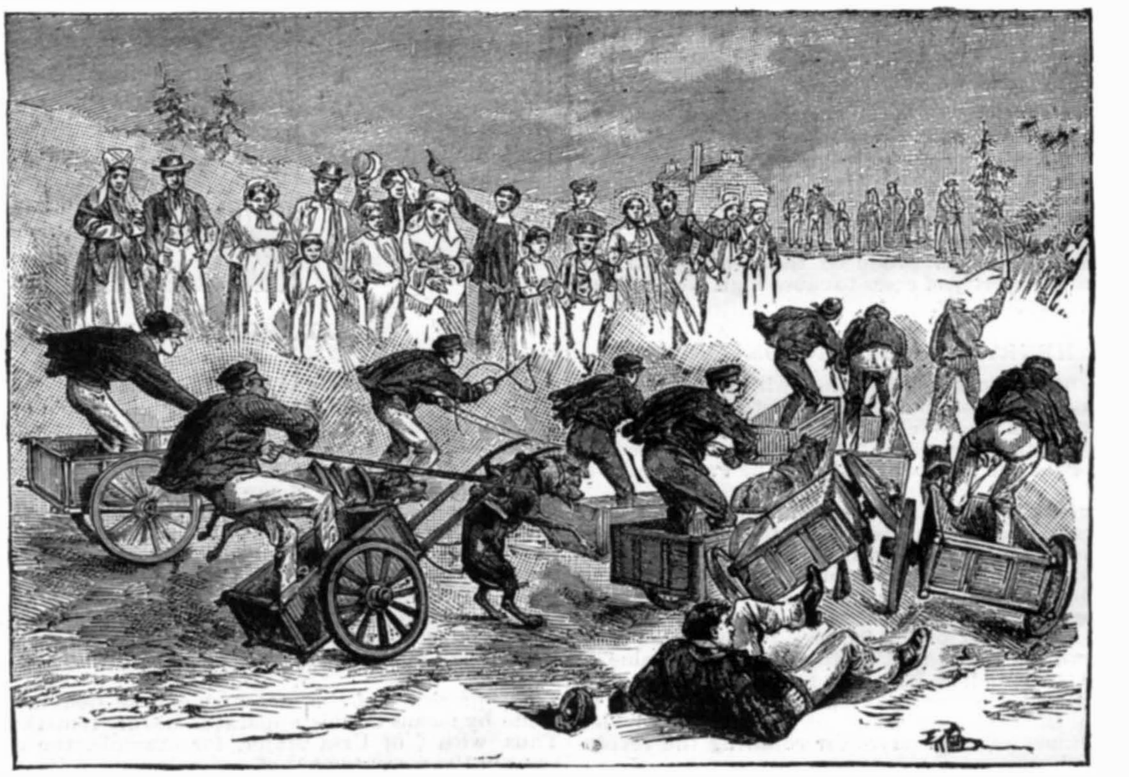
The race course is the public highway, and the distance is one and a half or two miles. All passers-by and dwellers at the roadside can enjoy the spectacle.

The contestants put themselves in a line, and the impatience of the steeds, which is shown by voice and gesture, can be kept within bounds only by an application of the whip.

Finally, the signal is given and they start off with great speed and loud barkings.

Falls are frequent, and the racers often literally bite the dust; but the coachmen in short blouse quickly pick themselves up and jump into their carts, and again excite their vigorous steeds. The latter, which have in most cases fallen, do not on that account always reach the goal last.

The speed of these dogs is often such that bets offered on a race between a good horse harnessed to a cabriolet and a dog harnessed to a cart have been won by the dog. It costs less to keep a good draught dog, say the Belgians, and the animal sells for a higher price than a common ass, although the latter may often do as much work.



A DOG RACE AT BRUSSELS.

[SWISS CROSS.]

ASPHALTUM AND THE PITCH LAKE OF TRINIDAD.

ALTHOUGH asphaltum, or mineral pitch, is not, like the closely related mineral coal, one of the great agents of modern civilization, its uses in the arts are varied and important. The popular knowledge of its nature and origin, however, is limited and imperfect. Asphaltum is one of many native bitumens; and among these bodies we observe a gradation from the solid asphaltum, through intermediate forms known as mineral tar, to liquid petroleum and limpid naphtha. It has been definitely settled that, in their origins, the bitumens are organic, being transformed tissues of plants and animals.

Chemically considered, the bitumens, like the coals, are hydrocarbons, but differ in containing little or no oxygen and a much larger proportion of hydrogen. The influence of this extremely fluid element is very evident; for, while the coals agree in being infusible and insoluble, the bitumens are either naturally liquid, or become liquid when heated, and are soluble in benzole, ether, etc.

Modern investigations, however, have made it certain that, in their origins, the bitumens are more varied than the coals. Coal is due to the accumulation of half-decayed land plants in the waters of swamps and marshes; but geologists are now well agreed that the lighter and more fluid bitumens, like petroleum, are mainly marine, being derived partly from sea-weeds, but chiefly from marine animals, such as corals and mollusks. It is well known that petroleum gives off gas freely, especially when heated; and this is the source of the natural gas now being obtained from the oil fields of Pennsylvania and Ohio. When the conditions are favorable for the escape of this gas, its evolution continues, and the petroleum becomes less and less liquid, and finally changes to asphaltum. Where this drying up of the petroleum has taken place in fissures or cavities in the earth's crust, asphaltic deposits of great purity and value have been formed. The brilliant and almost jet-like albertite in Hillsboro, New Brunswick, which was mined for many years and used for the manufacture of gas, is a variety of asphaltum having this origin. The grahamite of West Virginia is a substance closely resembling albertite, and occurs in a similar fissure or crevice. It is quite certain, however, that the typical asphaltum, which is used so extensively for paving, roofing, and like purposes, has not been formed chiefly in this way. It is not of marine or animal origin, for the evidence is very conclusive that, like the coals, it is the product of land vegetation. Indeed, under the proper conditions, it would have become coal itself. The most important of these conditions is, perhaps, temperature; for it is a curious fact that asphaltum is found chiefly in warm countries, while coal occurs in colder latitudes.

Asphaltum, usually accompanied by mineral tar and petroleum, occurs at many points on Trinidad and also on the adjacent main. The largest and most interest-

ing deposit, not only of this region, but of the world, is that known as the Pitch Lake. This is on Point La Brea (Spanish for "the pitch"), in the southwestern part of the island, and one mile from the Gulf of Paria.

The topography of the country about the lake is extremely simple. From three sides—north, west, and south—the land slopes gradually upward from the sea to the surface of the lake, which lies one hundred and forty feet above the gulf; while on the east the land is slightly higher than the lake, which therefore differs from ordinary lakes in resting, not in a valley, but on a hill top. In fact, its appearance is as if the broad-mouthed crater of a low-lying volcano were overflowing with sluggish streams of black lava, slowly creeping down toward the sea. These slowly moving masses present curved lines and convex surfaces; and Canon Kingsley has very aptly likened them to glaciers, the lake representing a *mer de glace*. The asphalt becomes harder the longer it is exposed to the air and sun, and consequently the downward progress of the "black glaciers" must constantly be checked, if not at last entirely stopped. It seems impossible to determine the extent of the overflow; for although the entire slope from the lake to the sea appears as a continuous sheet of pitch, yet it is probable that most of this has exuded from the asphaltic sandstone beneath it. The area covered or underlaid by this mantle of pitch is estimated at three thousand acres.

The bitumen is not injurious to plant life; for the scanty soil covering the pitch, and consisting largely of that material in a pulverulent state, supports a luxuriant vegetation. The village of La Brea, on the shore, rests on the pitch; and the inhabitants complain that their houses are thrown out of level by the rising and sinking of their tarry foundations. It seems as if everything here—vegetation, houses, roads, etc.—were slowly drifting toward the sea.

upon with impunity. The temperature is uniform throughout. Its surface, soft enough in a few spots to receive the impression of a man's boot, is for the most part quite hard and firm, and everywhere of a dull earthy-brown or brownish-black color. The fracture of the pitch is eminently conchoidal, but the luster is always dull, the result of an admixture of twenty to thirty per cent. of earthy matter, sand, and clay. These impurities are removed by boiling, and the pitch then becomes shining black and still more brittle.

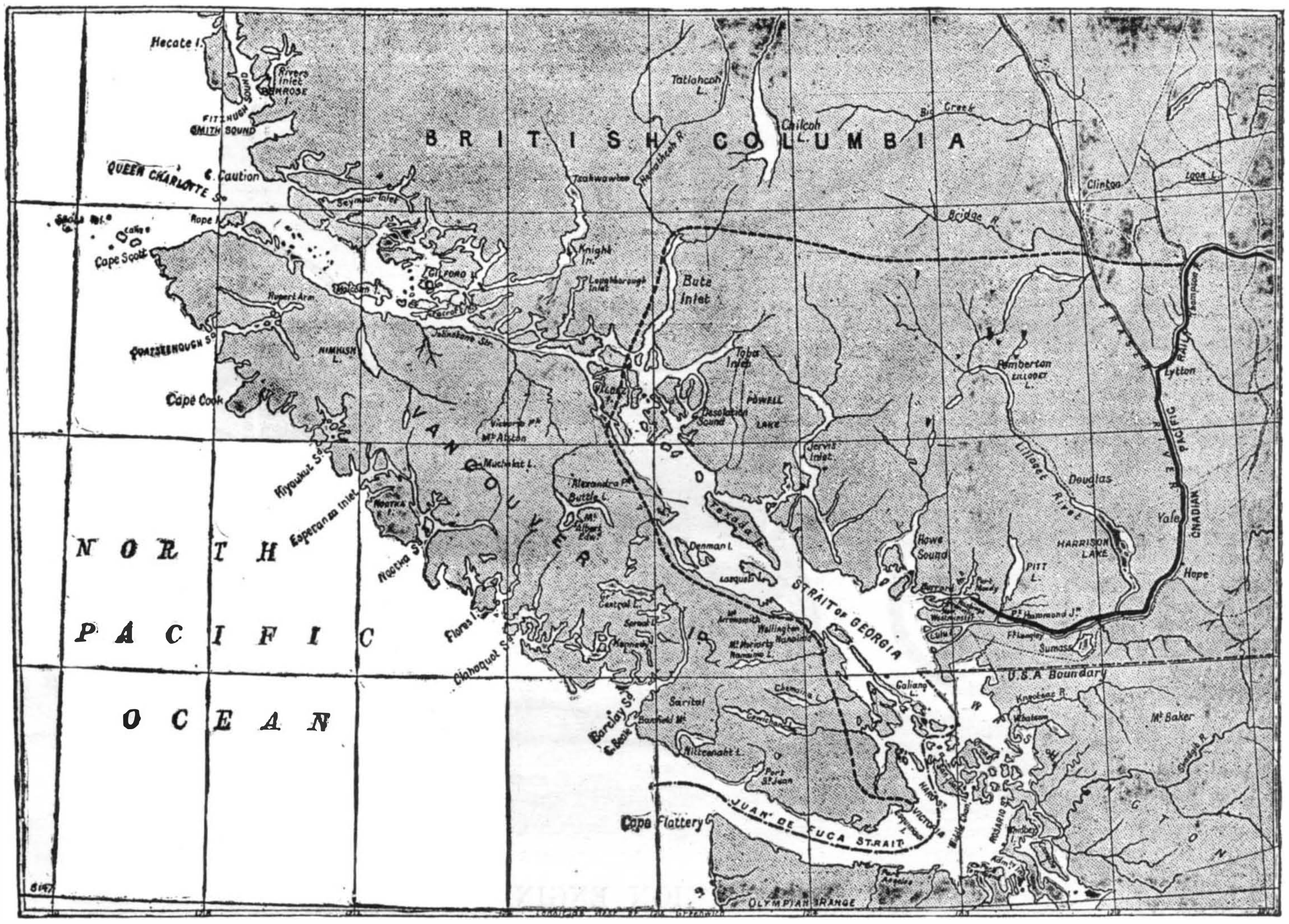
There are some twenty or more patches on the lake, five to fifteen yards in diameter, where soil has collected, and vegetation—trees, shrubs, and grasses—has gained a foothold, forming green islands or oases. The surface presents many small, dome-shaped swellings, from an inch to a foot in diameter. These are pitch bubbles, are always hollow, and contain traces of half-decayed vegetation. Excavations made in the pitch show that below the surface these cavities or vesicles are exceedingly numerous. They are usually almond shaped, and, though always the result of gaseous expansion, are commonly filled with water. In fact, the entire mass of the pitch is saturated with water, so that even where quite soft it will not soil the hands, because the water oozes out and prevents adhesion.

The pitch is quarried by excavating areas thirty or forty feet square to a depth of two to four feet. As soon as the work ceases on one of these excavations, the asphalt begins to obliterate it, the walls not closing in perceptibly, but the bottom rising up; and in a few days no trace of the opening remains. This is one of many indications of greater fluidity below the surface. Toward the center of the lake are several detached areas, a rod or two in breadth, which are softer than the rest of the surface, and yield under the feet; "so that, on standing a few minutes, one feels that he is gradually settling down, and in the course of ten or fif-

We find unique and conclusive evidence of this revolving process in "numerous pieces of wood, which, being involved in the pitch, are constantly coming to the surface. These fragments of wood are of the same recent origin as the leaves and twigs contained in the vesicles of the pitch. From the surrounding forests, or the green islands of the lake itself, they have found their way into the water channels, become water-logged, sunk to the bottom, and been drawn up again by the ever-revolving pitch." The true cause of the revolving motion of the pitch, and of the structure resulting therefrom, is apparently the great diurnal range in the temperature of the surface of the lake. On unclouded days the asphalt attains a temperature of about 140° F., and sinks during the night to 70° or 60°, suffering a variation of 70° to 80°, which must produce a considerable change of volume. This expansion is superficial, and its chief tendency is to extend the pitch horizontally. Where the pitch is covered by water, it will not experience this alteration of volume; and these protected areas are forced downward by the expansion of the unprotected areas.

No soundings have ever been made in this lake, and its depth is unknown. The thickness of the deposit is, of course, a factor of the first importance in determining whether the supply of asphalt is likely to prove practically inexhaustible. In considering the question of the probable permanence of the supply, it is also important to remember that the material is doubtless still escaping from the underlying asphaltic sandstone, though perhaps very slowly.

As regards its origin, the lake is believed not to differ essentially from any of the patches of pitch scattered over the surrounding country. It appears to be simply a large puddle of pitch, which has oozed out of the sandstone and collected in a basin-like depression in that rock.



THE WESTERN TERMINUS OF THE CANADIAN PACIFIC RAILWAY.

"It is fortunate," as one writer has remarked, "that the pitch, when compact, will not kindle, or, in other words, will not burn without a wick; for, otherwise, the entire region, including the village, might suffer the fate of Sodom and Gomorrah."

The pitch not only forms the seashore for nearly four miles, but in front of the village, and perhaps a hundred yards from the shore, it rises from the sea as a solid barrier-reef, which is often a source of danger to unwary boatmen. It is probable that the peninsula of La Brea owes its existence to the protection afforded the land by this reef of asphalt, which resists the action of the water better than the unconsolidated clays and sands forming the coast to the north and south.

We may now return to the lake. Of the published descriptions of this remarkable phenomenon, very few are accurate. Probably no object in nature has been so grossly misrepresented as the Pitch Lake of Trinidad. In an official history of the English Exposition of 1851, it is stated that "the Pitch Lake is on the highest land in the island. It is soft and fluid at the center, and there is an active submarine volcano near the coast."

Another writer speaks of "a submarine volcano, which at times makes a noise like thunder, and emits naphtha and petroleum." I have already given the true altitude of the lake as one hundred and forty feet, while the highest point on the island is Mount Tucutche, 3,100 feet above the sea. The "submarine volcano" is a petroleum spring which comes up under the water a short distance from the shore; the water is visibly oily over an area of several rods, and bubbles of gas are sometimes seen to escape, but nothing further. The lake itself is usually described as "three miles in circumference, hot and fluid in the center, but cold and solid toward the shore." In point of fact, this body of pitch, which is of approximately circular outline, is scarcely one and one-half miles in circumference, and there is no part of its surface that may not be walked

teen minutes he may find himself ankle-deep." "But," as Mr. Manross truly says, "in no place is it possible to form these bowl-like depressions around the observer described by former travelers." Nor is it probable that Kingsley is right in saying, "No doubt there are spots where, if a man stayed long enough, he would be slowly and horribly engulfed." The inferior density of the human body would prevent its submergence, even if the pitch were quite fluid.

In the vicinity of these places many small streams of gas escape from the pitch. The evil smell, and the deposit of sulphur left on the pitch, tell us that the gas is chiefly sulphureted hydrogen; but the sulphureous odor ceases to be perceptible at a distance of a few rods, and does not extend for ten or twelve miles, as some writers have asserted.

The surface of the lake does not present a continuous sheet of asphalt, but is traversed by a network of channels in which the rain water collects. These unite and divide most curiously, forming one connected system, and dividing the pitch into numerous flat-topped or slightly convex areas or islands, which are usually of quite irregular outline, though sometimes nearly circular, and from ten to one hundred feet in diameter. A piece of marbled paper would give an excellent idea of the appearance of the lake. The sides of these channels are convex, presenting curves of great regularity and beauty; and, where three or four channels meet, a star-shaped depression is formed.

Several explanations of this peculiar structure of the lake have been proposed. Each of the many hundred areas into which the lake is divided possesses an independent revolving motion, in this wise: In the center of the area the pitch is constantly rising up *en masse*, displacing that which previously occupied the center, and forcing it toward the circumference. Where the edge of such an expanding area meets that of the adjoining one, the pitch rolls under, to be thrown up again in the center at some future period.

The observations of Mr. Wall have placed the vegetable origin of this bitumen beyond question. The asphaltic sand rock is rich in vegetable remains; and it is possible to trace every step in the conversion of these into asphaltum, until the organic structure of the wood is entirely obliterated. W. O. Crosby.

THE WESTERN TERMINUS OF THE CANADIAN PACIFIC RAILWAY.

Victoria, the capital of British Columbia, hitherto known as the "Empress City of the Plains," has the promise of a very dangerous rival in the future in the new born town of Vancouver, the terminus of the Canadian Pacific Railway.

British Columbia, as we know, is the extreme western province of Canada, and was one of the latest States to join the Dominion. Since the completion of the Canadian Pacific Railway last year this province has become of increased value. The fact of its being the one only outlet on the side of the Pacific is sufficient to render it of great importance, but beyond this its mineral capabilities, to say nothing of its furs, fisheries, and agricultural powers, promise to bring it well to the front. The completion of the Canadian Pacific Railway is a great step toward bringing the province forward, and indeed of binding together the whole Dominion. However, this is a matter which is more or less known to all who take an interest in colonial affairs; what we propose to do now is not so much to discuss the effect of the railway generally on British Columbia, as increasing its value in the eyes of proposing settlers, but to go still further and discuss the local effects that may be caused by the position of the terminus being at Vancouver instead of, as originally intended, at Victoria.

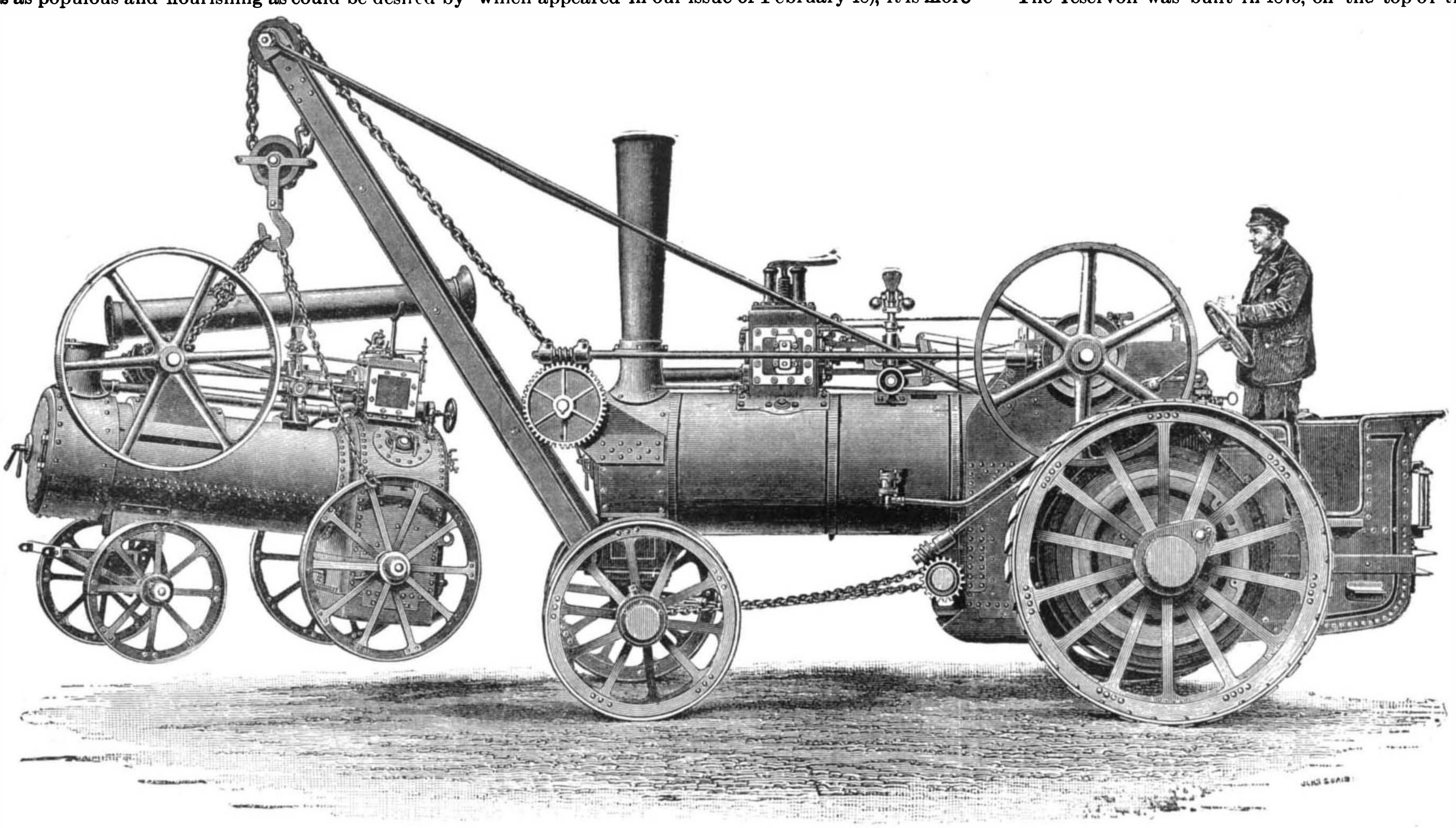
A glance at the accompanying map will give an idea of the relative positions of the two towns which we are

going to discuss, observing that Vancouver, to which the line has just been completed, and which has not as yet a place on the chart, is situated at the entrance of Burrard's Inlet and on English Bay, just below where the terminus is now shown at Port Moody.

When the line was first started, the people of Victoria, who were the prime movers, were of course very anxious that its terminus should be at Victoria, which was, and indeed is, the only decent seaport town in British Columbia; and at one time it was proposed to run the line somewhat as shown by the dotted line in the chart, that is, crossing the water by Seymour Narrows and so wending its way down to the capital. The work, however, was found to be too heavy, and eventually it was resolved that the terminus should be fixed at the mouth of Burrard Inlet, the new town being christened Vancouver.

Taking everything into consideration, there is no doubt that this is a wise determination, for the harbor is infinitely superior to that of Victoria, which is too shallow to admit vessels of deeper draught than 15 ft., and these only in very limited numbers. The site for the town is magnificent, and the natural formation of the place makes the approaches comparatively easy of defense. This town numbers at present about 3,000 inhabitants, and the site presents an appearance calculated to make any of our English readers, used to trim streets, with brick or stone houses and paved highways, laugh at the presumption of settlers in calling it a town. Some 200 houses, most of these of wood, situated in the midst of a vast blackened area where trees have been cut down and the roots burnt in order to make room for the houses that are to grow up, and take the place of these "original possessors of the soil," are all that as yet constitute the town of Vancouver. Yet to look at the plans of the land surveyors you certainly would be persuaded that the town of Vancouver was as populous and flourishing as could be desired by its best wishers. However, Rome was not built in a day, and doubtless another year will make a vast difference in the general appearance of the place. The question that remains for us to discuss is how Victoria—up to the present time the principal and only city on the coast—will be affected by this new place being selected as a terminus for the Canadian Pacific Railway. To do this, we must look at what the state of trade has been that has nourished Victoria for all these years, and then see how this trade is likely to be affected by the completion of the Canadian Pacific Railway, which will doubtless become one of the most important highways in the world. Will the opening of this road increase or decrease the trade of Victoria? Will the increased facilities afforded by the Canadian Pacific Railway for bringing trade to Victoria be more than counterbalanced by the fact that vessels proceeding to Vancouver can communicate direct with any portion of the interior?

The trade of Victoria consists at present of lumber, furs, fish, and gold dust as exports, meaning that it is the center or emporium from which the different branches of these industries spring, and from where the supply is issued direct to the home markets, it up to the present time being the only place from which there was direct communication with Europe and America. Thus all the head offices and agencies of the various salmon canneries, sealing companies, prospectors, lumberers, etc., are situated at Victoria, and it is to this place that ships come to load with the selfsame furs, lumber, gold dust, canned fish, etc., destined for European or American markets. Besides this, Victoria was not only the outlet of the northern coast, but everything from or to British Columbia had to pass through it, the communication between this province and the east being effectually closed by the Rocky Mountains. Now, however, the opening of the Canadian Pacific Railway has changed all this. Why should agriculturists up the country get their implements and stock, etc., through San Francisco or round the Horn *via* Victoria, when they can get them probably more cheaply and in a shorter time from Canada by the Canadian Pacific Railway? Or again, supposing they did get these things from San Francisco or from England by sea, why should they go first to Victoria to transship these for Vancouver and then up by the Canadian Pacific Railway in preference to shipping direct to Vancouver? In the same way the sealers, lumberers, canners, and miners have a Canadian market opened to them by means of the Canadian Pacific Railway. Surely it appears only too probable that Vancouver, with advantages in choice of routes equal to Victoria (with reference to the Northern and Central Pacific, whose termini are respectively at Portland, Oregon, and San Francisco), and with infinitely greater advantages as being itself the termini of the Canadian Pacific Railway (the English high road), should be found a better trade center than Victoria, separated from its base by sixty miles of water. Naturally all this will take a little time to work out. A city with old established trading connections like Victoria will not lose its trade all in a day; but looking at it as affecting future generations, or even intending settlers, there appears to be little doubt that Vancouver will be the city of the future on the Pacific coast, and as such offers the best opening for those who desire to seek their fortune in the colony. The dry dock at Esquimalt will be one inducement for ships to go to Victoria, and the fact of there being a dockyard there must always attract men-of-war and keep trade going; but it appears only too probable that if once Vancouver attracts the trade, these adjuncts will in a very short time spring up there. As it is, there has been serious talk of removing the naval stores to Burrard's Inlet on account of the extremely exposed position in which the dockyard at Esquimalt now stands, and the great difficulty in defending it. Had it not been for the dry dock which we have just mentioned (a description of which appeared in our issue of February 18), it is more than probable that by this time the naval establishments at Esquimalt would have found themselves on their way to the neighborhood of Port Moody, where the Admiralty have land reserved, and where the arsenal would be safe from the chances of any bombardment.—*Engineering.*



COMBINED TRACTION ENGINE AND CRANE.

COMBINED TRACTION ENGINE AND CRANE.

WE illustrate, from the *Engineer*, a very simple and powerful combined crane and traction engine, made by Messrs. Burrell & Co., of Thetford. The power of the crane is effectively illustrated by our engraving, the small portable engine being lifted and carried with great ease by the traction engine. The crane gear involves, it will be seen, little or no complication; and the whole machine is admirably adapted for hard general work, either at home or in the colonies. The engine pertains to the show in Newcastle.

A NEW DANISH IRONCLAD.

THE new Danish ironclad Iver Hoitfeldt, built at the Royal Dockyards, Copenhagen, and engined by the Burmeister and Wain Engineering and Shipbuilding Company, limited, Copenhagen, is at present undergoing a series of trials in the Sound. The Iver Hoitfeldt was commenced in April, 1884, and was launched April 14, 1886. With the exception of the Helgoland, launched in 1878, and which is more than 2,000 tons larger, the Iver Hoitfeldt is the largest ship built at the Royal Danish Dockyard. Her displacement is 3,280 tons, length 235 feet, breadth 48 feet, and depth in the water 18 feet. Her armor is for 100 feet 11½ inches iron plate covered with steel; at both ends of this, straight across the ship, are bulkheads covered with 10 inch armor of the same kind to within 2 feet over the water line. The ends of the ship have below the water line a slightly arched deck of 2¼ inch steel plates, extending to 4 feet below the water line. In the unarmored ends of the ship are a number of small water-tight compartments. The ship has a double bottom and a large number of water-tight bulkheads. The steering gear is protected by the armor. The ram is 8 feet below water, and there is a discharging apparatus for Whitehead torpedoes. The Iver Hoitfeldt has twin screws, each propeller with four wings. The engines are to indicate 3,000 horse power under ordinary circumstances, and 5,000 horse power with artificially increased draught. A speed of 14 to 15 knots is calculated upon. The boilers number eight, and are placed in four compartments. The coal boxes can accommodate some 2,000 barrels. There are several minor steam engines for various purposes. The guns are: Two 20½ centimeter Krupp, in two turrets (barbette), protected by 9 inch iron plates covered with steel. Armored wells lead from the turrets down into the ship, for the transport of ammunition. Further, there are four 12 centimeter breechloading guns and some lighter quick-firing guns, of which two are placed on the ship's two masts. Besides the discharging apparatus for Whitehead torpedoes under water, there are three discharging apparatus above water—one aft and one at each side. The ship is lighted by electricity, and is fitted with eight of Captain Rung's pneumatic rotation indicators. Besides boats and steam launch, she has two torpedo boats, with a speed of about 15 knots and weighing 15,000 kilogrammes each. The cost of the Iver Hoitfeldt is about 3½ millions kroner; of this amount the engines count for 800,000 kroner, and the artillery for about 500,000 kroner.

BREAKS IN A RESERVOIR.

AT a recent meeting of the Engineers' Club of Philadelphia, the secretary presented an illustrated paper by Mr. Lewis N. Lukens upon "Some Remarkable Breaks in a Reservoir."

"The reservoir was built in 1873, on the top of the Conshohocken hill, about 200 feet above the level of the Schuylkill River, from which the water is pumped. In plan it is a square of 151 feet at the top of the embankment, with a division embankment rising half way to the top of the side walls. When ordinarily full it holds about 1,000,000 gallons.

"The earth of the locality is of a rather light character, with enough talc in it to make it feel rather greasy. The general rocks of the locality are limestone, and the variety quarried and sold as Conshohocken stone. The exact geological conditions of the locality I have not knowledge enough to describe.

"In constructing the reservoir the banks were raised about as much above the natural level as the excavation was beneath it, the earth from the excavation being used for the embankments. These were well rolled and allowed to settle as much as possible in the course of construction. The bottom and sides were then lined with 18 inches of stiff fire clay, put on in layers of about 3 inches, each layer being well rammed. Above this there was put a brick pavement, and this was washed over with hydraulic cement.

"The inlet and outlet pipes were cast iron pipes laid in masonry. This masonry was composed of ordinary undressed stone, laid in hydraulic cement and extended out to about the middle of the embankment.

"The reservoir was finished in the fall of 1873, and water was let in soon after. In December, 1873, only a few months after the water was let in, the first break occurred. This break commenced just above the outlet pipe and followed the line of the pipe through the embankment, laying bare some of the masonry described as surrounding the pipe. It broke through the embankment just about at the natural level of the ground, and was about 15 feet across at the top of the embankment, narrowing, of course, toward the bottom. The curious part was, however, that instead of the ground below showing evidences of such a large body of water passing over it, it showed that only a comparatively small part of the water had escaped that way and covered the low land just below. The

larger part of the water must have escaped by some other channel, necessarily a subterranean one. The first break was repaired by filling in with stiff fire clay and finishing as before. In the summer of 1876 the second break occurred. This was in the middle of the west compartment, and was an absolute giving way of the bottom, there being no break in the sides. It was simply a hole of about 25 feet in diameter and of indefinite depth. A line was let down at least 85 feet without finding bottom, and stones thrown in seemed to rattle down indefinitely. The ledges of rock seemed to be inclined toward each other thus V, and the slippery talcous earth had been washed from between them, nobody knows where. Whether the water from the first break started it is, of course, not known, although it seems, at least, possible.

"In repairing this, the crevices between the rocks were filled up and arched over with masonry, going as deep as necessary to get a solid support for the masonry, in one case as much as 34 feet below the bottom of the basin. The hole was then filled in with stiff clay and iron ore screenings, principally clay. The top was then planked over with hemlock planks, and the clay lining rammed down and covered with brick, as before.

"In the spring of 1879, three years after, the third break occurred. This was in the other compartment, taking away part of the partition wall and part of the bottom, and was a good deal like the preceding one. An interesting fact is that a well near by, 80 feet deep, and which had had 8 or 10 feet of water in it, was completely emptied the night the break occurred and has not held any water since. There must have been some underground channel by which the water from both found its way to the river.

"This hole was filled up with masonry and clay, like the other. The clay lining was then taken off, and the whole basin—sides, bottom, and partition embankment—was planked over with heavy hemlock plank. The clay was then put on again to a depth of 14 inches, and the whole surface bricked as before. This time it lasted for eight years, until last fall, when a small break occurred. Some small quantity of water had washed the earth from between two rocks, in the side of and near the bottom of the end embankment, in the same old way. The weight of the superincumbent water had then sprung back the side planks, and the water had escaped by some underground channel. Being relieved of the weight, the planks had sprung back. The fact of the springing back and subsequent release is shown by there being a number of small fish caught and crushed in the cracks. This was repaired, as usual, by filling in with fire clay, and at that particular place there is now three feet of fire clay rammed in between the rocks, then the planking, then 14 inches more clay, and then the brick lining. It is hoped now that it will last."

IMPROVEMENT OF THE MISSISSIPPI RIVER.

C. H. TALMAGE, C.E., writes as follows in the *Railroad Gazette*:

In explaining my method, which is on the same principles as the Eads jetties, only more economical, because the conditions are more favorable, I will have recourse to the attached diagram. Let A Z represent two consecutive bends in the river. These bends are usually three to five miles around, and for that distance there is always good deep water. The crossing between the bends is generally about the same length, or a little less, if you include all the deep channel as bend and all the shallow bar as crossing. Now I propose to take the times of low or medium low water and build sills or dikes out from the high water shores opposite one another, so that their ends shall come within 1,000 to 2,000 ft. of one another. These sills are represented on the sketch by letters *b*, *c*, *d*, *e*, *f*, etc. The center line of channel between the opposite sills should be as near in the tangent line of the centers of gravity of the currents in the bends as practicable. As you will see by the diagram, and as you well know, at medium stage of water a large part of the high water channel is dry sand bar. Out of a total width of 7,000 ft. of high channel an average of 3,000 or 4,000 ft. of it is high sand bar either on one side or the other, or both.

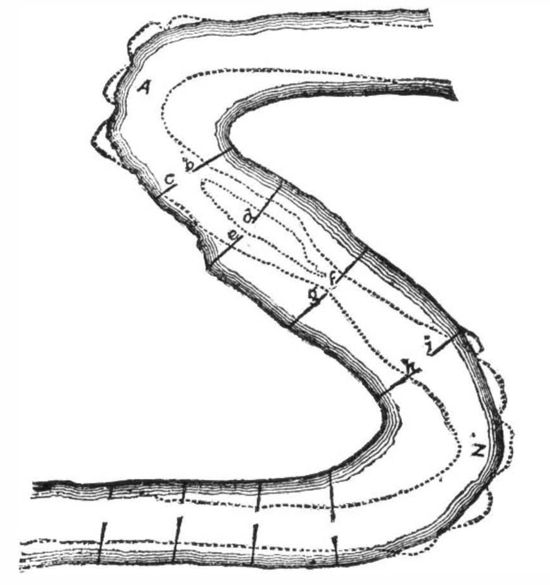
That portion on the bar could be built very cheaply with brush sides and top and earth center; and the portions under water would also be comparatively cheap, for the water would be shallow and current slow. The mats we build for that purpose are not woven with wire, as the government weaves them, but are simply two layers of brush fascines laid endwise of each other on a frame of cottonwood or other cheap lumber, held together by oak pins and wedges and spikes. These are found sufficiently strong to resist in sinking a current of 6 to 10 miles an hour, such as is produced by jutting out a dike into 35 ft. of water in the bends. I would lay such mats to form a sill, commencing at the water line on the bars and building out two mats thick till the ends of sills were as near 1,000 ft. apart as possible. Then from the water line back to high bank I would first lay one tier of mats 64 ft. wide, then lay the brush fascines butts outward, so they would be about 60 ft. from out to out, and scrape sand into the space between and on top of the boughs of the brush, and thus form a dike with the proper longitudinal slope to give ample room for the high water channel and at the same time confine it. The side slopes of the dike would be about 1½ to 1, and the width of dike on top about 20 ft.

A mat would be built on top and well weighted with stone to form a sort of roof. Assuming the high banks to be 20 ft. above the water line, at which work was commenced, the average height of the high water dike would be say 12 ft., an average width of dirt portion 30 ft., not counting space occupied by fascines, making about 14 yards earth per foot, which would cost not more than $3 per running foot of dike. Then the brush part of dike would cost on a basis of one mat 64 feet wide, one 20 feet wide, and the brush walls about 16 ft. wide each, charging $3 per cord of brush in fascines, $10 per running foot, and about one yard of stone per foot would weight the thing down together with the sand mixed with the brush; making a total of $15 per foot of dike for that portion on the dry bar averaging 12 ft. higher than the bar. That portion under water would cost about $15 or $20 per foot, using the figures obtained from our own work. Taking 4,000 ft. of sills as on dry bar and 2,000 ft. under water, the cost of sill and dike would be about $100,000.

These sills could be placed about one mile apart, or, at the least, three-quarters of a mile apart in the crossings.

My experience has been that dikes 250 to 300 ft. long on sand bottom in water 35 to 40 ft. deep at medium low stage, placed on the convex shore of the bends, one half mile apart, will protect the shore from erosion and cause a very deep channel beyond the ends of dikes. And therefore I think these sills and dikes placed one mile apart would be sufficient to maintain a narrow channel at low water 15 ft. to Vicksburg, 12 ft. to Cairo, 10 ft. to St. Louis, 8 ft. to Keokuk, and 5 ft. to St. Paul, which are the desirable but, in your opinion, unattainable results.

Then in the bends I would not build any dikes, but let the river itself build them by sinking one or two mats at prominent points around the bend about one-half mile apart, and riprapping the bank, and then as the current cut the shore away I would continue riprapping both sides of the point till it formed a dike about 400 ft. long from the shore line, as shown by dotted lines on sketch around the bends. Such work would not cost more than $5,000 per mile of river line.



Now, assuming that the miles in the bends are equal to the miles in the crossings, we have an average expense of $52,500 per mile of river, or $105,000,000 for 2,000 miles, which would take it up to St. Paul nearly.

This work should be carried on all from below, starting at the lowest point of difficult and uncertain navigation, and improving that first, and working thence up stream always. It is, in my opinion, the height of folly to work on all portions of such a stream at once, or to try to improve the upper portions before the lower portions. By my method, if the lower portion was diked all the work above it would simply serve to make the lower portions still deeper; for as the channel above was narrowed it would become swifter and keep the lower portions open better than formerly, because after the work is done, as suggested, the channel can only take the one course between the ends of the sills, and it cannot cut where the sills are not between them seriously.

I think $200,000,000 would be cheap if the government could complete the improvements to St. Paul for that amount of money; but it can never be done by the methods now followed. The only practicable method is to do it by contract, as the jetties were done. You might say no one would undertake the contract, and probably that is so, for capitalists would be shy of risking their money on what appears such an uncertainty; but I would undertake to do it for that amount of money, and accept half pay as work progressed, till it was completed. In the setimes of treasury surplus it would not hurt the government to appropriate $20,000,000 a year for the work and let the contract for ten years.

THE GATMELL EXCAVATOR.

THE illustrations below represent a type of excavator originally devised by the late Mr. Gatmell for sinking cylinders on the Empress Bridge over the River Sutlej. Fig. 1 is a side elevation of the excavator in the position in which it descends preparatory to excavating; Fig. 2 is a side elevation showing the position of the buckets when filled; and Fig. 3 is a front elevation of the excavator when filled.

The excavator is attached to the chain of the crane or hoisting engine by the ring, C, the hook, B, also catching into this ring, so that the buckets, A A, may be free to assume the position shown in Fig. 1. The excavator is then lowered until the edge of the buckets rests on the material to be excavated, when the hook, B, falls out of the ring, C. The chains are then drawn upward, either steadily or by a series of jerks, according to the nature of the material which is being excavated. This action causes the buckets to excavate the ground and to fill themselves at the same time, until they reach the position shown in Fig. 2, when the whole is drawn up to the surface. The contents are discharged by lowering the excavator on to a platform and engaging the hook, B, with the ring, C, when on tightening the lifting chain the buckets fall downward, relieving themselves of the spoil and assuming the position shown in Fig. 1. They are then ready to descend for a fresh charge.

Where greater expedition is required for discharging, the excavator may be fitted with an automatic apparatus for relieving the buckets of their load.

The buckets may be replaced by suitable tines with pickax points for breaking hard substances, the action remaining precisely the same as previously described. A modification of the same arrangement is employed for undercutting the edges of concrete cylinders; one half of the excavator, which is slung independently so as to hang at an angle, and is made to operate at any point of the edge of the cylinder by moving the sling.

The excavators, which are manufactured by Mr. Henry J. Coles, of Southwark, London, are constructed in a most substantial manner, so as to withstand the roughest usage without incurring stoppages for repairs, all the parts being made as weighty as practicable, so as to provide sufficient power for excavating the hardest material.—*Engineering.*

PAPYROTINT—A NEW PHOTO. PRINTING PROCESS.

THE following description of a new photo. printing process, devised by Sergt. Major Husband, R.E., is given in the *Journal* of the Photographic Society of Great Britain. The process is especially adapted to the reproduction of subjects in half tone, and is stated to be inexpensive—much cheaper than the old process of photo-lithography in line, while the working is exactly the same as ordinary lithography. Its advantages over other methods are that a transfer can be taken in greasy ink, for transfer to stone or zinc, direct from any negative, however large, without the aid of a medium, the grain of reticulation being obtained simply by a chemical change. The transfer paper being in direct contact with the negative, the resulting prints are sharper than by those processes where interposed media are used; while the same negative will answer either for a silver print, platinotype, or a transfer for zinc or stone. The advantage of being able to use a non-reversed negative is very great, now that gelatine plates have so largely superseded those made with collodion. The method of manipulation is as follows: Any good surfaced paper is floated on a bath composed of—

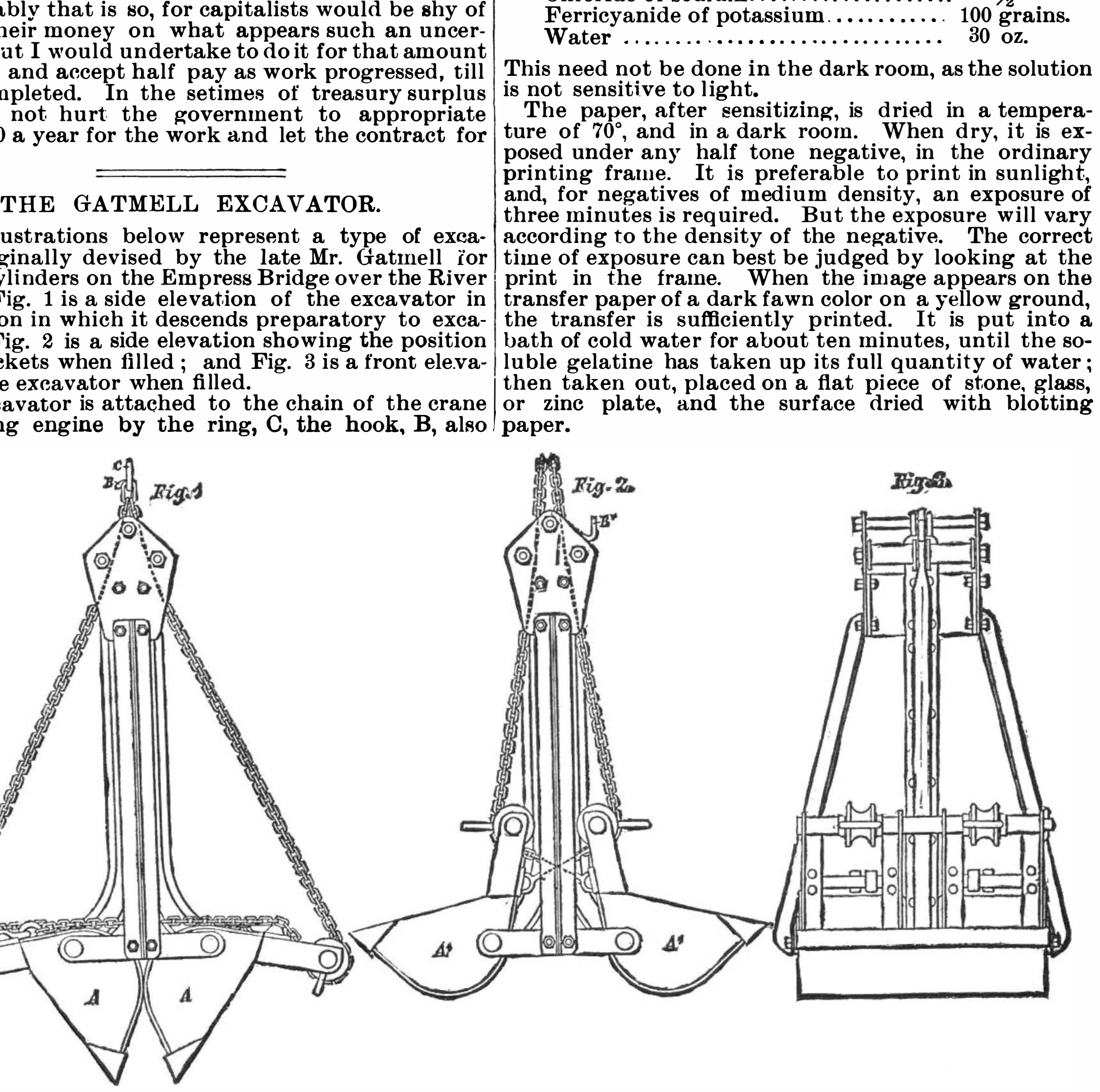
Gelatine (Nelson's flake)	8	oz.
Glycerine	1½	"
Chloride of sodium (common salt)	2	"
Water	50	"

Great care should be taken that the solution is not overheated, and that the paper is coated without bubbles. It is then dried in a temperature of 60° Fahr. The paper will take about ten hours to dry, and in this state will keep for years. When required for use, it should be sensitized by floating, or immersing, in a bath of—

Bichromate of potash	1	oz.
Chloride of sodium	½	"
Ferricyanide of potassium	100	grains.
Water	30	oz.

This need not be done in the dark room, as the solution is not sensitive to light.

The paper, after sensitizing, is dried in a temperature of 70°, and in a dark room. When dry, it is exposed under any half tone negative, in the ordinary printing frame. It is preferable to print in sunlight, and, for negatives of medium density, an exposure of three minutes is required. But the exposure will vary according to the density of the negative. The correct time of exposure can best be judged by looking at the print in the frame. When the image appears on the transfer paper of a dark fawn color on a yellow ground, the transfer is sufficiently printed. It is put into a bath of cold water for about ten minutes, until the soluble gelatine has taken up its full quantity of water; then taken out, placed on a flat piece of stone, glass, or zinc plate, and the surface dried with blotting paper.



THE GATMELL EXCAVATOR.

The action of the light has been to render the parts to which it has penetrated through the negative partly insoluble, and, at the same time, granulated. A hard transfer ink is now used, composed of—

½ oz. of white virgin wax.
½ " stearine.
½ " common resin.

These are melted together in a crucible over a small gas jet, and to them are added 4 oz. of chalk printing ink, and the mixture reduced to the consistency of cream with spirits of turpentine. A soft sponge is saturated with this mixture, and rubbed gently over the exposed paper (in this stage the nature of the grain can be best seen). An ordinary letter-press roller, charged with a little ink from the inking slab, is then passed over the transfer, causing the ink to adhere firmly to the parts affected by the light, and removing it from the parts unacted upon. It will be found that with practice, rolling slowly and carefully as a letter-press printer would his form, the ink will be removed by the roller according to the action that has taken place by light, leaving the shadows fully charged with ink and the high lights almost clear, the result being a grained transfer in greasy ink. The transfer is next put into a weak bath of tannin and bichromate of potash for a few minutes, and when taken out the surplus solution should be carefully dried off between clean sheets of blotting paper. The transfer is hung up to dry, and, when thoroughly dry, the whole of the still sensitive surface should be exposed to light for about two minutes. A weak solution of oxalic acid should be used for damping the transfer (about 1 in 100), and this should be applied to the back of the transfer with a soft sponge. After it has been damped about four times, it should be carefully put between clean sheets of blotting paper, and the surplus moisture removed. A cold polished stone is then set in the press, and after everything is ready the transfer is placed on the stone and pulled through twice. The stone or scraper is then reversed, and the transfer is again twice pulled through. A moderate pressure and a hard backing sheet should be used, care being taken not to increase the pressure after the first pull through. The transfer is taken from the stone without damping, when it will be found that the ink has left the paper clean. Gum up the stone in the usual way, but, if possible, let the transfer remain a few hours before rolling up. Do not wash it out with turpentine, and use middle varnish to thin down the ink.

It should have been mentioned that varying degrees of fineness of grain can be given to the transfer by adding a little more ferricyanide of potassium in the sensitizing solution, and drying the transfer paper at a higher temperature, or by heating the paper a little before exposure, or by adding a little hot water to the cold water bath, after the transfer has been fully exposed. The higher the temperature of the water, the coarser the grain will be. The finer grain is best suited to negatives from nature, when a considerable amount of detail has to be shown. The coarse grain is best for subjects in monochrome, or large negatives from nature, of architecture, etc., where the detail is not so small. Even from the finer grain several hundred copies can be pulled, as many as 1,200 having been pulled from a single transfer, and this one would have produced a great many more if required.

SIBLEY COLLEGE LECTURES.—1886-87.

BY THE CORNELL UNIVERSITY NON-RESIDENT LECTURERS IN MECHANICAL ENGINEERING.

VI.—COSTS IN MANUFACTURES.

By HENRY METCALFE, U.S.A., of the West Point Military Academy.

I REQUEST your attention to a subject which is possibly of as much importance to you as individuals as is any theme considered necessary to your education as engineers for the mere opportunity of practicing the principles in which you are trained will depend upon the net valur of your services, the difference between what you can save to your employers and what you will cost.

It is perhaps essential to instruction that the economical aspects of mechanical subjects be subordinated to the more ideal vie r s upon which the demonstration of abstraet peincieles depends. Without great experience, the necessary compromises of actual practice are confusing, and lead eo misunderstandings between practical and theor tical workers, between the workshop and the office I have attempted to bridge the chasm which too often lies at the door of the "office," and shall try to lay before you some of the methods and symbols by which I hope to make two worthy sets of people work in the harmony befitting their complementary relations.

It has been well said that "Science is measurement." You are too well accustomed to scientific methods to object to being measured yourselves by the money values of your future work. Yet, however conclusive your ideas may appear, concurrent circumstances may so affect their actual operation as to leave them in a distant place of decimals when their ultimate profit is determined. How may we determine these concurrent circumstances in advance? Only by asking the practical man, accustomed to the "old way," and often unable from that very familiarity to see the advantages of the new plan. You see that I assume a choice of methods, which it will be particularly your province to suggest to your employers. The life which competition gives to trade involves the series of changes which are characteristic of all life, the unceasing round of selection, assimilation, and elimination.

Those who select new methods wisely and get rid of the old processes, in time will survive the struggle and thrive upon their competitors' mistakes.

Shall we feed, or be fed?

The answer to "Will *this* pay?" is "What has *that* cost?"

There's the rub. Very few know, many guess, with more or less uncertainty, owing to the untrustworthiness of their data.

But why not collect data for future estimates? What data? Not mere memoranda, for, unless made with an object, they are soon without meaning; and if made for a special object, they lose in general application what they gain in special application; because, since it is impossible to foresee all the objects for which data may be needed, the omission of some of them will give undue prominence to others, and lead to false impressions. The alternative seems to be to prepare a genera system of records, including all data relating to cost, significantly expressed in predetermined terms. With these we shall be on firm ground, for our reasoning will be based on independent observations.

What shall be the scheme of the records? They must include all the data, and distinguish between them. With ordinary bookkeeping the only way of distinguishing the data is by opening separate accounts, because, once combined—like wine and water—the identity of the items is lost. Prices are nowadays so close that it is in these small items that our interest lies. These are the differentials out of which the profit is to be integrated. The nature of the business has much to do with the amount of differentiation, but with an ordinary manufacturing business I believe that an account should be kept of the cost of performing each operation on each component of every staple product. Suppose we make a machine containing eighty pieces, each one of which requires on an average fifteen different operations. We would have 80×15=1,200 different accounts to open for this one kind of machine alone.

Now, there may be one hundred or more jobs in progress at once, depending on the size of the factory. This is surely enough to deter one from keeping any books at all, and to lead one to seek some more convenient method of arriving at a general average of some sort, such as is currently done in the stove business, where the cost of stoves is computed by their weights and they are sold by the piece—a practice which a witty writer has compared to asking Tiffany for the price per pound of an assortment composed of an ice pitcher and a diamond ring.

This way of getting at the cost of stoves would, however, be less absurd than would the overcrowding of the counting room by the clerks required to keep the twelve hundred accounts of which I have spoken. So the manufacturer generally chooses the easiest alternative, and either places himself at the mercy of the market by keeping no shop accounts at all, or depends upon his foreman to "make up the time." The latter method leaves too much in the hands of the foreman, for he himself makes out the unverified statements upon which his efficiency and economy are established. It also involves the direct loss of his time and the incidental waste of energy in those whom he should direct while occupied in work for which his nature and surroundings unfit him. The workman's business is to *act*. The foreman's business is to *direct* the workman's acts. The clerk's business is to *record* the acts of both. A good foreman is rare enough; but one who is at the same time a good clerk is rarer still. Is it the fault of the supply or of the demand?

Since we must have some records, since the foremen should not keep them, and since clerks are not familiar with the terms of the workshop, the alternative seems to be to have the foremen supply the data of record to the clerks, to be by them compiled.

A comparison is here suggested between the building of a brick house and the compilation of an account. The bricks may represent uniform independent data of record, passing continuously from the workshop to the office, where, by the labor of the clerks, they are arranged into whatsoever structures may be required.

There are two similar conditions here:

1. The movement of the bricks must be continuous. What would become of our bricklayers and their scaffolds if a week's or a month's supply of bricks were showered upon them at once? So of our clerks when accounting is made periodically.

2. All the brick which have "climbed the hodman's stair" must be *somewhere* in the building. All our data must be *somewhere* in the account. We arrange at the start to direct them both to their most probable objects. In the case of the data this is done by making the record a necessary means of getting supplies or wages, which leads the corresponding datum to the office. This balances the amounts in advance. One peculiarity of our building is that it is constructed without mortar, so that the bricks, having been laid in one design, may be redistributed and rearranged like printer's types.

This leads us to consider what shall be the size of our bricks, the detail of our data.

Here we have to compromise between two conflicting tendencies:

1. The larger the bricks, the less trouble in collecting them, and the fewer the joints to be looked after in laying them.

2. The smaller they are, the greater the variety of patterns in which they can be laid, the greater the amount of information which the records will impart.

Which course shall be chosen will depend upon its net value to the business. I know of one concern in which the saving from going to greater detail in the records amounted to $75,000 in one year.

The cost to be recorded includes not only the actual labor and material going into a product, but a large proportionate expense for incidentals.

In so far as these concern salaries, taxes, rent, insurance, etc., they may easily be apportioned according to methods to be indicated.

But there is one large cause of expense—*waste*—which is difficult to treat by ordinary methods.

Waste may come from two causes—pilfering or extravagance

To stop pilfering, it is the custom in government shops, and also in some large corporations, to divide the status of material into two conditions:

1. In store, under charge of the storekeeper. Here it is subject to no change but that which comes from time.

2. In current service under charge of the foremen. Here, if a machine or tool, it meets with wear and tear; if material, it may be consumed by the metamorphosis of labor into a material of another name. Thus: boards+nails+labor=boxes. It may also be wasted.

Now in order to maintain responsibility, we must require a record of every change of condition:

1. As to status.
2. As to name.

We may hold the storekeeper responsible for units of material, viz., feet B. M. of boards, pounds of nails, number of boxes, etc.; but since the identity of the units is lost when the name of material is changed by manufacture, our only trace of it, when passing from store (the area of conservation) into current service (the area of consumption), lies in charging its value at the time against the object most probably benefiting by its consumption. By providing means for subsequently reapportioning this charge among more probable objects still, we may direct the distribution of the expenses to their most distant objects, and so increase the accuracy of our detailed knowledge of the cost. But how secure this distribution?

1. By always charging to its most probable object material taken from store, making this charge a condition of its procurement.

2. By providing means for reapportioning this charge among other objects which, as time goes on, are more directly benefited.

3, and most important. By holding foremen accountable:

1. For the specific cost of producing any article.
2. For the general expenses of their departments.

Between the opposing tendencies of the interest which leads the foreman to reduce the specific cost of any present product, by shifting too much to general expenses, and that which leads him to reduce the cost of future products by diminishing unduly the amount of general expenses, the line of least resistance will be truth; knowing which, we may decide what to hold fast to and what to change.

Assuming that we have disposed of the question of past cost, there still remains that of future cost, or estimate, upon the correctness of which all success is founded.

One job or order is seldom made under precisely the same conditions as another. The price, quality, or quantity of labor is apt to vary, and so may material. Therefore, our ideal record must take account not only of the money value of the article turned out, but also, in order that differences may be allowed for hereafter, it must give us the number of labor units of each grade, and of material units of each kind consumed. For example: On a trial order of an experimental character we have used high grade labor to assure mechanical success; hereafter we shall employ a larger volume of labor of a lower grade. Where, in one case, we used forgings, it will now pay to get malleable iron, etc.

These requirements, and particularly the last, require a correspondence between the accounts by units and the account of cost, which is secured by means similar to those by which interchangeable mechanical parts are produced, viz., by having all hands copy the same model.

Each change of name or status is recorded but once, by the person, presumably, best knowing the nature of the change, and the record is passed from hand to hand requiring it, not to be copied, but to be compiled.

When one hears of records, one thinks of books; but books are too inflexible for the consecutive uses which we require. A needs them most while B is using them. Their entries are necessarily arranged in a chronological series which forbids any other immediate classification; and they have no means of eliminating the effete entries of yesterday which obscure the effective ones of to-day. Besides, books are bulky and heavy, and do not permit that readiness of entry upon which the intrinsic veracity of original evidence depends.

Suppose that instead of books we use cards, made out at the moment the record is, so to speak, born, and passed from hand to hand requiring them, until they find a common resting place with the cost clerk. On their way they may be compiled as often as need be by a simple assortment, and its results transcribed into whatever books of record may be kept.

This is the true function of books, to contain the integration of data between limits. They are photographs of the various structures into which our bricks have been combined; maps of the phases of a stream.

A book full of disconnected data is an obelisk, a frozen stream, a form needing decomposition to make it useful. The independent data are like drops of water collected from a hundred sources by a central force, toward which, with fixed identity though changing form, they flow with that power which comes from the harmonious operation of a natural law, not fruitlessly, but yielding, as they pass, that life and energy which will be returned to them again.

In a broad sense, a manufactory may be considered as an engine for transforming material, and its efficiency, like the duty of a pump, may be measured by the ratio of the effort exerted to the effect produced.

It will not be disputed that this ratio is best expressed by the true costs of its products, and that managements may be compared by their costs.

The object of the proposed system of accounts is to provide automatic, and therefore impartial, means for determining the most probable cost of manufactures in gross, or in such detail as the expense of its determination may permit.

A manufactory may be functionally divided into two main portions, the workshops and the office.

In the shops are performed the processes with the records of which the office is principally concerned; on one side stands the foreman expending labor in transforming material; on the other sits the clerk recording the results of the other's acts. Taking these two as typical figures, I propose:

1. To require the highest local authority to define the objects on which its resources are to be expended. In other words, what accounts are to be opened.

2. To require the foreman to define the object most probably benefiting by the expenditure which he directs, as nearly as possible at the time that the expenditure is made.

3. To require a clerk, independent of the foreman, to compile the record of the foreman's acts.

4. To provide a simple symbolic language common to both office and workshop, by which the same object of expenditure, whether it be a product, a component or an operation of manufacture, shall always be called by the same name, and by which the foreman's symbols shall suffice the clerk, without requiring of either a knowledge of the other's work.

5. To make each act of record an independent unit by entering it on a separate card, certified by significant punch marks.

6. To save clerk's work in combining similar entries by assorting mechanically cards containing similar symbols, only transcribing the summation of the charges they contain.

7. To provide that no claim for labor shall be allowed, nor any material put in the way of expenditure, unless

charged to its most probable object; so that to every right there shall attach a responsibility of record.

8. To provide for the transfer between general and specific expenses of charges more probably belonging to either.

9. To prefer natural methods to arbitrary, so that those who may use the system shall of themselves tend to conserve it.

SYMBOLS.

You will see from the examples of these cards before you a common feature in the recurrence of the symbols S-O, C, O, N. These symbols serve the purpose of indicating plainly and briefly, yet with the utmost detail, the object benefiting by the expenditure reported.

I. S-O, shop order, refers to the serial number of the shop order or job. Of these there are two kinds:

1. Special orders, requiring the performance of specific work.

2. Standing orders, requiring the maintenance of certain facilities for the execution of the special orders.

These facilities may be either in charge of certain foremen, the costs of whose management we wish to compare, or may be too general in their nature to be assigned to any one department.

The first are called departmental, and the second, general, standing orders.

Designation.

The special orders are designated by serial numbers, beginning at 100, according to their sequence in the shop order book.

Each department of the manufactory is known by a number, preferably in the order of work, and the standing order relating to its maintenance has the same number as the department. The numbers below 50 may be reserved for these orders; *e. g.*, 1 for the pattern shop, 2 for the foundry, etc.

General standing orders may run from 50 to 100. In deciding how many and what they shall be, we must remember that our first analysis may safely be detailed, because details may always be combined by neglecting their differences, and it is easier so to combine them than to analyze results too grossly stated into their component parts. The more complete is our preliminary analysis, the more stable will be our synthesis. The history of chemistry and of mathematics teaches this. In another sense, we say "we divide that we may rule."

The following general standing orders are suggested:

51. Office expenses relating to factory.
52. Office expenses relating to sales.
53. Office and other expenses which cannot be classified.
54. Power.
55. Heat.
56. Light.
57. Transportation, in and about factory.
58 Repairs of buildings, not departmental.
59. Superintendence, general.

II. The letter C refers to the *character* of the work done, or the ultimate purpose for which the labor or material referred to has been expended. If it is done as for sale, if it has to be done over again, every time such an order is repeated, it is known as *work*, symbol W. If it is done in preparation for the order, having, when this is completed, a permanent value to the shop for future work of the same kind, say a drawing or pattern, it is called the plant of the order, and is designated by the letter P.

III. The letter O refers to the component part or object worked upon. This is known from a corresponding symbol affixed to the working drawings. The proper selection of these symbols is a matter of considerable importance.

It will not answer to follow the practice of some who have given arbitrary numbers to parts, following, let us say, the order in which they were designed on the order of size. This allows no room for growth or change. For example, suppose we began to call the bed of a lathe 1, the legs, 2, 3, 4, 5, and the other parts up to 75. In course of time, we might make the bed in more than one section; we would then have one section No. 1 and another, almost like it, No. 76. To overcome this difficulty, I propose to subdivide the parts of the machine into affiliated groups, leaving gaps in the numeration for expansion, something like the Philadelphia system of numbering houses.

This is only intended to be applied to the staple products of an establishment. Casual products do not require this analysis.

Definitions.

1. A staple product or staple is one of the principal productions of a given workshop, concerning which in all its parts definite economical information is wanted. *Ex.:* Let us say any particular pattern of lathe made in quantities by Sellers & Co. for sale.

2. The staple is supposed to be formed by combining *members* which have definite mechanical functions. *E. g.:* The bed, B; legs, L; head stock, H; tail stock, T; carriage, C; power feed, F; back gear, G; countershaft, S.

The members designated by letters are formed by uniting *components*, which are simpler mechanical instruments composed of *pieces*.

A *piece* is that portion of a staple product which is not intended to be taken apart by ordinary means. Pieces are designated by digital numbers, components by decimal numbers.

The distinction between members and components is somewhat arbitrary, and the extent of the analysis will depend upon the complexity of the machine. The following illustrations will explain the application.

I ask your indulgence as to the details of the illustration, which, owing to a somewhat imperfect acquaintance with the internal economy of lathe construction, may be inaccurate. I was assisted in its preparation by a builder of machine tools, who surprised me by the prevailing laxity or, rather, want of nomenclature for such details. This, however, facilitates somewhat the task proposed, which consists of classifying parts functionally related. Leaving aside the direct advantages from marking drawings, gauges, tools, and interchangeable parts, I cannot help thinking that other advantages may follow from the observance of these distinctions. Modern chemistry grew out of its nomenclature.

Members.	Components.		Pieces.
Bed (B)	Assembled, if in sections	10	Head section.... 1 Tail section.... 9 Intermediate sections 2— 8 Bolts, nuts, etc., 11 upward.
Legs (L)		10	Bolts, nuts, etc., 11 upward.
Head stock (H)	Body	10	1— 9
	Spindle	20	11— 19
	Spindle gear	30	21— 29
	Face plate	40	31— 39
	Arm pulley	50	41— 49
	Arm gear	60	51— 59
Tail stock (T)	Body	10	1— 9
	Spindle	20	11— 19
	Screw	30	21— 29
	Wheel	40	31— 39
	Spindle lock	50	41— 49
	Body clamp	60	51— 59
	Adjusting screw	70	61— 69
Carriage (C)	Cross slide	100	1— 99
	Feed { hand	150	101—149
	Feed { power	200	151—199
	Compd rest { body	250	201—249
	Compd rest { slide	300	251—299
Power feed (F)	Feed screw	10	1— 9
	Change gear	20	11— 19
Back gear (G)	Large gear	10	1— 9
	Small gear	20	11— 19
	Quill	30	21— 29
	Shaft	40	31— 39
	Handle	50	41— 49
Countershaft (S)	Shaft	10	1— 9
	Pulley { loose, cone }	20?	11— 19
	Shipper { handle, arm, collar }	30?	21— 29
	Hangers	40	31— 39

N, finally, refers to the symbolic number of the mechanical operation performed upon the object, O. This number is obtained from a classified list of mechanical operations, by which those of the same nature are grouped together. Thus, operations for forming cylindrical surfaces are put in one class by themselves, the 500 class for example, and the special operations of turning, boring, and drilling are numbered in that class as 501, 521, 541, etc.; gaps are left between them for the insertion of symbols corresponding to similar operations to be discovered. The means for making ruled surfaces are, perhaps, in the 600 class; thus, planing and sawing are 601, 621; and the means of uniting objects together are in the 800 class; thus, gluing, nailing, screwing, riveting, are respectively 813, 831, 832, 833, etc.

Only so many of these symbols need be used as the scheme of administration may require; some will be satisfied with gross costs, and will need only the first symbol given below; others will require plant to be separated from work; and others still, for staple manufactures, will want to know the cost of components and of the operations upon them. Such demands must be anticipated at a cost proportional to the benefit expected; as we would reap, so must we sow.

Examples.

Suppose shop order No. 1875 calls for the manufacture of 20 engine lathes of the smallest size. A reference to S-O 1875 covers all ground necessary for identifying the general object of expenditures made under it.

S-O	C	O	N
1875	W	H.11	501.1

would signify work done in first or rough turning head stock spindles for the lathes made under shop order No. 1875.

Suppose a gauge required for this turning. It would be useful for all future work, and its cost must be distinguished from that of the work for which it is made. It is done by using P instead of W on cards reporting time and material.

Thus: 1875 . P . H 11 . 501.1.

Gauges.

Now as to the marking of this gauge. Order No. 1875 for 20 lathes being complete, the gauge, to be valuable for future orders, must be capable of identification without necessary reference to any of them. The number of the first order on which it was used might suffice, but that would involve too frequent reference to the book. We want to mark the gauge so that its purpose may be immediately known wherever seen.

We therefore use the following descriptive symbols for the staple, calling L generally lathe,
E L engine lathe,
F L foot lathe, etc.

And designating various *sizes* by successive letters, we have E L A E L B E L C, etc.
F L A F L B F L C, etc.

Varying *styles* of lathes might be further distinguished by prefixed letters, beginning at the other end of the alphabet; Z for first pattern, Y for second pattern.

Now the gauge made for the first turning of the head stock spindle for the smallest sized engine lathe of the first pattern made would be stamped Z E L A H 11 501.1; and that for fourth planing (scraping) tail section of bed for second sized foot lathe of the third pattern made, X F L A. B. 9. 601.4.

Thus all gauges for the same *pieces*, *components*, or *members* could be kept together when not in use.

ORDERS.

Taking the objects of the system in the order of their importance, we have the prompt performance of work by the prominence given to unfinished orders.

Authority to issue orders.

The authority for all orders is vested in the office; but, as is customary, is more or less extended to include transactions between foremen. With the free exercise of this right is combined the incidental responsibility of a written record, retained by the recipient, who is in turn restrained by the automatic record of the cost of his work. Both records coming finally to the office, one foreman is accountable for the necessity of the order and the other for the cost of executing it. This principle of liberty qualified by responsibility runs throughout the plan.

Form of order.

The shop order book provides a place for the record of every order originating in the office. A special order here receives its serial number, and work of a general nature worth special entry takes the number of its proper standing order.

To distribute orders, and for other purposes, the order ticket is devised. A punch mark of special design in the "authority" space indicates the giver.

Standing orders and their numbers are circulated in lists which are soon memorized.

Course of tickets.

I shall describe the simplest case first, as its principles apply in all others.

1. For short jobs on which only one kind of work is done at a time, single tickets serve.

They are displayed in a rack in each foreman's office, while the work is in his shop. When the work is done he punches out his own number in the marginal line headed "completion," and passes the work and the ticket with it to the next foreman in order. This is continued until the ticket reaches the office, where the date of its completion may be entered in the shop order book.

2. When work is to begin or continue in more than one department at a time, separate tickets must be made out for each department. These issue directly from and are returnable directly to the office as soon as each department's work on the job is done.

3. Subordinate orders.

Foremen requiring the co-operation of others may originate tickets specifying the work to be done, by indicating the number of the original order authorizing the work and punching the authority space with their special punches. The tickets are returned to the office by the recipient. They may well be white to distinguish them from office tickets, which may be of two or three different colors to indicate the relative urgency of the work they authorize.

Thus S-O. 789. *Build* 6 *double axle lathes,*

might be on a yellow ticket, indicating a staple manufacture, and—

S-O. 2, P. *Cut door, north side pattern shop,*

on a blue ticket, to indicate local work of an important nature. Such tickets emanating from the office would be in ink, and would refer to drawings, specifications, etc.; but a merely local order or foreman's request, such as

55, W, *Stop leak in steam coil,*

sent, say, by the master carpenter to the master machinist, might be in pencil on a white ticket.

It is desirable, but not essential, that subordinate orders be in writing. The advantage in definiteness, in responsibility, in the certainty of execution, and in the accuracy of the record which follows from writing them are so great as to outweigh the slight loss of time taken to fill them up and punch them. A package of tickets, a lead pencil and a ticket punch are all that a foreman needs for attending finally to any order which he is competent to give.

In complicated operations, where it is desirable to take heed of the receipt of orders on their delivery, duplicate tickets may be used to advantage. The duplicate ticket is also intended for a complete exhibit say in the racks of the superintendent's office of unfinished work ordered by him or by his superiors. As the completed tickets come in from the foremen, he takes down his retained copy from the proper rack, punches it, and returns it to the main office, keeping that which he has received.

Advantages of order tickets.

Each foreman's unfinished work is always displayed before him, relieving his memory and permitting him to apply all his energy to active work. This applies in even greater measure to the superintendent.

The tickets in the racks may be classified as work in hand or as not in hand, by departments, and in many other convenient ways. When returned to the office after completion, they may be resorted, so as to form an indefinitely expansible index to the order book.

Disadvantages, loss of tickets.

The loss of a ticket, at the worst, would correspond only to an order forgotten under common methods; in practice they are never lost.

COSTS—RECORD OF EXPENDITURE.

Having shown how an order, started from the heart of the administration or from one of its intermediate points, finds its way out to the circumference and along it, and how, its work accomplished, it is by natural means brought back to its source, it remains to show how the records of the expense it has involved are similarly directed in their centripetal course.

The expenses of a workshop may be classified under two heads:

1. Services { Internal.
External.

2. Material.

1. *Services.*

Labor may be performed either within the establishment or without it. To both kinds of labor the name service is given, and their record is kept on uniform service cards.

Internal services.

For internal services these are roughly bound into little books, like check books, each page containing one card detachable like a bank check, and having a memorandum stub for the workman's private use. All cards are printed on one side of brown manila paper.

Employment of service cards.

When a man is hired, he receives a book in which, on each card, his name and rate of wages are stamped, or merely a number, referring to a list kept in the office containing corresponding rates of wages. This certifies his employment to his foreman. He gets his book from his foreman in the morning and returns it at night with one page filled for every order on which he has worked during the day.

If he has worked all day on but one order, his writing may consist of its number and the number of time units in a working day. Thus, if the hour is taken as the time unit, he might write—

S-O. 789 Time units, 10

If time is kept by the half hour, it would read—

S-O. 789 Time units, 20; and so on.

The foreman looks over the books when handed in; if correct, stamps them with his dating stamp, tears out the leaves filled, and sends them to the office. The next morning he returns the books to the men.

The book serves a double purpose. It affords the workman an opportunity for making a definite charge for his labor, and it gives him the only opportunity of doing so. This makes certain a record of his employment during the time for which he is paid, and also affords original evidence from an impartial source as to the object on which that labor has been spent.

It takes the place of a roll call or time check. Early comers get their books at once and can go to work. Late comers are so marked on their own books. Those who leave early have their books verified at the time.

If a man has worked on several orders during the day, he fills out a separate leaf for each order, the sum of the times equaling the total time, as before.

Now comes the consolidation. The cost clerk sorts together, if need be, all coupons referring to the same man, and enters on the time book the total time for which the man is to be credited. This is the last time that they are together, for he immediately distributes them among a set of pigeon holes, each of which bears a temporary number corresponding to the shop order. If so desired, he can add up daily the increased charges under each order, and so give the office an idea of how much each order is costing from day to day—a timely means of checking waste and extravagance. When the job is finished, these coupons are taken out and re-sorted; first according to P and W, and then—if need be—in each of these categories, according to O and N. Then these last may be sorted according to departments, rates of wages, and men's names. So that, finally, by this simple mechanical analysis we may know how long each man, at each rate of wages, in each department, has worked on each mechanical operation, on each component part of each job, and at what cost. No balancing is needed—it has been done in advance. Split it fine or coarse, as you may please, it is all there.

External services.

Outside services embrace freight, insurance, rent, taxes, telegraphing, attorney fees, etc., pertaining to factory.

Payment for such service must be similarly distributed among the shop orders benefiting by the expense. It is optional whether this shall be done for each bill before payment, or whether such charges shall be consolidated from the books monthly or oftener, or whether cards representing such expenditure, when approved, are filed like those first described.

2. *Material.*

Material card

This card, which is freely distributed in blank to the foreman, permits every transaction with material to be recorded. The accompanying form is devised

MATERIAL CARD.

APR 3 1886

QUANTITY.		NAME.
ASSUMED. 6	UNIT. *pcs.*	N. B.—Make but one entry on each card.
ACTUAL. *164*	*lbs.*	*Sanderson Steel* $\frac{3}{4} \times 1\frac{1}{4}$ *about 8 ft. long.*
Price per Unit.	Dolls. / Cts.	

CHARGE TO				CREDIT TO				AMOUNT.	
S-O	C.	O.	N.	S-O.	C.	O.	N.	DOLLARS.	CENTS.
820	*W*								

Ordered from *Corning & Co.*

REQUIRED BY ● CERTIFIED BY ●

especially for private shops. If a foreman wants some steel he fills the card as shown, charging it to the order for which most probably needed. He makes a direct charge to a special order if possible; if not, then preferably to his departmental standing order. The foreman makes his entry in pencil, entries of price and amount being added by clerks if need be.

Punching out "required by," he throws the card into his messenger box and concerns himself no more about it. Without awaiting a special time or opportunity for making known his wants, without awaiting the return from the office of his "requisition book," he has, at the very moment that the need of the steel presented itself, asked definitely and finally for what he wanted. He has set rolling a ball which will be in somebody's way until it is finally disposed of. At the office it may be approved or sent back for explanation, or simply suspended, without interfering with immediate action on other articles asked for at the same time. A long list is like a large bank note, easy to carry, but hard to change.

Suppose that the requisition is approved by the superintendent's also punching "required by," the card is sorted with other cards of the same kind, say for hardware, the name of the dealer from whom the material is to be ordered attached, or not, at pleasure, and the card sent with others to the foreman or storekeeper who is to receive it on arrival. If to the foreman, he knows what to expect.

When the steel has come, the quantity actually received is filled in, the receiver punches "certified by" or "received by," or whatever special form of acknowledgment may be required by the management, and sends the card to the bill clerk, who, after comparing it with the bill, and may be adding prices or amount, sends it to the cost clerk for filing in the proper pigeon hole.

Let us suppose again that the foreman, having no immediate use for the steel, has charged his departmental standing order with it. By and by he finds that he wants 10 lb. of it for a special job. He makes out another card, charging it to the special job and crediting himself accordingly on the same card, and punches "certified by" as before. The converse is possible if he finds that he has charged too much to the special order first mentioned.

If he lets another foreman have steel, he charges and credits appropriately between departmental orders, certifies the entry, and gets the other foreman to do so before he gives up the steel. The issuer keeps the punched card as his equivalent and sends it to the office for entry.

The card may also be used for reporting each batch of work packed or shipped or sent to the store room or warehouse, as the custom of the place may require. Such cards contain a credit to the order under which the material has been made. They take the place of all memoranda recopied into lists for office use. Each card may start independently of the rest at the very time that the batch is done or inspected, so that there may be any number coming into the office during the day. Like the other cards, they are movable memoranda, written once and for all by those responsible for their accuracy.

These are the simplest of many possible cases. I have so far been unable to imagine one in which the card fails to tell its story in the easiest and plainest way.

COST OF WORK.

This second division of our subject involves two elements:

1. The work done.
2. The cost of doing it.

The second of these divided by the first gives the price.

1. *The work done.*

An order having been completed, we may simply wish to know what it has produced.

This may be determined in any customary manner, subject to this precaution, that it is not always safe to assume that the exact number of articles ordered by the tickets has been made. The means just described are probably as easy and expeditious as any that can be devised.

2. *The cost of doing work.*

The net cost consists of—

1. The specific expenses for labor.
2. The specific expenses for material.

These are also called the direct expenses, or those which can be charged directly to any particular job. Added to—

3. A proper proportion of the general annual or indirect expenses, they make the gross cost.

It is comparatively easy to compute net costs by any of the usual methods. Their exactness depends upon the scale of trouble adopted, and, excepting errors of omission arising from unbalanced data, they may be assumed to be fairly accurate.

The main difficulty lies in apportioning those general or indirect expenses which cannot be referred to any special product. I therefore give special attention to this subject, as follows.

Apportioning the indirect expenses.

Factories are established for the profitable transformation of material by the organized employment of labor. How shall the indirect expenses be distributed—in ratio to the material or the labor? by quantity or by value?

I believe the incidental expenses are incurred for the purpose of making labor more effective, and that the more material enters as their divisor, the more does it vitiate the probability of the result.

For the more material costs, the more labor it has already had spent upon it; and the less, and not the more, does it need the facilities provided by the incidental expenses. On the other hand, the more men are employed, irrespective of their cost, the greater is the wear and tear, the waste, the cost for room, light, heat, attendance, etc.

These and other similar considerations lead me to determine for each department *a cost factor*, as follows:

1. To distribute such general expenses as rent, insurance, taxes, etc., among departments profiting by them according to the most probable hypothesis.

2. To distribute last year's general standing orders or the unclassifiable current expenses among departments in proportion to the total day's work done in each department.

3. To add this amount for each department to the sum of its own expenses for the past year, as given by the cost of its departmental standing order.

4. To divide the gross amount thus obtained by the number of direct days' work done in each department during the past year, and so obtain a cost factor, say of 0·95 per day, by which the cost of every day's direct work in the present year must be increased in order to make it bear its most probable share of the cost of facilities provided for it.

Thus a man at $2 a day would be really costing $2.95, and a bill as follows:

15 days at $4.00	$60.00
6 " 2.50	15.00
27 " 1.25	33.75
48 days	108.75

would be increased by $45.60, representing 48 days × cost factor of $0.95 per day.

The variation of the factor measures the foreman's management during the past year. Its amount is the cost of facilities for doing a day's work which is chargeable to a particular job.

COMPUTATION OF COST.

Simple case, gross cost.

Our accounts may be on so simple a scale that we shall require no more than a simple statement of the gross cost of executing a given order. To obtain this, we add up the charges contained on the service and material cards found in the pigeon hole corresponding to the order in question. This gives the net cost. This, increased by the sum of the products obtained by multiplying the number of direct days' work done on the order in question in each department by the cost factor for that department, and diminished by the sum of the credits, gives the gross cost. In such a case the cards need only contain room for the symbol S-O; the symbols C, O, and N being omitted. I would recommend this simple method to beginners, although I believe that all will find it to their advantage as they become familiar with the system to analyze more closely. To such the following method commends itself.

Continued analysis of cost.

Sort the service and material cards belonging to a completed order according to plant and work, and add together their amounts under each head. Then correct the net cost so obtained for indirect expenses as already described.

The appraised value for future uses of plant should then be charged to the most probable standing order and credited to the cost of work. The amount thus determined when divided by the output gives the factory cost per piece, lb., etc. The factory cost increased by its proportion of the selling expenses, and profit added, gives the selling price.

Detailed cost of components and of operations thereon.

If, as in staple products, the cost is needed in greater detail, we sort the cards by the object symbols, and those having like object symbols by the operation symbols, and service cards having like operation symbols by departments in which working, and those in each department by rates of wages. This being done, and the charges added together and labor increased by cost factor product, we may ascertain the most probable cost of every operation on every component. This is as far as any one would be apt to go.

Daily cost sheet.

By adding up daily the amounts in each pigeon hole, and entering their net sum on the cost sheet, the office is kept informed how and where the money is going. The cards may then be sorted in continuous preparation for the analysis above described.

And here I would state that experience shows that so much of the work of classifying the accounts is mechanical, being merely the assorting of cards bearing similar symbols, that boys can be used for this purpose, leaving to the intelligent accountant the more responsible duty of tabulating and comparing the results of their assortment, and of ascertaining and explaining the causes of difference between what is found and what was expected.

STOCK ACCOUNT.

The labor account is a simple one; it requires only such methods as may satisfy the claims of the employes, and exhibit the distribution of their time. Like gas when no longer required, the supply is cut off, there is no waste, no remainder. But material, which is only another form of cash, requires different treatment; and if suitable means were provided, it would, I believe, be accounted for almost as strictly. Until wholly consumed, as by fire, the responsibility for it never ceases. It is a continuing responsibility, following the material through all the changes of name imposed on it by fabrication.

By entering but one kind of material on each card we gain immensely in flexibility at a very small cost of trouble, for it takes but very little longer to fill say three cards with one line each than to write three lines on one card, and when written the cards are independent of one another. (This applies to both service and material cards.)

This feature is particularly valuable in the accountability for government property, which happens to be altogether by items, without regard to values. After the sortings, previously described, the material cards in each pigeon hole may be resorted by the names of material upon them. This forms a convenient bill of material, the difference between which and even careful estimates will often prove surprising.* Space fails me to describe all the advantages following the independence of these units of record, which, like that of the printer's type, adapts them to an immense variety of uses. I have tried them in every supposable case of the affairs of an arsenal, trammeled by all the precautions imposed by a most jealous audit, and have yet to find a case in which they fail.

HAND ICE MAKING MACHINE.

IN an ice making machine for domestic purposes the three qualifications of portability, rapidity and certainty of action, and cleanliness are essential. The machines herewith illustrated are designed to combine these qualifications, while at the same time they are easy of manipulation, and the production of ice by them entails but little labor. At present, machines are made in two sizes, the smaller one being represented in elevation by Fig. 1, while Fig. 2 shows the larger size partly in elevation and partly in section, Fig. 3 illustrating the air pump, common to both machines, in sectional elevation. From Fig. 2 it will be seen that the machine has a stoneware vessel, or absorber, E, to contain sulphuric acid. This is thickly covered with a composition, made from paraffin and resin, to prevent the passage of any air through the pores—which was found to occur in the early machines—and the whole is then inclosed in an outer metal case, as shown in Fig. 1. The lid, J, of this vessel is of lead, and has an angle iron, *e*, around its outer edge. Above the lid is an iron ring, *f*, with radiating arms. The absorber stands on another iron ring, *g*, the whole being mounted on a suitable base from which iron straps, *h*, are carried upward. The straps, *h*, are provided with

* A simple form of ledger arranged on the same plan as the cards permits the entire amount of material, either in its new state or manufactured, which is on hand at any epoch to be instantly known.

slots at their upper ends, through which the ends of the iron arms pass, as at *i*, and are held down by the thumb nuts, Q, while the screws, *j*, bear upon the ring, *e*, and so serve to jam the lid down on the top of the absorber. To insure a tight joint between the lid and the top of the absorber, a groove is formed around the outer edge of the lid as shown at *k*. Into this an elastic ring is put, and as the thin tongue of lead is partly

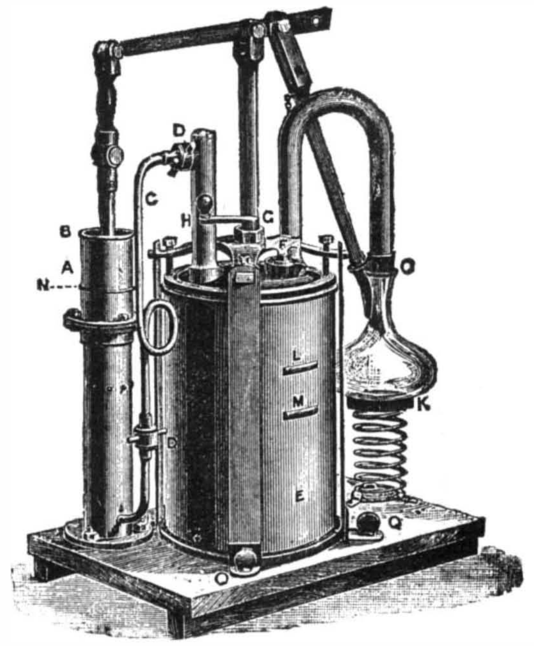


FIG. 1.—SMALL MACHINE.

flattened on the application of pressure by the screws, *j*, it follows that a liquid tight joint is made thereby which the sulphuric acid cannot pass, while the elastic ring makes an air tight joint around the outer circumference. In this way the elastic ring is protected from injury by the acid; and to still further insure tightness, the top of the absorber and the under side of the

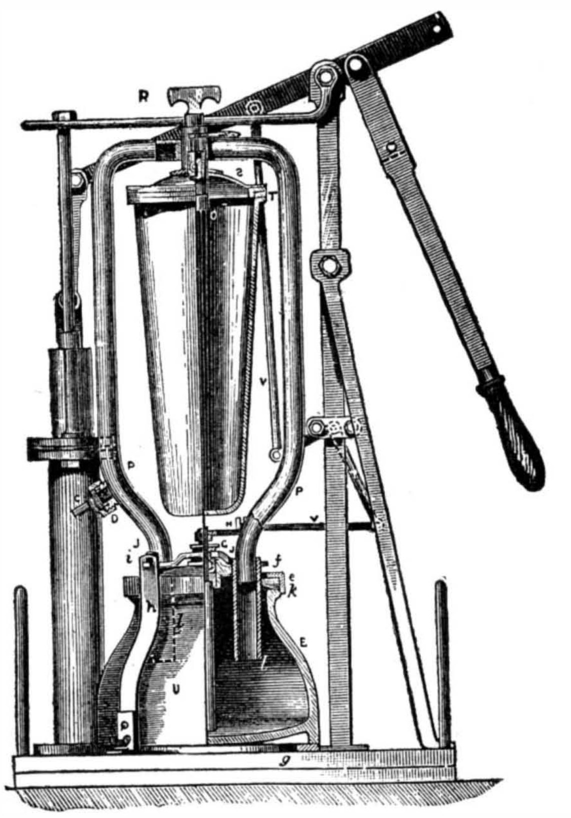
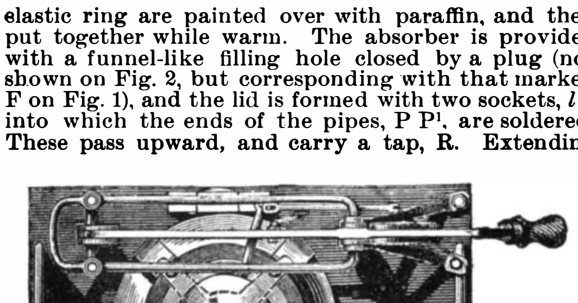


FIG. 2.—LARGE MACHINE.

elastic ring are painted over with paraffin, and then put together while warm. The absorber is provided with a funnel-like filling hole closed by a plug (not shown on Fig. 2, but corresponding with that marked F on Fig. 1), and the lid is formed with two sockets, *l l*, into which the ends of the pipes, P P¹, are soldered. These pass upward, and carry a tap, R. Extending



PLAN OF FIG. 2.

from the tap is a domed disk, S, which forms a lid or cover for the glass vessel containing the substance to be frozen, a ring of soft material at *r* insuring a tight joint. A nozzle, O, allows of the neck of a flask being substituted for the larger vessel shown. The tap, R, controls the communication between the interior of the vessel and the pipe, P, leading to the absorber, the pipe, P¹, being closed at the top and also at a point just above the entrance of the small suction pipe, C. The pipe, P, passes down to nearly the level of the acid in the absorber, so that all vapor may be brought into close proximity with the acid, and be rapidly absorbed thereby. The bell crank lever, T, and links, V V, work the agitator blade of lead, U, when the machine is in operation.

As this blade is mounted on a vertical spindle, an ordinary stuffing box, G, out of the reach of the acid, suffices. If it is desired to introduce the liquid to be frozen in small quantities from a jar or other receptacle, the small auxiliary tap, X, is used for the purpose, a piece of tubing serving to put it in communication with the jar. By this means layer after layer of water or other liquid can be frozen in less time than would suffice to freeze an equal quantity in bulk.

The machine shown in Fig. 1 differs from the one previously described in some respects. It is of smaller capacity, and in it the agitator is worked by the handle, H, from time to time as required, and not from the main handle. Normally, the acid stands at the level, M, and when, by absorption of the aqueous vapor, it reaches the level, L, it must be replenished. Though shown with a flask attached, a disk, and auxiliary tap arrangement, similar to S and X of Fig. 2, can be attached to the nozzle, Q. Approximately, the

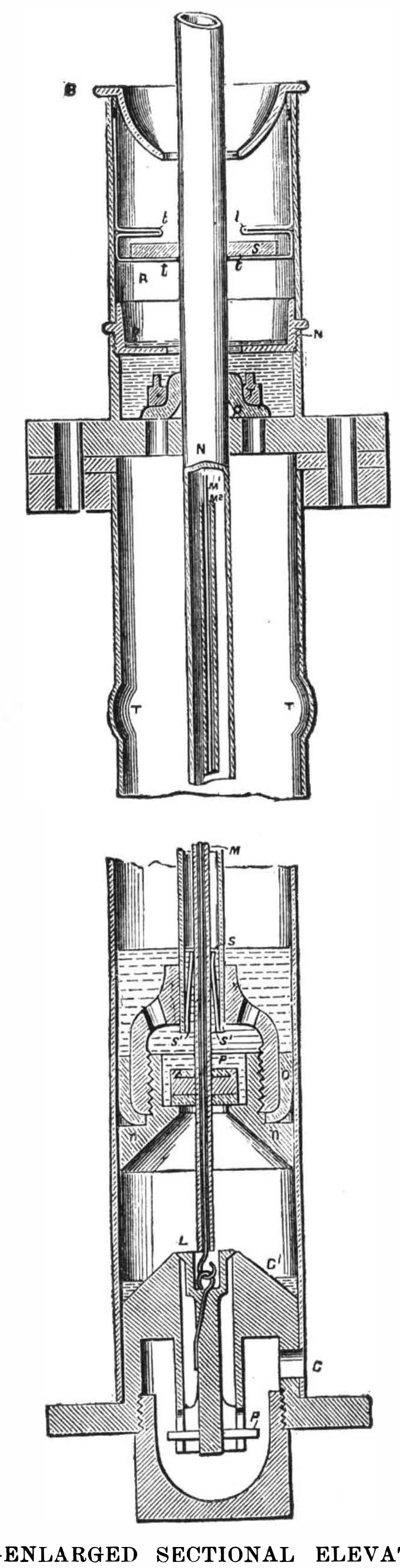


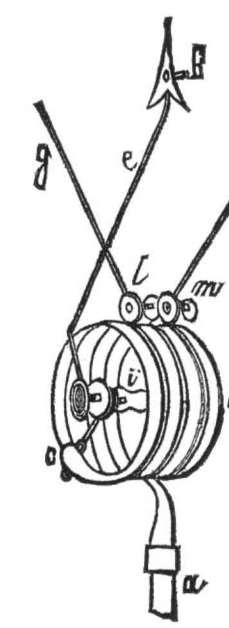
FIG. 3.—ENLARGED SECTIONAL ELEVATION OF AIR PUMP

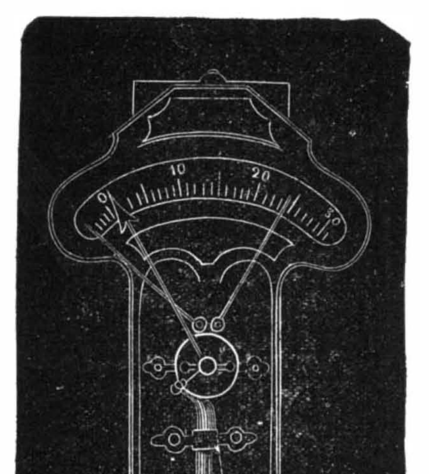
larger machine will freeze a pint of water in two minutes, or it will reduce the temperature of a pint of water sufficiently low for ordinary drinking purposes in from forty to sixty seconds. The smaller machine has about half this capacity. In either machine one charge of acid serves for about 100 freezings.

The *modus operandi* and principles of construction of the air pump, Fig. 3, will be best explained by considering one complete cycle of its action. Assuming the piston, *n*, to be on its down stroke, and the three-winged suction valve, L, to be closed, as shown, the hollow cone forming the bottom of the piston fits accurately down on the cone of which the valve, L, is the apex, and forces all the air, and after it the oil in the annular gutter, C¹, up through the valve, P. Thus all the air is effectually expelled from below the piston. The piston now commences its up stroke, drawn by the hollow piston rod, N, and the suction valve is lifted by the hooked wire, M¹, soldered to the tubular rod, M, at M². The lower end of the hollow piston rod, N, is provided with spring clips, *s s*, which gripe the rod, M, sufficiently to lift the suction valve during the up stroke of the piston, a cross pin, P, limiting the lift. At a point just before the piston reaches the top of its stroke, the clips, *s s*, pass beyond the top of the rod, M, and the valve falls into its seat. At the same time that the valve falls, the cavities, T T, formed in the pump cylinder, fill with some of the oil from above the piston, and on the still ascending piston uncovering these cavities the oil therein flows down into the gutter, C¹, ready for the next down stroke. The piston now forces the oil above it, and with it all trace of air, past the delivery valve, Q, and the up stroke is thereby completed. The delivery valve, Q, also serves as a stuffing box, and thus not only reduces the friction on the piston rod, but also does away with the necessity for accurate fiting that would otherwise exist. As will be seen, this valve consists of a disk of leather, formed as a hydraulic collar, and a metal ring, T. The latter serves to retain the leather in shape, and also acts as a weight. An oil chamber, R, surmounting the cylinder, insures the delivery valve being always covered with oil; while the disk, R¹, prevents the valve being lifted too high, and also checks the upward column of oil. To prevent any oil being splashed out at the top of the pump, the piston rod is made to pass through a disk of leather, S, placed between two stops, *t t*, carried by the cover, B, dished as shown to still further insure that no oil shall be ejected from the chamber. The valve, P, consists of a leather disk surmounted by a recessed metallic piston carrying a second disk of leather. The piston, *n*, has a deep leather packing, O, while the seat of the suction valve, L, is faced with kid; and as all these, together with the delivery valve, are constantly working in oil, it follows that friction is practically eliminated, and that great pliability of the various leathers, and consequent tightness throughout the pump, is obtained. With this pump a Torricellian vacuum can be obtained, and maintained without any further operation of the pump for a lengthened period of time. The machines can be seen in operation at the American Exhibition, Earl's Court.—*The Engineer*.

METALLIC THERMOMETER, FERNAIS' SYSTEM.

THIS apparatus is based on the principle of Bourdon's manometer. It consists of a brass tube, *a*, with very thin walls, about 30 cent. (12 inches) long, wound in a





spiral and filled with a suitably prepared oil. Under the influence of heat the oil expands, opening the spiral, which, by means of a lever, *c*, moves the index, *e*, the indications of which are read upon a graduated quadrant.

Two additional indices, *g* and *h*, respectively, movable about the centers, *l* and *m*, are acted on by the pin, *f*, of the index, *e*, and indicate the greatest displacements of the needle, *e*; *h* indicates the maximum and *g* the minimum. If *h* and *g* are of brass, they may serve to establish an electric circuit, throwing a bell into action at any desired temperature. The contact is thus produced at any desired temperature, and the range can be comprised within two points of the thermometric scale as near each other as desirable.

This apparatus therefore can be used to control the

temperature in mills, sugar houses, boiler houses, and the like. It may act as an indicator of light, as the temperature near a source of light diminishes when the light ceases.

It can also serve as an ordinary thermometer. If the two indices, *g* and *h*, are added, it becomes a maximum and minimum thermometer, and availing ourselves of the metallic contact, we may make it a temperature annunciator and a *fire alarm*.

This is the account given of it in the *Journal de la Meunerie*. In addition, we may observe that the metallic thermometer is really susceptible of many useful applications. As a simple indicator of temperature, it will never have the accuracy of the mercurial thermometer, because the flexible tube expands along with the thermometric liquid, in proportions that cannot be controlled. But as an *industrial thermometer*, we do not hesitate to recommend it to all who desire to control the temperature between limits practically exact.

The well known law of Joule enunciates that a current of electricity of intensity, I, produces in a wire of resistance, R, in the time, *t*, a quantity of heat expressed in this equation :

$$H = \frac{I}{A} I^2 R t$$

It might be possible to use the metallic thermometer as an amperemeter, surrounding the bulb with a coil of known resistance. The heat produced in the coil is always proportional to the intensity of the current, and hence the scale might be graduated in degrees of current intensity, instead of thermometric degrees.—*U. Bagnoli, in L'Elettricita.*

NEW GAS GENERATING BLAST LAMP AND BLOWPIPE.

New Gas Generating Blast Lamp.—The gas generating blast lamp in which naphtha is used as combustible presents features of absolute safety as regards explosion, economy of fuel, and durability. The flame itself can be moderated by a valve—something unattained in previous constructions. The lamp can be used on work in the open air in the strongest wind without danger of extinction.

The new gas generating blast lamp has the following construction (see Fig. 1) :

At *a* the body is filled with naphtha, which is absorbed by a quantity of wick contained therein. By burning a little spirit or naphtha in the groove, *b*, the naphtha absorbed by the wick is heated and converted into vapor, which, when the thumb cock, *c*, is unscrewed, rushes out through a small nozzle and is lighted at the opening, *d*. By the cock, *c*, the size of the flame is regulated. The longer the lamp burns the more intense becomes the flame, as the naphtha is more highly heated. The pressure in the lamp never exceeds 1¼ atmospheres, even when the lamp has burned down to the last drop of naphtha. If from any cause whatever heat should act upon the lamp from outside, as in the boiling over of resin, pitch, etc., and the pressure in the reservoir of the lamp should exceed five atmospheres, the arched bottom springs outward, and the conical plug attached to the bottom with lead and to the top by tin solder provides an opening, out of which it is pulled, and through which the gas can slowly escape, thus avoiding the danger of an explosion. The collar, *e*, is for shutting off or increasing the air as desired, and must in the open air be pushed down by the operative; this prevents the extinction of the flame, and accordingly is provided so that the lamp can be used in the strongest wind. With one filling, costing 16 pfennigs, one can work for four hours without intermission, bringing the cost down to 4 pfennigs an hour. This is calculated for a fully opened valve. If the flame is regulated to a smaller size, the consumption

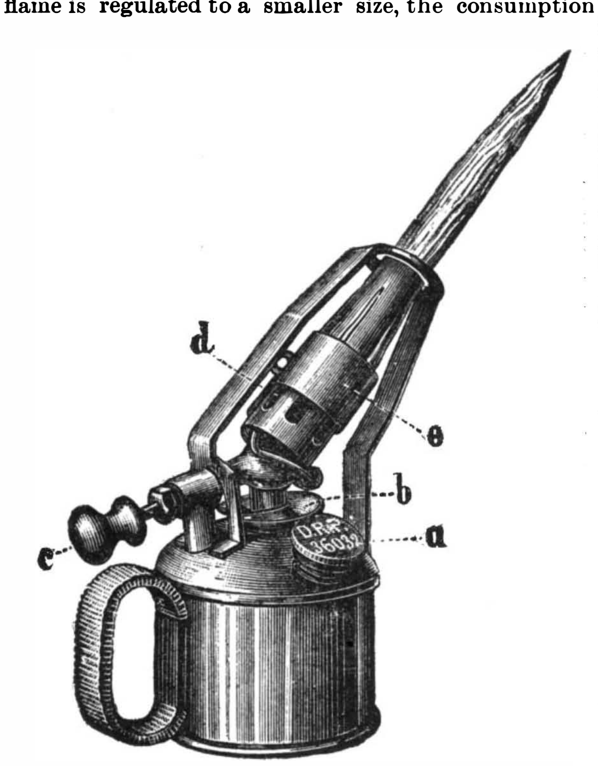


Fig. 1.

of naphtha is naturally reduced. Repairs are hardly ever required.

The new gas generating blast lamp is extremely useful to gas fitters and plumbers (for soldering as well as for thawing out frozen pipes), to coppersmiths, tinsmiths, electric linemen, cabinet makers (for soldering band saw blades), to ship builders, lacquerers, in all workshops (for heating small articles), as well as in laboratories (for chemical uses). For the last named purposes the lamp is made with an upright burner tube.

New Gas Generating Blowpipe.—This instrument is constructed on the same principles as the blast lamp. At *a* the hollow shaft is filled with naphtha. By heating the portion, *b*, over a little basin in which spirit or naphtha is burning, the naphtha absorbed by a wick in the tubular handle is changed into gas, which issues from a small nozzle in the handle, opened by unscrewing the valve, *c*. The gas is lighted at the opening, *d*, and the flame is regulated by the valve, *c*. In five to six minutes the apparatus can be used for soldering. The collar, *e*, serves for regulating the admission of

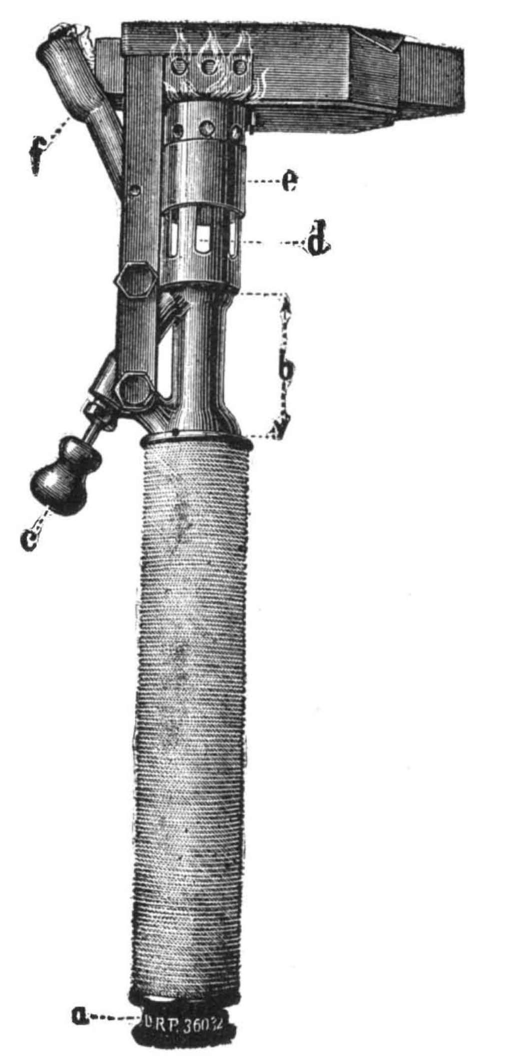


Fig. 2.

air. The tongue, *f*, hinders the flowing back of the flame and also serves to secure the collar, *e*.—*Deutsche Industrie Zeitung.*

MANUFACTURE OF COTTON THREADS.

At the mills of the Lee Spinning Co., Sunnyside mills, Rumworth, Bolton, England, and at Black Lane, Radcliffe, the cotton for thread is spun ; at the Dan Lane mills, Atherton, it is doubled and wound ; and at the Cornbrook works, Manchester, it is spooled and packed. The mills at Rumworth have 72,000 spindles, those at Black Lane 60,000, and those at Atherton 45,000 ; while the engines employed aggregate more than 2,000 horse power at Rumworth, about 1,000 at Atherton, and about 700 at Black Lane. At the same time the firm's extensive business as manufacturers of fancy cotton and other goods goes on, the production of sewing cotton being a branch which so vast a concern has not only special facilities for entering upon, but one the products of which they have also special means of placing in every shop in the remotest parts of the world.

A volume might be written upon the Sunnyside mills alone; they are in every respect model mills, and the most perfectly organized concern we have ever seen. For rapid, efficient, and economical production, under complete and easy control, they stand supreme.

Threads are spun from the long stapled Sea Island or Egyptian varieties ; and in our visits to the mills above named our attention was first directed to the large quantities of raw material in bales as it arrives in this country, each bale weighing about 600 lb. Placed in cool, fire proof stores, these are opened, weighed, and examined. In strength, length of fiber, and beauty of staple the cotton exposed to view promises well for the production of the best sewing threads. And as we follow it through the preliminary processes these appearances improve. The first of these, all of which are carried on at the Sunnyside and at the Black Lane mills, is "opening," that is, the cotton must be relieved from the tangled and knotted state in which it leaves the bales. This is done by machines known as "blowers" or "openers." The hard lumps of cotton are fed in at one side by a combination of rollers. They are struck several times by revolving blades or teeth. The fiber is loosened, the dirt is disengaged, while the draught caused by a fan carries the cotton forward to a "scutching" machine. This effects a further loosening of the cotton until it is in a fleecy state, all dust and dirt being blown out of it. It is then formed into a roll or "lap" and is ready for the carding engines. These processes are carried on in the Sunnyside mills not far from the stores in which we see hundreds of bales recently received from Egypt. And here, as throughout the entire works, the greatest order and cleanliness prevail. Ample space, light, and ventilation are provided ; and the visitor may pass from one end of the premises to the other without seeing even the slightest waste of material and scarcely a speck of dust—apart from the snowy flakes of cotton which in certain processes are driven into the air.

We pass along stone corridors and up stone staircases into large and lofty floors, measuring more than 100 feet in width, and with windows far more numerous and larger in proportion than those of any dwelling house, and see everywhere busy throngs of women and girls, who in point of physique and good looks are superior to those in our large towns, and whose general appearance and expression augurs contentment and an assurance of work. Neither the "mill look" of some Lancashire districts nor the slovenliness of the Cockney are to be met with. A quiet sense of order and respectability prevails. And this is accounted for by the care with which the operatives are chosen, the means taken for their general education, and the fact that never yet in the history of the firm have the work people at Sunnyside been put upon "short time," or endured the misery and privations of a strike or lockout. But of these and similar matters we propose do deal fully when describing the firm's mills generally. Let us now follow the cotton for sewing thread to the carding engines.

Leaving the numerous machines engaged in opening and lapping, and the long rows of bales in cool and shady stores, we pass to the carding house—one of the noisiest in the buildings. And here let us premise that we shall not attempt to deal sectionally with the different floors on which the various processes are carried out—the shortest and clearest method will be to sketch briefly the manner in which the raw material is dealt with, stating only that each department is fully occupied, and that in many instances several rooms or buildings are set apart for a duplication of the same process.

But to go back to the laps and carding. The light and loose layers of clean cotton known as laps are carried to the carding engines. And if proper care or the best appliances have been used in feeding the cotton into the openers, the laps will be perfectly uniform in density and width. The fibers, however, are found lying in different directions. And it is the object of the carding engine to stretch them out and place them parallel to each other, in order that they may be afterward spun into a thread. Carding is, in brief, much like the combing of hair—all the fibers are placed in one direction, while the short and broken ones are taken out. In the machine this is done by a series of rollers, the surfaces of which are covered with "cards"—a "card" being a piece of leather or India-rubber or cloth studded with a multitudinous array of small wire pins, which seize a fiber and drag it out from the mass. When this has been done several times, the cylinders are found covered with a thin layer of cotton with the fibers in the required position. This cotton is then removed from the cylinders by a bar or "doffer," which, so to speak, scrapes it from the surface in a neat and deft manner, and draws it together sideways into a long band, technically called a "sliver." This falls into rows of tin cans. It is this sliver which has to be spun into yarn ready for doubling into sewing cotton.

In order to prepare it for the spinning frame, the sliver must be drawn out till it is the thickness of a quill, and this is done in machines known as drawing, slubbing, intermediate and finishing roving frames. In following the cotton from stage to stage, it cannot but be remarked how numerous and intricate are the processes by which so apparently simple an article as sewing cotton is produced. And it would strike the visitor as marvelous in passing such machinery as that employed at the Lee Spinning Company's mills how with all this elaboration sewing cotton can yet be placed upon the market at a prices easily within the reach of every class. But the secret of the cheap rates now prevailing is the enormous quantities produced simultaneously. When our great-grandmothers sat at their spinning wheels, they made but one thread at a time. Now one little girl can watch a spinning frame or "mule" which makes automatically hundreds of threads at a time ; all that it is necessary to do is to feed the machine, to see that it does its work, and to mend any delicate threads which may break in the course of drawing out. Then, too, the marvelous improvement in the article made ! From the days of the distaff and spindle is not a very long period ; but compare the sewing thread of a hundred years ago with the beautifully finished six cord sewing cotton of the Lee Spinning Company of to-day ! How enormous is the difference in appearance ! and the difference in price may be inferred from the fact that in 1786 the price of 1 lb. of yarn containing 100 hanks was 38*s.* ; at the present day such cotton yarn can be bought for 2*s.* 6*d.* Before the invention of the mule few spinners could make yarn of 200 hanks to the pound (the hank being always 840 yards), though the natives of India wove yarn by hand of numbers ranging from 300 to 400. Now, however, our manufacturers have so perfected spinning machinery that they can spin for weaving purposes number 700 ; the greatest tenuity reached was 10,000, a pound of which would reach nearly 5,000 miles, but this was done to test the perfection of the machinery. The art of mechanical invention from the steam engine to the self-actor mule, the division of labor, and the rapid treatment of large quantities of material have alone made this possible.

Passing through room after room filled with drawing frames, we stopped after a while to see the cotton sliver again, and to examine its changed appearance. It has been drawn and doubled repeatedly—that is, six ends or slivers have been put together, and drawn down into one sliver by being passed between a series of rollers. The slivers thus made are "doubled" again in the same way, six of them being again drawn into one.

The general reader will be able to understand from this how closely the fibers are made to lie and how the sliver can therefore be drawn into greater length. After this comes the "slubbing" operation, in the course of which the sliver has a certain amount of twist given to it, and is wound upon a bobbin or large reel. The next stage reached is the intermediate frame. This resembles that for slubbing, but has a larger number of spindles and smaller sized bobbins. It is called the "intermediate" because it comes between the slubbing and roving frames ; but it is only used for certain numbers or counts of yarns, and may from a popular point of view be regarded as one of the drawing and twisting operations applied to the sliver. In the "roving" frames we see the cotton sliver for the last time before spinning strictly so called begins. The sliver now resembles a piece of loosely twisted cord, about one quarter of an inch in diameter. The roving frames complete the degree of elongation to be given ; they also twist it, and wind it upon the bobbins, which are taken away to the spinning mules—the class of machinery in the perfecting of which Samuel Crompton passed his life.

The lofty and wide building in which the mules with 72,000 spindles are placed—each mule being placed across the entire width—is perhaps the most important in the mills. And here we observe how the company are keeping to the front in the use of the most modern machinery, thus saving time, space, and labor, and adding to the high quality of the sewing cotton produced. Every stage of production is under constant and careful supervision, but none more than that of spinning; and the best efforts and the long experience of the heads of the company are devoted to insuring the perfection of the finished article. Starting with the best strong and long stapled cotton, the system is applied to its thorough cleaning and opening, to its uniform lapping, to its systematic cording, drawing, and roving, until it reaches the most important stage of spinning. At every point there are checks for the detection of flaws and the curtailment of waste, and by the time the roving reaches the mules it is as clean, uniform, and strong as it is possible to make it. In the spinning mills are such modern innovations as "ring" spinning, electric stop motion frames, and frames on which the yarn is wound into cops without the use of wood reels.

The principle of mule spinning, however, still remains the same. It has a traveling frame upon which the spindles are set. This frame is now made long enough to carry hundreds of spindles, and it gently draws out and twists the thread after it leaves the last pair of rollers; and when it has reached its limits—now several yards, but in Crompton's time only five feet—it rapidly returns, winding up the spun thread on the spindles as it goes back. Ring spinning mules, about 100 feet long, are to be seen at the Sunnyside mills thus working their thousands of spindles, watched all the time by the keen eyes of the girls, who instantly discover broken threads and rejoin them while the machine is at work. It is in this process that some of the twist is put into the yarn—a quality upon which the value of sewing cotton greatly depends.

We now leave the Sunnyside mills, having seen the cotton from the bales made into thin filaments of great length wound upon bobbins or cops. To produce sewing cottons, these filaments or yarns must be doubled or trebled, *i. e.*, two or three single threads are twisted together; or if the famous six-cord sewing cotton is to be made, three of the doubled threads must be wound or twisted together in special machines. For the carrying out of these operations the Lee Spinning Company have set apart the Dan Lane mills at Atherton, a small town a few miles from Bolton. These are used entirely for doubling the yarns spun at Sunnyside and Black Lane; and here we find some of the most recent machinery adapted to the purpose in view. We first see the stocks of yarn in cops, and the new steam engine which the company have put down; and we then visit the rooms in which the doubling process goes on—two single yarns being twisted together to form one thread, which is used either for weaving or, and more often, for the making of sewing cottons. Several floors of the mill, in which the company have introduced great changes and improvements since it has been in their hands, are set apart for doubling. Each piece of yarn is passed through water in order that the fibers may be more firmly twisted together or "laid," and that they may be toughened. Clearing is another process carried on here. By this the yarn is "cleared" of any superfluous fiber or edges which may be hanging to it. Three or four threads from four cops are also twisted into one to make weft or thread. When the requisite number of threads has been twisted together, a second process of clearing is applied, which leaves the surface of the thread free from all loose filaments. When three yarns have been run into one, the thread produced is cleared, after which comes a process of rewinding. No trouble is spared to insure a very firm twisting of the yarns, whether of one or two threads; and the care with which the clearing processes are applied leaves no room for knots or for want of a uniform size from one end of the yarn or thread to the other. The thread is then reeled into hanks, in which form it is sent off to be dyed or bleached at the works of the company set apart for these processes. These applied, the threads in hanks are taken to the company's Cornbrook works, in Manchester. It is here that the finishing touches are given to it, and that it assumes the form of sewing cotton as generally known.

The first scene in the eventful history at Cornbrook is the winding room, the thread in the bleached or colored state being wound by machinery from the hanks to large bobbins, from which it is again wound upon the small reel of commerce. This is done chiefly by a set of patented machines, automatic in their action, and among the most ingenious labor-saving machines of modern times. Not only does the machine wind the cotton upon the reel, but immediately the requisite quantity has been put on—be it 100, 200, or 400 yards—the motion as regards that particular reel ceases, the thread is cut, the reel is notched, the end of the thread is pulled into place; and the filled reel ready for the salesman's hands is thrown out, while another empty reel is put into the place of the filled reel. All that the girl operative has to do is to keep up the supply of reels, and to insert fresh filled bobbins when those in the machine are empty; but as these bobbins are large enough to contain about 10,000 yards each, this is not often required. Spooling is also done by girls at single working machines equally automatic in their action. The wood in each reel is neatly polished and the thread receives a certain finish by being pressed down upon the reel by a kind of steel finger or pointer which guides it into its position. The company's three cord *glace* receives, as its name implies, a high finish; but the six-cord is wound upon the reels as it comes from the dyer or bleacher, a form in which it retains its greatest suppleness and strength. The reels filled, the lengths are tested, the company guaranteeing each to contain a certain length, either 100, 150, 200, 300, to 400 yards. All errors rectified by the readjustments of the machinery, the reels or spools are passed on to the labeling room and packing rooms, where a handsome label bearing the company's trade mark—a mastiff dog—is affixed. The cotton is also wound upon pieces of cardboard to suit the requirements of particular markets.—*British Trade Journal.*

TO REMOVE FRECKLES.—Scrape horse-radish into a cup of cold sour milk, let stand twelve hours, strain, and apply two or three times a day.

MILITARY VELOCIPEDISTS.

THE art of war is now borrowing from applied science all the resources that are at the latter's disposal, and there is nothing up to velocipedism that is not contributing to the service of the army. For a few years past, the Germans have been using the velocipede for the rapid carriage of dispatches, and, on this side of the Vosges, we have not neglected to put to profit the advantages of an analogous service, a corps of velocipedists having been organized in our army. The type of apparatus adopted is the bicycle, such as is seen in Fig 1, which shows an army velocipedist, during the period of a campaign, commissioned with the quick carriage of an urgent dispatch.

Our neighbors across the channel have gone beyond such a use of the velocipede for dispatch sending, and have endeavored to use it for the carriage of ammunition. A very curious experiment of this kind was very recently made at London with a multicycle apparatus constructed by a Mr. Singer.

This truly curious apparatus is shown in Fig. 2, which we borrow from the London *Graphic*. It consists of a series of bicycles, six in number, each carrying two men, and hauling a small vehicle loaded with ammunition. The bicycles are arranged in a single file, instead of being two or four abreast, thus much facilitating the operation of the apparatus, and diminishing the surface of resistance to the wind. The speed on a good road varies from 9½ to 15 miles per hour. The rubber tires are made in such a way as to secure them from being injured, even on roads that are somewhat stony.

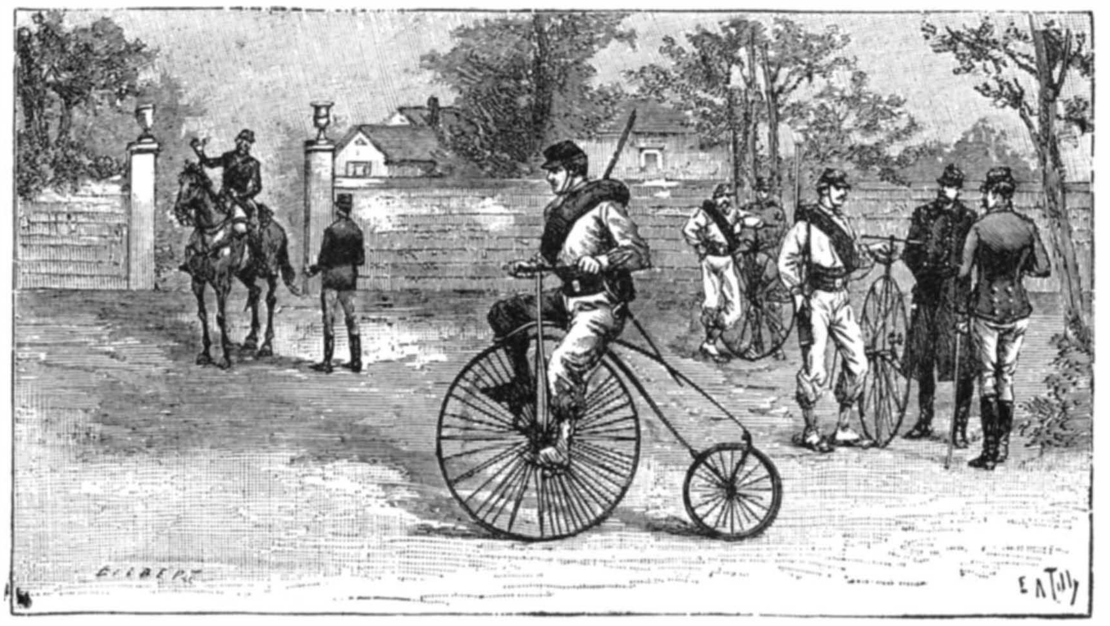


FIG. 1.—FRENCH MILITARY VELOCIPEDISTS.

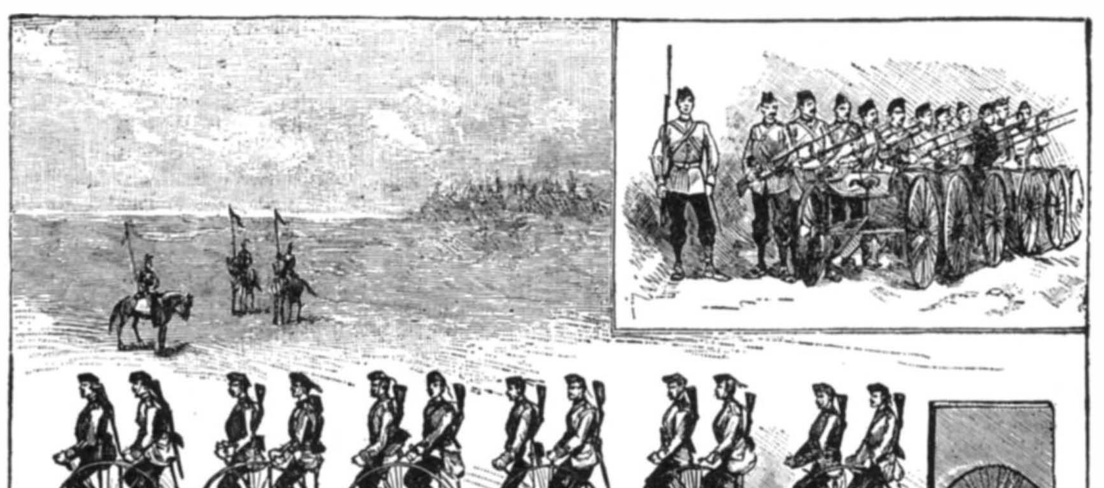


FIG. 2.—USE OF VELOCIPEDES IN THE ENGLISH ARMY.

The starting of the whole is under control of the man who sits in front. Last month the affair was run through one of the most frequented streets of London, and was found to turn easily in a much more circumscribed space than could have been done by an ordinary carriage, and to run with great speed through the streets without any accident resulting.

The body of men selected to maneuver this multicycle consists of experienced volunteers, who are capable, in addition, of going through all military evolutions.—*La Nature.*

THE ELECTRO-DEPOSITION OF IRON.*

By Professor W. CHANDLER ROBERTS-AUSTEN, F.R.S.

THE great interest which would attend the investigation of the properties of pure iron has long been recognized, and although but few results have as yet been obtained, elaborate preparations for such an inquiry have from time to time been made.

A committee appointed by the British Association described, in 1869, a method which yielded iron of a high degree of purity, the work being intrusted to the late Professor Matthiessen, who ignited pure ferrous sulphate, mixed with sodium sulphate, reduced to oxide of iron, so obtained by pure hydrogen, and melted the spongy iron in a lime crucible before the oxy-hydrogen blowpipe. The committee reported that, "with regard to the physical properties of pure iron, owing to the want of time, nothing has as yet been accurately determined."

It appears, however, that many of the physical properties of the pure metal differ considerably from those of the commercial. The work appears to have been interrupted by Matthiessen's lamented death, which occurred in the following year. It may be that metallurgists have been satisfied that Bessemer metal is sufficiently pure to afford a basis for investigation without resorting to elaborate chemical methods of preparation, for but little has hitherto been done to prepare on a large scale a material in which the above mentioned impurities are entirely absent. The volume of the reports of the British Association to which reference has just been made also embodies a paper by M. H. Jacobi, of St. Petersburg, whose name is so well known in connection with electro-metallurgy. M. H. Jacobi and M. Eugene Klein took out a patent in this country in 1869 (No. 2,456), which was, however, allowed to lapse. Jacobi worked for some days in the mint laboratory, and communicated to me the details of the methods of manipulation, and in 1870 I visited St. Petersburg, and had the advantage of seeing the iron deposited on a large scale with a view to the preparation of plates to be used for printing the paper money of Russia.

The deposition of iron is attended with many difficulties, and in this country, so far as I know, iron has only been deposited electrolytically on a very small scale, and the metal deposited has been considered rather a metallurgical curiosity than as possessing any practical value. It may be well to describe briefly the method of procedure.

"The bath used is a solution of ferrous sulphate and magnesium sulphate in equivalent proportions of specific gravity 1·155.

"The solution must be so far neutralized by the addition of magnesium carbonate that blue litmus paper barely shows any acid reaction. A wrought iron anode of about the same size as the object which is to receive the deposit must be employed, and the best interval between the poles proved to be 4 cm. The secret of success appears to be in the use of very feeble currents. Mr. W. H. Preece, F.R.S., Electrician to the Post Office, has kindly afforded me facilities for determining the strength of the currents employed, and it may be sufficient to state that the current best suited for the deposition of an iron medallion the surface of which measured 560 sq. cm. proved to have a strength of only 0·089 ampere, and such a current was yielded by two Smee's cells, each having a silver plate of 50 sq. cm. area coupled up for intensity. The only objection to the process is the length of time required for its completion.

"It was not found possible to deposit such a medallion of sufficient thickness for use in the reducing machine in less than three weeks. The adherence of the de

* From a paper recently read before the Iron and Steel Institute, London.

posited iron to the surface of the copper gives rise to considerable difficulty in detaching it, and in order to reduce this adherence it was found best to throw down on the copper model a thin film of nickel, and after exposing this for a short time to the air in order to slightly tarnish its surface to cover it with a second film of nickel, on which the iron was subsequently deposited. Even when this precaution was taken, several moulds were spoilt by partial adherence of the iron and copper through the nickel.

"I am now conducting some experiments on the deposition of iron on copper moulds covered with a thin layer of silver iodide, that substance being well known as an excellent conductor." The metal has a high degree of purity. Mr. A. Dingham, a skillful analyst in my laboratory at the Royal School of Mines, finds that a specimen submitted to certain physical tests, to which reference will be made presently, contained only the slightest trace of magnesium and 0·005 per cent. of sulphur. Its density is 7·675, which becomes 7·811 when the metal is annealed. By annealing carefully measured strips of metal they were found to contract about 1 per cent. of their length. I found in 1869 that the metal as deposited occludes from 17 to 20 times its volume of hydrogen. Cailletet showed that iron deposited under certain conditions occludes 248 times its volume of hydrogen, the pressure of which gas renders the metal very hard and augments considerably its coercive force when magnetized.

Notwithstanding the purity of the metal, its magnetic capacity does not appear to be high. Tested by the magnetic balance designed by Professor Hughes, it would appear to possess less than two-thirds the magnetic capacity of a strip of Russian sheet of the same dimensions. The magnetic capacity of the strip of electro-iron rises considerably when the metal is annealed, which tends to show that the defective magnetic quality is due to the aggregation of the metal, and not to impurity, as well as to the partial expulsion of the occluded gas. With a view, however, to set this important question of magnetic influence at rest, I have deposited a carefully turned rod of copper, 1·01 foot in length, 0·511 inch in diameter, and of a maximum thickness of 0·035 inch. Dr. John Hopkins having expressed a wish to conduct some experiments in this direction, the rod (now exhibited) will be placed in his hands.

From the point of view of its molecular structure the electro-deposited iron promises to afford interesting experimental results. Strips of the iron about 5·4 inches in length, 0·033 inch in thickness, and 0·75 inch in breadth, were tested for tensile strength. It was found that the deposited metal crushed in the jaws of the machine, and it was therefore necessary to anneal the ends of the test piece before submitting it to stress. A piece of deposited iron so treated broke in the center of the strip with a load of 2·7 tons per square inch. A similar strip annealed at the temperature of molten zinc (about 412° C.) was found to possess a tensile strength of 13½ tons per square inch, and another piece annealed at a temperature between the melting point of silver (940° C.) and that of the melting point of aluminum (about 300° C.) had a tenacity of 15½ tons per square inch, two separate experiments agreeing very closely. The elongation was in each case very small, and very delicate instruments would be required to determine its amount with accuracy. It will thus in future experiments be possible to examine by photographic methods, described by Mr. Sorby, the change in structure of a pure, brittle, and non-coherent metal to one having a considerable tenacity.

The use of electro-deposited iron for printing purposes has already been mentioned. One other application remains to be described.

Many years ago I suggested that electro deposits of iron should be employed with a view to test the capabilities of a machine devised for reducing designs modeled in low relief, and the reproductions in metal and ivory were so faithful that the superiority of such iron deposits to the metal casts or copper electrotype ordinarily employed was at once demonstrated.

The preparation of the dies for the coins to be struck on the occasion of the jubilee of her Majesty the Queen presented a favorable opportunity for the more extended application of similar deposits of iron. The designs modeled in plaster were reproduced in "intaglio" by the electrolytic deposition of copper, and on the copper moulds so prepared iron was deposited. The iron proved to be hard and of excellent quality, and up to the date of this paper obverse dies of all denominations of gold and silver coin, as well as the obverse of a medal, have been produced by a reducing machine from such deposits.

If they were to take a plate of copper and deposit on it a layer of iron, then glue to the back of the iron a piece of wood, and wrest the iron away from the copper, the iron did not separate cleanly, but the iron slipped off copper, just as it was asserted that a bank-note could be split by gluing it between two surfaces of wood. What this meant he did not at present know, but it was a question that he was investigating. The paper was by no means in a state in which he could have wished to present to the Institute; but he thought that the interest attached to the exhibition for the first time in London of a medallion, and that medallion in iron, and a portrait of her Majesty, was likely to be of far more interest to the members of the Institute than any remarks he could have to offer in the interval between now and the next meeting.

AN ELECTRIC VENDER.

IT is remarkable to see with what rapidity ideas sown in the field of applied science develop and are improved upon. A few years ago we gave a description of the curious automatic money boxes that were seen in operation at the London and Paris exhibitions. It was only necessary to throw a coin into the box to set in operation a little mechanical scene, in which the moving puppets always delighted the children. The sum thus collected was generally devoted to some charitable work. After this appeared the money-box scales that showed one's weight when he stepped on the platform of the apparatus and dropped a coin into the box. These scales are now meeting with much success, and are to be seen all over in places where there is much passing. From these to distributers, that is to say, to apparatus that deliver an object, such as a box of marbles, a postal card, etc., in consideration of a coin representing the value of it, there was but little progress to be made. Such progress has been made, and is shown in the form of many apparatus that are more or less ingenious and more or less well conceived.

Not long ago, we described an English distributer of postal cards and letter paper. There is a large number of analogous devices. Some of these will deliver a ticket that contributes to a savings bank lottery, and others give a box of notches, etc. It is certain that these apparatus, which are genuine automatic *venders*, are capable of rendering great services in large cities, and of being applied to many uses.

We shall now call attention to a new distributer of this kind, which is widely scattered throughout the streets of Paris. This apparatus, which was invented by Mr. Brunet, is used for distributing the *Petit Journal*, in consideration of a sou, but is especially used for distributing little ten centime boxes of candy.

FIG. 1.

This device is a great improvement upon its predecessors, so we think it of interest to describe it. The apparatus is applicable to the selling of any object whose weight and bulk are constant, and the prices of which are 5, 10, and 50 centimes, and 1, 5, 10, and 20 francs, etc. While other distributers operate through a more or less ingenious and improved mechanism, the Brunet apparatus operates through an electric ungearing that occurs when the money is paid. One point that is important to note is that this distributer is the first, and the only one up to the present, that operates itself. As soon as the proper coin is dropped into the box, it passes out the goods sold, while in all other existing distributers, the customer, after depositing his money, must himself either pull out a drawer containing the object sold, or actuate a lever, etc.; in a word, he must furnish the power necessary for the operation, and which the apparatus is incapable of producing of itself.

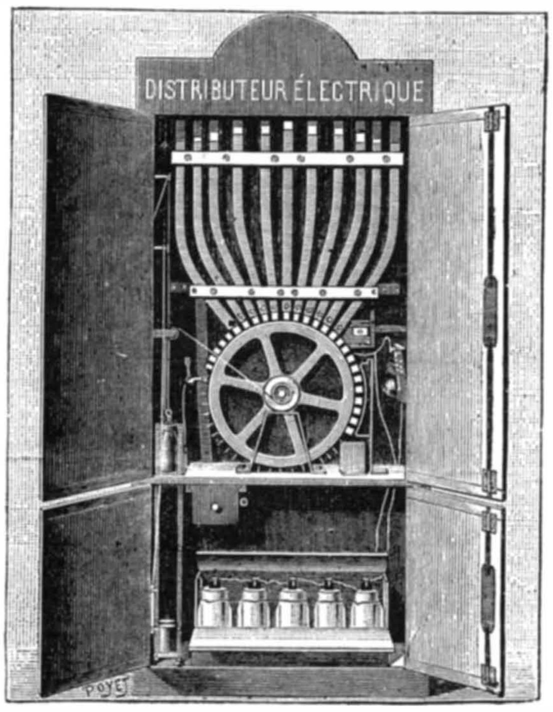


FIG. 2.

The electro-automatic distributer consists of a distributing wheel, provided at the circumference with boxes of equal size in which are placed the objects of constant bulk and weight. These latter are distributed in measure as the whole revolves. On another hand, there is a flat tube in which the money is placed, and in the center of which there are two contact points, the space between which is equal to the diameter of the coin. In the bottom of the apparatus there is a battery, the current from which is interrupted between these contact points.

If a ten centime piece be placed in the tube, it will drop to the points, and be held by them, and will thus close the circuit, and the current will pass through it and actuate the electro-magnet placed above the distributing wheel. The armature of the electro-magnet being attracted raises by its own prolongation the little click, which engages with one of the notches between a series of teeth on the rim of the wheel. This latter being freed, and being pulled by the weight of the packages to be distributed, begins to revolve, and allows of the escape of a package, which falls upon an inclined plane and slides outside.

It should be remarked that the point of contact is movable, and forms part of a copper elbow that vibrates, and one arm of which terminates in a rod placed in front of the divisions of the distributing wheel. As soon as the latter begins to revolve, one of its divisions lifts the rod, the elbow rotates, and the contact, moving, lets the coin drop into the box. The current is then interrupted, the armature is pulled back to its first position by a spiral spring, and the click again locks the wheel by engaging with the succeeding notch. The apparatus is thus at rest and ready to effect another distribution when another coin is introduced.

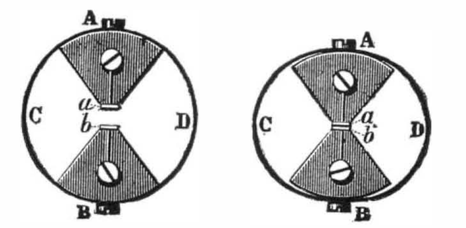
In addition, a series of tubes are placed over the wheel, and these are filled with packages which, by their weight, replenish the empty boxes beneath them. A weight, whose cord runs over a pulley, has the effect of increasing the velocity of revolution. A small door closes the aperture through which the money is introduced, as soon as the last package is distributed. Finally, an electric bell placed in the circuit announces the deposit of each coin.

Fig. 1 gives an external view of the distributer. A schoolboy is represented putting a coin into the box. The package of candy falls into a receptacle placed at the left, and beneath the letter P of the word *Pastilles*. Fig. 2 shows the internal mechanism of the distributer.

A NEW INTERRUPTER.

A VERY ingenious little interrupter has been invented by Mr. Bucknill, and is being manufactured by Messrs. Elliott Bros., of London. The contacts are mounted in the interior of an elastic ring, so that it is only necessary to exert a pressure upon the latter to establish a contact.

In the accompanying figure, A B C D represent a



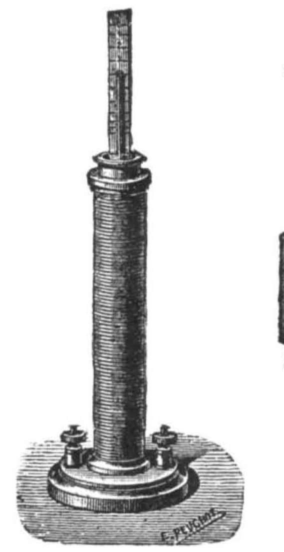
steel ring provided with pieces of ebonite, in the form of sectors, fixed to the opposite sides. These sectors are provided, at *a* and *b*, with a piece of platinum that communicates with the terminals, so as to form part of the electric circuit that is to be interrupted. When the ring is squeezed, as shown in the figure to the right, the contact is closed, while it is opened again when the ring has resumed its prior shape, as in the left hand figure.

The apparatus has been adopted by the department of war, for use in the army and navy in mining operations.—*La Lumiere Electrique.*

APPARATUS FOR MEASURING ELECTRIC CURRENTS.

APPARATUS for measuring electric currents which depend upon magnetic needles, or permanent magnets in general, for their working are objectionable because the magnetism of the magnets is constantly changing with time, tending always to decrease, and also because the magnetism of the earth varies with each locality in which the instrument is used.

The instrument about to be described has no permanent magnet, and is therefore free from the above



named fault. It is a kind of areometer, consisting of a number of iron wires inclosed in a metallic case, and is prolonged by a wire which extends upward and is straight, so that it can be clearly determined which mark on a scale it reaches. The areometer is held in a cylinder half filled with water, in which it sinks to a certain depth. To prevent it coming in contact with the walls of the cylinder, a ring is secured in the axis of the same, through which it rises and falls.

The cylinder containing the areometer is placed within a coil of copper wire. If a current of electricity is passed through the latter, the areometer moves according to the strength of the current, more or less downward, exhibiting a high degree of aperiodicity. In other words, it immediately attains a fixed position without many oscillations.

In the apparatus as constructed by Carpentier a depression of 10 cm. (4 in.) corresponds to an intensity of 10–25 amperes, or with suitable winding of the instrument as voltmeter, to a difference of potential of 100 volts.

The wire coil of the amperemeters contains one or two layers of very thick wire, with a resistance varying from $\frac{1}{100}$ to $\frac{8}{100}$ ohm. For voltmeters, the winding consists of many layers of very fine wire of a resistance of 1,700 ohms.—*Elektrotechnische Rundschau.*

NEW APPARATUS FOR ILLUSTRATING FOUCAULT'S CURRENTS.

By Dr. A. VON WALTENHOFEN.

AMONG the apparatus which I sent to the Vienna Exhibition of 1883 was my induction pendulum, with which I first carried out the conception of illustrating, in the most visible manner, the generation of Foucault's currents. This I effected by causing a copper pendulum to oscillate between the poles of a strong electro-magnet. This apparatus, which is described in Wiedemann's Annals, and in several electrical journals, has been much appreciated, and in Kittler's excellent "Text Book of Electricity" a sketch of the essential parts of my apparatus serves as explanatory diagram of the production of the Foucault currents.

A plate of copper forming the segment of an annular

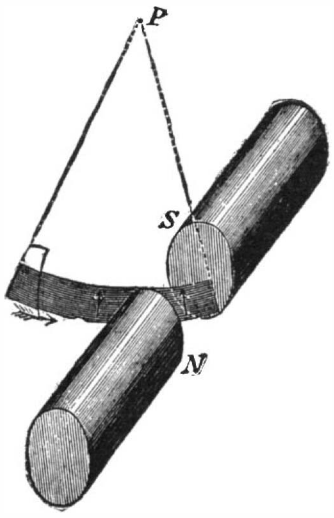


FIG. 1.

disk swings, representing a pendulum bob, between the poles of an electro-magnet (Fig. 1), and is brought quickly to rest from the state of oscillation as soon as the magnet is excited by a current. In my apparatus the plate of copper is 20 cm. (8 in.) long, 5 cm. (2 in.) broad, and 1 cm. (0·4 in.) thick. Professor Weinhold, in Chemnitz, showed me a specimen of my induction pendulum apparatus, constructed of much smaller dimensions, and told me that it answered perfectly for the exhibition of the induced currents alluded to.

In the meanwhile, I had thought over the possibility of constructing an apparatus which would show the reverse effect of that illustrated by the induction pendulum. In this new apparatus, which I now am about to describe, the inducing magnets swing in the form of a pendulum, and their oscillations are checked by a copper plate held stationary between their poles.

This copper plate forms the segment of a disk, the rest of which is composed of ebonite. If we turn the vertical disk through an angle of 180°, and clamp it fast in this position, then there is no copper between the poles of the swinging magnet, but only ebonite, an insulator, and no damping of the oscillations takes place. This, in brief, is the principle of the construction of the new apparatus. For more explicit illustrations Figs. 2 and 3 are given, the first of which gives the side view and the other the end view of the apparatus.

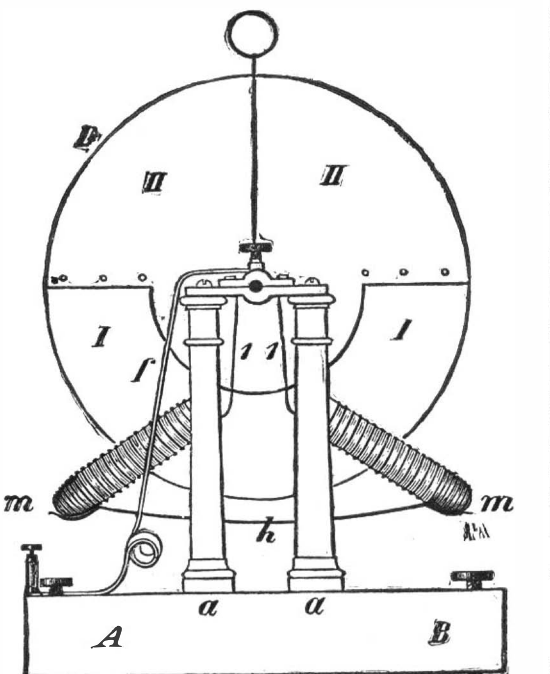


FIG. 2.

On a base, A B, provided with leveling screws, rest four columns, *a a* and *b b*, in pairs (*a a* in front of and *b b* behind the disk). These support a bearing on their top in which the disk, D, made of copper and ebonite, rotates. The segment, I I, is made of copper; the part, II II, is of ebonite. In my apparatus the disk is 40 cm. (16 in.) diameter and 1 cm. (0·4 in.) thick.

The journal box is provided with clamp screws, by which the axle of the disk may be clamped in any desired position, so that either the copper portion (which of course preponderates in weight) or the ebonite portion shall occupy the lowest position.

Upon the axle of the disk hangs a system consisting of two electro-magnets, whose form is best shown in Fig. 3. The iron core has the shape of an elliptically curved bar with a radial slit. The opposite parallel faces of the slit form opposing magnetic poles, whose distance apart is not much greater than the thickness of the disk, so that the disk, lying between the faces of the poles of the magnet, as it swings to and fro is not rubbed by, but is merely in contact therewith.

The magnets are united by a rod, *h*. From the two magnets, or rather from their encircling coils, proceed four wires. Two of these, marked 1 1 in the sketch, are connected with a copper ring carried by, but insulated from, the axle of the disk, which the spring, *f*, a conductor of the current, bears against. This rubbing contact is found on both sides of the disk, as an identical arrangement with the spring, *g*, exists on the other side of the disk. The contact springs, *f* and *g*, are connected to the binding screws, *i* and *k*, and are made of copper foil 3 mm. (0·12 in.) thick. The electro-magnets are wound with two layers of well insulated copper wire, rather more than 3 mm. thick, and, as follows from what has been already said, are wound in parallel. This brings both north poles on one side of the disk and both south poles on the other side.

The rings, *c* and *d*, to which the wires from the magnets are attached are lined with ebonite, and then are pushed over the axle of the disk, so as to slide upon it with very little friction. The magnet and connections, which to some extent resembles a pendulum, when drawn to one side far out of equilibrium and then released, starts swinging, which motion lasts for a long time, as the contact springs serving to conduct the current rest upon the rings so as only to produce a slight friction. If the magnetic pendulum (as we may call the oscillatory system of the two electro-magnets) is released, for instance falling from a horizontal position, it will only come to rest after fifty oscillations.

If the disk is placed and clamped in such a position that the ebonite portion is lowest, and if a strong current is passed through the coils of the magnet, the magnetic pendulum still will make fifty oscillations when dropped from a horizontal position. If the trial is repeated after the disk has been reversed and the copper portion brought underneath, the number of oscillations will be found much curtailed from their former number (on account of the electro-dynamic damping taking place in virtue of the Foucault currents established in the copper plate), and the swinging magnet will come to rest after a very few oscillations.

To make the oscillations and their diminution in frequency visible at a distance, on the front ring, *c*, a pointer is affixed which rises above the edge of the disk and carries a small red leaden disk on its end. This little disk, swinging with the magnets, makes their oscillations visible to a large audience.

An inconvenience attached to the use of this apparatus is due to the fact that a proportionately very strong magnetic power is required to produce a conspicuous damping effect. When the magnet itself is the pendulum, and must swing with the least possible friction, it becomes impracticable to use for the production of the magnetic field large masses of iron and copper. In this regard the essential features of an induction pendulum are more favorable, and permit easily the production of an almost instantaneous damping of the oscillations of the pendulum, while in the present apparatus, even when using a very strong current (about 40 amperes), I have only succeeded in reducing the number of swings one-half. If this point is kept strictly in view, it may be possible to obtain for the dimensions of the various parts more favorable conditions and relations.

If the magnet is kept stationary, and the disk is allowed to swing (owing to the eccentric location of its center of gravity toward the copper segment, it constitutes a pendulum), the damping by passage of an electric current naturally becomes also manifest.—*Elektrotechnische Rundschau.*

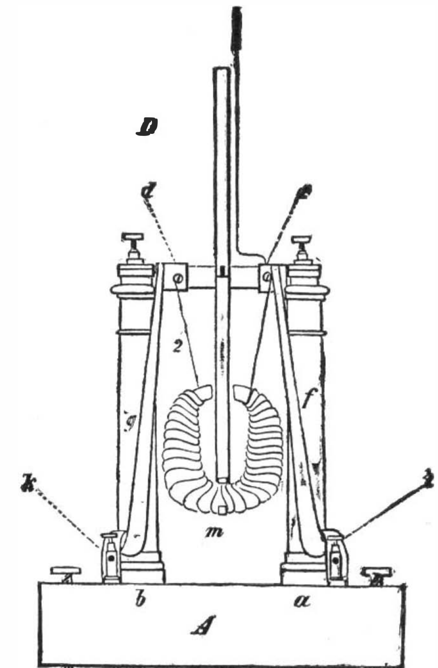


FIG. 3.

REMOVAL OF PAPILLOMA, PIGMENTARY MOLES, AND SUPERFLUOUS HAIR.

DR. J. W. CARPENTER, in a recent number of the Cincinnati *Lancet and Clinic*, discusses as follows the application of acetic acid in the removal of facial blemishes:

Various are the methods for removing defects and eradicating diseased excrescences in the early stages.

These methods vary in the ease of application, the time required, the amount of pain caused, and the nicety of the result.

To call forth an expression of the various ideas and especially experiences in this department is the object of the presentation of one simple method, with report of cases.

Though the weightier matter of grappling with disease and death occupies most of the physician's time, there are lesser ills, whose removal gives comfort, and where there is also an ample field for skill.

Warty growths, pigmentary moles, and superfluous hair in conspicuous places have sometimes given as much discomfort as Byron's club foot. And a patient is often as grateful for freedom from a defect as for being rescued from a dangerous typhoid fever.

Among the many remedies for such cases glacial acetic acid has some qualities that highly recommend it.

First, its caustic properties are superficial, it does not sink into the tissues, and thus the depth to which one wishes to penetrate can be easily controlled.

Second, it is painless when applied with proper care, the most that it causes being a little itching or very little smarting after the skin is broken.

Third, there seems to be no necessity for a resulting scar. In the many cases in which I have used it there was not left a mark of any kind, except in two, where, in spite of warning, the patient could not resist the temptation to pick at and pull off the little scab as it formed. A slight depression was the result.

The following reports will show the efficacy of this preparation in various affections.

Case first illustrates its use in pigmentary moles on the face, where nicety of result is the great desideratum.

A fine-looking young lady of the brunette type was annoyed by one of these discolorations on the cheek, a little in front of the ear. It was about the size of a ten cent piece, and a little elevated about the surrounding skin. The acid was painted upon the surface and not allowed to pass over the edges. After several applications with two to five minutes' interval, the upper part was softened sufficiently to be removed with a little pine stick. One more application was made, when the tissue was softened to the required depth and removed as before. When the level of the surrounding skin was reached, no more pigmentation remained. A thin scab formed, and when this fell off and the little resulting redness had disappeared, there was an even surface of skin of natural color. There was no scar nor any trace of the former mole.

When these discolorations are elevated above the skin, I have so far removed them in this way, leaving, as in the case reported, an even surface of natural color, and no scar. If they are simply discolored spots and not elevated, there is left necessarily a little depression, and when one prefers the slight depression to the pigmentation, they can be removed.

The second case shows the efficacy of this preparation in a different class of affections, viz., that of superfluous hair.

I was requested to remove quite a conspicuous beard from the chin of an otherwise fine-looking lady. This superfluity was easily disposed of in the following manner, taking out, of course, one hair at a time.

A little pine stick, sharpened to a very fine point, is dipped in the glacial acetic acid and applied to the skin by the side of one hair, this hair being put slightly on the stretch, either with the fingers or fine pincers. The skin, after touching it several times with an interval of a few moments between, is soon softened so that the point can enter the hair follicle. The hair then comes out easily, and another application is made, letting the point pass as deep into the follicle as it will.

Sometimes I have used the head of a needle for the last application, the eye of the needle holding the acid, which is thus carried to the bottom of the follicle.

About ten hairs were removed at a sitting, and when the work was completed the face presented a different aspect minus its appendages.

Of course, in removing many hairs close together there is some danger of changing the natural appearance of the integument from this fact. In destroying the hair follicle the sebaceous cyst is also often destroyed, and if many of these are wanting it gives a dry or even glazed appearance to the skin. This result follows no more from this method, however, than from any other, as electrolysis.

In this case the hairs, though coarse, long, and very conspicuous, were not so closely situated that enough of the sebaceous cysts were destroyed to change the texture of the skin. The soft, fine hairs were allowed to remain.

When the growth is fine and close together, electrolysis would be a better way, but when not too close, or in cases of isolated hairs, this means is very simple and efficient.

Case third represents another class in which this remedy is useful. Miss H. was the possessor of a curious little growth on the inner aspect of the thigh. This excrescence she wished removed because she feared it might increase in size, and also because with the dimensions it then had, it was often irritated by the clothing.

The general outline of the little tumor was spherical, with a diameter of ¾ of an inch, and it hung by a pedicle ¼ of an inch in diameter. The surface was corrugated, but smooth to the touch, and of a brown color.

The glacial acetic acid was applied around the pedicle with a little pointed pine stick, several times, with, as usual, a few moments' interval between, until the skin was softened and could be separated. As the patient had but little time to wait, this case was finished differently. A little strip of absorbent cotton, saturated with a two per cent. solution of cocaine, was placed around the pedicle and inserted between the edges of the severed skin. This was applied twice, waiting about a minute each time. The rest of the pedicle was then severed with the knife with the loss of about a teaspoonful of blood. The patient was not aware that the knife was used or one drop of blood lost, and the object was accomplished, viz., to remove the excrescence without any sensation to the patient. She expressed her appreciation of the method by saying she would not have known that anything had been done. No dressing was used, and no soreness resulted.

Inspection of the growth after removal showed it was not solid, and of a warty nature, but its bulk was made up of the thick corrugated walls of a little sac.

The inner surface was smooth and glistening, but the sac was not distended with any liquid.

On questioning the patient it could not be discovered that at any time it had contained fluid, as she said she was not aware of its ever having been different or larger previous to the day of removal.

Severing the skin first in this painless manner prepares the way for the use of cocaine and the knife, if it is preferred. When only the acid is used all bleeding is prevented, unless there are vessels of some size, and even then they may not always bleed.

Case four is one of more importance, and shows the safety of this remedy in a graver class of cases.

Mrs. A., aged about sixty, came to consult me about the removal of a large warty growth on the bridge of the nose. She feared it was either a cancer or would take on eventually a cancerous degeneration.

The growth had an almost circular base about three-fourths of an inch in diameter. The elevation at its highest part was half an inch. The surface was rough, cracked, and had bled at points. The whole was incircled by a hard inflamed ring.

To test the nature of the case, soothing applications were prescribed to be applied several times daily upon this ring to see how much the inflammation could be reduced. In three weeks the redness and hardness had so far disappeared as to make it seem safe to remove the growth by this method.

As a large scar in so prominent a place would be only less unsightly than the growth itself, it was necessary to proceed with caution. She being elderly and in rather feeble health, it was safest to test the healing power of the skin first by applying the acid to a very small part in the beginning. Accordingly it was applied at the base on the left side, and a separation of one sixteenth of an inch effected. No irritation was set up, and it healed perfectly.

After waiting nearly two weeks, the healing power of the skin having proved to be excellent, the removal was again begun, and a little done each day, until after a ten sittings the last part of the mass fell off. A scab formed over all the surface, and when this fell off there was healthy skin beneath. And when after a few weeks all redness had passed away, there was no scar nor the least trace of the former trouble.

The patient of course was extremely grateful to have that feature just as nature made it in the first place.

The face was watched carefully for any return of the growth, but the skin remained perfect until the patient died four years later of pneumonia.

Many vegetations of the skin, as small warts on the face, and those little excrescences on the neck and shoulders that hang by a little pedicle or are cone shaped and attached at the base, are easily and quickly removed in this way, and no soreness results.

The application is of course made at the point of attachment, as it is not necessary to soften the whole mass.

For protection, it is well to put a little soap on the surrounding skin.

For the large growths, if the patient is nervous or imaginatively sensitive, after the skin is broken, cocaine is applied, and then the process continued.

The various other means, electrolysis, solution of potassa fusa, concentrated lactic acid, etc., have their advantages and advocates. No one method is perhaps equally suited to all cases or succeeds equally well in all hands.

It is not meant to laud this plan above all others, but simply to mention it as one that is safe, painless, and can have a perfect result without a scar.

AURAMINE.

AURAMINE is the name given to a group of coloring matters which are obtained from tetramethyldiamidobenzophenone. This substance is now made on a large scale at Basle, in Switzerland, by the "Gesellschaft fur Chemische Industrie," by the action of phosgene gas ($COCl_2$) upon dimethylaniline. M. Kern, the chemist at this company's works, has succeeded in overcoming the difficulties attending the production of phosgene gas in large quantities, and has thereby enabled the manufacture of this new class of coloring matters to be produced at a profit. Another coloring matter, known under the name of crystallized violet, and consisting of hexamethylrosaniline hydrochlorate, is also obtained by the use of the same substance. The Badische Anilin und Soda Fabrik has also, within the last few years, been manufacturing the same class of compounds. Auramine is the hydrochlorate of a colorless base of the formula $C_{17}H_{24}N_3 . HCl+H_2O$, from which compound the base is obtained by the addition of an alkali. It can be prepared from tetramethyldiamidobenzophenone, the substance already referred to, by heating it with ammonium chloride and a dehydrating agent, such as chloride of zinc. M. Graebe, the professor of chemistry at Geneva, has recently investigated the reactions and constitution of these new bodies, and considers that the formula of auramine can be thus expressed—

$$C{=}NH<\begin{matrix}C_6H_4N(CH_3)_2\\C_6H_4N(CH_3)_2\end{matrix}$$

that is, it can be viewed as the phenone in which the oxygen of the group CO has been replaced by the imido group NH. Auramine is characterized by forming a yellow salt with iodide of potassium, not easily soluble in water, and also by an insoluble sulphocyanide. Solutions of the coloring matter have their color destroyed on heating with hydrochloric acid. Its reduction by sodium amalgam has also been studied, but full discussion of its properties must be reserved until the result of M. Graebe's further researches on this substance have been published.—*Industries.*

LOW TEMPERATURES.

PROFESSOR OLSZEWSKI has communicated to a recent number of the *Annalen der Physik und Chemie* the results of his experiments on the liquefaction of gases. The rapid advance in this direction of late years is due to the employment of liquid ethylene as a covering agent. It boils under ordinary atmospheric pressures at —102° C. and in vacuo at —150°, and with it Olszewski and Wroblewski, as well as Professor Dewar in this country, have succeeded in liquefying air in sufficient quantity to determine its boiling point and other physical constants. Liquid marsh gas has been suggested as a substitute for ethylene in these experiments, since it boils in air at a lower temperature than does ethylene in vacuo; while under reduced pressure the temperature is so low that it would probably liquefy oxygen without any compression. Professor Dewar has suggested a mixture of hydrogen and air, which can give a temperature of —200° C., instead of ethylene, when endeavoring to liquefy hydrogen. This gas has, however, been liquefied by Olszewski under a pressure of 190 atmospheres, when the cooling agent employed was oxygen boiling in vacuo. These low temperatures are recorded either by a hydrogen thermometer or by means of a thermo-electric couple of copper and German silver. The boiling points of the following gases under a pressure of 760 mm., according to Olszewski, are: Marsh gas —184°; oxygen —181·4°; nitrogen —194·4°; carbonic oxide —190°; nitric oxide —153 6°. The specific gravity of the liquid marsh gas under these conditions is 0·415, and of liquid oxygen 1·12. When allowed to evaporate under diminished pressure, the temperatures registered are still lower, *e. g.*, under 100 mm. p. oxygen gives a temperature of —194°, air —205°, and nitrogen —213°. The lowest temperature observed by Olszewski is that of nitrogen evaporating under a pressure of 4 mm., and is —225°, as recorded by a hydrogen thermometer. For lower temperatures than this the thermo-electric method will have to be resorted to, as the readings of the hydrogen thermometer will then become untrustworthy.

CONVEX PAPER CYLINDERS.

AN improvement has been made in which a barrel shaped form is given to the peripheries of calender rolls. As ordinarily made, the weight of rolls or cylinders of considerable length that revolve in their bearings, become deflected, allowing the portion of the surface of the periphery of the roll which comes uppermost to be concaved and the portion below to be convexed.

The object of this invention is to cause the peripheries of rolls to be made so curved in their length that the increased central diameter may accurately compensate for the deflection, and form a fitting line of contact and equal pressure along the whole length of the roll.

TABLE OF CONTENTS.