Technical and Bibliographic Notes / Notes techniques et bibliographiques

Canadian Magazine of Science and the Industrial Arts.

Patent Office Record.

Vol. XVII. FEBRUARY, 1889. No. 2.

PECULIAR ROTARY MOTIONS FOUND IN LIGHTNING AND OTHER ELECTRICAL CURRENTS.*

By Moses Greely Parker, M.D.

Photographing lightning and making good pictures, representing the forked and irregular light as it shoots across the sky, or from cloud to earth, has become quite common, and is easily done in a dark night; having first focussed the lens for distant objects, one has only to point it in the direction he expects the flash to appear, expose the plate and wait for the lightning. If the night is dark, one can obtain several flashes of lightning on the same plate, as they often occur near together. The only difficulty is to have the flash come within the field of the lens.

Photographing the current itself so as to get detail in the track, showing how the electrical currents travel, is quite another thing; this we have been able to do, and present some results.

From these we see that the electrical current may travel without dividing; or it may divide and sub-divide, twist and meander in its passage from cloud to earth, its image on the negative presenting such a variety in form, that many names have been given descriptive of its general appearance, without any reference to the real motion of the current itself.

Three of these motions I have observed, viz.: The twisted, the curled, and the straightforward. Being unable to find anything descriptive of this in print, a short account may not be uninteresting.

The twisted motion resembles a loosely twisted rope; it twists both ways, usually from left to right, as the twining vine winds around its support. There are exceptions to this rule in the electrical, as well as the vegetable kingdom, for we find it twisting not only both ways (*i.e.*, from left to right and right to left), but it reverses its motion in the same course.

The curled motion resembles a twisted ribbon or shaving as it curls from the carpenter's plane, and in some respects is most remarkable.

The straight presents straight lines in its track, and is evidently travelling with great force.

Before describing the figures, or saying more about these currents, it may be well to quote the report of the committee of the Royal Meteorological Society, London, England, on lightning. The report published this year is as follows:—

"1. Stream lightning, or a plain, broad, rather smooth streak of light. Only two or three specimens of this form have been received. The committee are disposed to consider this a distinct type of a single stream-like character without distinct irregularities or branches, and not merely the result of bad focussing, because other objects, such as trees, are extremely sharp.

"2. Sinuous lightning, when the flash keeps in some one general direction, but the line is sinuous, bending from side to side in a very irregular manner. This is by far the commonest type. It is very noticeable that the thickness of the line varies during the course of discharge. Sometimes the thinnest part of the white streak is the highest, and the flash appears to get thicker as it approaches the earth; at other times a flash in the air begins thin, broadens out in the middle, and fines away again at the farther extremity. The committee can offer no explanation of this at present, but they would call attention to the fact that in some photographs of electric sparks, taken from an induction coil, those of high tension are thinner than those of low tension.

"3. Ramified lightning, in which a part of the flash appears to branch off from the main streak, like the fibres from the root of a tree. Of course, there is no evidence as to whether these fibres branch off from, or run into, the main flash.

"4. Meandering lightning. Sometimes the flash appears to meander about in the air without any definite course, and forms small, irregular loops. The thickness of the same flash may vary considerably in different parts of the course, as mentioned above, and a flash may go pretty straight in one portion of its path, but meander considerably in another.

"5. Beaded or chapleted lightning. Sometimes a series of bright beads appear in the general white streaks of lightning on the photographic plate. Occasionally these brighter spots appear to coincide with beads in a meandering type, but often the beads appear without any evident looping of the flash. But as a flash is moving in space, while two directions only can be shown on the plane of the paper, there is every reason to believe that the brighter spots on the positive picture may be points where the flash was zig-zagging, either directly toward or away from the observer, and thereby giving a somewhat longer exposure to those spots.

"6. Ribbon lightning. Nearly one-sixth of the photographs received by the society show flashes exhibiting more or less of a ribbon-like form. One edge of the ribbon is usually much whiter and firmer than the other. Occasionally in the same picture some flashes appear normal and others rib-

* Read before the New York Electric Club, November 15th, 1888.

boned; but the flashes in a picture need not have occurred simultaneously. The committee have not yet in their possession any conclusive evidence as to whether the same flash may be normal in one portion and ribboned in another portion of its course. In one picture there is a bright streak on the top of the flash; then about an eighth of an inch of ribbon-like light, the folds following the sinuosities of the bright streak; then a dark band parallel to and following every irregularity of the bright streak, and then nearly another ⅛th of an inch of ribbon-like light. In another picture a very thin beaded flash has a precisely similar beaded streak, rather fainter than itself, running parallel to it at a distance of about $\frac{1}{16}$th of an inch on the paper. It might be suggested that the second fainter image was formed by internal reflection from the back surface of the glass plate; but it should be noticed that sometimes very thin flashes, which are not particularly bright, are so duplicated. A far more probable cause is the double image formed by the internal reflections of doublet photographic lenses. All doublets are essentially two meniscus lenses, mounted with their concave surfaces facing one another. The greater portion of a strong point of light, passing through both lenses, forms the usual image on the plate, but a smaller portion is reflected from the concave surface of the front lens, and from thence back through the rear lens to the sensitive plate. The amount of displacement depends on the angle formed between the direction of the bright point and the optical axis of the lens.

"M. C. Moussette, of Paris, showed some photographs of the sun, in which this double reflection image was very conspicuous; and there is not the slightest doubt that some lightning flashes are bright enough to give this secondary image. M. Moussette also showed the photograph of a flash in which the centre of the flash was the whitest, with a darker edge on either side. This may have been produced either by a double reflection from the lens or by internal reflection from the back of the glass plate. Two bands of light—the primary and secondary images—slightly overlapping would form an extra bright band where the overlap took place.

"In the majority of cases, the folds of the ribbon formation are most obvious when the course of the flash is square to the width of the folds, and they are but slightly pronounced when in a line with them. This would suggest the idea of a shaking of the camera in the direction of the folds of the ribbon; but, if this is so, the duration of a lightning flash must be much longer than is supposed. The committee hope to have the opportunity of making some experiments on the photography of sparks from a coil or electrical influence machine. In the meantime, they defer expressing an opinion as to whether lightning ever really takes a ribbon-like form, till further evidence is available, but would point out that both sources of error—the duplication of the image either by reflection inside the lens or by reflection from the back of the plate—would be avoided by the use of single lenses, and of paper, instead of glass, supported films. The committee also forbear for the present from publishing a reproduction of a ribbon-like flash till they are satisfied that such a form of lightning really exists, and that the whole appearance is not due to photographic causes."

Some two years ago, while experimenting with electricity, I obtained a photograph, showing the dividing and twisting rotary motion of the electrical current. My plate was not quite in focus, but the image is sufficiently sharp to show that the current divides and rotates, not only on itself, but upon its fellow.

Knowing, as we do now, that the current has a rotary motion, we can see in the main track indications of this motion that would be impossible for any jarring of the camera to produce. Further investigation disclosed the three motions before mentioned, to illustrate which I have, by permission of A. H. Binden, taken his remarkable photographs of many flashes of lightning, about which it was truly said in the Boston *Herald* of July 29th, 1888—"Mr. Binden has been singularly fortunate in securing, with his two plates, photographic reproductions of all the typical forms of lightning flashes mentioned in the committee's report."

The lightning flash, examined as a whole, is seen to leave the cloud and reach the earth in an irregular, twisting, rotary manner, throwing off branches as it goes; these also twisting, rotating, and sub-dividing into the sinuous, ramified, meandering, beaded or chapleted, and ribbon lightning, mentioned in the Meteorological Society's report, while the main current, rotating as it goes, finally enters the earth in a divided form, which plainly shows this twisting rotary motion in the main current as well as in its branches.

Stream lightning is well described by its name alone. In this form I find what I have called the straightforward motion. Its photographs show almost straight lines, without the curves indicating the rotary motion.

Sinuous, ramified, and meandering lightning are all very much alike, if we grant that which we can hardly doubt, viz.: that they all may divide and sub-divide as they advance. In all of these we find a rotary motion, with a direction either from left to right, or right to left; in some branches both motions are found, and when well defined resemble the twist of a rope.

Beaded lightning has that about it that is much more interesting from a speculative point than either of the others. The explanation given in the Royal Meteorological Society's report of the beaded form hardly explains all that we find in and on both sides of this bead; for we see the rotary motion of this current before entering the bead to be in one direction, and immediately after leaving the bead to be in the opposite direction, plainly indicating that the motion sometimes changes in the bead.

Ribbon lightning has what I have designated the curled motion. In this one sees the resemblance to a curled ribbon. This current is evidently flat, with a motion that forms this ribbon into a curl. It somewhat resembles the beaded form, inasmuch as it is seen to change its direction, thus forming curls twisted in opposite directions and united, not by a bead, as in the beaded lightning, but by a white edge where the process of reversing its motion goes on, while at another point it presents the appearance of a curl pulled sidewise, being thin and narrow; afterward proceeding in a more regular manner than before. No possible shaking of the camera could produce this curled appearance.

That currents of electricity are influenced by the medium through or upon which they travel, is also seen, and to the well-known theory that the resistance of the air changes its direction, may be added, that the current changes in size and contracts in volume as it enters the earth.

If we compare the size of these currents with the trees or other known objects, seen in the same photograph, taking into consideration the distance each one is from the lens, one must, by comparison, judge the size of large currents to be, while passing through the air, *several feet* in diameter; distance must always be considered in judging the size, for as the current goes from the lens its image on the negative gets smaller, and larger as it approaches it.

Sparks from an induction coil or Holtz and other machines give the same indications of the three motions found in the lightning; they are easily photographed; the variety is not so great as in lightning, but one has an opportunity here of varying the current in many ways.

The three motions, the reversing of the rotary motion in the continuous track of a spark, as well as the bead, are found in these currents as in lightning, and add proof that these currents and lightning are similar.

With one observation more, I close this paper. No doubt many have noticed what I am about to mention, but its frequency last summer attracted my attention. While travelling in Maine last August, I noticed that many of the telegraph and telephone poles, which were of the native white cedar, twisted as this tree always grows, had been struck by lightning, and that the current, travelling from the top of the pole to the ground, always followed the twist in the wood, often taking a groove out of the wood from top to bottom, winding once or twice around the pole, following the grain of the wood.

Whenever it struck a pine pole or tree, these being straight without twists, it ran down on one side, taking out the groove or tearing the bark down on one side only.

(A large number of interesting views of flashes of lightning and a few of artificial discharges of induced electricity were illustrated by means of the stereopticon, and fully described by the lecturer.—*Electrical Review.*

THE WORKING STEAM ENGINEER.

While it is true that in every line of manual labor, whether skilled or unskilled, genius and thought are recognizable, and the service of one man is enhanced beyond that of another, still the divergence from the plane of a general average, in most trades, is so slight as to make a standard of wages possible. The working steam engineer is an exception to this condition.

The street laborer may, by care and thoughtfulness, make himself of more intrinsic value to his employer, yet in a general sense his superiority is not materially felt, and a standard of wages for him is possible. Thus, also, in those branches of skilled employment where the labor becomes of a routine character, and where slight variation of subject is necessary, the same conditions exist.

This being the case, it is easy for combinations of tradesmen or labor to establish, by general consent, a code of wages for the guidance of its members. The further removed from that class of labor where bone and muscle are the only elements necessary for success, the more difficult it is to set any standard by which to estimate excellence or make an equalization of payment.

The medical profession may set a standard of payment, the mere physical act of making a visit being the basis from which payment is estimated; but if the absolute service rendered a patient were to enter into a discussion, the question of remuneration would be somewhat difficult to settle.

The mere fact that a man enters a shop and there toils for the allotted number of hours makes it possible to settle his wages by the standard of another man performing a like service; but when the service rendered is the product of thought and study, when the results of mental activity are thrown into the balance against muscular exertion, then the reward can only be measured by the profit given to the employer.

The greater and more varied the knowledge necessary to perform a certain line of duty, the greater the extreme from the inferior to superior talents; hence in proportion is the service rendered increased or decreased in value.

One of the leading English steamship lines, while having one established code of payment for its chief engineers, has a bonus fund, payable monthly to each chief engineer, which payment is determined by the success of the engineer and the absence of neglect on his part in the fulfilling of his duties. Thus each engineer becomes a competitor for this extra emolument. As the business of steam engineering takes to itself certain qualities of the professions it becomes necessary to gauge the emoluments by the same standard—that of especial fitness. To set a standard by which all attorneys were to be paid would at once close the doors to the chamber eminence, and no member of the legal profession would consider the incentive sufficient to warrant him in putting forth the energy necessary to advance beyond mediocrity.

In the employment of men, that class of labor that is purely mental commands higher price than does that class where only physical strength is wanted. One brain may design a steam engine, but more than one is necessary to build it. Hence, then, among brain workers, experience and originality are factors of success. Neither can we gauge a man's worth—commercially speaking—by lapse of time, for one man with frosty locks may have traveled a shorter distance along the highway of observation than his neighbor with half his years.

Certain qualities are always necessary to enable any man to succeed in his vocation, and a man's advancement above his competitor depends upon the magnitude of these qualities.

The working steam engineer is a man in whom must be found executive ability, and in proportion to his ability to execute is his service as an engineer enhanced.

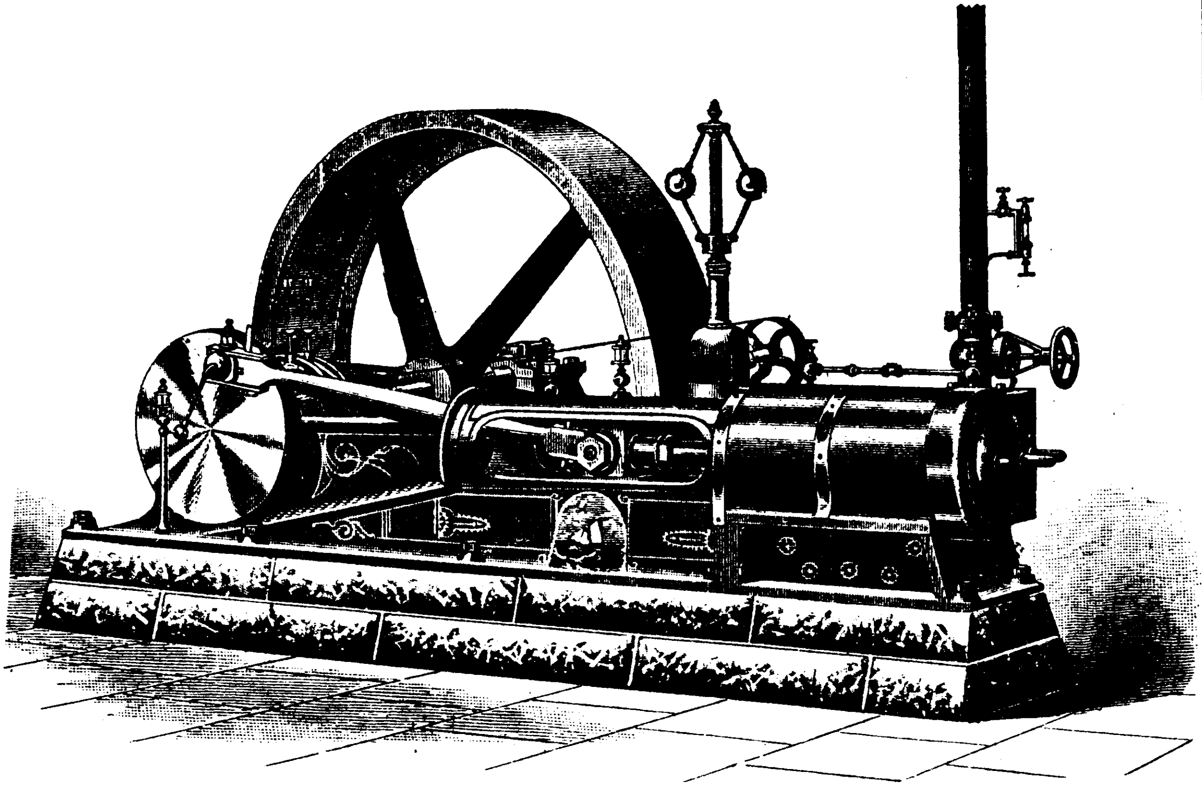
Twin sister to executive ability is self-reliance. The working steam engineer must be endowed with keen perspicuity, so that he may be able to absorb generalities at a glance, and sufficient executive powers to carry out details with correctness and precision. One of the best and most reliable second engineers that we ever met—in marine service—was one of the most inglorious failures as a chief. He lacked completely the attribute necessary to execute. He was so devoid of self-reliance as to hesitate to back out into the stream at the beginning of a new trip any steamer upon which he was chief engineer. A thorough mechanic, and of more than ordinary education, he was in every way a first class man to carry out the details under the general planning of another.

Originality is the cradle in which eminence is nursed, for originality lifts men from the beaten track of the past into unexplored fields, giving the world new productions in science, literature and art. To succeed, the engineer must be original, and his performing a certain act must not be because someone else did it, but because from his own observation he knows it to be proper and correct.

Not only must the engineer be able to do for himself, but he must plan for others to do; he must be able to direct generalities and execute details; in fact, he must combine the practical and scientific to such an extent as to make it difficult to establish a general standard of payment for his services.—*American Engineer.*

PAINT stains that are dry and old may be removed from cotton or woollen goods with chloroform. First cover the spot with olive oil or butter.

Lignum-vitæ has been successfully used for blocks on piston cross heads, and is said to be superior to metal for that purpose, requiring less oil and never heating.



THE RAMMING AUTOMATIC ENGINE. FIG. I.

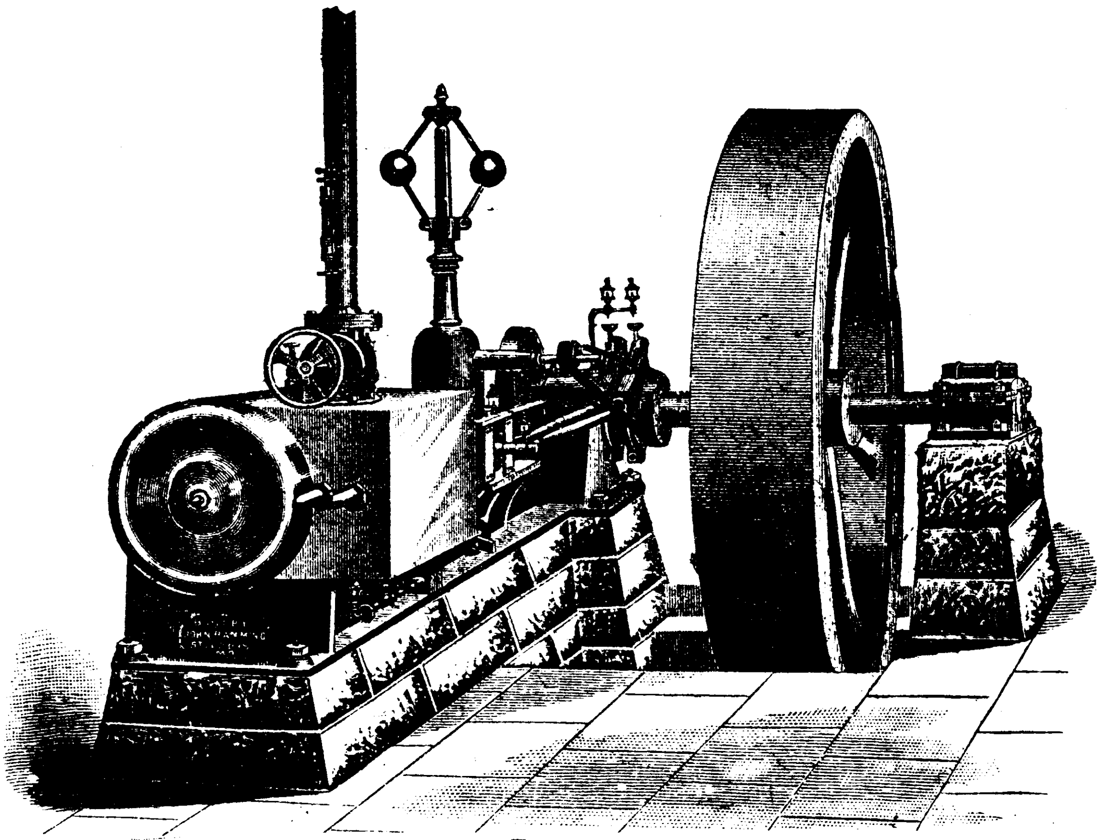


FIG. 2.

THE RAMMING AUTOMATIC ENGINE.

The Ramming Automatic Engine, which we illustrate herewith, presents in point of attraction a number of interesting features which we explain in detail.

The bed is a combination of the box and girder type, possessing great strength and rigidity, together with compactness, and is constructed to obviate the springing of the old style of box bed, and also the common defect called breathing in the girder type of engine.

This engine does not require a foundation of more than ordinary strength. The main journal, or pillow block, which is designed for strength and compactness, also the circular guides and bed are in one casting. Owing to its peculiar construction the metal is so distributed that there are no weak points from shrinkage cracks or shrinkage strains. The pillow block is fitted up with heavy phosphor bronze shell in bottom, gun metal quarter boxes partly filled with best engine babbitt metal, and extends over the periphery of the shaft journal, and has wrought iron wedges the full length and width of quarter boxes with convenient adjusting facilities. It also has a well-fitted pillow block cap, with a large chamber on top to permit close inspection of the main journal while the engine is running. The circular slides have wearing surface of large area, and are very strong and rigid.

The length of the pitman or connecting rod is always calculated on a basis of three times the length of the stroke of the engine, and is fitted up with stub ends, gibs and keys of such proportion as to admit the use of wrist pins of a diameter of more than one-fourth of the diameter of the cylinder. The crosshead has its wrist in centre of the bearings—a matter of no little importance in the construction of an engine. The cylinder has short steam passage and large exhaust port, and is bolted direct to end of engine bed.

A false head which acts as a packing chamber for piston rod on outside, and for a cylinder centering piece inside, is forced into a bored opening in end of engine bed. The cylinder is finished on the bottom and rests on a planed extension piece which supports the full length of the cylinder. Automatic segmental cast iron piston packing of improved design is used in cylinder.

The steam chest which acts as a reservoir between boiler and cylinder contains two main valves and two cut off valves of a very simple balance device. They are driven by two eccentrics with wide wearing surface.

The governor is placed in centre of engine, and is especially designed to meet the requirements of this style of valve, and is very sensitive to the slightest change of speed. It can be adjusted to any required speed while the engine is running. This engine, owing to the peculiar construction of the valve, is guaranteed to give full opening for the admission of steam at a valve travel of three-eighths of an inch, and consequently full boiler pressure on the piston can be obtained.

The manufacturer claims that these engines can be run at any rate of speed desired, as there are no dash pots to increase the care of the engineer, as is found in the Corliss type of engine.

Special attention is called to the fact that there is not a single spring of any kind used in connection with the governor or valve. The valve arrangement is as simple as a plain slide valve engine.

All wrist pins are of steel as also are the piston and valve rods. Pitman and engine are of hammered iron.

The cylinder is neatly covered with a heavy sheet-brass jacket. Cylinder head and steam chest have polished and nickel plated cast iron covers, which not only add to the attractive appearance of the engine, but prevents condensation in cylinder and steam chest, and is easily kept clean and bright.

Mr. Ramming claims to have placed on the market an engine that is thoroughly first class in workmanship and design, and which for strength, simplicity, durability and economy of fuel consumption is unsurpassed.

These engines are built in sizes from 30 to 300 horse power.

BORAX: ITS OCCURRENCE AND PREPARATION.

BORAX AND ITS USES.

For nearly forty years I have been engaged more or less in promoting the introduction and useful application of borax. I have also visited many of the districts where it is found in its crude state, and have gained much information respecting its valuable properties and important uses—an almost inexhaustable subject, into which it would take too long to attempt to enter fully. I will therefore try, as briefly as possible, to give an outline of its mode of occurrence in the natural state, describe how it is collected and manufactured, and explain as briefly as possible its uses :—

Borax is no new article of commerce, but was known to and used by the ancients from time immemorial. Nero used it. Pansa regretted that he was not sufficiently rich to buy borax to cover the arena after the death of the combatants, at the time of the combat between the gladiators Lydon and Tetrides. Doubtless its use on the arena was to deodorize the blood.

At this time there is no record of borax being found in its crude state in any part of Europe, but it was known to the Arabians, who called it baurach. Hence its name. They used it to assist in reducing the oxides of metals. The conclusion at which I have arrived is that the borax used by Geber, who lived in the eighth century, was made from tincal, or crude borax, which is found in many lakes in Thibet.

In some of these lakes are numerous hot springs, the vapor of which contains boron, and the surface water is impregnated by it. Evaporation taking place, the tincal is found cystallized at the sides of the lakes. In addition to this, solid borax is found in some form or other in the soil around this district, and there is ample proof that unlimited supplies can be obtained. Tincal has been obtained from Yandok Cho from time immemorial. It is exported in small quantities hence to Lassa, where it is used by various workers in metal. After the tincal has been collected it is bartered for cowrie shells, Sheffield cutlery, and Birmingham ware. It is then sold to the Kassawaris and Khampos traders, who arrange for its transport to India on sheep's backs. Each sheep carries from 40 to 60 lbs. The transport across the Himalayas takes about nine weeks. Each driver carries a distaff, which they use to spin wool dragged from the sheeps' back, to make bags in which to pack the tincal. Should a sheep die on the way, its flesh is eaten by the drivers, and the wool taken off and spun as described. On the way vegetation is sometimes so scarce that boughs of trees have to be cut down and the leaves stripped, to feed the sheep.

From Moradabad and other parts of the foot-hills of the Himalayas the tincal is sent to Calcutta, and shipped from thence to Liverpool, where it is refined into borax, and used in making the glaze for china and earthenware. I may mention that tincal was the only form in which borax was known in Europe until the year 1742, when a Tuscan traveller and a geologist paid a visit to Monte Cerboli, Castel Nuovo, where he discovered a large number of hot springs, and noticed dense vapors arising from them; but it was not till the year 1777 that Hoeffer found out that the steam contained boracic acid at Monto Rotondo and Cestel Nuovo. In 1816 Hoeffer and Mascagni proposed to make borax from them, but the latter was too much engaged with other scientific labors, although he had obtained a patent during Napoleon's rule in Italy to make boracic acid from the fume-roles. This right he ceded to Fossi, who was the first to make it in any quantities. Gazzeri and Browret worked some of the lagoons at Monte Rotondo, but made only about 3½ tons in twelve months—a most unfortunate speculation for them.

In 1818 Laderet, a Frenchman, who was staying in Italy, hit upon a brilliant idea of utilizing the natural steam jets oozing up so plentifully from the soil, to evaporate the water, and so increase the supply of borax at a much cheaper rate, as the great cost hitherto had been the wood for fuel. I must now try and describe the very simple mode of preparing this boracic acid, and when I first visited Italy I was never more astonished in my life. I made my headquarters Castel Nuovo, which is the very centre of these curious steam puffs or fumeroles, and visited the most important places of production, S sso, Lustignano, Ladarello, Lago, and San Federigo. Scarcely any one could give me any idea why the steam puffs contained the boracic acid, and, as I am neither a scientific nor a learned man, I can but give you what I think may be the cause, though I may be altogether mistaken in my supposition.

My exact meaning will be best understood from the accompanying diagram—all that is seen below the surface being, of course, imaginary, but, I believe, correct. The subterranean lake, A, is supposed to be surrounded with crude borax vapor, generated from the lake by deep-seated heat or fire; the vapor rises through the crevices, B, of the rocks; C are artificial lakes on the surface of the earth; D is a tank wherein any impurities fall to the bottom, boracic acid still remaining in solution; F is the evaporating house; E is a soffione vaulted over with stone and firmly bound with wrought-iron bars; and G are the crystalizing tubs or casks. Now, it appears to me that for many miles round this district there exist subterrannean lakes and seas—the sides containing borax in some solid form; and that the internal heat of the earth affects the water, dissolving the borax. The steam forces its way through crevices and fissures, sometimes puffing up to a height of eight or ten feet.

To utilize the steam jets, a wooden chimney is constructed round those selected, which conducts the steam high up in the air, in order to protect the workmen while preparing the lagoon or lake. Around this is dug an artificial lagoon, about six feet in depth and twenty feet in diameter. This lagoon is faced with bricks or tiles. The wooden chimney is then removed, and clear water run in the lake from an adjacent stream. When it is full the water is turned off, and the stream which comes up in the centre of the lagoon soon heats the water, which quickly boils, the vapor rising with such force as to cause it to bubbie up to a height of three or four feet.

This is allowed to continue for about thirty hours, during which time the water gives off a perfume like that arising from rotten eggs. It is then conducted from the lagoon by a wooden trough into a large iron tank, placed near to, but slightly below, the level of the lake, when any impurities sink to the bottom, while the boracic acid remains in solution. From the tank the solution is conveyed through pipes to a series of leaden pans or evaporators standing in a large building open at the ends and sides, but having a roof to keep out rain. These evaporators are placed over a brick built chamber, into which steam from another fumerole is conducted by a pipe at one end of the building, and after traversing the entire length of the building, escapes through a pipe at the other end. By this means the leaden pans become heated, and drive off a good deal of the superfluous water, the solution thus becoming more dense, and while in this condition it is run off through wooden pipes into large casks. When cool, the boracic acid forms on the sides of the casks in a thickness of about five inches. The liquor being drawn off, the boracic acid is removed and put into wicker baskets. After a short time it is carried to the drying chamber and placed on a brick floor, which is heated by one of the steam jets. When dry, it is packed in casks and conveyed to Leghorn for shipment to England, and refined into borax.

About 3,000 tons of boracic acid are produced annually in Italy. Besides the districts I have already mentioned in Italy, there are others, but they are insignificant.

Chili is the next important district where borax is found in a crude state. It is also found in Peru and Bolivia, but the largest deposits are in Chili. There exist large numbers of dried-up lakes containing great quantities of borate of lime. The most important is known as the Laguna de Maricunga, which, besides borate of lime, contains solid masses of salt. It is situated between the two highest ridges of the Andes, at an elevation of 1,300 feet. In some parts of the lake there are deposits of borate of lime twenty feet deep, so that when the business gets thoroughly established, borate of lime may be collected and sold comparatively cheap; and when the uses of borax are better known, and more demand for it is created, this crude borax will be sent home in thousands of tons. The cost of collecting it is trifling, but the carriage from the place of production to the sea coast is expensive. There are wonderful deposits of borate of soda and borate of lime in the United States in Nevada and California.

I believe I am correct in stating that no case of cholera was ever known to have taken place in any of the villages where the boracic acid is made, the vapors arising from the lagunas acting as a charm against this terrible epidemic.—By ARTHUR ROBOTTOM, in *The Manufacturer and Builder.*

GRAPHITE LUBRICATION.

In the development of the world's history, the time has arrived, it would seem, when a change is to come about in the mode of lubricating machinery, carriages, waggons, etc.

This change is to be brought about by substituting graphite for oil or grease in whole or in part.

For more than fifty years it has been known that graphite was one of the best lubricants extant, but no way has been discovered to hold it in position and utilize it as a lubricant except by mixing it with oil or tallow, and yet its use in this form has gradually been growing for the last twenty years; and it is now quite extensively used in oils for heavy bearings and particularly for packing boxes for railroad cars.

A few years ago the process was invented, and the invention patented, for holding graphite in its position, in a journal box, thus furnishing dry lubrication.

Like all other useful inventions, the graphite bushing or journal box was greatly in advance of the times, and after being invented the invention came near to being lost to the world for want of recognition. Graphite bushings and boxes could not be sold, in fact they could not be given away with an agreement that they were to be put in use and used. Scientists were against the invention, engineers condemned it, and capital could not be found to introduce it; and while it was successfully introduced in the block trade in the fall of 1877 and on machinery in the fall of 1883, and on carriages and waggons about the same time, we are informed that its progress in actual use has been very slow. In this particular history repeats itself. Professor Morse in 1832 discovered the first principles of the telegraph, but for want of means he struggled until 1837, a period of five years, before he could get sufficient assistance in money and mechanical skill to put up the first few miles of telegraph wire in a room. In 1837 many of the principles of the telegraph were as perfect as they are to-day, but pecuniary assistance could not be obtained to construct a mile of telegraph wire for commercial use, and Congress was also appealed to in vain, notwithstanding Morse and Vail had put up a wire in a room ten miles long in Washington in 1838, and operated it successfully. In 1842 Morse again applied to Congress for an appropriation, and on March 3, 1843, Congress appropriated $30,000 to build a line of telegraph from Baltimore to Washington, and the first message passed between the two cities on May 24, 1844, some twelve years after the first discovery of the telegraph. The rest is fully known.

We have observed above that graphite bushings went into use in the block trade in 1877, but the difficulty then presented itself of getting a box into use upon a machine in a mill or factory, and the first one put to use was in the factory of the Norfolk and New Brunswick Hosiery Company at New Brunswick, New Jersey, and was started November 20, 1883. On the 5th of March, 1884, the company, by their superintendent, issued the following certificate:

"We have one of the graphite boxes in use on a fancy move of our cards since November 20, 1883. We oiled it a few times after putting it on, but it has been running since November 28th without oil at a rate of about 600 revolutions a minute, and about 10 hours per day."

"The bearing surfaces at this date are found to be in good condition, without showing signs of cutting or beating."

From this single bushing, the graphite boxes on machinery started, and in future articles we will endeavor to trace its further development and also to explain the principles of the lubrication, so that engineers, mechanics and others using machinery can see how the revolution is being brought about of discarding oil and substituting graphite in its place.—*American Engineer.*

HEAVY UNIVERSAL MILLING MACHINE.

It is designed for boring, facing, turning, milling, profiling, key-seating, splining, rack cutting (any length), gear cutting with the vertical attachment up to five feet in diameter, etc.

It not only admits of a greater range of work, but will do work than can be done on no other universal milling machine. It is specially designed for use in railroad shop, and for builders of locomotives, portable and stationary engines. In repairs to locomotives, where duplication of wearing parts is so frequent, it is particularly valuable on account of its great capacity, and work can be done to better advantage and with greater precision than on planers, lathes, shapers, etc.

The gearing as shown in cut is external and back geared 4 to 1, it is also made with external gearing, back geared, 8 to 1. All running parts have oil tubes and are accessible for oiling, and is driven by a $3\frac{1}{2}$-inch belt on a 4-step cone, of which the largest diameter is 13 inches.

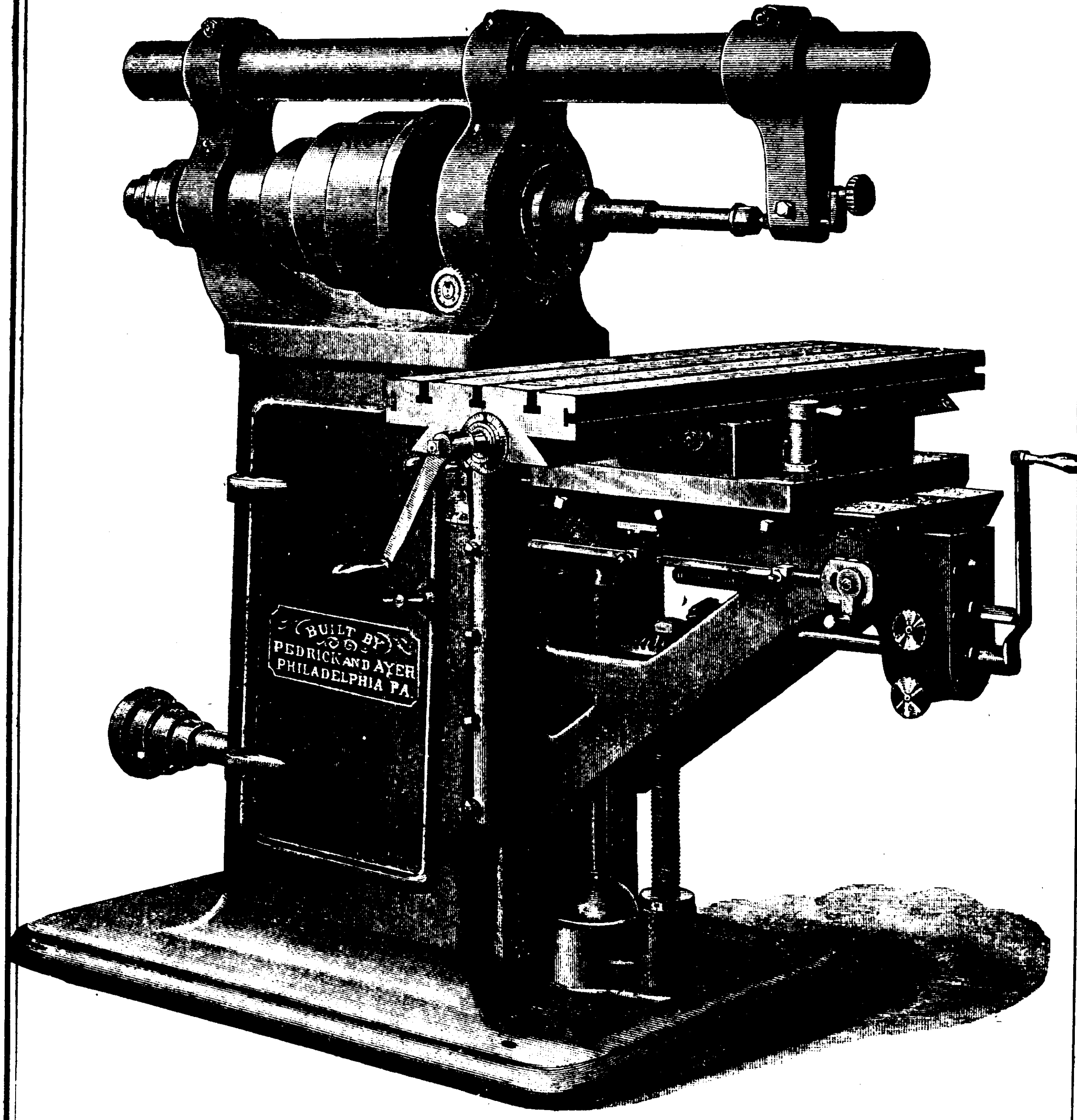
The spindle is of steel and runs in atlas bronze boxes. The front bearing is $3\frac{1}{2}$ inches in diameter by 6 inches long; back bearing $2\frac{9}{16}$ inches diameter by 5 inches long and provided with easy means of adjustment for wear. The front end of the spindle is threaded on the outside for face plates or face mills. In the spindle is a taper hole for cutter arbors 2 inches diameter at the front end, diminishing $\frac{1}{2}$ inch in 12 inches, to $1\frac{1}{16}$ inches diameter, through which the arbors are driven out by a rammer. The atlas bronze boxes have an adjustment by which the original centres are always retained without altering their position laterally—this is a very important point, as the journal and bearing wear always in the same place. In all other sleeve bearings, when wear is taken up by moving either the box or spindle laterally, a new position is taken and wear commences and takes place very fast—the above style of bearing overcomes this entirely.

The cutter arbor supporting bar, with its adjustable centre, can be moved out to support cutter arbors 26 inches from the end of the spindle or pushed back out of the way, thus facilitating the milling or boring of a large piece of work that would be prevented by the ordinary fixed bar.

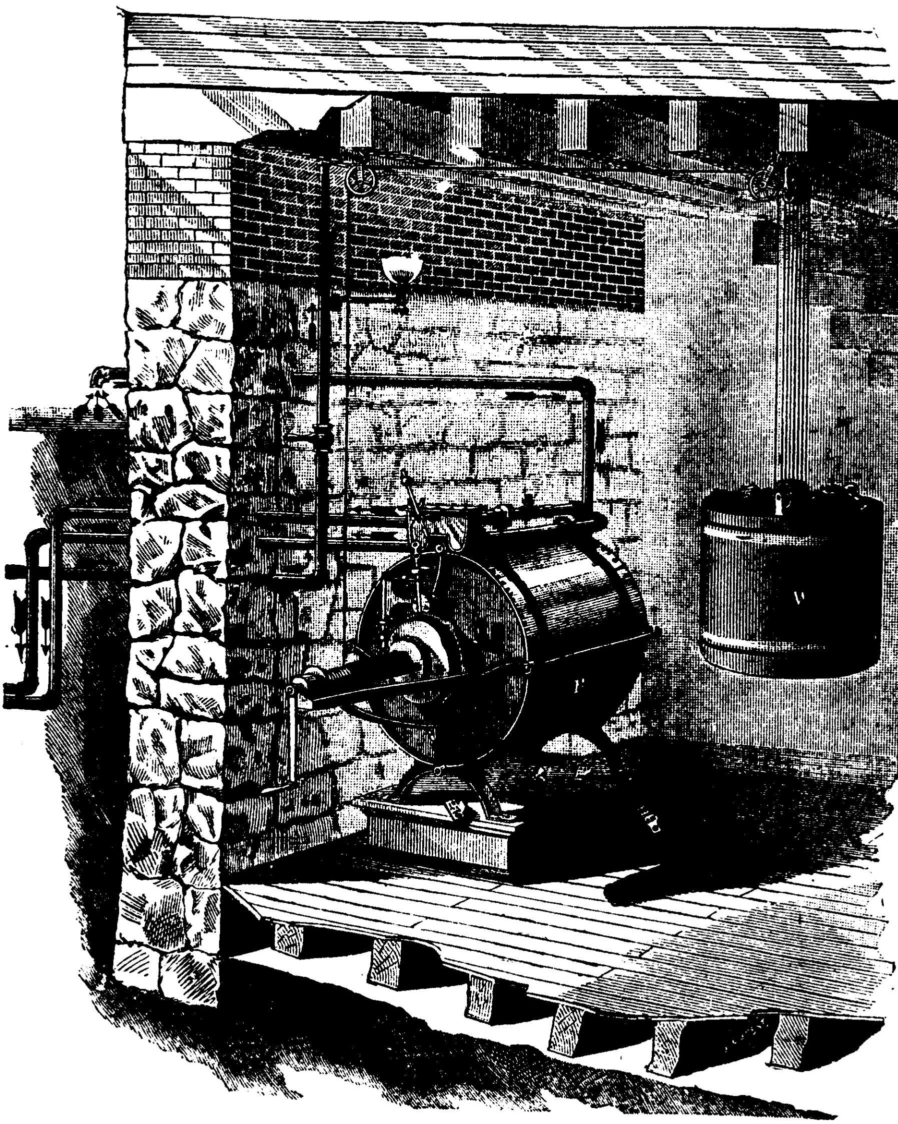
The three feeds, vertical, horizontal (in line with spindle), and traverse (at right angles to spindle), are all *reversible*, and are operated and stopped altogether by the handle shown in the cut near the cup-board. This reversing device is common to engine lathes, does away with the crossing of belts and saves time. The 4-step cone on the spindle belts to the lower cone, the shaft of which runs in a hollow stud and drives, by means of the reversing device referred to above, a shaft running through the base of the column. Bevel gears connect this shaft with the vertical shaft, and the latter by bevel gears with the horizontal shaft in the knee, which communicates in turn with the several screws for the various feeds in the front of the knee by clutch gears. These clutch gears can be engaged or disengaged at will by the knurled knobs shown in front, giving a vertical or horizontal feed. The platen feed is operated from the upper shaft in the knee by means of a pair of mitre wheels running in a bearing which is a part of the platen slide on the knee. A vertical stud passes upward to the long screw in the platen, and is connected to it by clutch mitre wheels. The screw in the platen is splined, and can be engaged and disengaged by a clutch lever, shown in the cut, convenient to the operator. In addition, there is an automatic stop for the horizontal feed, useful for boring. These stops can be set at any point.

The platen is 48 inches long, 14 inches wide, and has three slots for ⅝-inch bolts on the top and on the edges two slots. The latter are very useful and convenient. The platen has a transverse feed of 32 inches and a horizontal feed of 12 inches. It can be turned completely around and fed in line with the spindle. It has an automatic stop, while feeding in either direction, and is secured by four ⅞-inch bolts in the swivel base, of easy access with a wrench.

The knee is so designed and constructed as to withstand all strains liable to be put upon it. It has a bearing 24 inches long and 14 inches wide. In addition, there are two slots, running the whole length of the column, for ⅞-inch bolts. The two bolts in these slots secure the knee to the face of the column, making it absolutely rigid.—*Practical Mechanic.*



HEAVY UNIVERSAL MILLING MACHINE.



TIRRILL'S EQUALIZING GAS MACHINE.

TIRRILL'S EQUALIZING GAS MACHINE.

The illustrations accompanying this article represent the appearance and arrangement of parts of a gas machine, which, after a careful study of the principles involved in its construction and operation, we find to represent a decided advance in machines of its class, in that it provides, without unnecessary complication, the means for obtaining at all times *an illuminating gas of uniform quality.*

The variability in the quality of the gas furnished by the so-called gas machines, has always been a serious objection against them, and has, more than anything else, hindered their very general adoption in situations remote from cities. The conditions of practical safety have been fully met in machines of this order, and to the entire satisfaction of the fire underwriters, by locating the generator outside of, and a minimum distance of 30 feet, from the building to be lighted, and by the observance of other details of construction of minor importance unnecessary to specify here ; but the variable quality of the gas produced has, until lately, been recognized as the one great and apparently insuperable objection to their usefulness.

This difficulty arises from the fact that the more volatile portions of the gasoline employed in the generator are the first to pass off as vapour, yielding an extremely rich gas, which is difficult to burn properly on account of its tendency to smoke. On the other hand, the process of evaporation is a chilling operation, and after a number of hours of constant use, the liquid becomes so highly refrigerated that its volatility is greatly reduced, and the gas yielded grows progressively poorer in illuminating property. The same result will follow in time as the liquid in the generator becomes progressively heavier, and consequently less volatile. So that a gas machine that may work satisfactorily for some time after the generator has been freshly filled with gasoline, will make a progressively poorer gas as the material is consumed, unless provision is made to prevent this action by mechanical or other expedients.

These difficulties have long been recognized by the makers of machines of this class, and various plans have been resorted to, to meet and overcome them. Of these, two plans only deserve mention—that is, the use of adjustable burners, which permit of being set to suit the variable gas delivered by the machine; and the application of artificial heat, to assist the process of vaporization, and thus to insure a practical uniformity in the quality of the gas manufactured.

Concerning the first of these expedients—the use of adjustable burners—the fact that they involve the necessity of frequent manipulation to adapt them to fit the variable gas made by the machine, is sufficient to condemn the plan as inconvenient and objectionable. Concerning the second expedient—the use of artificial heat—no amount of ingenuity in construction, and no amount of argument adduced, can remove the grave objection to the use of fire about machines of this class. We have seen several of these machines, and have marvelled at the extreme ingenuity displayed in their construction and automatic operation, but have not been able entirely to disabuse our minds of the feeling of insecurity in considering the question of their introduction.

In the solution of the difficult problem of producing a gas of uniform illuminating value at all times and under all circumstances, Mr. O. Tirrill, of New York, the inventor of the machine here illustrated, and a veteran in this particular field, has proceeded upon a plan entirely different from that followed by his predecessors, and we feel well assured that he has struck at the very root of the difficulty, and eradicated it as a disturbing element.

Instead of permitting the air, forced or drawn through the generating chamber, to saturate itself with the *maximum* quantity of gasoline vapour, forming at first an exceedingly rich gas, that can only be burned, without smoking, through burners of small outlet, and which, later on, will give trouble from inadequate illumination when the gas grows poorer in quality from the causes above described, Mr. Tirrill permits the air to convey to the burners the *minimum* quantity of vapour necessary to produce a light of standard illuminating quality with a burner of definite size. By this procedure, it is evident, *a priori*, that the gas produced can never become too poor. To overcome the opposite condition—that is, to reduce a richer gas to the minimum standard, therefore, is the task which the machine is called upon to perform; and this is accomplished very effectually by a simple attachment called an "equalizer," by which the proper percentage of air required at any time to reduce the gas to the standard quality to fit the burner, is automatically added by the machine. By this simple and scientific artifice, therefore, the gas delivered to the burners will not be effected, in respect of illuminating quality, no matter what may be the quality of the liquid remaining in the generator, or whether one burner or many are being used, or how long they may be in operation, or how far—within the area of the largest building to which the gas is to be conveyed.

The manner in which the "equalizing" feature is applied in the Tirrill machine will appear in the following description:—

Experience has determined the fact, that, to produce an adequate illumination, the least quantity of pure gasoline vapour that must be consumed at each burner per hour, will be about one cubic foot. This cubic foot of vapour must be mingled through some volume of air—more or less—as a carrier; but, in all cases, it may safely be assumed that each burner connected with a gas machine, to yield a satisfactory light, must deliver as many cubic feet of air per hour as shall contain one cubic foot of gasoline vapour. Experience has shown, likewise, that when this cubit foot of vapour is diffused through about 8 to 10 cubic feet of air, it will yield a satisfactory light, brilliantly white and smokeless. If diffused through a lesser volume of air, the light will be yellowish, or even smoky, if the proportion of air is greatly reduced; and if diffused through a larger volume of air, the flame will become progressively more and more bluish, and finally, entirely non-luminous.

From these considerations it will appear, therefore, that the most advantageous conditions in respect of illumination will be realized when a cubic foot of gasoline vapour, diffused through ten cubic feet of air, are consumed in each hour through a burner capable of delivering this quantity of gas—*i.e.*, 10 cubic feet. These conditions, it is found, can be realized in practice with the best results, for the reason that when the gasoline becomes heavy and nearly exhausted in the generator, it will require just about ten cubic feet of air to absorb one foot of vapour.

From the foregoing explanations, it will be understood why the inventor of the "Equalizing" gas machine has selected as his standard of quality a vapour gas of the minimum degree of saturation (1 vapour to 10 air), to be consumed through a burner of definite size (10 feet capacity per hour).

The *modus operandi* will best be understood by reference to the illustration, in which B is a meter-wheel air pump, placed usually, as in this case, in the cellar of the building to be lighted, and actuated by the suspended weight; W, the gasoline reservoir containing the carburetor, is placed outside of the building, about 30 feet distant from it, and entirely buried in the earth. The air pump B, when one of the burners is opened in the house, is set in action, and through a suitable pipe (seen in the picture) a current of air is forced through the carburetor placed inside the reservoir. The air is thus charged with gasoline vapour, by which it is given an illuminating quality. Now, in the ordinary gas machine, the vapour-laden air thus formed in the carburetor, no matter what its grade or quality, would be passed directly to the burners in the building, by the action of the pump. In this machine, on the other hand, it is not permitted to reach the burners until it has been standardized to conform with the above described conditions. As the inventor expresses it, the gas, before reaching the burners, must first be "reduced to a standard quality, and made to fit a definite sized burner." How this is accomplished will appear in the following:—When the machine is started (with a freshly-charged gasoline chamber, for example), two cubic feet of air will carry off one foot of vapour. It is required, however, that ten cubic feet of air shall hold only one foot of vapour, since this quantity of vapour must be consumed through a fixed ten-foot burner. The "two-foot gas," or any other that the machine may be generating at any given time, must have enough *air added to it* to make up just ten feet in all; and this is what the "equalizing" machine of Mr. Tirrill does. It takes the gas of any grade that is being made in the machine, and, by the simple adjustment to the proper degree of the air-percentage cam provided for the purpose, the machine automatically and reliably reduces the gas to the proportions of the predetermined standard mixture—that is, a gas containing 1 cubic foot of vapour to each 10 cubic feet of air. The radical difference between the operation of this machine and all others, will appear from the single statement that when the machine is generating gas of the maximum degree of saturation (*i.e.*, one cubic foot of vapour to two of air), the operative mechanism is called upon to incorporate with it 80 per cent of air, in order to reduce it to gas of standard quality, capable of yielding a white, smokeless light when consumed at the rate of ten cubic feet per hour through fixed burners of this capacity.

The reader will by this time have comprehended the fact that the previous difficulty encountered in the operation of machines of this class—namely, the variability in the quality of the gas produced—is in this form of the machine simply and effectively met and overcome, as it is capable of delivering to the burners at all times, and under all circumstances, a gas of uniform composition and illuminating quality.

In addition to the capital advantage of invariably uniform light, the "equalizing" machine of Mr. Tirrill must obviously be more economical in service than the ordinary forms of the gas machine, for the reason that the air being almost always *under-saturated*, there is at no time any loss of illumination by reason of imperfect combustion—a smoky flame with this machine appears to be a practical impossibility. Again, the Tirrill equalizing machine, providing as it does a gas carrying the minimum quantity of gasoline vapour, will consequently be far less subject—and, within reasonable limits of temperature, not at all—to condensation, and consequent deterioration, which is one of the notable difficulties encountered in the operation of the ordinary gas machines. Where the latter, therefore, will be limited to a comparatively few lights, the Tirrill machine may be successfully employed for a much larger number.

One of these machines, capable of furnishing 4,000 lights, (by way of proving this statement) has been in use for over two years in the Binghamton State Asylum for the Insane. It was introduced under the most stringent stipulations, and after a vigorous test of its performance, the trustees, the superintendent, and the architect, have united in a letter endorsing it in the most unqualified terms, as having in every respect fulfilled the stipulations of the contract under which it was introduced.

We feel fully justified, therefore, in the statement made at the opening of this article, that the "equalizing" gas machine designed by Mr. Tirrill represents a decided advance in machines of its class.—*Manufacturer and Builder.*

WORK DELIBERATELY.

There are some things that must be done in a hurry, or not at all. Catching a flea is one of the best examples *apropos* to this. But as a rule, it is safe to say, the man or woman who works deliberately accomplishes the most. The deliberate worker is the thoughtful worker, with whom the habit of system has become second nature. Any one may cultivate it who will take the trouble to try; and the most unsystematic, spasmodic worker will realize with amazement how easy it is to get through an allotted task in half the time it formerly required, by planning it all out before entering the office, workshop, or kitchen.

The hurried worker is the one who fancies he is an uncommonly busy man. True, he is; so is the man who tries to bale out a leaky boat with a crownless hat; and in proportion to the energy expended, very often, the one accomplishes about as much as the other. The busiest men we have known were those who never seemed to be in a hurry, and they accomplished more in a given time, and were less worn out when their work was done, than many who accomplished half as much, and almost ruptured themselves in doing it.

Think about your work before beginning it, then go at it deliberately. It will save wear and tear of nerve and muscle, you will accomplish more, and what you do will be better done.

ONYX.—The Mexican marble, which we know as Mexican onyx, is not onyx at all. Onyx is an agate consisting of parallel layers of chalcedony. Marble is a carbonate of lime.

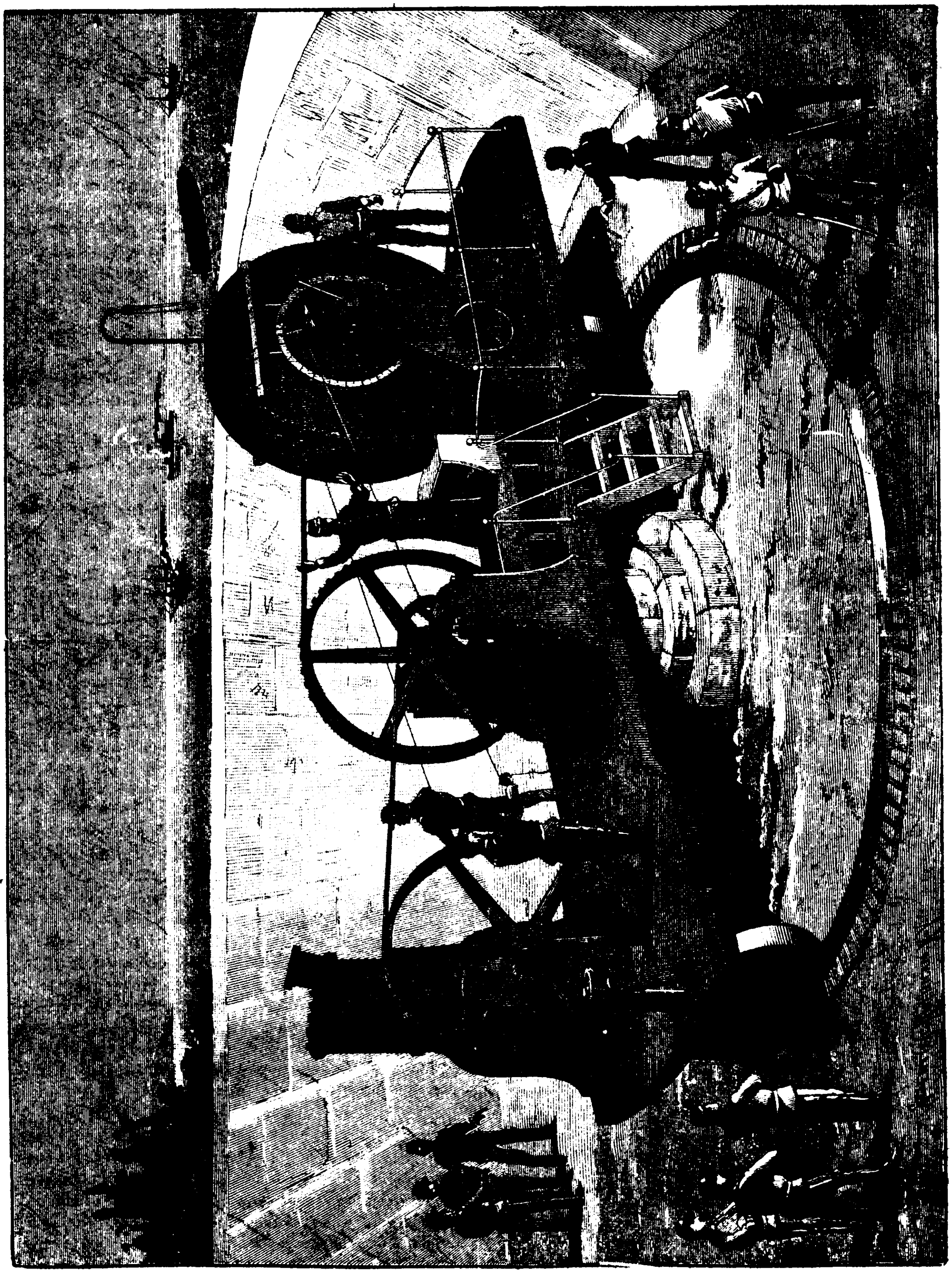
NEW DYNAMITE GUN.

From time to time we have published accounts of the various experiments that have been made of late years in ordnance for the discharge of the high explosives. During the past eight years, the value of dynamite, gun cotton, nitro-glycerine, mercury fulminate, etc., for use in warfare, has been thoroughly appreciated, and the only problem to solve has been how to handle these explosives with less destruction to one's self than to the enemy. This has not been altogether so easy of accomplishment. It is believed that the problem of throwing large charges of explosives to a considerable distance has been accomplished by Captain Zalinski's dynamite gun, in which the inertia of the shell in the gun is gradually overcome by subjecting it to a gradually increasing pressure of compressed air. The experiments to this end have been successful, and the shell leaves the muzzle of the gun at a very high rate of speed, while the initial shock is comparatively slight. Owing to the peculiar structure of the projectile used in this type of gun, the range is somewhat limited. We have also illustrated a dynamite gun in which common gun powder was used as the propelling power. In both of these guns the shell is made of a peculiar type, being adapted to take up the initial shock of discharge.

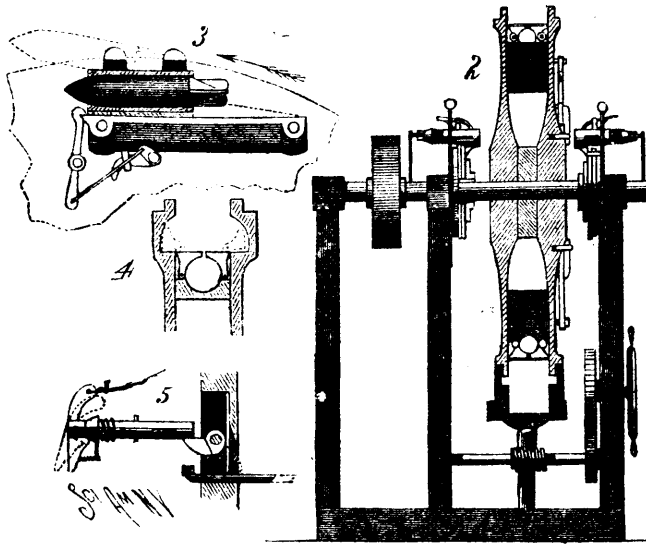
In the gun which is illustrated on page 44, and which is the invention of Walter E. Hicks, of New York City, the danger of self-destruction from accidental explosion at discharge has been reduced to a minimum, as there is absolutely no shock, the shell being projected by the rotary motion of a revolving carriage. As this motion begins with a slow movement, gradually increasing in rapidity, there is no jar or shock until the projectile has been discharged and has come in contact with some obstructing object. The power that is employed to this end is centrifugal force—that force which bursts grindstones and tears them into a thousand pieces, and which dashes flywheels to destruction. It is that same force which, according to La Place, gives the planet Saturn her beautiful rings.

The rotatable carriage from which the projectiles are discharged consists of two steel disk wheels (see detail) mounted parallel upon a shaft, which is provided with a pulley wheel for connecting it with a steam engine, or any high power motor, by means of which the carriage may be set at a high rate of rotation. These wheels are constructed thick and strong at the point at which they connect with the shaft, in order to resist the great strain, which is measured by the square of the velocity multiplied by the weight of the carriage. The gun represented in the cut is constructed for carrying four charges at a time, each of which may be discharged in rapid succession. The projectiles are inserted in carriers or chambers (see Figs. 3 and 4), which are arranged between the wheels at equal intervals from one another, and near the periphery of the wheels. The projectiles fit closely in these chambers, where they are firmly held until the instant of discharge by two doors, which lock and unlock automatically, and which hold the projectile in a vise-like grip.

The end of the carrier is journalled in the side of the wheels, and the other end is left free to oscillate in radial slots in the wheels. The free ends of these carriers are held down when loaded and locked by clutch bars meshing in teeth on the free ends, the clutches being attached to a shaft connected with the firing mechanism; when the gun is to be discharged, the clutch bars are released from the free ends of the carriers, which fly upward by reason of the centrifugal force exerted upon them, the doors fall automatically (see Fig. 4) into recesses in the sides of the wheels, and the projectiles, having received their momentum from the rotary motion of the carriage, are pro-



NEW MILITARY ENGINE FOR THROWING DYNAMITE SHELLS.



DETAILS OF DYNAMITE GUN.

jected into space. As was observed, the carriers are pivoted at one end, which allows a certain amount of outward play, for the reason that when a body is suddenly set free from the outer edge of a revolving disk or carriage, that body, owing to the centripetal force, will follow a curved path, therefore, the projectile carriers are mounted to admit of a certain amount of outward play in order to counteract to a certain extent their tendency toward a curvilinear trajectory. The gun can be used as a mortar for high angle fire or close siege work, and is also adapted for long range. The journals on each side of the wheels are provided with flanges and concentric disks (see Fig. 2) which revolve on sleeves extending on the inside of the journals. These concentric disks have the firing bolts attached to the peripheries (see Fig. 5), and they are adjusted by caps and set screws to the journal flanges, the whole being surrounded by an annular rim, indexed with the degrees of two quadrants, so that by adjustment of the concentric disks, the alidades attached to the sleeves through which the firing bolts slide will point to the degrees of elevation or depression desired.

The gun can be discharged at any angle in the vertical plane, while the arc of fire in the horizontal plane is the same as in any other piece of ordnance. The tripping device on the rotary disk is arranged in such a way that the shell can be discharged at the point previously fixed upon ; this being entirely arranged before discharge by the position of the quadrant. The tripping devices for two of the carriers are located upon the right hand disk, and those for the other two carriers on the left hand disk, whereby two of the shells may be discharged at a time, the other two being left in the carrier until it is desirable to discharge them. The four shells may be discharged in rapid succession, and the trajectory of each being practically identical, each successive shot will add to the destruction done by the preceding one. One peculiarity of the gun or engine, as it might perhaps more properly be called, is its comparative noiselessness. There being no expansion of gases and no vacuum, there is no report of any kind, the only sound being the whiz of the shell as it passes through the air. There is neither flash nor smoke, report nor recoil, and there is nothing to apprise an enemy of the whereabouts of the gun, and the destroyer might come in the midst of an enemy unseen and unheard. It is hoped that a thorough trial of this new gun will be made, from which data may be obtained concerning the efficiency range, and practicability of this as a weapon of warfare.

The combination shot and shell designed to be used in this engine is of regulation shape, having a solid steel head for the purpose of producing the greatest penetration upon impact. It is provided with a steel rod or precussion striker, extending through the center, one end of which is adjusted in the apex of the ogival head, while the other end rests against a percussion primer, which upon impact explodes the charge of explosive, thereby producing a double blow by impact of the shot and by the subsequent explosion.

The shot can also be exploded submarine, being provided with a device which will produce an explosion in case the target should be missed. Should that target be a ship, that effect would thus not be wholly lost.—*Scientific American.*

Photographing the Sun or Moon.—Mr. J. C. O'Loan of Liverpool writes to the *Scientific American* as follows :—"While experimenting with a ray of sunlight in a darkened room, I had my attention directed to pinhole pictures, and am of the opinion that startling results can be obtained in photographs of the sun or moon in this way. In a room darkened by blocking up the windows with thick paper, make a small hole in the paper with a darning needle, so as to admit a ray of direct sunlight. Hold a piece of paper in the path of the ray, 12 in. from the hole, you will have an image of the sun $\frac{1}{8}$ in. in diameter, at 4 ft. an image of $1\frac{1}{2}$ in. and so on. The size of opening used as lens does not alter the size of image at any given distance, but only in sharpness. Say the opening is 1 1-16 in., and gives a sharp picture at 4 ft., by enlarging the opening to one-eighth, the size of the image at 4 ft. would be still the same, but unsharp, so that the screen or plate must be removed to twice the distance to obtain equal sharpness. In a room 100 ft. long, a 12-inch picture of the sun could be had, and of the moon very much larger. A series of pipes 100 yards long for camera would give a 3-ft. photograph of the sun. In fact, there is no limit to size of image but the length of camera. Perhaps some one who has more time and space at his disposal than I have may take the subject up.

SHALL INVENTORS BE ENCOURAGED?

By J. H. G.

There has been much said on this subject first and last, but still it has not been exhausted. The question in reality is simply this: Shall we continue to advance, or shall we stop and begin to drift backwards? It is evident that we cannot occupy a neutral position. There is no such thing as reaching a point from which we can neither advance nor retreat. We must go one way or the other. Who is willing that we should fall back into the old ruts, and live and act as our forefathers did? Who is willing to be deprived of the advantages and comforts of the present day? In other words, who is willing to exchange what is to-day for what was 25 years ago! I will venture the assertion that not one such person can be found in a thousand; and possibly if that one will acknowledge the truth, his opposition is grounded upon an unreasonable prejudice. You will find him one of that kind whom nothing that anyone else does will please. Any fair minded person who has lived in the world long enough to know anything about it, can realize that during the period of his observation—though short it may be—great improvements have been made, not simply in some particular line, but in every line. Machinery processes and appliances of every kind in every branch of manufacture and in every avenue of production and consumption have been so improved and perfected as to almost baffle the conception of the finite mind. Indeed some have been so foolish as to make the assertion that we have gone far enough and that we ought to stop, that we do not need any more than what we already have. When we began in our grand march of progress a quarter of a century ago, there were those who thought that we needed no improvements, that what we had was good enough, and just so it is to-day. Those who were then trying to do something for the advancement and enlightenment of their fellow-creatures were laughed to scorn, were ridiculed and even in some instances punished. To-day this same class is met with the same derisive insinuations that we have enough and that it is time to stop.

The result of any undertaking is the means by which we can judge it, and in this case it has most clearly proven its correctness. The world has never, during its history, made such rapid progress as it has within the last few years, and the reason is that never before was so much encouragement given to inventors.

While the inventors have, most of them at least, as a natural result, been in a measure repaid for their trouble, the world has received no less benefit therefrom. Inventions have made it possible to plough through the waves of the mighty deep with as much safety and certainty as one would stroll over the hills and through the forests of his native country. They have encircled the globe and spanned the continents with almost innumerable lines of railway, over which thousands of giant locomotives speed with the velocity of the wind. They have annihilated time and distance and placed man in direct and immediate communication with his friends, though thousands of miles intervene. Many other things of as great importance to us as these have been accomplished.

Can there be found one so foolish or inconsiderate as not to appreciate all that has been done? Is there anyone who feels that he or the world would be benfited by not having any of these things? Is the world to-day not in better condition financially, morally, intellectually and socially, than it ever was at any previous time? It certainly is, and there is no one thing which has had half so much to do with bringing about this grand result as inventions. Then are these not good reasons why we should give encouragement to inventors?

We have clearly seen that no boundary line can be drawn, and past experience teaches us that there is ever room and a demand for something better. No machine or anything else has ever been made so perfect that it could not be made better, cheaper or to better advantage in some way.

As a people we are naturally ambitious, and we always want the best of everything that can be had, and the only way is to get the latest improvements. We must keep advancing; we must keep pressing onward and forward with all the zeal and energy of which we are possessed, and the only way to do this successfully is to encourage the inventor and carry him along with us, for he is the only source from which we can expect anything; and if we fail to encourage him, he certainly will not make any effort to help us.

I am aware that inventions have been made a source through which to swindle people, but it is not the inventor proper who does this. Almost invariably it is some scheming person who gets hold of the article for no other purpose than to swindle.

Instead of crying down inventors and inventions, why do not people discountenance this wholesale patent traffic? They will buy every patented article or patent right that is offered for sale, and if they get the worst of the bargain they are ready to blame the whole patent system and every inventor in the country, when they themselves are to blame. Why don't they have sense and judgment enough to pass these things unnoticed, and only encourage the sale of patented articles through honest and legitimate channels of trade?

As a rule people are not willing to take any blame upon themselves in anything, when the truth of the matter is that they alone are to blame. If they would not encourage such things they would soon cease to exist. I want to see the day when people will regard this matter in its proper light. We know that inventions have been of inestimable value to us, for there is hardly an article of any kind used that is not the subject of a patent. We have many things of comfort and necessity that our fore-parents knew nothing of, and still we need a great many more. We are like the miser, the more we have the more we want, and this everlasting want will never be fully supplied. Each year finds us better prepared to encounter the difficulties and hardships of life, and surely ease and comfort are what we are looking for.

It is plain enough that inventions tend to reduce the labor and cost of gaining a living in the world. If then an advantage to us, why cease to encourage them. Why not keep the banner of progress hoisted and press right on. We always need the best and the best we must have. We must show some appreciation of his efforts, or he who is instilled with the genius necessary to meet these demands will lose interest and cease to make an effort to do so.

The number worthy the name of inventor is few, and to these we must look to fill the demands of future ages. Let us then throw off this untimely prejudice against patents and inventions, and make every effort possible to encourage further progress and development. It cannot possibly work to our disadvantage, but, instead, will be of untold benefit to us in advancing every interest connected with our welfare and prosperity. Give the inventor a chance, encourage him, and good to all will certainly be the result.—*Practical Mechanic.*

Some one tells how to prepare soft coal in such a way, at small cost, that there will be no accumulation of soot in the chimney, and that the under sides of the stove lids will be kept clean. Here it is: For a ton of coal buy a few cents' worth of common salt, make a brine of it and pour over the coal. We do not say that the result will be as effective as the promise.

BRACING BOILER HEADS.

We commend the following article, which we glean from a late impression of the Hartford Steam Boiler Inspection and Insurance Co's. *Locomotive*, to the attention of Boiler-makers:

The proper bracing of flat surfaces exposed to pressure, which are necessarily present in almost all forms of boilers, is a matter of the greatest importance, as the power of resistance to bulging possessed by any considerable extent of such a surface, made as they must be in the majority of cases of thin plates, is so small that practically the whole load has to be carried by the braces. This being the case, it is evident that as much attention should be given to properly designing, proportioning, distributing, and constructing the braces as to any other portion of the boiler. This is not, however, always done, and it is no uncommon thing to subject new boilers to hydrostatic pressure well within the limit of strength of the shell, and so strain the bracing that the heads are bulged to quite an appreciable extent, and when the pressure is released the braces are found to be loose and badly strained. The prevalent idea regarding bracing is, that it should be just sufficient to prevent "vibration" of the heads. There is no objection to regarding it in this light if we consider properly just what is required to effectually do it.

The subject might profitably be discussed in a general manner, but we think more advantage will be derived from the consideration of an actual example, such as would arise in daily practice. Suppose, for example, we are designing a boiler 72 inches in diameter. How many braces shall be put on the heads above the tubes? We first arrange our tubes. Let us assume that they are 3½ inches in external diameter; then a good arrangement of them, paying due regard to a free circulation of the water, will admit about 86, and will leave a clear hight from the top of the upper row to the top of the shell of 29 inches. (See Fig. 1). Then it is evident that this segment, 29 inches high, of a circle 72 inches in diameter, constitutes the surface to be braced, and we must next ascertain the strength of bracing required to render it safe.

Let us consider first just how much of the pressure on this segment must be carried by the braces, and how much shall be allotted to the flange of the head and the top row of tubes. For it is evident that as the area to be braced is bounded by these parts, and they possess ample strength, they may be calculated to sustain their due share of the load.

The flange of the tube sheet may be assumed to have a radius of two inches. This curved portion will take care of itself, and, if it had a chance to do so, a great deal more besides. So we draw the line A-A′ with a radius of 34 inches, and disregard the portion outside of it.

Now, we know that on heads or flat surfaces of ordinary thickness, the pitch of stays should not be much more than 8 inches from centre to centre. In the fire boxes of locomotives and similar boilers they must be much closer, but the head of an ordinary boiler is not exposed to such intense heat, and they may be placed much further apart, with safety. So we draw the line B B′ B″, with a radius equal to 30 inches, and consider that the load on the area between it and the flange may safely be borne by the flange itself.

Now, how much of the load on the head above the tubes may safely be carried by the tubes themselves? We know by experiments that the tubes, if well put in, have a great holding power when new. We also know that if the water used is corrosive, or the fuel is of such a nature that its gases attack the ends of the tubes externally, they may in time corrode and lose much of their holding power. If this were not so then we should be justified in keeping away from the tubes 8 inches or so with the nearest brace; but for the reasons above stated it would be deemed judicious to brace closer down to the top of the tubes, so that if a portion of them lose their holding power, the boiler will still be perfectly safe. So we would put the line of braces as nearly as might be 4 inches above the top of the upper row of tubes, and drawing the straight line from B to B′, 2 inches above the tubes, put in braces enough to carry safely the pressure on the segment of the head B B′ B″. The area of this segment is easily computed by means of the table given in the *Locomotive* of December, 1886, page 184. In this case it is a segment 21 inches high, of a circle 60 inches in diameter, and its area is 882 square inches. The braces should be sufficient to carry safely the entire pressure coming on this surface. If the boiler is intended to carry a pressure of 100 pounds per square inch, it would aggregate on this segment 88,200 pounds, and the braces should be sufficient to safely sustain this pressure. The number of braces required will depend upon their form. If, of the ordinary crowfoot pattern, which if well made is as good as anything yet devised, and one inch in diameter, they could safely be allowed to sustain a tensile stress of 7,000 pounds each. This would give 88,200 + 7,000 – 13 braces, which should be distributed as uniformly as possible over the surface to be braced, about as shown in Fig. 1, making the arrangement as symmetrical as possible, grouping them slightly closer to each other near the centre of the heap than we do out toward the flange. The braces should be attached to shell and head by two rivets at each end. The rivets shauld be of such size that the combined area of their shanks will be at least equal to the body of the brace, and their length should be sufficient to give a good large head on the outside to realize strength equal to the body of the brace. We have seen cases where the rivet used was so short that when hammered down outside, the head was so thin and weak that it stripped off under the test pressure. Such scrimping of material is very poor economy in the long run.

Fig. 2 shows an arrangement for a different form of brace. Four-inch T-irons are riveted to the heads, and the braces, with forked jaws, are attached to the web by a turned pin or bolt. The T-irons are, as far as practicable, so arranged that the rivets which secure them to the heads will fall in about the same position that they would if crowfoot braces were used, that is, they should be distributed as uniformly as possible. This enables a less number of braces to be used, but they should be somewhat larger. Owing, however, to the stiffening of the heads by the T-irons, which act as girders, and transfer the stress due to the pressure to the flange and the tubes, it is usual to make these braces but one inch in diameter. We have never known the least trouble to occur where a boiler was braced in this manner and the work was well done, and recommend it as a very superior form. Fig. 3 shows the detail of this brace and its connection. Two angle irons are sometimes used instead of the T-irons with this form, but the T-irons are to be preferred, as they are free from the "claw hammer" strain which is unavoidable when the angles are used.

Many boiler-makers prefer to arrange the T or angle irons horizontally across the portion of the head to be braced instead of radially. This form is shown in Fig. 4, and there is no objection to it provided the braces are swung horizontally to the point of attachment to the shell. Where they are swung upward, as they are in the majority of cases, an awkward bend is necessitated in the brace, and a square pull on the jaws is impossible, and the consequence is they do not remain taut for any great length of time. They should never

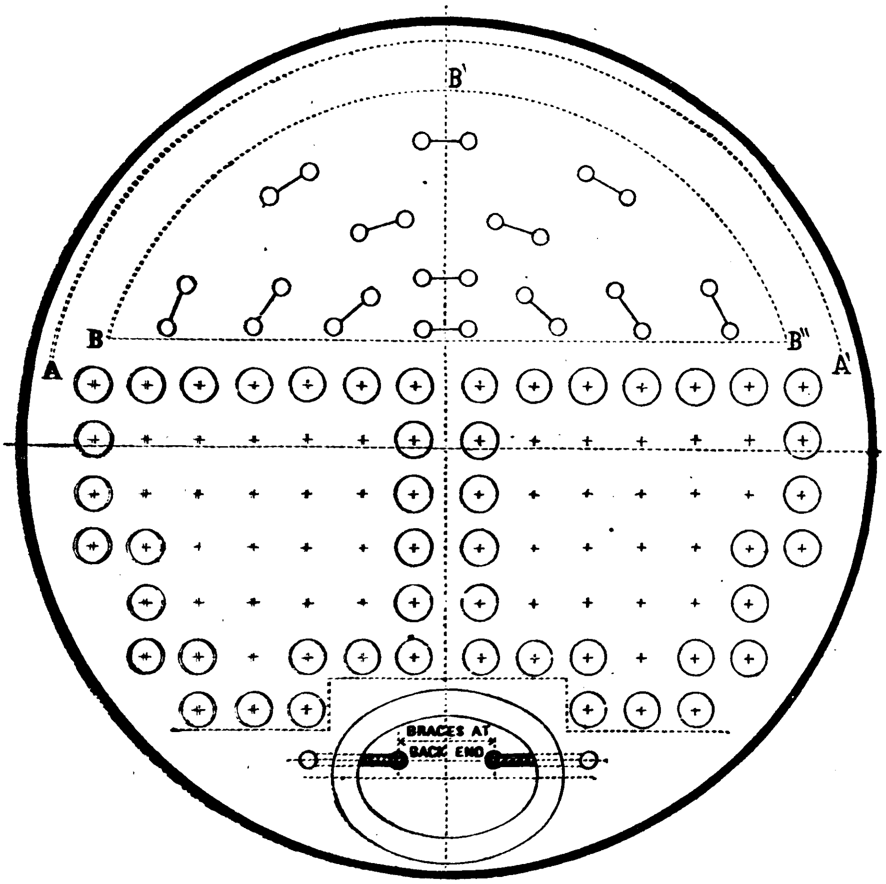


FIG. 1.

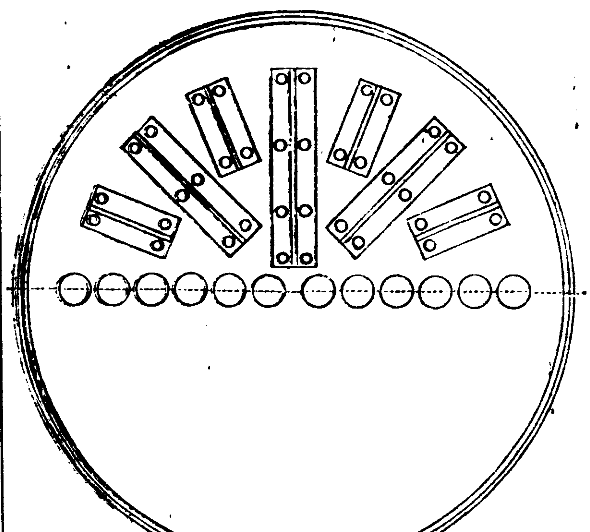


FIG. 2.

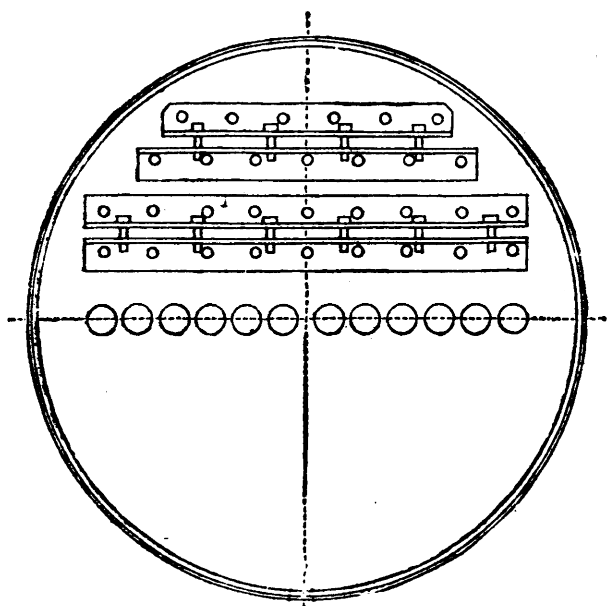
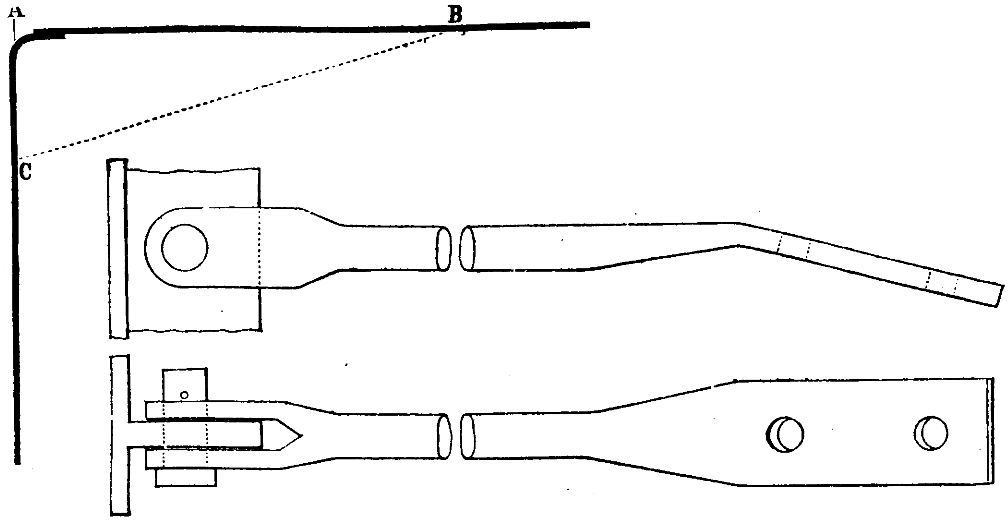


FIG. 3.

BRACING BOILER HEADS.



be put in in this manner. When we wish to resist a direct pull, a straight piece of material is the best thing to do it with, and there is no reason for using anything else to brace a boiler head with.

Another favourite style with some makers consists in riveting heavy forged bars horizontally to the heads above the tubes. These bars are provided with projections, to which are attached heavy braces extending from head to head. The objection to this form of brace is, that it offers a very serious obstruction to a proper examination of the boiler, and is very much in the way when cleaning and repairs to the inside of the boiler become necessary. The principle embodied, that of tying the heads of the boiler together, is all right, but it should be remembered that boiler shells have an excess of strength in a transverse direction to carry *all* the pressure that can come on the heads, and so ample strength is secured by bracing back well on the shell. We have yet to learn of a case where braces attached to the shell have *caused* an explosion by the strain on them tearing it apart transversely.

In localities where the water available for use in boilers is very bad, a man-hole in the front head below the tubes will be found very useful to enable the bottom of the shell to be kept clean. Now, it is evident that a portion of each head, equal at the least to the area of the man-hole frame [see area below dotted line on lower part of Fig. 1], will be deprived of the supporting power of the tubes, which must be displaced to admit the man-hole, and this unsupported area should be properly braced, more especially that at the back end. This is done in a variety of ways. Some run crowfoot braces from the head back on to the shell. The objection to this is, the foot of the brace where it is attached to the shell is apt to form a lodging place for sediment, which will accumulate until there is danger that the shell may be burned at this point. The better way is to put in through braces here, extending from head to head, leaving the bottom of the shell entirely clear. Various methods are practiced of attaching these braces to the heads, but the preferable one would seem to be to make the brace of round iron 1⅛ inches in diameter, upset the ends to 1½ inches diameter, and cut a *full smooth* thread on them; drill and tap the heads for this thread, and screw the braces through, making them just long enough to enable the ends to be headed down nicely outside, after the manner of the ordinary screw stay. This will leave no chance for sediment to accumulate.

Where this form of brace is used they should not be run through parallel with the direction of the tubes; if they are, they will be of very little account as braces of the back head. For their ends must be separated at the front end by a distance of at least two or three inches more than the greater outside diameter of the man-hole frame, or say about 24 inches; if they are run through parallel, this same distance on the back head will be wholly unsupported, and will be apt to bulge sooner or later. The braces should therefore be brought closer together on the back head; from 9 to 10 inches apart will generally be found to give a better and more uniform support to the back head, where a man-hole of ordinary size is used in the front head. This is shown in Fig. 1 with sufficient clearness to render further explanation unnecessary.

A few words concerning the frames usually put around the man-holes in boiler heads may not be amiss. The common practice is to rivet on a wrought-iron ring about half an inch thick, and as narrow as can be used, and get a rivet through it! This is entirely insufficient for the purpose, and the practice may be described as entirely too economical, or some stronger name may perhaps be profitably applied to it. This ring should under no circumstances be less than 2¼ inches wide (2½ inches would be better), and one inch thick (from 1¼ to 1½ inches thick would be much better.) Then a degree of stiffness would be imparted to the front head, if a suitable plate were used, which would insure perfect freedom from trouble. It is no uncommon thing for these thin, narrow rings to give out under the hydrostatic pressure while the boilers are being tested.

On a diagonal brace, which term will apply to any brace which is not parallel to the direction of the stress applied to it, such as gussets, braces attached to heads, and having the other end attached to the shell, etc., the strain is theoretically somewhat greater than it would be if the brace were parallel to the direction of the stress applied. The actual stress on the brace may be found by dividing the total pressure on the area supported by the brace by the cosine of the angle between the brace, and the direction of the stress. Or, to arrive at the result without resorting to calculation, lay out the brace in correct proportions, as shown in Fig. 5. Then, if the pressure on the area to be braced is represented by the length of the line A–B, the length of the brace B–C measured by the same scale will represent the actual stress upon it. With the ordinary proportion of braces, this difference is so small it may be neglected; but where the brace makes a comparatively large angle with the shell, as may be the case with gusset stays, it should be taken into account, and the brace made correspondingly larger.—*The Manufacturer and Builder.*

HANDLING OF ACIDS.

A correspondent informs us that he has met with a serious accident, caused by the spattering of some drops of muriatic acid into his eyes, while loosening the glass stopper of a five-pint bottle containing it. He suggests that we caution our readers against similar mishaps, and he thinks that it would be a useful thing to repeat such cautions occasionally, even without waiting for the occurrence of an accident. We think this suggestion deserves attention, and, in compliance, will append here some cautionary remarks, which do not claim to embrace all that could be written upon the subject, but which may afford some practical hints at least for the younger and less experienced members of the profession.

When emptying *carboys* of acid, see that they are securely held. Do not tilt them over with one hand, while holding a receiving vessel in the other, unless they are so hung or placed that you have absolute control over them. A good way is to put the carboy on an elevated place, say about 18 to 24 inches high, so that when it lies on its side, its upper edge will be about three inches within the edge of the platform. If the carboy has a wooden strip or side rail, instead of a handle, it is best to tilt it on the side where this is situated, as this assists in keeping command over the carboy while it is tilted. If you have a carboy swing, be sure you see that the carboy is securely fastened, and that allowance be made for the change in centre of gravity as it becomes more empty.

Never stand in front of a carboy while emptying it, but sideways, and use a receiving vessel with a substantial handle. Do not hold a bottle with a funnel under the mouth of a carboy, nor hold any vessel so that if it should overflow, the acid would run over your hands.

Choose such a place for emptying carboys, or any other containers of acid, as will suffer the least injury should the vessel be broken, or any of the acid be spilled.

Remember that the larger or the flimsier the container is, the more care and circumspection must be exercised. A person may have emptied a hundred or more carboys without any mishap, when unexpectedly an accident will happen, and in nine cases out of ten this is due to pure carelessness.

Never carry large containers of acid in contact with your body. Should they accidentally break, a most painful burn (sometimes turning out fatally) may be the result.

When opening acid bottles, for instance, the usual five-pint sizes, first remove the cement from around the stopper, and wash and wipe the neck carefully to remove every trace of foreign matter. Then, if the stopper cannot be easily loosened by hand, place a coarse towel over the stopper and bottle, and while bearing with the thumb of one hand against the edge of one side of the stopper, tap the other side gently, with the wooden (*not* metallic) handle of a spatula, when it usually will become loose. Should it be very obstinate, and the bottle at the same time appear to be of rather thin glass, place the bottle into a sufficiently deep and large acid-proof jar to receive the contents in case the bottle should break. The reason why a towel should be put over the stopper is almost self-evident. Our correspondent would have had no occasion to write to us had he used one. If a bottle of acid is exposed to a warm temperature, evidently some pressure will be developed within the bottle. By moving the bottle about, the neck and bottom of the stopper will be wetted with the acid, and if afterwards the stopper is suddenly loosened, the compressed air or gases will throw out any particles of liquid which are between the neck and stopper.

All acids are not equally dangerous. Hydrochloric or muriatic is perhaps the least risky. Sulphuric acid comes next, as it does not evolve any gases. The greatest care, however, must be exercised with nitric acid, and still more so with aqua regia.

When compelled to work for any length of time with acids, it is well to have a vessel of fresh water close at hand, to wash off any drops that may have come in contact with the hands or face. Sometimes it may be advantageous to wear India rubber gloves, though most of those sold for this purpose are rather clumsy.

In packing acids, it should be made a rule to put them in a box by themseves, if at all possible. It would certainly be dangerous to pack sulphuric acid promiscuously with such articles as chlorate of potassium and organic substances.

In storing acids, equal care must be exercised. As a rule, they should be kept in a place so arranged that, if the containers should be broken, the acid would be unable to reach other substances.

When diluting acids with water, remember always to pour the acid, gradually and under stirring, *into the water*, and not the water in the acid. In the case of sulphuric acid, for instance, the latter method may develop such an amount of steam at once that the whole liquid may be scattered about and do much damage. The last time we saw this happen was about a year ago, when several carboys of acid accidentally fell from the rear end of a truck in front of a factory of mineral waters. The acid collected in a pool in the gutter, and one of the workmen connected with the establishment, wanting to wash it into the sewer, turned a small steam of water upon it by means of a hose. The consequence was, a violent evolution of steam, almost resembling an explosion, and a number of the bystanders received more or less of the spray, to the damage of skin and clothes.—*American Druggist.*

A NEW SOLDER.

A soft alloy, which adheres so firmly to metallic, glass and porcelain surfaces that it can be used as a solder, and which is invaluable when the articles to be soldered are of such a nature that they cannot bear a high degree of temperature, consists of finely pulverized copper dust, which is obtained by shaking a solution of the sulphate of copper with granulated zinc. The temperature of the solution rises considerably, and the metallic copper is precipitated in the form of a brownish powder; 20, 30 or 36 parts of this copper dust, according to the hardness desired, are placed in a cast-iron or porcelain-lined mortar and well mixed with some sulphuric acid having a specific gravity of 1.85. Add to the paste thus formed 70 parts (by weight) of mercury, constantly stirring. When thoroughly mixed, the amalgam must be carefully rinsed in warm water to remove the acid, and then set aside to cool. In ten or twelve hours it will be hard enough to scratch tin. When it is to be used it should be heated to a temperature of 375 degrees C., when it becomes as soft as wax by kneading it in an iron mortar. In this ductile state it can be spread upon any surface, to which, as it cools and hardens, it adheres very tenaciously.—*Exchange.*

It is stated that a solution of pearl-ash in water, thrown upon a fire, will extinguish it immediately.

POLISHING GRANITE.

The form is given to the stone by the hands of skilled masons, in much the same way as is done with other stones of softer nature. Of course, the time required is considerably greater in the case of granite, as compared with other stones. If the surface is not to be polished, but only fine-axed, as it is called, that is done by the use of a hammer composed of a number of slips of steel of about a sixteenth of an inch thick, which are tightly bound together, the edges being placed on the same plane. With this tool the workman smooths the surface of the stone by a series of taps or blows given at a right angle to the surface operated upon. By this means the marks of the blows as given obliquely on the surface of the stone are obliterated, and a smooth face produced. Polishing is performed by rubbing in the first place with an iron tool and with sand and water. Emery is next applied, then putty with flannel. All plain surface and moulding can be done by machinery, but all carvings or surfaces broken into small portions of various elevations, are done by the hands of the patient hand-polishers.

The operation of sawing a block of granite into slabs for panels; tables, or chimney-pieces is a very slow process, the rate of progress being about half an inch per day of 10 hours. The machines employed are few and simple. They are technically called lathes, waggons, and pendulums or rubbers. The lathes are employed for the polishing of columns, the waggons for flat surfaces, and the pendulums for moulding and such flat work as is not suitable for the waggon. In the lathe the column is placed and supported at each end by points, upon which it revolves. On the upper surface of the column there are laid pieces of iron, segments of the circumference of the column. The weight of these pieces of iron lying upon the column, and the constant supply by the lathe attendant of sand and water, emery or putty, according to the state of finish to which the column has been brought, constitute the whole operation. While sand is used during the rougher state of the process, these irons are bare ; but when using emery and putty, the surface of the iron next to the stone is covered with thick flannel.

The waggon is a carriage running upon rails, in which the pieces of stone to be polished are fixed, having uppermost the surface to be operated upon. Above this surface there are shafts placed perpendicularly, on the lower end of which are fixed rings of iron. These rings rest upon the stone, and when the shaft revolves they rub the surface of the stone. At the same time the waggon travels backwards and forwards upon the rails, so as to expose the whole surface of the stone to the action of the rings. The pendulum is a frame hung upon hinges from the roof of the workshop. To this frame are attached iron rods, moving in a horizontal direction. In the line upon which these rods move, and under them, the stone is firmly placed upon the floor. Pieces of iron are then loosely attached to the rods, and allowed to rest upon the surface of the stone. When the whole is set in motion, these irons are dragged backwards and forwards over the surface of the stone, and so it is polished. When polishing plain surfaces such as the needle of an obelisk, the pieces of iron are flat ; but when we have to polish a moulding we make an extra pattern of its form, and the irons are cast from that pattern.—*The Stonemason.*

TO FIX PENCIL DRAWINGS.—First pass the drawing through clear water, go carefully over with skimmed milk, using a camel's-hair pencil, dip in a weak solution of alum, and let it dry flat. Allow a thin solution of isinglass to run over the drawing on perfectly level surface.

THE GEYER-BRISTOL METER FOR DIRECT AND ALTERNATING CURRENTS.*

BY PROFESSOR WILLIAM E. GEYER.

In the meter about to be described we make use of the heating effect of the current. Electric measure instruments depending on this heat effect are not new, as in the Cardew voltmeter we have an application which has found much favour. Here the current of greater or less strength traverses a long thin wire, heats it more or less, and the direct expansion is a measure of the current, and indirectly of electromotive force.

In an ammeter it is necessary to keep down the resistance, and I therefore doubt whether direct expansion can be usefully applied for this purpose ; for the actual elongation of a bar of metal, even when raised through a considerable range of temperature, is very small. In the familiar compound bar we have a case where a very small actual elongation produces a relatively very great lateral displacement.

I think I shall best be able to explain to you our meter, by recalling to your minds this old device. In the simplest compound bar two strips of metal which have different coefficients of expansion are securely soldered flatwise along their entire length. Brass and steel are metals frequently employed. On heating, the brass expands more than the steel, and, in consequence, the bar bends, becoming convex on the side of the brass. When such a bar is heated by the passage of the electric current, it will deflect, and this deflection may be made a measure of the current. The disadvantage of such an instrument would be that atmospheric changes of temperature would also cause deflection, so that troublesome corrections would have to be introduced.

In our meter we also use a sort of compound bar, but eliminate at once the effect of the surrounding temperature by taking metals whose coefficients of expansion are the same or sensibly equal ; in fact we take the same metal. Our first form of construction was as follows :—A wire of German silver is laid upon a strip of German silver of considerably greater cross-section and radiating surface. The wire and strip are soldered together at one end, separated for the remainder of the length by a film of mica, then tied together at frequent intervals with silk or other insulating material, and suitably supported or clamped at the unsoldered end. If now a current, either continuous or alternating, is allowed to enter the strip at one end, it runs along its length, there enters the wire, and leaves the instrument at the other end of the wire.

For a given current the wire, on account of its greater resistance and also on account of its smaller radiating surface, becomes hotter than the strip. In consequence of the difference of expansion the bar bends, becoming convex on the side of the smaller conductor. This combination we call a differential bar.

We would also state that inasmuch as the results obtained by the use of this instrument are due to the excess of the heating effect of an electric current upon one portion of the bar, or its equivalent, over the other, it is in a measure immaterial to the principle of the invention whether the current which produces the differences in temperature be caused to heat the two parts directly or indirectly. For example, the more expansible part, in lieu of being included directly in the circuit, may be arranged in close proximity to, but insulated from, a wire or conductor which is heated by the current. The other part or element may be in the circuit or not, but in either case formed or arranged to be less sensibly heated than the other.

It will readily be seen, however, that to heat one or both of

* Read before the American Institute of Electrical Engineers, New York, November 13th, 1888.

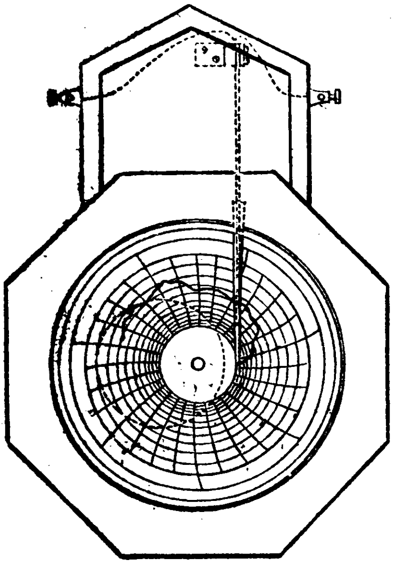


FIG. 1.

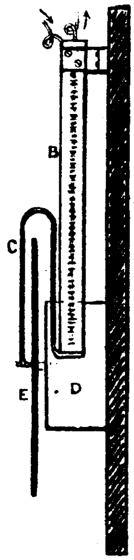


FIG. 2.

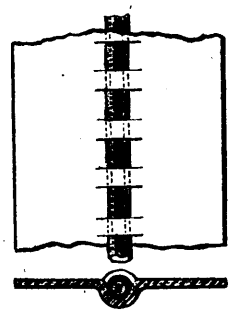


FIG. 3.

the parts of the device in this manner would be clearly equivalent to connecting them both in series in an electric circuit. Unlike the case where magnetic action is employed, the force here available is very considerable, so that to make the instrument self-recording, it is only necessary to attach an inking device to the free end and move in front of it a properly ruled chart. In this respect we have no difficulty whatever. My associate, Prof. Bristol, who has done the larger part of the work, has, since our first experiments, very much simplified the method of constructing the differential bar, and the one used in the instrument exhibited was made by placing a flat strip of German silver between a pair of dies which make alternate depressions and elevations along the length of the bar ; the wire, insulated with asbestos, was then slipped in the tube-like space thus formed, and the whole pressed between plates provided with grooves of the proper depth so as to leave the wire ' ` one side of the centre line and at the same time to insure its being held firmly by the little bridges along the length of the bar. Since the bars can be constructe' essentially by these two machine operations it is evident that they may be readily reproduced and at very small cost.

We have determined experimentally the best relation between the cross section of the strip and wire to give maximum deflection. We believe the instrument could readily be made integrating, but doubt the desirability of doing so. Our reason for this could probably not be better expressed than in the words of an eminent engineer, Mr. Charles E. Emery, in his paper on "Heating cities by steam," before the Franklin Institute, which we quote as follows :—

"It was at first considered unfortunate that a reliable meter could not be obtained, which, like a water meter would show by differences of reading the quantity of steam used for the interval between observations directly without calculation, and without expense of maintaining a time register at each location, and of integrating the chart afterward. This system, however, proved a blessing in disguise. The greatest difficulty in settling with consumers lies in the fact that employés waste the steam. This is particularly the case during the heating season, when steam for various uses is left on continuously during nights and Sundays, thus increasing the time of consumption from, say, 60 hours a week to 168 hours. In many cases, too, the rate of consumption keeps uniform during the night as well as during the day, so that it is an easy matter to more than double the bills. The consumers at first naturally lay the blame to the steam of the steam company, but the meter charts have been the means of enabling the company to satisfy consumers when, and to what extent, the increased bills were due to mismanagement on their premises."

Substitute electricity for steam and the reasoning will apply perfectly to our case.

In the accompanying illustrations, Fig. 1 is a general view of the differential bar, mounted in a case with inker and recording dial. Fig. 2 is a side view of the important parts, the case being removed.

The following letters refer to the different parts :—

A, supporting framework ; B, differential bar ; C, inking pointer attached to bar ; D, clockwork moving dial ; E, revolving dial for receiving record.

Fig. 3 shows a small portion of the bar and a cross section on an enlarged scale.—*Electrical Review.*

SIMPLE EXPERIMENTS IN PHYSICS.

BY GEO. M. HOPKINS.

The engravings represent a few examples of the projection of simple physical experiments upon the screen. Besides a lantern, a few glass tanks with parallel sides will be required. These are preferably, but not necessarily, made of three pieces of plate glass, one a thick piece, having the shape of the cavity cut out of it, the others simply flat pieces, attached to opposite sides of the first by means of marine glue or other suitable cement.

A cell made of plates of glass clamped on opposite sides of a bent rubber strip serves a good purpose. It is a great convenience to have several of each kind, so that preparations for projection may be made at leisure.

In Fig. 1 is shown the well known experiment illustrating cohesion. In the tank is placed a mixture of alcohol and water, having the same specific gravity as olive oil. Into the mixture is very carefully introduced a globule of olive oil, which may be colored or not. The oil assumes a perfectly spherical form, and produces a very interesting image on the screen.

In Fig. 2 is shown the method or projecting the experiment in which the volume of equal parts of alcohol and water is less when they are combined than it is when they are separate. The tank has a large chamber with a narrow neck. The chamber is divided in the centre by a removable partition having

Fig. 1.—COHESION.

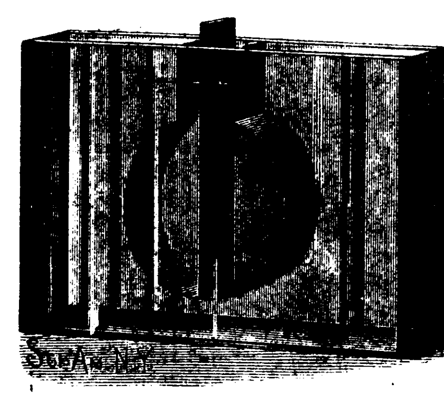


Fig. 2.—REDUCTION OF VOLUME BY MIXTURE.

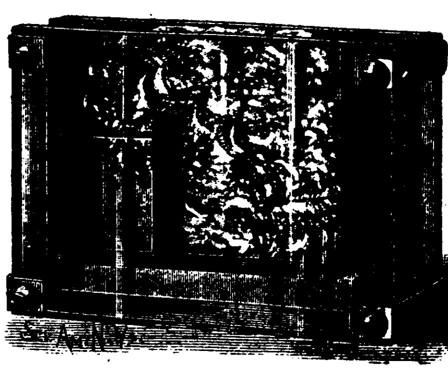


Fig. 3.—COTTON AND ALCOHOL EXPERIMENT.

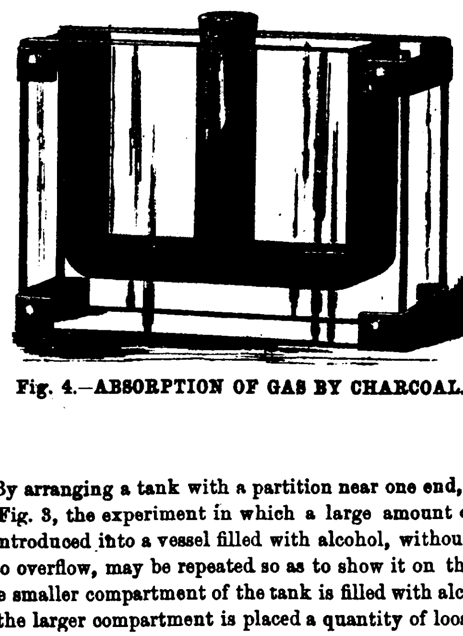


Fig. 4.—ABSORPTION OF GAS BY CHARCOAL.

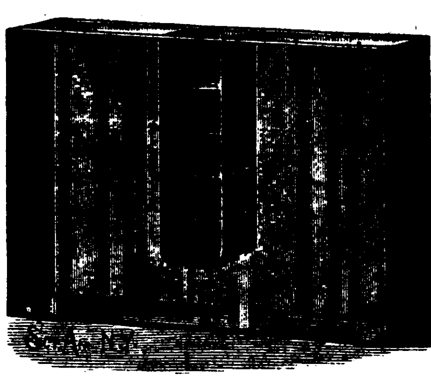


Fig. 5.—EQUILIBRIUM OF LIQUIDS.

soft rubber edges. Water is introduced into one division of the chamber, and slightly colored alcohol is placed in the other division. The water and the alcohol are level with a mark on the glass. On turning the partition, the water and alcohol mix, and the level of the mixture immediately falls some distance below the mark on the glass. After a thorough mixture of the liquids, the partition may be replaced in its first position.

By arranging a tank with a partition near one end, as shown in Fig. 3, the experiment in which a large amount of cotton is introduced into a vessel filled with alcohol, without causing it to overflow, may be repeated so as to show it on the screen. The smaller compartment of the tank is filled with alcohol, and in the larger compartment is placed a quantity of loose cotton. This is gradually transferred from the larger to the smaller compartment, by means of a pair of fine tweezers, without causing the alcohol to overflow.

The absorption of gases by charcoal is readily shown in the manner illustrated in Fig. 4. A glass tube, open at both ends, is dipped in mercury contained in the bottom of the tank. A cork is fitted to the upper end of the tube. Carbonic acid is poured into the tube, then a piece of freshly heated charcoal is dropped in, and the cork is instantly replaced. The charcoal absorbs the gas rapidly, creating a partial vacuum, which causes the mercury to rise in the tube to a considerable height.

In Fig. 5 is shown a tank containing four liquids of different densities, the densities decreasing from the bottom upward. This is simply the well known experiment of the "vial of four elements." The liquids are mercury, a saturated solution of carbonate of potash in water, colored alcohol, and kerosene oil. This simple experiment is very interesting when performed in the usual way; but when it is projected upon the screen, the struggle of the different liquids to regain equilibrium, after having been thoroughly stirred up, is striking.—*Scientific American.*

WHAT WAS KNOWN ABOUT BELTING FIFTY YEARS AGO.

BY JOHN H. COOPER, AUTHOR OF "USE OF BELTING."

Many devices now much employed in the arts, and which are claimed to be of recent invention, are, indeed, not new at all, but were used in the same forms, and for similiar purposes, as much as half a century ago. Turning the face of a pulley a little high in the middle seems not much of an achievement in mechanic art—hardly worthy of noting—nor have we discovered the person who first did this, but here is a statement showing that it was early done, and is entitled to a record. From Oliver Evans' "Millers' Guide," published in Pennsylvania in the year 1807, we quote his method of making a wheat-elevator belt, and the pulleys over which it runs. He says: "Make a strap 4½ inches wide of good, strong, white harness leather, only one thickness. It must be cut and joined together in a straight line, with the thickest, and, consequently, the thinnest ends together, so that if they be too thin they may be lapped over and doubled until they are thick enough singly." . . . "Make the pulleys 24 inches diameter, as thick as the strap is wide, and half an inch higher in the middle than at the sides, to make the strap keep on." These pulleys are of wood, secured on "gudgeons" of square wrought iron, with round end for bearing.

In Buchanan's elaborate work on mill gearing, published in England in 1814, the following observations occur: "Throwing a wheel into gear very often occasions the breaking of the teeth, whereas a pulley is generally put in motion by a belt so gradually, that no part of the machinery can receive any injury. There is the elasticity of the belt, as well as the liberty of slipping on the pulley, to yield to the inertia, till by its friction the belt gradually brings it into motion.

The sliding pulley is one of the oldest contrivances for disengaging and re-engaging a machine moved by a belt or band.

The fast and loose pulley is shown in Fig. 1, in which B is a pulley firmly fixed on the axle A, and C a pulley with a bush, so that it can revolve upon the axle A without communicating motion to it. This contrivance is remarkable for its beautiful simplicity, as the axle A can be thrown in and out of gear at pleasure, without the least shock, by simply passing a strap from the one pulley to the other. Its application in cotton mills is now general.

When a cord is used, the arrangement then consists of two grooved wheels, B and C. Fig. 2, one being fixed on the axle and the other loose thereon. The cord which conveys the motion and force may be shifted at pleasure from either pulley to the other, driving or not driving, the axle A.

Reference is made also in this work to the numerous contrivances for the purpose of engaging and disengaging machinery, in which the particular object aimed at has been to communicate motion without shock or jar, and the author proceeds also to divide these inventions into two classes; when the motion is communication by bands, belts or chains, and when it is communicated by wheel-work. The former is referred to as "possessing the advantage of bringing on the motion more gradually."

English mechanics also discovered the necessity of rounding the faces of the belt pulleys. "It may be proper here to mention," says one authority, "that, in order to make a belt run properly on a pulley, it is necessary to have the rim a little rounded or swelled in the middle. The belt always inclines to that part of the pulley which is of greatest diameter. This curious property is of great practical use, and, until it was knewn, it was found very troublesome to prevent belts slipping off the pulleys." The remark is also made that Arkwright used iron bevel wheels and band pulleys in cotton-spinning mills in the year 1775.

Long cones, with shifting belt thereon, and opposite cones of pulleys with belt that may be run on any pair for changing speeds, are graphically shown; also combinations of belted pulleys and gears for producing two very different speeds by the shitting of a belt. There must have been many modifications of these simple contrivances, for our author says: "I have only given the way in which they are most generally applied. To give all the varieties would be an almost endless labor."

High-speed belts, now well known to be in the line of economical transmission of power and motion, were also suggested and much employed in the earlier years of this century. By way of comparison, witnes one of the conclusions arrived at on making an exhaustive experimentation of belt-driving in Philadelphia in the near past, and which may be formulated in the following words: "The economy of belt transmission depends principally upon journal friction and slip, and it is important on this account to make the belt-speed as high as possible within the limits of 5,000 to 6,000 feet per minute."

I give herewith a statement printed in Philadelphia in the year 1837, which spun abont the same thread some fifty years before: "A belt adheres much better, and is less liable to slip when at a quick speed than at a slow speed. Therefore it is better to gear a mill with small drums, and run them at a high velocity, than with large drums and to run them slo wer; and a mill thus geared costs less, and has a much neater appearance, than with large heavy drums."

Much of the cumbrous, lumbering cog-wheel gearing, running slow and sure, and attended with a deal of friction and noise, was done away with when this century was young. Mr. Fairbain dates the introduction of the new system of gearing from the year 1815. "At that time," he says, "the shafts of our cotton mills were moving from 40 to 50 revolutions per minute, whereas now (prior to 1841) many are running 300 to 350.

One of the earliest attempts at investigating the essential conditions of driving belts, and of formulating a rule and table for ready reference, is that of M. Laborde, dating prior to the year 1833. As his memoir is little know and not easily accessible, a correct presentation of his views is desirable, and to this end the literal rendering of his paper is given below. It is worthy of note that M. Laborde derived his data from belts in use, and that he relied for years upon the rule which he has given.

"The first idea which presents itself in this research is, that the resistance to be overcome must be less than the force which causes the belt to slip upon the circumference of the pulley. The second is, that the tension of a belt must not arrive at a point to stretch It, because it would be too quickly destroyed. The third is, that drawing too strongly upon the axes, the resistance increases, as if these axes were increased, in the same proportion in weight as is represented by the tension, which necessitates an increase in the strength of the journals.

"Yet a fourth question presents itself: That a belt must be very flexible, or, to express it better, very supple, in order that the power employed to cause it continually to touch in all its parts, be as little as possible.

"One can then conclude, with these four reflections, that a belt ought never to be doubled, but consist of a single thickness of leather, softemed, when dry, with plain tallow; that it must never be employed at a tension which can stretch it to a point to deform it, and that it ought to adapt itself perfectly to the circumference of the pulleys; that, for this reason the pulleys must be turned smooth, and not ridged, neither lengthwise nor crosswise, as is often done.

"These well known truths have only helped us to find a rule which governs the breadth and the speed, according to the resistances to be overcome.

"If we wish to transmit power, the necessary force of which be represented by 7, and the breadth of the belt be represented by a number, for example, 10, and by a speed of 100, it is evident that to transmit a double force, a breadth of 20 with a speed of 100 will be necessary; or 10 of breadth with 200 of speed; or, briefly, there is necessary a breadth and a speed, such that their product, comparative at first, be in the ratio of 2 to 1; hence, we may conclude that the forces to be transmitted are to each other as the products of the breadths of the belts, multiplied by their speeds.

"It is then no longer the question to find, in practice, a base or starting point.

"Here each practitioner can vary his opinions on the adoption of this base, but all must be in accordance with the formula.

"My experience has shown me, as a good base, that the force of 6 men, or of a horse, or, to express it better, a dynamic unity, is transmitted very well with a breadth of 3 inches, and 500 feet of speed per minute. Such a belt, acting upon a non-ridged pulley, *i. e.*, smoothly turned, has no need of a strong tension, and does not deform itself. It is well understood that this refers to a half-embraced pulley, for in transmissions where the pulleys are embraced but a fourth or a sixth, we must modify the rule but the base is correct, whatever the diameter of the pulley may be; and, in fact, if the pulley be 5 feet in circumference, it will make 100 turns per minute, but if it be only 2½ feet, it will make 200 turns; it will then, during the same time, have presented the same surface to the action of the belt; which explains why, when a large or small pulley, each half embraced by the belt does not slip sooner on one than on the other.

Succeeding to this, Paul Heilmann communicated to the Industrial Society of Mulhouse, at its general meeting, May 27, 1835, some observations on the friction of belts upon the surface of the pulleys, and upon the width to give belts in special cases. Laborde's views were sustained by the society, and the dimensions indicated by him are reported as being good, but apply only to the cases where the pulleys are embraced just one-half of their circumference by the belts which they drive.

Mr. Heilmann then resorts to and employs the higher mathematics, from which he deduces a formula which will solve all cases in practice. This formula is a very knotty one, and we leave it untied for the present, offering the plain fabric which he has woven for us in this form:

"It results, therefore, that the friction is the same for the same angle of contact, whatever may be the radius of the pulley; or, in other words, that the length of the arc of contact should be proportional to the radius of the pulley to produce the same friction, all the rest being equal: A result of great simplicity. All this being considered, we see that the laws concerning the friction of curved surfaces are very different from those which relate to plane surfaces; from which it follows, that, the friction is the same for a same angle and a same tension, whatever may be the width of the belt. We see, then, that the friction of a belt upon a pulley depends:

(1). On the pressure or on the tension of a belt.

(2). On the angle of contact; and that the friction is independent:

(1). Of the diameter of the pulley; and

(2). Of the width of the belt. The friction is proportional to the pressure.

"According to the formula cited above, I have constructed with the aid of logarithms, a table which gives the ratio of friction to pressure for any angle. The ratio of friction to pressure for leather upon plane surfaces of cast iron has been taken from the experiments of Mr. Morin; I have, however, verified the figures with a belt such as is used in cotton mills. All the results relate to the cases where the machine passes from a state of rest to that of motion—the case in which the maximum of force is necessary."

The part of this table which is applicable to those cases coming within the limits of usual practice, I have reproduced, by way of showing the variation of drive in belts when they envelope their pulleys more or less than half their circumferences:

Degrees.	Fraction of the Circumference.	Ratio of Friction to the Pressure.
120	$\frac{4}{12}$	0.2911
150	$\frac{5}{12}$	0.3763
180	$\frac{6}{12}$	0.4670
210	$\frac{7}{12}$	0.5674
240	$\frac{8}{12}$	0.6669
270	$\frac{9}{12}$	0.7769
300	$\frac{10}{12}$	0.8941
112½	$\frac{5}{16}$	0.2706
135	$\frac{6}{16}$	0.3330
157½	$\frac{7}{16}$	0 3933
202½	$\frac{9}{16}$	0.5390
225	$\frac{10}{16}$	0.6145
247½	$\frac{11}{16}$	0.6937
292½	$\frac{13}{16}$	0.8642

If, for instance, the width of a belt to do a certain work be found to be 6 inches, and in this case it embraces the pulley but 120°, we must multiply the width of this belt—6 inches—by

$$\frac{4670}{2911}$$

which are numbers taken from the table opposite the two enveloped arcs expressed in degrees. This will give $9\frac{7}{12}$ inches, the increase of width required to make up for the loss of arc contact. I mention this table, and these methods, because modern writers have repeated this history as if original with them.

Chief among the things that were know about belting fifty years ago, is its co-efficient of friction, and it is mentioned in this connection now because modern experimenters have given us another measure for this, detracting from Morin's figures upon which we have so long relied. Later still, by careful experiments made at the Massachusetts Institute of Technology, by Prof. Lanza, Morin's figures have been re-established, and we can therefore rest surely again on Morin's figures—namely, 0.282, expressing the ratio of belt friction to belt pressure, and relating to dry belts on dry pulleys. Morin also established at least three laws of belt friction:

"By recapitulating the results of these series of experiments upon the friction of belts upon wooden drums, or upon cast-iron pulleys, one can see that we are justified in concluding therefrom that the ratio of this resistance to the pressure is:

"1st. Independent of the breadth of the belt.

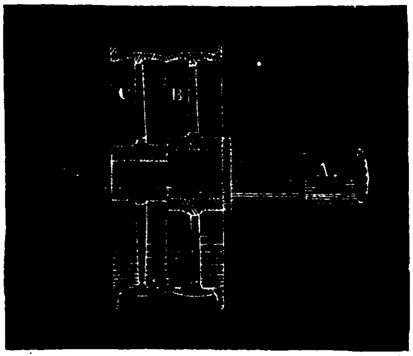


Fig. 1.

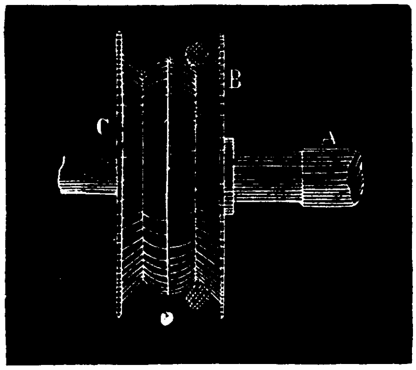


Fig. 2.

"2nd. Independent of the surface of contact.

"3rd. Proportional to the angle subtended by the belt at the surface of the drum."

These experiments were made, and conclusions drawn therefrom, at Metz, in the year 1834.

In the Philosophical Transactions for 1829, experiments are detailed which were made by G. Rennie, to a point or two of which I here refer: "The friction of fibrous materials is increased by increased extent of surface and by time of contact." .... "The friction of lubricated surfaces is determined by the nature of the lubricant, rather than by that of the solids themselves."

Here are plain statements, early made, recognizing a difference between *friction* and *adhesion*, proving fairly by ample tests that yielding surfaces smeared with unctuous or adhesive matters offered more resistance to sliding than the surfaces of clean, dry solids.

Much more of interest in this relation might be collated and re-presented, but enough has been said already to prove the text that much was well known about belting *more* than fifty years ago.—*Manufacturer and Builder.*

THE IMPROVED WOODWARD STEAM PUMP.

The Woodward steam pump, manufactured by the Woodward Steam Pump Co., of 10 Reade street, New York city, has lately been improved in its construction, and we are enabled to present the following illustrations and description concerning it:

Fig. 1 is a general view as at present manufactured, which shows a fly-wheel pump. The great economy in the consumption of fuel, which is claimed for this pump, as well as the extremely low cost and simplicity of repairs, is due to the arrangement and design of the steam valve and cylinder, its motion and the design of the water cylinder. The valve used to admit steam to the cylinder is made in the shape of a D-slide, its motion being obtained through a rod connecting with a strap on an eccentric on the fly-wheel shaft. The steam passages in the cylinder consist of one exhaust and two admission ports, one at each end of the cylinder, there being no necessity for double ports or poppet-valves with springs, etc., to overcome the momentum of the piston at each end of the stroke. The side-valve is usually set to cut off at five-eights of the stroke, so that the steam may be used expansively for remaining portion. For delivering water at very high pressures the slide-valve may be set by any engineer to cut off later if desired, and it is possible for the attending engineer to arrange its steam-valves with perfect satisfaction. The economy is claimed to be due to the use of the steam expansively, to the fact that it is not required to waste any live steam for the purposes of "cushioning," and to the high speed of piston, 300 to 400 feet per minute, which can be attained, while, at the same time, obtaining the benefit of the full length of stroke at each revolution.

To the centre of the rod between the cylinders is keyed a cross-head A, Fig. 3, from the outer ends of which two connecting rods pass at each side of water cylinder joining in a T head, which is fitted to crank-pin of fly-wheel shaft in pillow blocks, all being firmly bolted and held in position on a substantial bed-plate. Between the steam cylinder and pillow blocks the water cylinder is bolted to bed plate, as illustrated by Fig. 2. The greatest effectiveness and durability are claimed for this water cylinder and its valves. It consists of a longitudinal cylinder for the water piston, having four transverse horizontal cylinders, two below and two above, respectively, to receive the suction and delivery valves. The ports for the valves, as well as the openings above them, are rectangular in form. At the opposite ends of the valve cylinders are caps, the inside of which project inward, having slots to receive pivots of valves. They are held in position by a long bolt and valve

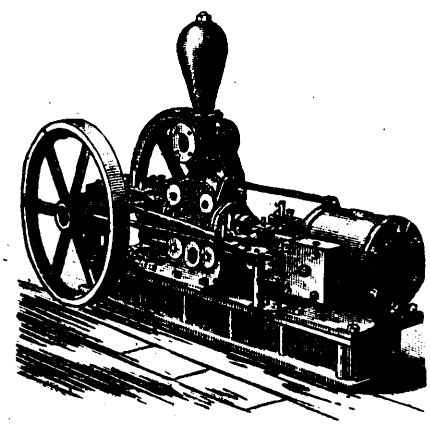


FIG. 1.

Combined Pump and Engine—General View of Improved Woodward's Steam Pump.

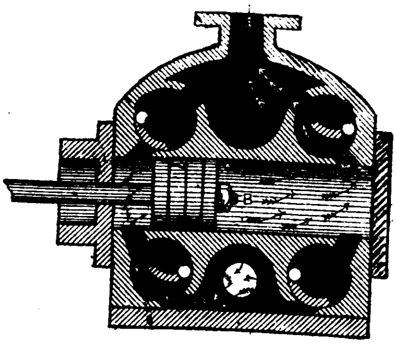


FIG. 2.
Section through Cylinder.

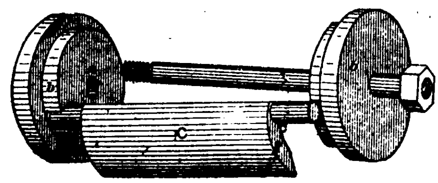


FIG. 4
Details of Valves.

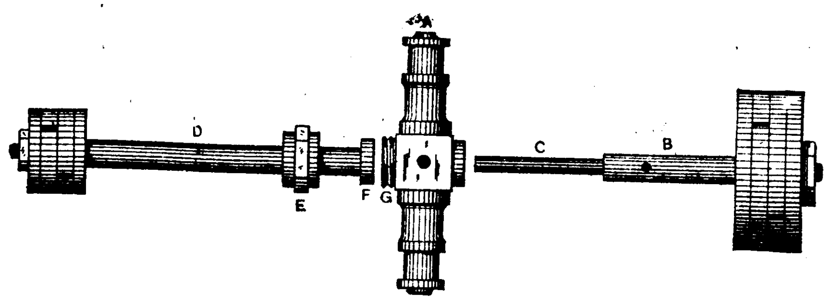


FIG. 3.
Detached Piston Rod.

guide in each cap, with external nuts on each end of bolt, and this bolt limits the extreme lift of valve. The faces of the valves are made true to the same radius as the inner surfaces of the cylinders and are accurately fitted, while the valve pivots are turned to exactly fill the slots in the caps. These valves fall on their seats of their own weight, and, being circular on the faces, evenly and gradually bed themselves, so that no composition in the seats or valves is necessary and springs, etc., are dispensed with. The wear of these valves is very small. Dirt cannot lodge on the seats, and large objects or impediments, such as fish, rags, etc., are cut, and any hard matter large enough to pass through the ports goes through without injury to the parts, or is removed by the swinging motion of the valve. The working of this form of valve increases the tightness, and they are thus made capable of forming an almost perfect vacuum in the suction-pipe. This pump, we are informed, can pump molasses, mashes of any kind, glue or anything that can be made to move.

An ingenious arrangement of piston rods is used when power is transmitted from the fly-wheels of these pumps. In Fig. 3, *B C* is the main steam piston-rod, the end *C* being turned to small diameter so as to fit within the hollow part of the water cylinder piston-rod *D*. The dotted lines denote the hollow, which acts as a guide for the rod *B C*. The nut *E* passes on to shoulder *F*, which nut is screwed to thread *G* on cross-head *A*. When the pump is to deliver water this nut is detached, when power only is needed and the water piston remains at rest. These pumps are used for power engines in a number of instances, and we are informed give satisfaction, and for fire pumps or where a high pressure and rapid flow is required they are very efficient.—*American Engineer.*

THE DANGER OF ELECTRIC DISTRIBUTION.

Notwithstanding the susceptibility of the public mind to suggestions of alarm, it is doubtful if a full realization of the risk to which the members of the community are exposed from electric wires has been generally attained. If the recent law providing for death by electricity as the punishment of murderers never goes into effect, it will doubtless do its meed of good. It will cause a more thorough discussion of the subject in technical circles, and the idea and true conception of the danger will be disseminated among all.

Electric companies, whether supplying current for lamps or motors, have every inducement to increase the danger inevitably attendant upon their installations. The cheapest wire is the uncoated one. A wire however poorly insulated costs more; a properly insulated one is still more expensive. The quality of the insulation at the start is only one element—its duration when exposed to the weather is another.. Insuring the latter gives a further increase in cost. As the network of wires grows thicker, and as the lines cross each other more often, an additional cause of deterioration appears. The contact of swinging wires with one another tends to rub off the insulation and expose the metal. The lines which have done the damage then serve as conductors to carry off the current, possibly to a telephone box or other place where it may do much harm.

Recent experiments in death by electricity which have been made upon animals illustrate the fatal nature of the dynamic shock. In the early days of the science, the static discharge of immense potential and very small quantity was considered the most fatal. It corresponded to the lightning stroke, both in its electrical characteristics and effects. Following the developments of the last decade, dynamic currents of very high intensity are everywhere in use, and these have been found to be deadly, though of comparatively low potential. It is to such currents as these that imperfectly protected wires are carrying above the streets. When the dynamos are running, contact with wires conveying such currents is liable to be fatal. A broken wire that has fallen so as to reach from the top of a pole to the street has now come to be regarded as dangerous by the populace. The dread is only too just. Repeated deaths have proved it so.

It is futile to attempt to restrain the march of progress. No advance in practical science is more remarkable than the development of electricity. Goethe's prediction, true for so many years, is now being falsified. He said that electricity would only be applied to the minor uses of life. Now engines are driven by it, and the difficulties in the way of its application to outdoor locomotors are gradually disappearing. The electric light is practically complete in its development. But while no effort should be made to restrict the uses of the current, the fact that it is dangerous should not be overlooked. The rival exploiters of different systems claim each a higher degree of safety, or more properly a less degree of danger for his own installation. The direct and alternating current advocates are engaged in active attack upon each otheron the basis of the relative harmfulness of the two systems. One engineer has suggested a species of electric duel to settle the matter. He proposes that he shall receive the direct current, while his opponent shall receive the alternating current. Both are to receive it at the same voltage, and it is to be gradually increased until one succumbs, and voluntarily relinquishes the contest. The absurdity of the suggestion, which is made in apparent earnestness, shows how decided the war has become. Back of it all the fact remains that the working current of the day, direct or alternating, is dangerous. One solution seems adapted to protect the public. It is to properly dispose of the wires underground.

In examining the effects of the dynamic current upon the systems of animals, several points of interest have been developed. One such point is the small amperage required for a fatal result. Thus, with a current of 536 volts electromotive force a dog with a resistance of 11,000 ohms was killed. This reduces to a current of less than 0·05 ampere, leaving out of consideration the resistance of the dynamo. A horse weighing 1,230 lb. was killed by a current of about 0·06 ampere. In the case of the alternating current, the question of time seems to enter. A current requires a certain period to destroy life, which period varies with the current intensity. These data go to prove how slight a contact with the wires may be fatal. Sooner or later the plan of a modern city will have to provide some effective system of subways. The overhead wires will be a perpetual menace, will be the cause of death and injury.

But a few days have elapsed since a forcible illustration of these dangers occurred. A storekeeper in Meriden, Conn., started to take in some articles of clothing that had been hung up in front of his store. It was raining at the time. He was thrown violently back by an electric shock as soon as he attempted to remove a knit jacket. He soon recovered and continued his work only to receive an additional shock which scorched his hand. The attention of bystanders was excited, and it was found that brilliant flashes of light could be drawn from the iron front of the store. On investigation it was found that an electric light wire had come in contact with the wet awning, and thus had caused the trouble. Here at least is a case where it would be hard for the electric light company to plead contributory negligence.—*Scientific American.*

THE MANUFACTURE OF LARGE BELLS.

It may not be generally known, says a writer in *Stoves and Hardware* that there are only five concerns in the United States engaged in the manufacture of church, school, and chime bells, and that the Hy. Stuckstede Bell Foundry Company, St. Louis, claims to be the largest of the five. In fact, it is not an industry that calls for many factories, as a well made bell will last almost for ever, and hence but little has ever been said about them in public print. Nevertheless, the process of manufacture is one full of interest, and worthy of more than passing notice.

A visitor to be in a bell foundry, where nothing but large bells are manufactured, experiences peculiar, if not weird, sensations. Not many workmen are employed, and as they move around, with apparently noiseless motion, occasionally stepping in the full light of the open furnace door, showing their begrimed faces, and all the while the soft, resonant tones of the bells being tested, in his ears, the impression is one far removed from churches and church chimes. There is no conversation or bandinage, or loudly expressed orders, for the workmen's duties keep them separated, and, as the floor is of clay, there is not even the sound of a footfall. This is the first impression received by a *Stoves and Hardware* representative on his visit to the works above mentioned. A casual glance gave no indication of the work being done. A lot of bells, of various sizes, distributed over the floor, a larger number of moulds, a pile of cast iron mountings, and a furnace with a deep pit in front of it is all that is to be seen, yet here some of the finest chimes in this country have been made.

Contrary to the popular idea, the exact musical tone of a bell depends neither upon the metal nor upon any change in it after being cast. If the bell should not be of the exact pitch, there is no alternative but to melt it over and recast it until the proper tone is secured. Hence, it is clear that the greatest care must be exercised, and the most thorough skill displayed.

The first operation, and the one upon which success depends, is the forming of the moulds. They are made according to plans which are at first prepared to demonstrate the weight, thickness, and dimensions necessary to produce the required tone. The moulding is done entirely by hand, without the use of patterns. For the inside, the shape is made up of loam, which is merely sand mixed with enough clay to make it cohesive. With nothing but a trowel, a paddle, and his hands, the operator moulds the loam into the desired shape, working from the bottom toward the apex. The work is necessarily slow, as great care must be exercised, as any variation from the plans would inevitably ruin the effect, and frequent measurements are taken to see that there are no deviations. The surface is now covered with black lead. This is mixed into a thick paint, or mortar, and applied with a brush. Each coat must be allowed to dry, and successive coats applied until it reaches a thickness of about three-quarters of an inch, or until the desired shape is accurately secured. The outside half of the mould is built up of loam in the same way, only in this case no coating or plumbago is used. The exterior mould fits over the inside mould, the space between the two determining the thickness of the bell. The moulds being finished, they are placed in position in a pit in front of the furnace. At the apex or at the point where the bell would be hung, an opening is made in the outside mould of about two inches in diameter. A trough then carries the molten metal directly into the mould.

The furnace is very similar to those generally used in melting large quantities of brass. The melting pot is built between two fire-boxes, so constructed that the heat strikes the sides and bottom with almost equal force, effecting quick results. The metal used is simply ingot copper and tin, in the proportion of four parts of the former to one of the latter. The copper is first melted, and then the tin is put into the molten mass, soon becoming a part of it. The kettle has a capacity of about a ton. For a bell weighing three hundred pounds, the mould is completely filled in seven or eight minutes. For bells weighing six hundred pounds, it requires about fifteen minutes, and so on.

The bell having cooled sufficiently, the moulds are broken, and it is taken out and turned over to the polisher. The inside, having been moulded against the smooth surface of black lead, needs no polishing, but the outside requires attention in that respect. The operation is very simple. The bell is hoisted to the centre of a double revolving table. The part the bell rests upon revolves one way, the surrounding part in an opposite direction. This latter part is so constructed that it will hold a large quantity of coke. Thus, in revolving, the coke scours the outside of the bell, the result being a smooth, bright surface.

Before polishing, however, the tone of the bell is tested, and it is again tested after polishing, as carefully as the string of a piano, or the reed of an organ. If satisfactory, nothing remains to do but the mounting.

An idea of the great accuracy that must be displayed in the plans and preparation of the moulds can be seen in that from ten to twenty-five pounds of metal, either too much or too little, in bells weighing from six hundred to two thousand pounds, or a variation of from one-twentieth to one-twelfth of an inch in thickness, will affect the tone. The successful manufacture of chimes and peals, therefore, can only be done by those whose knowledge of the business is as accurate as instinct, and this is possessed only by those who have followed the business for a lifetime.

THE INVENTOR OF THE SEWING MACHINE.

We glean the following curious scrap of history from the *Sewing Machine World* :—

If you should inquire from some one of the numerous persons now using the sewing machine—Who is the inventor of the sewing machine? every one, accustomed as he is to see everywhere the pictures of Elias Howe and the gigantic S of the Singer Sewing Machine Co., would undoubtedly answer you that the sewing machine was devised by American inventors. Well, this is not true. American inventors have unquestionably contributed largely to endow the sewing machine with the numerous improvements which it has received for some thirty years, but they did not originate it. As early as 1830, a man—a modest tailor—had appeared who had succeeded in building, and running in an industrial way, a sewing machine supplied with a continuous thread, and the needle of which was not passed entirely through the cloth, and that man was neither an American nor an Englishman; he was a Frenchman, by name Barthélemy Thimonnier.

The English and Americans have so many industrial devices of their own invention, that we do not hesitate to take away from them, in behalf of a modest French inventor, who struggled hard during his whole life, the glory of having devised a machine by means of which many manufacturers—Elias Howe, Singer, Wheeler, Wilson, among others—secured large fortunes.

Barthélemy Thimonnier, whose picture the reader will find on page 60, was the son of a dyer of Lyons, and was born at the Arbresle (Rhone), in the year 1793. He studied a little while at the seminary of Saint Jean, and was put to the tailor trade which he practiced at Amplepuis (Rhone), where he had been brought up. Thimonnier, who had many opportunities of seeing the female sock embroiderers working for the manufacturers of Tarare, took it into his head to build a machine to perform with it the work of the embroiderers and the tailor.

In 1828 he removed to Saint Etienne, and during several years neglected his own business, his only means of earning a livelihood for himself and his family, and devoted himself in a lonely room to many pursuits and studies, which his friends, as they were unable to understand them, considered at once as foolish. At last, in 1829, after four years' hard work, which, ignorant as he was of mechanics, was the more painful, he mastered his idea, and, in 1830, he applied for a patent for a chain stitch sewing machine.

Taken to Paris by Mr. Beaunier, a supervisor of mines, who guessed at first the real value of the invention, and became morally and pecuniarily interested in its success, Thimonnier was, in 1831, made a partner and appointed manager of the firm Germain Petit & Co., and set up on Sèvres Street, in Paris, a workshop, where he used eighty machines, making army clothing.

At this time, the workingmen were adverse to every kind of new machinery, and used sometimes to destroy it, as the boatmen on the Soan river broke Marquis de Jouffroy's steamboat about twenty-five years before Fulton launched his boat on the Hudson river. Thimonnier's machine shared the fate of the other machines; the inventor was obliged to take flight, and, a few months later, on account of the death of Mr. Beaunier, the partnership with Germain Petit & Co., was dissolved, and Thimonnier returned to Amplepuis, in 1832. In 1834 he went back to Paris, and, as a journeyman, ran his machine, which he was always studying to improve.

In 1836 he was penniless, and obliged to go once more to Amplepuis; he went on foot, carrying his machine on his back, and to earn his living during his journey he made a show of it as a curious piece of mechanism. He manufactured at Amplepuis a few machines, which he sold with a great deal of trouble in his neighborhood; in 1845, his machine would run at a rate of 200 stitches a minute. He made then a partnership with Mr. Magnin, and built in Villefranche some machines which he used to sell at fifty francs apiece; and on August 5th, 1848, jointly with Mr. Magnin, he applied for an improvement patent for his machine, which he called "Cousobrodeur" (the English patent was applied for on February 9th, 1848), and which he no longer made of wood, but of metal, and with accuracy.

The revolution of 1848 having stopped Thimonnier's business, he started for England, where he stayed a few months, and sold his patent to a Manchester firm.

At the exhibition at London in 1851, on account of inexplicable bad luck, Thimonnier's machine was not ready for the examination of the commissioners; whereas, the Americans exhibited their first improvements to Thimonnier's machine, and the shuttle and two-thread machine of Elias Howe; as early as 1832 Thimonnier had studied this kind of machine, and was yet studying it in 1856. But, exhausted by thirty years' struggling and suffering, he died penniless at Amplepuis on Aug. 5th, 1856, leaving a widow and several children. Later, in 1866 and 1872, the French Government, at the request of the Industrial Science Society of Lyons, relieved by its subsidies the last days of that poor widow, who died on August 9th, 1872.

The Board of Commissioners of the Exhibition of Paris in 1855, wrote the following about Thimonnier's machine:—

"Thimonnier's machine was evidently the standard of all the

Barthelemy Thimonnier, Inventor of the Sewing Machine.

[*From an Old Print*]

modern sewing machines," and they bestowed on Thimonnier-Magnin's "Cousobrodeur" a first-class medal; the prize was well-deserved, as the "Cousobrodeur" of 1855 was by far superior to the machine of 1830, which, made of wood, and put in motion directly by a cord, was unable to make more than one stitch at each oscillation of the treadle.

A SIMPLE DYNAMO.

I venture to send you a brief description of a simple electro-magnetic instrument which I have recently devised for illustrating the principle of the Gramme ring.

Two pulleys, A.B., having semicircular grooves, are mounted, as shown in the figure, on a piece of board; round the two wheels is stretched a continuous coil of copper wire; a horse-shoe magnet is placed with its poles close to the vertical parts of the coil; the wheels are connected to the terminals t t^1: when the wheel A is rotated the whole coil moves, and a steady current is at once generated, which flows from terminal to terminal when they are connected together, the direction of the current depending on the direction of rotation.

It will be noticed that, since the coil and wheels are always in contact, no undulations are produced as when brushes come in contact with successive ends of coils, as in the ordinary dynamo.

When the instrument is placed in circuit with a sensitive galvano-meter, the rotation being constant, no variation in the current can be detected, even when the motion is very slow. The coil when arranged with one wheel at A, and a mercury contact at B, will revolve when a current is sent through it, becoming in this case a motor. If an iron chain, or an elastic band of iron, such as a measuring tape, be placed inside the ring coil, it then becomes a distorted Gramme ring, the wheels taking the place of the brushes, the way in which the current is produced being the same. If coils approaching N produce a current upwards, then those which are leaving N produce one downwards. The same takes place on the other

side; coils leaving the S pole produce a current upwards, while those which approach it produce a current downwards; both of the ascending currents, being in the same direction, go to the wheel A, while both of the descending currents, being in an opposite direction, go to the wheel B.

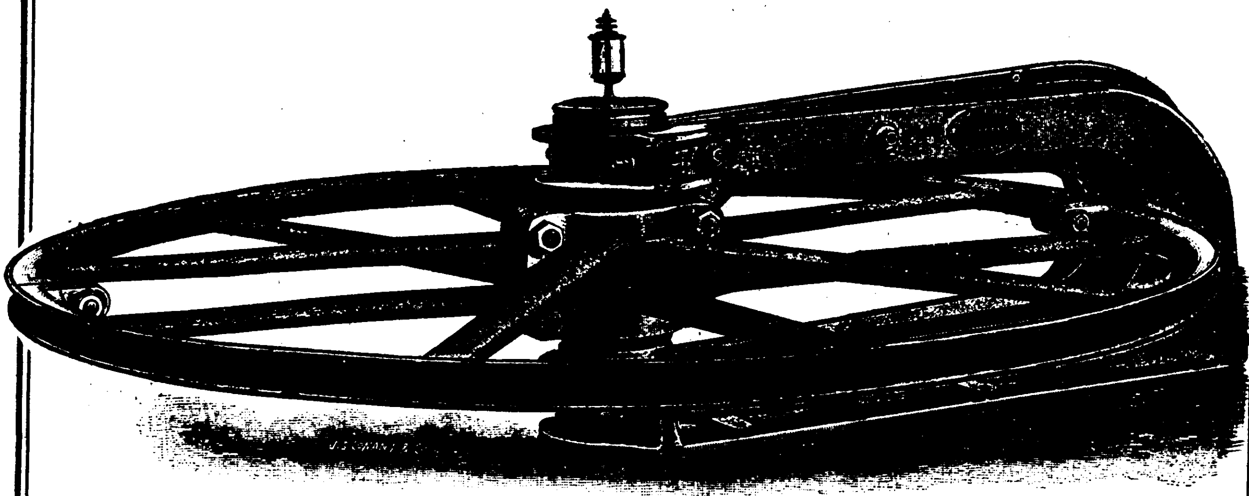
The first coil made was of copper wire. Phosphor bronze wire answers better, being less easily distorted.—FREDERICK J. SMITH, in *Nature*.

Trinity College, Oxford, Nov. 12.

THE DURATION OF LIGHTNING FLASHES.

It is well known that the lightning flash, or the spark between the terminals of an influence machine, exists for so short an interval of time as to be beyond measurement by any ordinary means. But notwithstanding the acceptance of this knowledge, the peculiarities of some of the flashes photographed have been supposed to be due to the camera, or the sensitive plate, being at the time in a state of vibration. To test this line of thought, Mr. James Wimshurst has made a dark slide for his camera, in which is fitted a train of clock-

work carrying a disc, upon which is an arrangement for holding the sensitive plate. When all is complete for photographing a flash, the clockwork is wound up, the sensitive plate then rapidly acquires great velocity, which at the maximum reaches 2,500 revolutions per minute, and with the plate rotating at this speed the spark is photographed. The annexed engraving is from a photograph taken under these circumstances; as will be seen, it in no way indicates movement in the sensitive plate, for the photograph, throughout its length, is as sharp and as clear as though the plate had been at rest. The experiment is interesting, for it not only shows the infinitely short existence of the spark, but it also shows that chemical change in the sensitive film takes place in an equally minute interval of time.—*Engineering*.



"U" FRAME AND STAGGERED ARM SHEAVE.

IMPROVED CABLE RAILWAY MACHINERY.

We give herewith another example of the improved cable railway machinery, manufactured by The Wakler Manufacturing Company, of Cleveland, Ohio.

The "U" frame is cast in two pieces so as to mold easily; it is hollow with flanges in the center to bolt each half together and also has ribs and sides. The flanges form a back bone to the frame when bolted together. The sides are not pierced with holes as is common in such castings to get core out when cast in one piece; these holes make such castings quite weak, especially so as the metal forming the plate or outside of the casting gives the greatest strength. The castings are securely bolted together and dowell-pinned before they are bored and fitted for the boxes.

The sheave has staggered arms which makes a very rigid sheave for either horizontal or vertical motion. The principal advantage of the staggered arms sheave is a uniform casting; the arms not coming opposite each other dispenses with all undue strains such as occur in straight arm castings.

The company has made a great many of these sheaves of 8 feet, 10 feet and 12 feet diameter, with the same general success.

As the sheave appears from an ordinary standpoint of molding it would be very difficult indeed to mold; but they have a system of molding them which is very simple.—*American Engineer.*

SHOP HINTS.

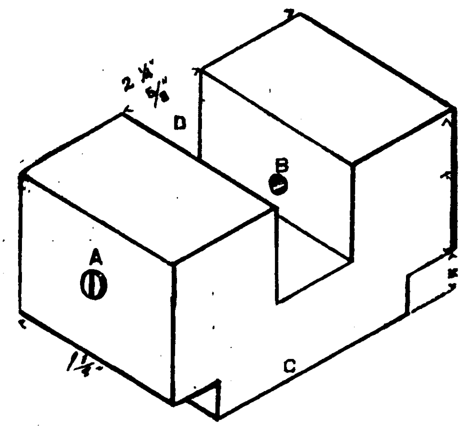
When boring deep holes in the lathe with the ordinary tool used for such purposes, the leverage of the cut often forces the point of the tool away from the work. This trouble may be easily avoided by making a soft steel block of the shape shown in the sketch, and inserting the same in tool rest immediately behind the boring tool, the tenon on the bottom at *C*, fitting nicely in the top slot of rest, and the shank of the tool passing through the groove *D*, the set screws shown at *A* and *B* being used to prevent side play. The effect of this arrangement is to hold the boring tool as firmly as if two tool posts were used, while being much more simple, cheaper and convenient. Its employment will be found especially valuable for inside threading tools, and it makes a handy acquisition to the machinists' kit.

Arbors or mandrels for machinists' use, also the screws for tool posts, should be made from a good quality of tool steel, and lathe centers of the best cast steel.

For polishing arbors, and every shop should have a special set for this purpose, iron is much to be preferred to soft steel, as the centers will last longer, and there is less liability to cut when driving them into the work.

Musket steel of small size may be readily cut off without the trouble of heating in a forge by nicking the bars all around at the point where separation is desired, on the edge of an emery wheel; it may also be conveniently shaped for small cutting points by the same means.

It pays to use this steel on cast iron, as the speed of work and the feed may be greatly increased.—*Ex.*



AN INTERESTING FACT.—A boat may be pierced in several places below the water line, and yet continue to float indefinitely, so long as a swift motion through the water is kept up.

This was recently proven by an interesting experiment tried by the English builders, Thornycroft & Co., with a new boat. For the purpose of making the experiment a three-quarter inch hole was bored into the side, about one foot under water. When the boat was at rest the water flowed in very rapidly, but when moving at a speed of about ten miles an hour a skin of water was drawn over the hole, which resisted any inflow.