## Technical and Bibliographic Notes / Notes techniques et bibliographiques

The Institute has attempted to obtain the best original copy available for scanning. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of scanning are checked below.

L'Institut a numérisé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de numérisation sont indiqués ci-dessous.

☐ Coloured covers / Couverture de couleur

☐ Covers damaged / Couverture endommagée

☐ Covers restored and/or laminated / Couverture restaurée et/ou pelliculée

☐ Cover title missing / Le titre de couverture manque

☐ Coloured maps / Cartes géographiques en couleur

☐ Coloured ink (i.e. other than blue or black) / Encre de couleur (i.e. autre que bleue ou noire)

☐ Coloured plates and/or illustrations / Planches et/ou illustrations en couleur

☑ Bound with other material / Relié avec d'autres documents

☐ Only edition available / Seule édition disponible

☑ Tight binding may cause shadows or distortion along interior margin / La reliure serrée peut causer de l'ombre ou de la distorsion le long de la marge intérieure.

☐ Coloured pages / Pages de couleur

☐ Pages damaged / Pages endommagées

☐ Pages restored and/or laminated / Pages restaurées et/ou pelliculées

☑ Pages discoloured, stained or foxed/ Pages décolorées, tachetées ou piquées

☐ Pages detached / Pages détachées

☑ Showthrough / Transparence

☑ Quality of print varies / Qualité inégale de l'impression

☐ Includes supplementary materials / Comprend du matériel supplémentaire

☐ Blank leaves added during restorations may appear within the text. Whenever possible, these have been omitted from scanning / Il se peut que certaines pages blanches ajoutées lors d'une restauration apparaissent dans le texte, mais, lorsque cela était possible, ces pages n'ont pas été numérisées.

☑ Additional comments / Commentaires supplémentaires: Continuous pagination.

THE

CANADIAN MAGAZINE

OF

SCIENCE AND THE INDUSTRIAL ARTS.

Patent Office Record.

Vol. XIX. MARCH, 1891. No. 3.

## EXPLOSIONS FROM UNKNOWN CAUSES.

BY J. C. BAYLES, EAST ORANGE, N. J.

The most unsatisfactory occurrences in the experience of a manufacturer are those from which he suffers damage and learns nothing useful. That there are such incidents, and that they occur with annoying frequency, is unfortunately true. An accident which can be understood and explained always carries some consolation with it. However bad the consequences, one finds comfort in reflecting that they might have been worse, and that the knowledge of how to avert a more disastrous calamity from the same cause is worth what it cost. But when an accident occurs, which remains unexplained after anxious days of investigation, and sleepless nights of reflection, and which is as liable to occur twice or twenty times, as once, very little satisfaction of any kind can be extracted from it by the most philosophical victim. Three such incidents have come under my notice in one establishment. Fortunately none of them were attended with very serious consequences, as no one was hurt, and the damage to property was slight; but in each instance, loss of life and great destruction were escaped by so narrow a margin as to make them extremely disquieting. I have recorded them in the hope, that from the experience of others may be gained what my own careful investigations have failed to reach—satisfactory explanations.

The first of these curious occurrences was the bursting of a 16-inch pipe carrying air under a compression of about 1 pound. The pipe was made of light galvanized iron with soldered seams. Into it a rotary fan-blower delivered air, and from it smaller pipes were carried to the furnaces. The blower was run continuously. Neither the main pipe nor its branches had any connection with the gas conduits. Both air- and gas pipes delivered into the furnaces; but although the gas was under much higher compression than the air, there appeared to be no good reason why, having free escape in case of leakage, it should ever make its way back into the air-pipe. One warm afternoon in June the main air-pipe exploded with great violence. Every window in the mill was blown out, a considerable section of the roof was raised an inch or two, and in several places it was broken through. The pipe was torn into a thousand pieces, and a wagon-load of fragments not larger than my hand were scattered all over the mill. Several of these fragments were driven edgewise into the roof-timbers. The disk closing the end of the pipe was projected against a brick wall with such violence that it remained fastened in place, and is there yet, a mural tablet commemorating the event.

I promptly investigated the accident and learned the following facts: The pipe in which the explosion occurred extended the whole length of the mill. The machines then in use were placed together near the end connected with the blower, leaving some 80 feet of what may be called dead end. It was in this dead end that the explosion occurred. The portion of the pipe from which outlets were taken was substantially uninjured, but 75 feet of the 80 feet beyond the farthest outlet were utterly destroyed. The fact that, with very little mending, the part of the pipe which the explosion had not reached continued for some months to supply the machines with air, shows how local the explosion was; and the damage to the mill building gave sufficient evidence of its violence.

The natural explanation of this explosion is that gas found its way into the air-pipe and was packed away in the dead end, and that when mixed with air in explosive proportions, it reached a furnace and exploded. I can only say that the most rigid investigation failed to explain how the gas got into the air-pipe against the pressure it carried, and why an explosion beginning at a furnace should have restricted its effects to the dead end of the air-pipe. It was undoubtedly a gas- or vapor-explosion, but I can find no other explanation of the presence of gas or vapor than that it was formed by the volatilization of the oil consumed in lubricating the trunnions of the blower. It is conceivable that the large amount of oil consumed by the blower is volatilized, and that it becomes a hydro-carbon gas which would behave like any other gas of similar composition. This gas, being lighter than air, would occupy the upper part of the pipe, and remain undisturbed, while air was drawn from outlets taken from its underside. This light gas may have worked along and accumulated in the dead end of the air-pipe until it reached, in admixture with air, the explosive condition. But whence the spark? And why, if fired by a furnace, was the destructive force of the explosion exerted so far from the point of ignition? This hypothesis assumes that the volatilized or gasified oil of many days' running would remain undiffused for as many nights, until its accumulated volume was great enough to explain the phenomena of the subsequent explosion. The best that can be said of it is that, perhaps, it is better than no theory at all.

Nothing similar has occurred since. We replaced the galvanized iron pipe with a 16-inch steel tube, 400 feet long, to meet the increased requirements of the establishment. All the other conditions remain the same, except that a small opening was left in the end of the pipe which cannot be wholly closed. Whether this is necessary we do not know. The accident taught us nothing whatever; and, so far as we are aware, the same causes are now at work, and may at any time produce like results. The fact that no great damage was done is due to the frail character of the tube in which the explosion occurred. If the 16-inch steel tube should ever be destroyed with equal thoroughness by such an explosion as I have described, I hope I shall be in another State.

The second of the curious actions I shall mention was the explosion of a No. 6 Sturtevant blower. I was a witness of this amusing, though somewhat alarming, occurrence, and can speak of it from personal knowledge. The blower was inside the mill, and was driven by two belts from pulleys on the main line of shafting. It was used to furnish blast for the gas-generators. Some trouble with the main driving-belt necessitated a stoppage of the mill-engine, and the blower stopped. In a few minutes the engine started again, and with it the blower. It had been long in other use, but as this was its first day of service in that position I was naturally curious to see how it worked. So I stood watching it. Suddenly it disappeared. One side passed close to me and lodged against a post. Fragments weighing twenty to fifty pounds were distributed in all directions. The explosion was accompanied by a violent report and succeeded by a dense cloud of yellow-brown, offensive-smelling smoke, which rose to the roof, rolled right and left, and finally escaped at the monitor.

Again I investigated, until there remained no questions to ask. That it was not a centrifugal rupture I know without being told. The conclusion was that during the stoppage of the engine some air-gas from the producers had worked back through the pipe into the blower. When the blast was resumed these products of imperfect combustion were carried with the air-current into the producers, and being mingled in explosive proportions had been fired by contact with the incandescent fuel and exploded. This explanation was never quite satisfactory to me. An explosion which began in the producer could only reach the blower through two branches of a tee, six feet of vertical pipe, an elbow, twenty-five feet of horizontal pipe under ground, another elbow, six or eight feet of vertical pipe, another elbow, and four feet, more or less, of pipe connected with the outlet of the blower. Some of these pipes were light and some heavy, and the section underground was much larger than the section at either end of the run. If an explosion violent enough to wreck the blower completely had occurred through the whole length of this very circuitous pipe, I should have expected to find some evidence of it in the pipe itself. It was intact. Not a joint was started. Furthermore, as the blower had been running at least four minutes immediately before the explosion, what could have remained in it to explode? The fact was, however, that the blower was shattered, while the pipe was undisturbed, even the delivery-nozzle of the blower remaining coupled to the length of pipe on the mill-floor, which was not thrown out of line. As in the first instance, this explosion taught us nothing.

The third of the series of unexplained accidents consisted of two explosions following one another so closely and under conditions so nearly identical that they may be considered as one episode. In the purification of gas we use purifying boxes of the usual pattern. We have four boxes so connected by the center-seal that we can throw any one of the four out of use when it is necessary to clean it. The gas always passes through three boxes before reaching the gasometer, and one is always kept ready to be filled with fresh iron and brought into use when needed. When the gas shows the presence of impurities or diluents it is time for a change. To make the procedure clear let us suppose the boxes to be numbered 1, 2, 3 and 4, and the gas to be passing through 1, 2 and 3 in the order stated. No. 1 would, of course, become foul first, as it first receives the gas. If a test of gas which has passed No. 3 shows that it is not completely purified, No. 1 is cut out and No. 4 brought into use. The gas would then go through Nos. 2, 3 and 4 in the order stated, and No. 1 would be emptied and refilled in readiness to become the third of the series when the fouling of No. 2 made it necessary to pass the gas through Nos. 3, 4 and 1. In reality, the box to be brought into use is not refilled until it is needed, but otherwise the procedure is as I have described.

One day, the superintendent and the manager had occasion to go into the purifier-house together, and while there the superintendent tried the gas. Getting a reaction indicating the presence of impurities, and finding the fourth, or idle box, ready, he turned the center-seal, cutting out the box which had been the first to receive the gas, and making the clean box the last of the series. The cap of the outlet was left off for the escape of the air, and not screwed on until there was a strong smell of gas, indicating that the air had been expelled. The same thing had been done in the same way hundreds of times. In two or three minutes the third box exploded with great violence. The cover was wrenched loose from the four clamps holding it down; carried up through timbers and roof and dropped again, badly wrecked. The center-seal was canted to one side, allowing a copious escape of gas. The building took fire, and a second explosion in the basement blew out about half the foundations. The second explosion was easily understood. Fortunately, fire-extinguishers and hydraulic jacks saved the building, and except the need of repairing the broken box, the damage was slight. I at once began an investigation, which has lasted ever since. The explosion was undoubtedly due to the ignition of a mixture of gas and air in the box; but how was it ignited? The gas, before reaching the box in which the explosion occurred, had passed through the hydraulic main, two scrubbers, more than 500 feet of unjacketed pipe, and two purifying boxes, each containing three layers of wet sesqui oxide of iron. It requires a violent stretch of the imagination to believe that a spark could travel so far under conditions so adverse. The pipe which delivers gas to the boxes is rarely quite cold, but I have never found it more than warm. The tops of the boxes are always cold, and the gas enters the gasometer at atmospheric temperature. While we were speculating as to the cause of this accident, and congratulating ourselves that it was never likely to happen again, another box, the third of the series in use, exploded under exactly similar conditions. A detailed account of one explosion describes the other perfectly.

Matters were getting serious. No one had been hurt; but it was not impossible that the thing would happen under conditions which could not fail to kill somebody. I must find out what was wrong and correct it. So I called in all the experts I could reach. Some were honest enough, after looking the plant over, to confess that they had no explanation to offer. Others gave reasons which would have been satisfactory had they not been at variance with the facts. For the information of those who may be disposed to speculate as to why these boxes exploded, I may say:

1. The hydraulic main is modelled after the best gas works practice.
2. The scrubbers are adequately supplied with water.
3. The iron in the boxes which exploded was found, on analysis, to contain less than nine per cent of free sulphur, and is still in use.
4. The iron was adequately revived before being replaced, and did not heat in the boxes. After the explosions it was found to be cold.
5. The iron was sufficiently wet.
6. There was no fire in the purifier-house and "no smoking."

Since these two explosions, which occurred in April last, we have had no trouble. There has been no change in the arrangement of the gas plant, for we can discover no way to improve it.

It would have been a great satisfaction to have been able in these instances to follow the sage advice of Hotspur, and out of the nettle danger pluck the flower of safety. But our nettle crop does not seem to be of the flowering variety. If I had investigated less closely I might have reached satisfactory conclusions—perhaps of no more value, however, than the honest doubts I am now willing to confess.

## THE PENNINGTON AIR SHIP.

"Flight every fifteen minutes" is the prominent announcement in front of the Exposition building, Chicago, where the Pennington air ship is navigating the air—within a small compass. It is a miniature ship, looking very much like a big fish with a cigar-like form, that floats—to the astonishment of the sight seers. Some are astonished at the sight of the queer thing going up and moving around so regularly. Others are astonished that it does not do much more than its present performance.

Our New York contemporary, *Engineering News*, designates it "The latest aerial humbug." We venture to say, right here—without the slightest disrespect to the greatest inventor of this inventive age—that this aerial floating machine is no more of a humbug than the phonograph was, in its infancy.

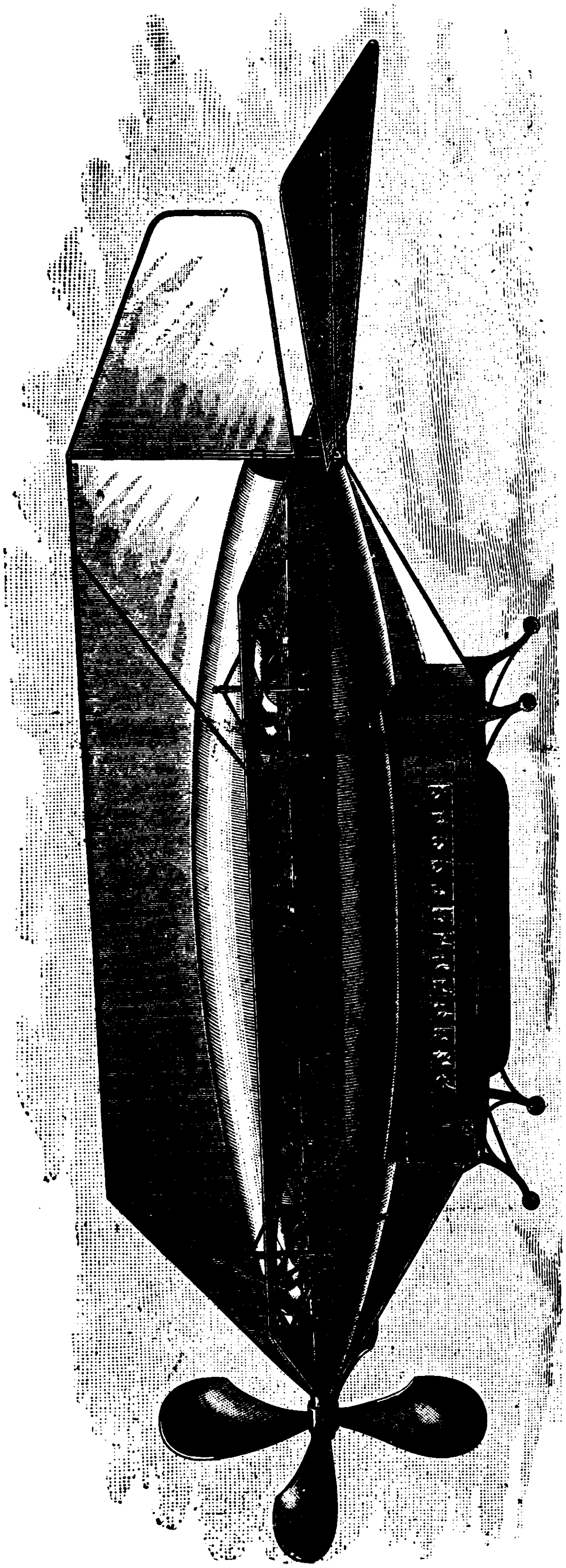
Mr. Edison was short of the needful, and his friend Johnson went to astonish the Buffaloites with a "talking machine," on the long distant telephone process. The press and public were deluded by the supposition that the machine talked. It was the means of inspiring Mr. Edison with the idea of the phonograph. And ultimately a machine to reproduce speech was actually devised. But what a clumsy thing it was. After it had a run of entertainments, until the public got tired of the "humbug," Mr. Edison "dropped" it for ten or twelve years. When he took it up again, the perfected phonogragh of the present day was the result. But, according to Mr. Johnson's own statement at the Kansas City Convention of the National Electric Light Association a year ago, the Edison talking machine was originally used to raise money by means of public exhibitions.

"Flying Machines 'N. G.'" is the caption of the reproduction in last Sunday's Chicago *Tribune* of an article by Arthur Mark Cummings in the *North American Review*, wherein he says:

"Air ships have had an exhaustive trial, and their limitations are now recognized by all intelligent investigators. Any vessel which depends for its upward motion upon its displacement of air must, of necessity, be so large as to preclude the possibility of propelling it against even a moderate breeze. Helpless and inert as an iceberg in the Gulf stream it must float wherever the aerial currents choose to carry it. Few even of the most visionary enthusiasts now really believe that the day will ever come when buoyant air ships will navigate the heavens in any governable direction.

"With flying machines, however, the case is radically different. In the first place, the flying machine follows the analogy of nature as no air ship ever could. Ships float on the water in very much the same fashion that fish and many aquatic birds float in and upon it; but the balloon finds no prototype in its sphere. No bird or insect exists that can for an instant support itself motionless in the air. The specific gravity of water and that of most animals is so nearly the same that an equipoise is easily established in various ways. But the specific gravity of air is so very much less than that of most of the other forms of matter that equipoise is very hard to establish. As has been observed, no living animal can support itself in the air without supplementing the specific gravity of the air by an expenditure of muscular energy, and in most cases this expenditure is very large.

"It is, then, only by means of some strong, light structure, plus a large amount of energy, that we may hope to imitate nature and traverse the heavens with both speed and certainty of course. But when the inevitable conditions are once accepted the outlook for success is by no means discouraging. The obstacles in the way of a successful flying machine are such that any decade of our age of aggressive science may surmount them. There is nothing absurd in the notion that men may learn to fly. Not by means of their own muscles, of course—nobody expects that—but by means of mechanical ingenuity, linked with the tremendous power of steam or with the magic of that wonder-working force which we call electricity. At the present time there is a general feeling, not only among wild enthusiasts but among men of sober judgment, both in the scientific and in the business



Pennington and Butler's Aerial Machine.

world, that a practical flying machine is among the near possibilities of the future. Learned and conservative societies have lent to this belief a very considerable degree of favor, while the faith of the commercial world is attested by the recent formation in a Western city of a company with an enormous capital which is devoted entirely to the building of flying machines."

So far, so good. Mr. Cummings, however, having said so much in favor of the Pennington machine, goes on to try to show that a practical flying machine would not be of great advantage anyhow. He says:

"When one examines carefully into the possible utility of flying machines, he is forced to the conviction that no great benefits to mankind are reasonably to be expected from even the most triumphant success in this line of invention. It is really curious that so many people assume without reflection that a successful flying-machine would mean either increased speed or increased carrying power over our present methods of transportation. An American journal of weight and ability, recently gave editorial utterance to this remarkable statement: 'The successful trial of an air-ship would in twenty-four hours' time cut down by half the value of all the railroads and steamships in the world, because it would afford an opportunity of cheapening to an incredible extent the cost of transporting persons and merchandise. This is sheer nonsense; and it is worthy of confutation only because it is a kind of nonsense to which people who talk on this subject seem to fall victims in a very unthinking way.'"

Then the learned author goes on to compare progress through the air with heavy loads, and the progress with such loads along railways. He seems to fall into the resurrection-of-the-body idea; as some think the material body will rise at last, with angels' wings, so Mr. C. has in his mind the weight, conditions and environments of our heavy trains when he writes about flying-machines. Why, sir, flying-machines will require no wheels for traction, no more than sea-ships.

The flying machine will be a new acquisition, for the entertainment and edification of mankind. As Mr. Cummings says, "man may yet harness himself into a light, tough framework of aluminium, and, compelling the electric current completely to his will, mount the ether like a lark or cleave the clouds like an eagle." Then comes our learned friend's conclusion, wherein he says that "the world has as little practical use for the flying machine as it has for the North Pole. Scientists would be deeply interested in them; the rich might conceivably use them as luxurious playthings; adventurous cranks would play mad pranks with them, not 'before high heaven,' but in high heaven; and the managers of agricultural fairs and Fourth-of-July entertainments would hail them with joy as the legitimate heir to that old favorite, the balloon ascension. But the spectacle of a perfected flying-machine to-morrow curving its graceful spirals above the New York Stock Exchange need not shake by a ripple the watery instability of the most dropsical railroad stock in that hydropathic center. The mass of mankind will live and move forever on the earth's surface. The power that binds solid substances to that surface will never be defied or evaded to any beyond the most limited extent."

On the other hand it is not unreasonable to expect that the world will gradually adapt itself to the new means of transportation, and find beneficial uses for it, as has been done with other inventions, Mr. Cummings.

But, in reference to the Pennington machine. It is neither a balloon, nor an air-ship, nor a flying-machine in the general meaning of those terms. It mounts up, goes round, and comes down again in a very gentle manner. A critical description of it is given in the *Engineering News*, supplied by "an eminent engineer," whose name is not given, but it is not inaccurate in any essential point, and runs thusly:

"The working model of the 'Pennington Air Ship,' now on exhibition as stated, differs from the earlier descriptions of the proposed air-ship as given out by its inventors, in several important particulars. It is not made of aluminium, it does not lift its motive power, and the speed is very slow. The model is a varnished silk balloon, clumsily like a whale, about 24 ft. long. Including the rudder it is said to be 30 ft. long and 6½ ft. in diameter. It has side wings or vanes of silk, but these do not sustain equilibrium propellers as shown in the picture. A vertical keel cloth and rudder are stretched above the balloon, and another cloth inclosure below representing the peculiar-looking car shown in the view. Both of these parts are of white cotton goods, roughly fitted, and mismatch the varnished silk of the balloon, which latter looks as if well made. Before the model was exposed to the public it was said that the upper keel cloth, rudder and car were of aluminium, but they either proved too heavy or failed to materialize.

"At the front of the balloon, and connected with it by a light wooden framework, is placed a two-bladed propeller, about 6 ft. in diameter. It is made of cloth, stretched upon a light frame, and is driven by a light endless string which runs from the propeller to the cloth inclosure representing the car. The latter presumably contains a light dynamo, and the power is conveyed thereto by a flexible wire some 50 ft. long, extending from the car to some storage batteries placed within an inclosure in the middle of the Exposition building. This inclosure, which is about 40 ft. square and 8 ft. high, screens the balloon from prying investigation when it comes down.

"Every 15 minutes or so the machine gently rises from the inclosure to a height of about 40 ft., and the propeller being put in motion flies around in a circle of about 60 ft. in diameter, either to the right or to the left as the rudder may be set, being kept from straying out of the circular course by the connecting wire, which on its way from the dynamo to the storage battery, is attached to the top of a staff, standing about 10 ft. above the floor and furnishing the pivot or center for the circular movement.

"After flying around for a few minutes, the machine is gently hauled down within the inclosure, and the loss of hydrogen gas made good, if so required, from a portable generator. It was first said that this model air-ship was to carry a passenger, possibly two, but the lifting power evidently amounts to but a few ounces, and the balloon is pulled down between finger and thumb. The propeller makes about 60 revolutions per minute, and the speed of the apparatus is from 3 to 3½ ft. per second, say 2 to 2.4 miles per hour."

Of course Mr. Pennington admits that this preliminary experiment is only to show that a machine can be made to propel and steer itself. It is rather aggravating to a great many that his progress is so slow—but he says it is sure.

And having given the views of his adverse critics, let us conclude by stating a few points regarding the ideas of the inventor applicable to the construction of his air-ship proper :—

### THE INVENTOR'S DESCRIPTION.

"The principles in the construction are five; namely, buoyancy, screw, vacuum, æroplane and parachute. To show how these principles are applicable to this ship, we will first define them and then show how they are applied. By buoyancy is meant the quality of floating; to have something that weighs nothing, and to have that something in a vessel that is shaped to take advantage of all other combinations that are applied in connection with it.

"The screw principle is used on this ship to propel the same as in water. Water is a fluid, so is air. The screw will work in air better than it will in water, because the air is flexible. The vacuum principle on this ship is combined with the screw. The blades on the screw are shaped so that after the air is discharged on their outer diameter it is deflected at a point aft of the center of the buoyancy chamber, aud is utilized to force the ship in the same direction that it is traveling. The æroplane principle is utilized the same way that a sail is used on vessels. The parachute is used to retard the velocity of the air-ship in its descent. The main part of the machine is the buoyancy chamber; this in shape is an oblated spheroid, being large at the center and tapering symmetrically to a point at either end and looks like a huge cigar. On the inside of this chamber are two compartments; one is a receptacle for gas and the other is used as an engine room. The engine that occupies this room is a three cylinder rotary, and propels the large wheel in front of the ship. The fuel that supplies this engine is gas, and is fed direct. The main shaft is hollow, and the large propeller is keyed directly on it. On the top of the buoyancy chamber is placed the sail. This extends its full length and can be manipulated so that the currents will act to propel the ship as it does a sailing vessel in water. Attached to this sail is the rudder that guides the ship either to the right or left, and underneath this rudder is the tail; this tail is patterned after a bird's tail, and is used to raise or lower the ship independent of the propeller wheels at the sides. On the sides of the chamber are placed the wings. These wings are so made that when the ship is descending they improvise themselves into parachutes, which make the descent gradual. On each of these wings are placed two propeller wheels, for raising and lowering the ship."—*American Engineer.*

* * *

## JET CONDENSERS.

### BY A GERMAN ENGINEER.

A steam engine condensing apparatus, has for its purpose, as is well known, to condense, with the help of cooling water, under vacuum, the dead steam forced out by the steam cylinder, and to lead it away in the form of water; thus we save in some other way in that work which the steam engine—a common escape steam engine—would have to do in forcing the steam directly into the open air, and in doing which had to conquer the atmospheric pressure. One thing, however, is to be considered in regard to this advantage, viz., that the condensation systems used up to the present need a motive force in order to produce the vacuum. With large and middle-sized engines this does not matter so much, considering the advantages to be gained; but with smaller engines, the loss of power through the air-pump is in most cases so important that it is generally considered unprofitable to supply such engines with air-pump condensers.

If we consider the greater amount of work which steam engines accomplish by the aid of condensation, or if we examine the reduction in the consumption of steam or fuel, we shall find that it is not proportionately the same in all cases; it fluctuates according to the size, completeness, and management of the engine, within large limits, from about 10 to 40 per cent., and under ordinary circumstances we may reckon 20 per cent. on the average.

By the proper management of steam, with a condenser, therefore, we may considerably reduce the expenses of fuel. This fact is generally known; notwithstanding, if people do not procure for themselves the advantages of a good condensation system—even where the water and other circumstances are not adverse to it—we may attribute it to the following reasons:

In the first place the acquisition of an air-pump condenser, as formerly generally used, is rather expensive. In the second place, this pump is not so simple, and is very sensitive, so that a capable and well-paid attendant is necessary; but such a man is not always to be found. In the third place, the working parts wear out very soon, and require frequent repairs, consequently the running expenses are rather high. Therefore the larger the engine, the cheaper proportionately an air-pump condenser will be, both as to first cost and to the general expenses connected with its running; consequently the more profit it will bring. On the contrary, it will prove the more expensive and less profitable the smaller the steam engine to which the condenser is to be applied. Therefore steam engines of greater power are mostly supplied with condensers while those of small and medium power generally work without them.

And yet are the less large works of a necessity compelled to diminish the manufacturing expenses as much as possible, in order to compete successfully with the larger establishments. Therefore, I think it would be of a great interest to many, to have a description of a condensation-apparatus which unites the greatest simplicity and cheapness, and renders it available not only for the larger steam-engines, but also with the same advantage for the smallest.

The jet condensers of the firm of Koerting Bros., Hanover and London, which produce almost as high a vacuum as injection or surface condensers, possess neither movable parts, nor parts to be regulated; they, therefore, need no attention, nor can they cause any disturbance in the working. The consumption of cooling water is the same as that with the air-pump condensers, and is 25 times more than the necessary feed-water of the boiler. The fundamental idea of the jet condenser is that it leads the cooling water with a little pressure through the apparatus, or puts the latter in a cooling water if this is a running water. In flowing through the cooling water sucks the dead steam from the engine, and, condensing it, a great vacuum is created. By the living power of the dead steam, the cooling water obtains at the same time such rapidity, that it is not only able to run out freely at the opposite side, but it can even be lifted up a few yards, although the vacuum is not in the least unfavourably influenced. There is no necessity for a single jet of living steam or any other assistance to remove the water from the apparatus.

The water jet condensers therefore produce the vacuum without the necessity of an air-pump. Such a vacuum is much more effective, because the benefit obtained by the vacuum is not lessened by the power consumed by an air-pump. Formerly the condensers applied to small engines did not give any great advantage, even when all the circumstances were favourable; for the gain of the vacuum was almost all consumed by the consumption of power.

For the jet condenser the following may be asserted:

"Where there is at all the needed quantity of cooling water, the Koerting condenser may be recommended." This has found full confirmation in many establishments, but it is also easily proved by calculation. For this purpose I will give you an example:

A small establishment has steam engine of 10 h. p. This engine, as a rule, does not work up to more than its indicated power. For each horse-power per hour it consumes, with an initial pressure of four atmospheres in the steam chamber, about 20kg,[*] on an average, or, say, 200kg.[*] in one hour. Now if this engine has to work with a condenser, then 25 lit.[*] of cooling water are needed for each kg. of steam, that is 200x25=5,000 lit. per hour. This water has to be led to the jet condenser, with a fall of at least 4m. Suppose it is 6m. below the engine, it is necessary to lift it 10m. in all. The pump put up for this purpose would thus require a theoretical accomplishment of work of 5,000x10=50,000 m. k. per hour; or, divided by 3,600 of 14 m. k. in a second, it would claim theoretically $\frac{14}{75}$=0.19 h. p. With an effect of 60 per cent. the pump would in reality use 0.32 h.p.; in regard to the above mentioned consumption of power of 20kg. for 1 h.p., it would need about 6.4kg. of steam per hour. With a pressure of steam of four atmospheres under corresponding expansion we save by way of condensation about 25 per cent. of steam; therefore in this case we should save 50kg. of the 200kg. of driving steam. If we take away the 6.4kg. which we need for driving the pump, a net profit of 43.6kg. would remain, or we should save $\frac{100\times 43.6}{200}$=21.8 per cent. of steam, and there would be an equal diminution in the consumption of coal.

Where the height to which the cooling water has to be forced is less, or where no working of the pump is needed, as is the case with many works with hydraulic power, the result is of course still more favorable.

From the above statement we see that the jet condenser saves more than 20 per cent. of coal, or increases the working capability of the engine by 20 per cent. even when the cooling water has to be lifted 10m. by a special pump, and this with very small engines where the air-pump condenser cannot be used.

The jet condensers are especially suitable for the middle-sized and smaller engines, on account of their moderate cost and requiring very little space. They are very simple, the wear and tear being consequently very much reduced, and require no attention. The expenses of an air-pump condenser in an engine of 15 h.p. amount to about £60,[†] a corresponding complete arrangement of jet condensation, however, may be obtained for £32 10s.[†] including a pump to lift the water; if the pump is not required the cost will be only £15.[†] The water jet condenser is much cheaper than any other condenser, not only in first cost, but also in working. As there are no movable parts, there are no expenses for repairs or lubrication, and regularity of working is ensured.

The handling of the jet condensers consists only in opening and shutting the water valve and the air cock when the engine is put on or stopped. This is so simple and easy that any ordinary workman may be entrusted with it. This condenser is therefore of great value, especially in small establishments.

Whilst at work the jet condenser requires no attention; it is perfect in action, and stops work only when there is a lack of water, or some obstruction of the water nozzle, which is easily and quickly cleaned by taking out the spindle.

The jet condenser has the form of a pipe, but inside it is made a nozzle. The cooling water enters it at the upper end and flows through it under a gentle pressure.

The apparatus may be fixed in various ways, as described in the following:

1. The best way to put up a condenser is to place it in a perpendicular position deeper than the engine. The water flows through it from a height of 5 or 6m, or under a corresponding pressure. This is, for many reasons, the most profitable way of putting up a condenser, as thus fixed, it produces the best results.

2. The condenser may be put directly into flowing water close by, placed in a horizontal position, and parallel with the current of water.

3. The condenser may be put up so that, by the means of pipes, the water is led to it from a distant lake, river or well. After the condensation it is raised by the condenser high enough to effect a sufficient discharge.

4. The condenser itself can suck the water by its own activity, and at the same time convey it to a more elevated point.

5. Finally the condenser may be put directly into the suction pipe of a cold water pump.

In all cases it is advantageous to fix the condenser a little deeper than the steam cylinder, and as near to it as possible. It is advisable to put a return valve into the dead steam pipe. This is absolutely necessary where the engine works irregularly, and is often stopped, or where the condenser is fixed above the level of the engine cylinder.

---

[*] kg. (kilogram) equals 2.2046 lbs. advoirdupois. Lit. (liter) is equivalent to 2.113 American pints.

[†] £60 equals $293; £32. 10s, $157; and £15, $74.

Further, it is to be recommended that the dead steam pipe of the engine be supplied with a special outlet directly into the open air, and which is hermetically closed with a valve. If for any reason we require to work without the condenser, we have only to open this valve and let the dead steam escape. It is absolutely necessary to have a little air-cock in the dead steam pipe. Before the steam or water valve of the engine is shut this air-cock must always be opened.

There is no need to omit an effective feed-water heater for the jet condenser's sake; it can be fixed in a suitable position between the steam cylinder and the condenser, the effect of the latter not being diminished. If we wish to heat with the dead steam before it is condensed the jet condenser must be erected at the end of the conduit of heat pipes.

If we have to lift the cooling water, and wish to be free of the running wheel-work of the pumps, a pulsometer may be used with advantage instead of a plunger pump. The water lifted by a good pulsometer is warmed so little that it does not prevent condensation. The fitting up of the jet condenser naturally always depends upon local circumstances; but no great difficulty need be apprehended, even where space is limited. The expenses of erection are very small in all cases, as there is no need of any foundation, the condenser having the form of pipes, and is not heavy, being generally simply hung between the conduit of pipes.

Where several steam engines work beside each other, it often happens that one jet condenser of corresponding size is sufficient.

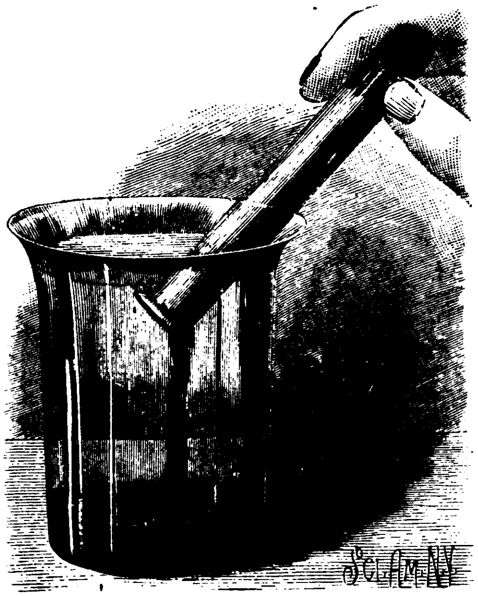
The above statements founded on practical experience, are probably sufficient to be a help to those who are interested in the matter, but who have no knowledge of this apparatus; they may now, however, be able to form an opinion of its merits or demerits. To this I have only to add that this apparatus is not a new and untried invention. Years ago the Koerting jet condenser proved itself very useful and profitable. To-day more than 1,100 of these condensers are in use in all parts of the world for engines of every kind and size, and I am convinced that its adoption will be more general the more its excellence and usefulness are known.—*American Engineer.*

## EXPERIMENT IN SPECIFIC GRAVITY OF FLUIDS.

T. O'CONOR SLOANE, PH.D.

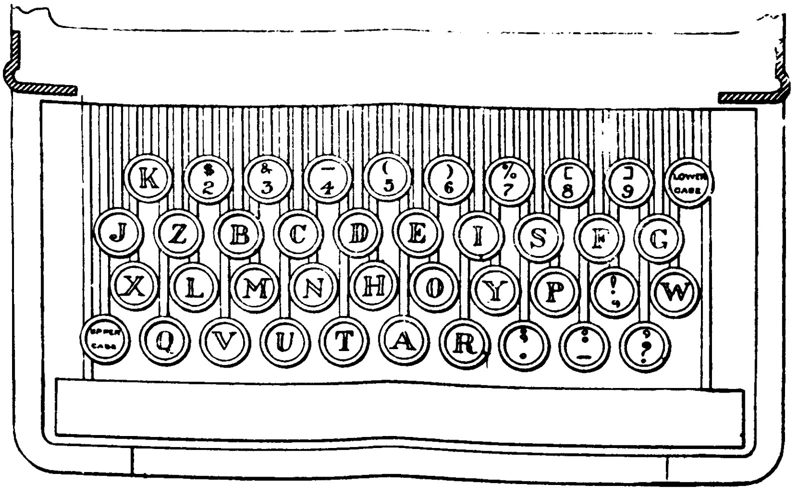
The illustration shows a very interesting experiment on the law of the specific gravity of liquids, which, simple as it is, presents a very good exposition of the phenomena brought out by the operation of this law. A strong solution of potassium bichromate in hot water is made in a test tube. By boiling the water and adding the salt as long as it dissolves, an exceedingly strong solution can be produced. It is then cooled. This cooling is best effected by placing the test tube in a beaker of cold water with its mouth upward in the regular position. As it cools, the bichromate of potash rapidly crystallizes from the supersaturated solution, and the building up of these crystals is in itself an exceedingly interesting process to watch. When it has cooled, the experiment proper can be carried out.

A beaker is filled with cold water. The test tube is next filled to the brim. It is closed with the thumb, and the mouth of the test tube is immersed in the water of the beaker and then released. The object is to prevent the admission of any air whatever. As soon as this is done, the bichromate of potash in what is now the upper end of the test tube begins to dissolve. As it dissolves, it forms a solution heavier than the water, and pours in a stream down the lower side of the test tube, through the water, to the bottom of the beaker. It inevitably mixes more or less with the water surrounding the streams, but at the same time the course can be distinctly traced by holding the beaker against the light. At the same time a stream of clear water can be observed, rising along the upper walls of the test tube to supply the place of the heavy fluid escaping therefrom. It is easy to see that carried out with the proper tank and a small test tube, this experiment would form an admirable illustration for projection by the magic lantern.



EXPERIMENT IN SPECIFIC GRAVITY OF FLUIDS.

The same experiment has its useful application. The principle is used in the laboratory for dissolving the melted mass from sodium carbonate fusions, as in the analysis of iron ores, etc. For cleaning out battery jars, in which very hard crystals of chrome alum often form, or for dissolving the same crystals in bottles in which battery solutions which are partially exhausted have been kept, the same method is applicable. By a little manipulation the battery jar or bottle can be inverted in a bucket of water, itself being full. It is well to support it on a couple of bricks, or by other means, as far above the bottom of the bucket as possible, in order to admit of the free escape of the strong solution thus formed. An inclined position, as favoring the regular ascent and descent of the two columns of liquid, is also to be recommended where the process is practically applied. Crystals quite



Type-writing Machine.

irremovable by ordinary means can thus be dissolved, and the bottle or jar saved. Sometimes several hours are required, and it is also well to renew the water in the bucket or other receptacle. Care must be taken to admit no air.—*Scientific American.*

## TYPE WRITING MACHINE.

Upon the arrangement of the keys of a type writer depends the facility of operation; hence, careful consideration is required in this matter. Long years of experience in the use of printing type has developed a system of arrangement in the type cases that is so perfect, as to be universally used, so that the hand of the expert compositor flies about over the case unerringly, without special effort of the mind. It is the aim of the present invention to so arrange the keys of the instrument, as to closely approximate the order of the type case, so that the letters and other characters will be peculiarly accessible, and in the order of natural word construction, so that there is a natural finger flow over the keys, that involves the least shifting or reaching of any system of arrangement yet devised for type writers. By this system printers could quickly learn type writing, and type writers could as quickly acquire the compositor's accomplishment. The arrangement, simple as it is, has required a long period of careful consideration and experiment, resulting in a system that may safely be set down as compassing the utmost possibilities of further improvement.

The inventor is Mr. William H. Robertson, of Allegheny, Pa.

## A CHANCE FOR THE INVENTOR.

The wonderful ingenuity developed by our mechanics, inventors, and contrivers during the past generation or two has about spoiled the dear public. It does not make much difference as to the purpose for which any piece of mechanism is designed, it must be more or less automatic and "self-operating" to take with the average buyer. In some respects the demand—craze we might call it—has been carried to the verge of absurdity; in others it has proved of the greatest benefit to the human race, while certain fields, in which the automatic principle should be peculiarly available, have failed of all benefit in the efforts of the inventor.

Take for instance the ordinary heating apparatus in our dwellings, whether it be steam, hot water, or warmed air that is employed. Many of the makers thereof have strong claims to advance for the "automatic" character of their appliances, and yet there is not one among them all that can be safely trusted, to to use a homely phrase, to "go it alone," even for a limited period. Here is a furnace man who will fit up your residence with a wonderful arrangement of electric thermostats, or thermometers having electric limit connections, by which he will guarantee to keep your house at an even temperature all winter. A steam heating outfit is provided with a diaphragm valve that controls the damper of the furnace and keeps just so much pressure, which means an equally well determined degree of heat. The hot water man has something else; all are equally infallible, but the only difference in their operation is the effect they exercise on the pocketbook. Either they are dismal failures, in spite of all that can be done for them, or they take so much looking after that the deluded purchaser reverts after all to the poker, shovel and shaker, which, controlled by the human sense of comfort and its opposite, are the best regulators of the modern heating apparatus.

Here is a chance for the inventor. The ingenious individual who will make it impossible for the ordinary heating apparatus to freeze us or "render" us out between bedtime and dawn; that will insure, without a constant worrying of the fires, an even temperature; that will obviate the necessity for flooding the ordinary residence with cold air and incidentally with dust, preparatory to the kiln drying of its contents, will win a fortune and honestly earn it. It does not matter what the heating medium may be or how regulated, provided it is not in any way more offensive, cumbersome, dangerous, etc., than the methods now in vogue; as long as it is reliable and effective, it will go, and price will be no object.

There is no doubt but what it will come to pass that the heating apparatus of the future will be as economical of fuel, as safe, as efficient and withal as mechanically beautiful, as the modern automatic high speed steam engine, with its cut-off and perfect self-governing devices, and inventors would find it mighty profitable to be first to the front with anything of the kind that would be really trustworthy. We have looked the field over very carefully, and found several contrivances that may ultimately fill the bill, but which labor under "just one" little defect or weakness that is fatal to their perfect reliability. With all the ingenuity they have thus far displayed in their constructions, the originators should certainly be able to complete them.—*The Sanitary Plumber.*

## FACIAL PERCEPTION.

By some singular instinct, says an exchange, a man who was born blind can tell when he is opposite an object, and can tell whether it is tall or short, slender or bulky. He can also determine whether it be a solitary object or a continuous fence; whether a close fence or an open one, and sometimes whether a wooden fence, a stone wall or a hedge. None of the five senses has anything to do with this perceptive power, says our contemporary, but the impressions are made on the skin of the face, and by it transmitted to the brain. This unrecognized sense is called "facial perception." The presence of fog interferes with facial perception, and makes the impression faint and untrustworthy, but darkness is no impediment. A noise which distracts the attention interferes with the impressions. In passing along the street such a blind man can distinguish shops from private houses, doors from windows, and whether the windows consist of a number of panes or a single sheet of glass.

## SYSTEMS OF PHOSPHATE MINING.

In the earlier days of the Canadian Phosphate industry, mining was largely carried on by contract. The miners provided their own dwellings, tools, and supplies, and the owner of the property incurred no outlay or expense, except to pay for phosphate won. This was usually paid for at the rate of six dollars a ton, the standard quality being seventy-five per cent. and any phosphate below that grade was liable to rejection. It was customary to pay monthly, at the rate of five dollars a ton, on a measurement of twenty cubic feet to the ton, one dollar's margin being reserved for a final settlement on the weight. An advantage of this system is that it avoids the investment of capital by the mine owner and saves him from all risk of loss in prospecting for shows or in working unproductive seams. It also secures an output that would not otherwise be made, as neighbouring farmers will occasionally put in a few weeks' work and produce ore at a rate that ordinary laborers would not accept as day wages. But the disadvantages of this method of working phosphate mines are many and have caused a general abandonment of the system, except for an occasional venture in a small way. The chief difficulty is to secure good quality. The miners build up walls with handsome blocks of apatite, within which they pile as much dirt as opportunity and conscience will permit, and the latter deterrent is not often operative. As payment has to be made monthly and every analysis by a chemist costs five dollars, expense debars the owner from securing accurate tests, and, as in winter time the piles freeze into a solid mass, the difficulty of inspection is great. Many a cargo of contract mined phosphate, upon which great hopes of profit were based, has gone below guarantee in Europe and been rejected by the purchaser. Another objection to this system of mining is the bad condition in which the property is left. The contractor, intent only upon present gain, works his pits in a cheap and shiftless fashion, having as much débris as possible unhoisted and working in the smallest space in which he can move. He "gouges out" the seam and moves to a new surface show to repeat the operation, the consequence being that the property is soon covered with holes in the ground that require an outlay before they are workable. There is a strong moral objection to this system. It places men in a position where all their interest lies on the side of dishonesty and where there is every facility for its commission. Contract work in sinking shafts and running drifts is popular and safe and is largely resorted to at the Sudbury Copper Mines at present. The men in such case are paid by the fathom of excavation and their work is readily checked. But the conditions of phosphate mining are very different, and both materially and morally the contract system of mining as applied to it must be pronounced bad.

The usual system of phosphate mining is by day labor. The chief difficulty about it is the lack of incentive to the workman to render faithful and efficient service. If he can get through the day without rebuke from the "boss" the less he does for his wages the better it suits him. In large mines under good superintendence and strict oversight and where machinery is used a fair amount of effort is secured from the men; but when the work is scattered over a wide area or is under careless management the loss from neglect on the part of the laborers is very great. Many a small enterprise that properly managed might have grown to success has been ruined by loafers. The city owner makes a rare visit to the property and sees things going on briskly. On other days the manager takes his horse and buggy and drives to the neighbouring town for a bar of soap or a hammer and the men "take it easy." Over-estimated reports of output are given and it is not long since a company, that was supposed to have 500 tons of ore raised, discovered a weight of only 150 tons.

A remedy for the ills of these two systems of mining seems to exist in the form of co-operation or profit sharing. Experience shows that it is impossible to devise means to avoid loss by dishonesty and laziness under the contract or wages system. Some miners are dishonest and lazy and all have a good deal of "human nature" in them and it is natural for men to give as little work for the money as policy will permit. The only effective way to overcome this tendency is by stimulating self-interest. If the miner's pay was contingent on the quantity and quality of the ore raised, an inducement would exist for him to use his best exertions. With a shifting force such as is commonly employed in mines this method is not easily practicable, but where steady labor is employed and the men are residents of the region some system embodying this principle of co-operation seems to be feasible and it is to be hoped that it may be tried in the phosphate industry. It was attempted in one case a few years since, but as the mineral was scarce no amount of effort could secure a profit. In nearly every department of industry, associative work for commom profit appears to be proving its fitness by favorable results ; but the difficulty of its application to mining has so far afforded but little opportunity for the introduction of this humanizing system. If it could be tried under suitable conditions and the success of the enterprise was alike the concern and interest of employer and employee or a mutual association of workers probably the results would be satisfactory to the pocket as well as elevating to the moral nature.—*Canadian Mining Review.*

## FLUORIDES AS AGENTS FOR SOFTENING HARD WATERS.

Dr. Doremus has recently found that sodium fluoride and other fluorides can be used with advantage for softening hard waters. He finds that the precipitation of magnesium is especially thorough, and that this reagent does not present any of the serious difficulties that are met with in the practical use of lime, soda ash, and caustic soda. The patentee at first experienced some difficulty in obtaining this reagent in large quantities at a reasonable rate, but states that he has now induced manufacturers to supply this compound in large quantities at a figure which will not prove prohibitive to the consumer.

## REVIVAL OF THE USE OF SUPERHEATED STEAM.

There appears to be a decided tendency amongst American engineers in particular, according to an article which appeared lately in our contemporary the *Engineer*, towards the revival of the use of superheated steam. Formerly it was the ordinary practice of engineers to work with steam in this condition, and there is no doubt whatever that unless the steam is dry a maximum economy cannot be gained. Surely then there must have been some good reason for discarding the practice ; for, granting it were possible to work with steam superheated sufficiently, there would be enormous economy obtained in engines working at high pressures and with large ranges of expansion. The advantage would be gained of doing away entirely with cylinder condensation. The reason of the change appears to have been that our engineers some thirty years ago were not possessed of a satisfactory lubricant, mineral oils were then practically unknown, and tallow, which was the grease ordinarily used for the cylinder, quickly charred under the influence of superheated steam. Again the packings used in stuffing boxes were of hemp, and those would not remain long now-a-days. As our contemporary points out in contrast to this, we have mineral oils which will stand a high temperature without charring or thickening, and we have metallic and asbestos-packed stuffing boxes. Moreover, thirty years ago, the present piston valves had not been brought into use, slide valves only being adopted. After considering the various conditions which would be met with at the present time in the adoption of superheated steam, our contemporary goes on to make the following useful suggestions. Assuming that it would be possible to work an engine under the stated conditions, we have next to consider how the steam is to be superheated. It may be said here at once that unless this can be done by utilizing heat which would otherwise be wasted, the economical advantage may be altogether sacrificed. The superheater should be situated in some part of the flues, uptake, or chimney. In all this there is no difficulty. The trouble is that wrought iron pipes, used as superheaters, burn away very rapidly, and, if used with high pressure steam, serious accidents might readily ensue. When we come to consider this difficulty, however, we find that it is more or less traditional. The pipes were always so situated that they were raised to a red heat, or something very near it, during the time the engine was standing, or while steam was being got up. Unless the engine was running, and steam passing through the superheater, there was nothing to cool the pipes, for there was no current. The situation of the superheater was much too hot. The pipes of Green's economisers last a long time, and the water within them may be raised to a temperature considerably above that of the water in the boiler. There would be little difficulty in making steam, on its way to a stationary engine, pass through a set of pipes answering in all respects to an economiser, in which all the suspended moisture in the steam would be evaporated and there would be no trouble in so arranging the dampers that, until the engine was started, the hot gases from the boiler would be diverted from the superheating pipes. There would be some trouble in making similar arrangements at sea, but ingenuity would overcome this. — *Machinery Market.*

## THE USE OF ALUMINUM IN IRON FOUNDRIES.

Mr. David Spence, in *American* **Machinist** says:

During the past winter I have used aluminum in foundry practice, and find that it is a splendid thing to make iron fluid and clean. It seems to take all the impurities out of the iron when it is charged in the cupola with the pig iron. Ten pounds of Cowles' ferro-aluminum to 2,000 pounds of pig iron will produce good, sound castings, free from blow holes.

It is as good in the use of crucible steel as in iron (its effects). It produces a sharp and solid casting, makes a uniform grain. It takes away the tendency to chill in cast iron.

In steel it reduces the shrinkage, and increases the welding properties in both wrought iron and steel.

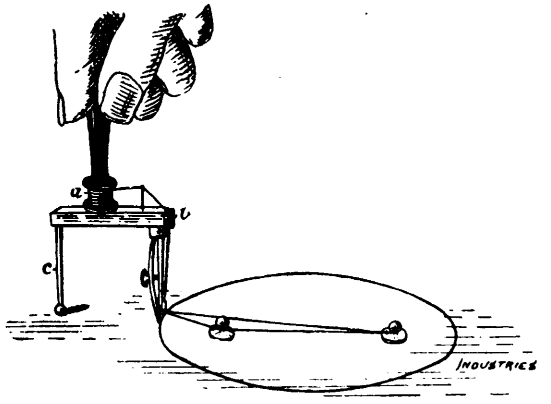
I recommend it to persons making tool castings, such as face plates, and in fact all kinds of work that has to be planed, milled, or turned.

There is one thing that I like in its use, and that is, it does not weaken the iron or take the strength from it, but rather adds to it. We are having good success with it in sewing machine castings. I believe in progress in foundry practice, and am always willing to give such things a trial, if I find that they are a benefit.

I want other foundrymen to know it. I believe we are making rapid progress in American foundry practice, and the foundryman that is satisfied to run his foundry in the same old-fashioned way his grandfather did, is going to get left. And the younger and more progressive men will come to the front.

## A SIMPLE ELLIPTOGRAPH.

The accompanying illustration represents a neat and useful little instrument for drawing figures of elliptical form, which has been patented by Mr. C. E. Egner, of Asarum, Karlshaum, Sweden. The principle of the instrument is based upon the well-known method of drawing an ellipse by means of a pencil and a thread whose ends are fixed at its two foci. The instrument consists essentially of a pen or pencil fixed at right angles to a small horizontal bar, at the other end of which is similarly provided a leg *c* with a ball point which acts as a rest. On the top of the bar a vertical handle, with a small reel *a* (containing a double thread) at its lower end, is mounted. This is revolved in order to lengthen or shorten the thread to suit the size of ellipse to be drawn. The thread passes down practically to the point of the pen or pencil, and is held secure by the small thumbscrew *b* (shown). The ball-headed pins are pressed into the paper at the foci of the required ellipse. The thread is placed around them, and the curve is then completed in the usual way. The instrument is provided with pen and pencil, legs and pins, and is neatly arranged in a small case. The combined set can be obtained from Mr. C. I. Lundstrom, 17, Fleminggt, Stockholm.



Laughing by Telegraph.—Telegraph operators lead a highly monotonous life, and are entitled to all the diversion they can extract from the unemotional machine over which they preside. A laugh transmitted over the wires cannot be of a very infectious nature, but it can be accomplished, nevertheless. When an operator becomes lonely, says the Indianapolis News, and his sounders are clicking out messages not intended for him he calls up some friend, and opens a conversation. This of course, cannot be continued long before something "funny" is said. It then becomes the duty of the operator to laugh, which he does by making four dots, then one dot and a dash, thus : . . . . . —, spelling ha. Thus to all jokes he replies h-a, h-a. From the same authority we learn that suprise or incredulity, as well as amusement, can be conveyed by a few clicks; thus, four dots followed by two dashes make the expression "hm," the precise meaning of which in any given instance is to be judged, no doubt by the context.

## OIL AND GAS.

### HOW A WELL IS DRILLED THOUSANDS OF FEET IN DEPTH.

When a gas or oil well is located, says L. A. Felter, in the *Indiana Farmer*, the first step is to build over it a derrick, which is a frame from sixty to ninety feet high, built of two by eight inch timber in the form of a square pyramid. In this is erected a "walking beam," or horizontal rocking shaft pivoted in the middle, twenty-six feet long, one end of which is connected to the crank shaft of the engine ; to the other is suspended the "drill," or boring tool.

The drill "bit" consists of a steel chisel blade, obtuse but sharp, about eight inches wide, with a shaft about six inches in diameter, about six feet long, weighing about 250 pounds. The lower or cutting part is of steel, the shaft is of iron. The "stem" is of iron rod, of the same size as the shaft of the bit, into which it is screwed, and is thirty-three feet long and weighs over 2,000 pounds.

In the upper end of the stem is a ring, by which the whole is suspended by a two and one-quarter inch Manilla rope. The drill is raised about three feet for a stroke, the weight being about 2,300 pounds, and let fall on the rocks beneath. The number of strikes average about forty-five per minute.

The hole is eight inches in diameter at the start, and the drill chops its way down as far as possible—sometimes from one hundred to two hundred feet ; when water or sand prevents further progress, by caving, it is necessary to case the whole with sections of iron tubing, having an inside diameter of 5⅝ inches, which are screwed together and driven down to the bottom of the hole.

Then a smaller drill, fitting the inside of the casing, is again set to work as long as possible. When again obliged to stop, the casing is withdrawn and a "reamer" or widening tool is put down, and the lower portion of the hole is enlarged to eight inches. Then the casing is again put down to the bottom. In this way the work progresses until the desired depth is reached.

The drill is made with horizontal notches throughout the entire length—as it often happens that the bit of stem breaks while in the hole. In such cases a "grab hook" is slipped over the end of the broken piece, and in this way recovered.

The "sand pump," which is used to clean the sand and pulveiized rock from the hole, is simply a tube twenty feet long and five inches in diameter, the valve being an iron or copper ball four and one-half inches in diameter. This tube is let down, and when filled is drawn out. The sand pump is used about every five feet, and a sample of the rock cut is put into bottles, numbered and labeled with number of feet and character of rock.—*The World's Progress.*

# ELECTRICAL

## HOW AN OCEAN CABLE IS MADE.

Let us first see what a submarine cable is and how it is made. To do this a visit must be made to the enormous factory on the banks of the Thames, a few miles below London. Here the birth of the cable may be traced through shop after shop, machine after machine. The foundation of all is the conductor, a strand of seven fine copper wires. This slender copper cord is first hauled through a mass of sticky, black compound, which causes the thin coating of gutta percha applied by the next machine to adhere to it perfectly and prevents the retention of any bubbles of air in the interstices between the strands, or between the conductor and the gutta percha envelope. One envelope is not sufficient, however, but the full thickness of insulating material has to be attained by four more alternate coatings of sticky compound and plastic gutta percha. The conductor is now insulated and has developed into "core." Before going any further the core is coiled into tanks filled with water and tested, in order to ascertain whether it is electrically perfect, *i. e.*, that there is no undue leakage of electricity through the gutta percha insulating envelope.

These tests are made from the testing room, replete with beautiful and elaborate apparatus, by which measurements finer and more accurate than those even of the most delicate chemical balance may be made. Every foot of core is tested with these instruments both before and after being made up into cable, and careful records are preserved of the results.

After the core has been all tested and passed, the manufacture of the cable goes on. The core travels through another set of machines, which first wrap it with a thick serving of tar jute and then with a compact armoring of iron or steel wires, of varying thickness, according to the depth of water in which the cable is intended to be laid. Above the armoring, in order to preserve the iron from rust as long as possible, is applied a covering of stout canvas tape thoroughly impregnated with a pitch-like compound, and sometimes the iron wires composing the armor are separately covered with Russian hemp as an additional preservative against corrosion.—*Scribner.*

◆

## AN ELECTRIC POWER HAMMER.

Charles J. Van Depoele, who has been prominently identified with the development of electrical traction for street railway purposes, has devised an electric power hammer which represents a radically new application of electro-magnetic principles. In general design the hammer is quite similar to the steam hammer, with its vertical cylinder mounted upon an arched frame, and the rising and falling piston by which the hammer-head is carried. The novelty of the apparatus lies in the substitution of electro-magnetic power for steam by a slight and very simple modification of the mechanism. The piston is of magnetic material, and the cylinder is composed of a series of coils through each of which an electric current may be passed separately. The apparatus is virtually an immense electro-magnet, the cylinder being the coil and the piston answering to the core. The passage of an electric current through the coils forming the upper part of the cylinder raise the piston into the magnetic field thus created. By cutting off the current and simultaneously transferring it to the lower coils of the cylinder the piston is released and its descent is accelerated by the magnetic attraction created below. As a magnetic field can be created in any of the series of coils, the blow may readily be shortened or lengthened as desired. The current is controlled by levers and connections identical with those used on an ordinary steam-hammer. The absence of the steam-pipe is the only feature distinguishing the machine from the common steam-hammer.—*Electrical Mechanical and Milling News.*

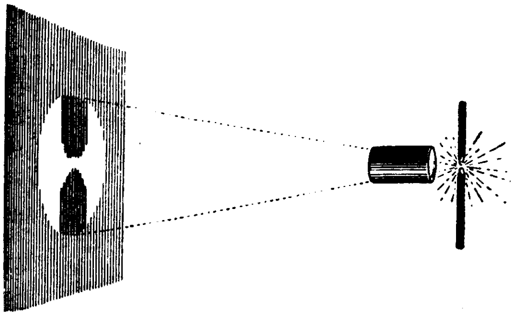
◆

## TESTING ARC LAMPS.

BY FRED. H. COLVIN.

There is in use at the main Brush Electric Light Station, Philadelphia, an ingenious and praiseworthy arrangement for testing the arc lamps before they are sent out, or on repair work. It is praiseworthy because it saves the eyes of the workman and ingenious because of its novelty.

The testing rack is of the usual form, but in front of each lamp is placed a lens which is provided with a rack and pinion focussing arrangement, and fitted in a horizontal sliding way or frame so as to be readily adapted to each carbon.



Simple Method of Testing Arc Lamps.

The lamps to be tested are switched on as usual, but the operator, instead of watching the carbon points themselves, adjusts the lens to focus on the white wall several feet away, and there watches the enlarged and inverted image of the carbons in all their processes of burning, and sees much more accurately than if he watched the carbons themselves. This does not injure the sight to any perceptible degree, and is not only humanitarian, but gives a clearer idea of the action of the carbons.

The accompanying figure will illustrate the plan quite clearly.—*Electrical Engineer.*

◆

## A NEW LINE CONNECTOR AND JOINT.

In all classes of electrical work it is necessary that the line connections at the joints should be as solid as possible and offer a minimum resistance. It is naturally desirable, also, that the making of a joint should be accomplished quickly and inexpensively. The usual methods of soldering are open to objections on the two last points, and moreover in a soldered joint, there is apt to be more or less local electrolytic action or corrosion as two different metals are brought in close contact.

The new line connector invented by Messrs. W. A. Giles and A. M. Hunt, U. S. N., has been designed to overcome both these difficulties, and is exceedingly simple in its construction.

It consists merely of a short, seamless copper tube of oblong section, shown in the engraving, Fig. 3, large enough to contain the wires to be connected, which are inserted side by side.

FIG. I.

The ends of the tube are then grasped by clamps, and twisted into the form shown in Fig. 1. During this twisting process, the wires are pressed and rubbed into metallic contact against each other, and the tube is drawn so tightly around them that the connection is practically a solid mass of copper, having even less resistance than an equal length of line wire. No soldering is necessary, and no local electrolytic action can therefore take place. Fig. 2 shows a section of a finished joint.

FIG. 2.

FIG. 3.

Wires of different sizes can be joined in the same way, as by sufficient twisting the tube can be made to conform to the shape of both.

The little device seems certainly destined to a wide application, not only in telegraph and telephone work, but especially in the distribution of current for lighting and power purposes.—*Electrical Engineer.*

## EXPLANATION OF ELECTRICAL WORDS, TERMS, AND PHRASES.

*(Frem Houston's Dictionary.)*

*Ampère.*—The practical unit of electric current.

Such a current (or rate of flow or transmission of electricity) as would pass with an *E. M. F.* of one *volt* through a circuit whose *resistance* is equal to one *ohm.* That is to say, a current of the definite strength that would flow through a circuit of a certain resistance and with a certain electro-motive force.

Since the ohm is the practical unit of resistance, and the volt the practical unit of electro motive force, the ampère, or the practical unit of current, is the current that would flow against unit resistance, under unit pressure or electro-motive force.

To make this clearer, take the analogy of water flowing through a pipe under the pressure of a column of water. That which causes the flow is the *pressure or head;* that which resists the flow is the *friction* of the pipe, which will vary with a number of circumstances. The *rate of flow* may be represented by *so many cubic inches of water per second.*

As the pressure of head increases, the flow increases proportionately ; as the resistance increases, the flow diminishes.

Electrically, electro-motive force corresponds to the pressure or head of the water, and resistance to the friction of the water and the pipe. The ampère, which is the *unit rate of flow per second,* may therefore be represented as follows,

viz.: $C = \frac{E}{R}$, as was announced by Ohm in his law.

This expression signifies that C, the *current* in *ampères,* is equal to E, the *electro-motive force* in *volts,* divided by R, the *resistance* in *ohms.*

We measure the rate of flow of liquids as so many *cubic inches* or *cubic feet per second*—that is, in units of quantity. We measure the rate of flow of electricity as so much electricity per second. The electrical unit of quantity is called the *Coulomb.* The coulomb is such a quantity as would pass in one second through a circuit in which the rate of flow is one ampère.

An *ampère per second* is therefore equal to *one coulomb.*

The electro-magnetic unit of current is such a current that, passed through a conducting wire bent into a circle of the radius of one centimetre, would attract a unit *magnetic pole* held at its centre, and sufficiently long to practically remove the other pole from the influence, with unit force, *i.e.,* the force of one *dyne.* The ampère, or practical electro-magnetic unit, is *one-tenth* of *such a current;* or, in other words, the *absolute unit of current* is ten ampères.

An ampère may also be defined by the chemical decomposition the current can effect as measured by the quantity of hydrogen liberated, or metal deposited.

Defined in this way, an ampère is such a current as will deposit .00032959 grammes, or .005084 grains, of copper per second on the plate of a copper *voltameter,* or which will decompose .00009326 grammes, or .001439 grains, of dilute sulphuric acid per second, or pure sulphuric acid at 59° F. diluted with about fifteen per cent. of water, that is, dilute sulphuric acid of Sp. Gr. of about 1.1.

*Ampère-Hour, Ampère-Minute, Ampère-Second.*— One ampère flowing for one hour, one minute, or one second, respectively.

The ampère-hour is in reality a unit of quantity like the *coulomb.* It is used in the service of electric currents, and is equal to the product of the current delivered, by the time during which it is delivered. The ampère-hour is not a measure of energy, but when combined with the volt, and expressed in *watt-hours,* it is a measure of energy.

The storing capacity of accumulators is generally given in ampère-hours. The same is true of primary batteries.

One coulomb = .0002778 ampère-hours.
One ampère-hour = 3,600 *coulombs.*

*Ampère-Meter ; Am-meter.*—A form of *galvanometer* originally designed by Ayrton and Perry to indicate directly, the strength of current passing in ampères.

Like all galvanometers, the strength of current passing, *i.e.,* the number of ampères, is indicated by the deflection of a magnetic needle placed inside or over a coil of insulated wire through which the current to be measured is passed.

In the form originally devised by Ayrton and Perry, the needle came to rest almost immediately, or was *dead beat* in action. It moved through the field of a permanent magnet. The instrument was furnished with a number of coils of insulated wire, which could be connected either in *series* or in *multiple-arc* by means of a *commutator,* thus permitting the scale reading to be verified or calibrated by the use of a *single* voltaic cell. In this case the coils were turned to series, and the plug to the left pulled out, thus introducing a resistance of one ohm.

A great variety of ampère-meters, or am-meters, have been devised. They are nearly all, however, constructed on essentially the same general principles.

*Ampère-Feet.*—The product of the current in ampères by the distance in feet through which that current passes.

It has been suggested that the term ampère feet should be employed in expressing the strength of electro-magnetism, in the field magnets of dynamo-electric machines or other similar apparatus.

*Ampère-Turns, or Ampère-Windings.*—A single turn or winding through which one ampère passes.

The number of ampères multiplied by the number of windings or turns of wire in a coil give the total number of ampère-turns in the coil. The magnetism developed by a given number of ampère turns, is independent of the current or of the number of turns of wire, as long as the product of the ampères and the turns remains the same. That is to say, the same amount of magnetism can be obtained by the use of many windings and a small current, as in *shunt dynamos*, or by a few turns and a proportionally large current, as in *series dynamos*.

*Ampère Volt.*—A watt, or $\frac{1}{746}$ of a horse-power.

This term is generally written *volt-ampère*.

*Ampèrian Currents.*—The electric currents that are assumed in the Ampèrian theory of magnetism to flow around the molecules of a magnet.

The Ampèrian currents are to be distinguished from the *Eddy, Foucault, or Parasitical Currents*, since, unlike them, they are directed so as to produce useful effects.

*Analysis, Electric.*—Ascertaining the composition of a substance by electrical means.

Various processes have been proposed for electric analysis; they consist essentially in decomposing the substance by means of electric currents, and are either qualitative or quantitative.

*Angle of Declination or Variation.*—The angle which measures the deviation of the magnetic needle from the east or west of the true geographical north.

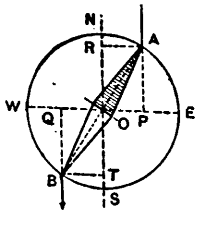


FIG. 16.

Thus, in Fig. 16, if N S represents the true north and south line, the angle of declination is N O A, and the *sign of the variation is east*, because the deviation of the needle is toward the east.

*Angle of Dip or Inclination.*—The angle which a magnetic needle, free to move in a vertical and horizontal plane, makes with a horizontal line passing through its point of support.

A magnetic needle supported at its centre of gravity, and capable of moving freely in a vertical as well as in a horizontal plane, does not retain a horizontal position at all parts of the earth's surface.

The angle which marks its deviation from the horizontal position is called the *angle of dip* or *inclination*.

*Angle of Lag.*—The angle through which the axis of magnetism of the armature of a dynamo-electric machine is shifted by reason of the resistance its core offers to sudden reversals of magnetization.

A bi-polar armature of a dynamo-electric machine has its magnetism reversed twice in every rotation. The iron of the core resists this magnetic reversal. The result of this resistance is to shift the axis of magnetization in the direction of rotation. The angle through which the axis has thereby been shifted is called the *angle of lag*. This term, *angle of lag*, is sometimes incorrectly applied so as to include a similar result produced by the magnetization due to the armature current itself. It is this latter action which, in armatures with soft iron cores, is the main cause of the angle of lead.

*Angle of Lead.*—The angular deviation from the normal position which must be given to the collecting brushes on the commutator cylinder of a dynamo-electric machine, in order to avoid destructive burning.

The necessity for giving the collecting brushes a lead, arises both from the magnetic lag, and the distortion of the field of the machine by the magnetization of the armature current. The angle of lead is, therefore, equal to the sum of the *angle of lag* and the *angular distortion due to the magnetization produced by the armature current.*

*Animal Electricity.*—Electricity produced during life in the bodies of certain animals, such as the Torpedo, the Gymnotus, and the Silurus.

Some of these animals, when of full size, are able to give very severe shocks, and use this curious power as a means of defence against their enemies.

All animals probably produce electricity. If the spinal cord of a recently killed frog be brought into contact with the muscles of the thigh, a contraction will ensue (Matteucci). The nerve and muscle of a frog, connected by a water contact with a sufficiently delicate galvanometer, show the presence of a current that may last several hours. Du Bois-Reymond showed that the *ends* of a section of muscular fibres are negative, and their *sides* positive, and has obtained a current by suitably connecting them.

All muscular contractions apparently produce electric currents.

*Anion.*—The electro-negative radical of a molecule.

Literally, the term *ion* signifies a group of wandering atoms. An *anion* is that group of atoms of an electrically decomposed or *electrolysed* molecule which appears at the *anode*.

As the anode is connected with the electro-positive terminal of a battery or source, the *anion is the electro-negative radical or group of atoms, and therefore appears at the electro-positive terminal.* A kathion, or electro-positive radical, appears at the kathode, which is connected with the electro-negative terminal of the battery. Oxygen and chlorine are anions. Hydrogen and the metals are kathions.

*Anisotropic Conductor.*—A conductor which, though homogeneous in structure like crystalline bodies, has different physical properties in different directions, just as crystals have different properties in the direction of the different crystalline axes.

Anisotropic conductors possess different powers of electric conduction in different directions. They differ in this respect from *isotropic conductors*.

*Anode.*—The conductor or plate of a decomposition cell connected with the positive terminal of a battery, or other electrical source.

That terminal of an electric source *out of which* the current flows into the liquid of a decomposition cell or voltameter is called the *anode*. That terminal of an electric source into which the current flows *from* a decomposition cell or voltameter is called the *kathode*.

The anode is connected with the carbon or positive terminal of a voltaic battery, and the kathode with the zinc, or negative terminal. Therefore the word anode has been used to signify the positive terminal of an electric source, and kathode the negative terminal, and in this sense is employed generally in electro therapeutics. It is preferable, however, to restrict the words anode and kathode to those terminals of a source at which electrolysis is taking place.

The terms anode and kathode in reality refer to the electro-receptive devices through which the current flows. Since it is assumed that the current flows out of a source from its positive pole or terminal, and back to the source at its negative pole or terminal, that pole of any device connected with the positive pole of a source is the part by or at which the current enters, and that connected with the negative pole, the part at which it leaves. Hence, probably, the change in the use of the words already referred to.

Since the *anion*, or the *electro negative* radical, appears at the *anode*, it is the anode of an *electro-plating bath*, or the plate connected with the positive terminal of the source that is dissolved.

When the term *anode* was first proposed by Faraday, voltaic batteries were the only available electric source, and *the term referred only to the positive terminal of a voltaic battery when placed in an electrolyte.*

*Anodic Opening Contraction.*—The muscular contraction observed on the opening of a voltaic circuit, the anode of which is placed over a nerve, and the kathode at some other part of the body.

This term is generally written A. O. C. When the anode is placed over a nerve and a weak current is employed, if the circuit be kept closed for a few minutes, it will be noticed that, on opening, the contraction will be much greater than if it had been opened after being closed for only a few seconds. The effect of the A. O. C. therefore depends not only on the current strength but also on the time during which the current has passed through the nerve.

*Annunciator, Electro-Magnetic.*—An electric device for automatically indicating the places at which one or more electric contacts have been closed.

Annunciators are employed for a variety of purposes. In hotels they are used for indicating the number of a room the occupant of which desires some service which he signifies by pushing a button, thus closing an electric circuit. This is indicated or announced on the annuciator by the falling of a *drop* on which is printed a number corresponding with the room, and the ringing of a bell to notify the attendant. The number is released by the action of the armature of an electro-magnet. The drops are replaced in their former position by some mechanical device operated by the hand. In the place of a drop a needle is sometimes used, which points to the number signalling, by the attraction of the armature of an electro-magnet.

Annunciators for houses, burglar-alarms, fire-alarms, elevators, etc., are of the same general construction.

## THE PROPOSED ADAMS ELEVATED ELECTRIC RAILWAY SYSTEM IN CHICAGO.

Like all cities whose population is spread over a wide area, Chicago, has for a long time experienced the want of a rapid transit system. It is true that it possesses even now a system of cable and horse cars probably not inferior to that of any other city of equal size, but the speed obtainable with these, even under the best conditions, does not satisfy the wants of he large majority who live at a distance from their place of occupation, and those also whose business requires a quick method of reaching the various parts of the city.

It is obvious that to obtain the desired speed some other method than the surface railway must be adopted, and with the great cost of an underground railway to be contented with, an elevated road is held to be at present the only solution of the problem.

Among those who have been prominent in agitating such a system for the city of Chicago is Mr. J. W. Adams, who has devoted a large share of his attention to the subject, and has elaborated a plan of construction and operation for such a road which cannot fail to attract the attention of electrical engineers.

The plan proposed by the Adams Company contemplates the erection of a single track, single column elevated railway, so as to present as little obstruction as possible to traffic and light in the streets, and the operation of the road by electricity, thus at once removing one of the principal objections to the elevated railway.

It is designed to effect the rapid and effective handling of passengers by frequent and rapidly moving single cars, and by confining entrance and exit to the opposite sides of the rear platform in charge of a gate man. The use of the single car instead of a train allows of a great reduction in time required in starting from rest to full speed, as well as in stopping at stations, so that an average speed of 20 miles per hour is confidently looked for as practical in this system.

The cars will be operated continuously in the same direction on a loop 20 miles in length, and at a distance apart of 750 feet, which is equivalent to a headway of 20¼ seconds; this is considered perfectly practicable with single car units, and with the special track brakes to be employed, so that 140 cars would be in continuous operation on the circle.

The proposed construction of the elevated structure and the cars will be readily understood from the accompanying engravings.

The columns supporting the superstructure are about 14 feet in height in the clear, and set 40 feet apart, and their dimensions are 15 x 18 inches; they are set in concrete about 8 feet deep in the ground. The girders forming the superstruction are 3′ 8″ in height by 2′ 6″ in extreme width. The strength of the whole structure is such as to sustain a moving load of 20 tons per car including dead and live loads, and 25 per cent. added to the strains derived from the above stated loads, the sections of the main girders being proportioned accordingly. This construction has been figured on the basis of carrying a maximum capacity of 279,000 passengers per day. Each car will be provided with two 4′ 6″ drive wheels, each of which is rigidly connected to a 2 foot pilot wheel, all being made of paper. These two wheels are supported, and both swivel on the same turn-table, and adapt themselves not only to the curves, but to the slightest irregularities of the track, making the movement of the car very easy. The rail employed is of special design, having the tongue space in the center and is rolled for this purpose, and the wheel is constructed with the flange in the centre.

Our readers will, of course, be particularly interested in the electrical arrangements to be adopted. These have been under consideration for some time by Mr. Frank B. Rae, the electrician and engineer of the Detroit Electrical Works, who has been retained as consulting electrical engineer to the road.

It is proposed to equip the cars with a double field motor having two armatures and gearing, by bevelled pinion, directly to the large wheel of the truck, as shown in the plan, Fig. 3. By this construction, the power is applied equally to both sides of the wheel and end thrust upon the bearings is entirely eliminated. The electrical horse power of the motor will be normally 50 h. p., the motor being designed to develop for a short time at least 75 h. p. The ratio of reduction by the gearing will be 9 to 1 and the maximum velocity of the armatures at a car speed of 25 miles per hour will be 1,400 revolutions per minute. By the use of leatheroid and raw hide pinions upon the motor shafts and by the use of paper wheels, the noise will be reduced to a minimum.

In considering a system of 20 miles of track, the maximum number of cars that can be operated practically is determined largely by the number of stops that will be made by each car, for the reason that the time required to raise the car from its position of rest to full speed depends upon the power available to overcome inertia and this is limited to the capacity of the motor. The weight of the loaded car is taken at 20 tons and the extreme maximum power of the motor for a few seconds, when it is just reaching the maximum speed of 25 miles per hour, is 70 h. p.

In the determination of the copper required to supply power as above to 212 cars, on a basis of 1 stop in 3, it is thought that the maximum draught cannot exceed that required by two-thirds the total number of cars, each taking the average number of horse-power which is required to raise it to a speed of 25 miles per hour from rest, so that the maximum horse-power equals $\frac{2}{3} \times 212 \times 36$, or, 5088 at the wheel axle. Allowing 80 per cent. efficiency in gearing, 80 per cent. efficiency of motors and 90 per cent. in conductors, this figure becomes 8,833 electrical h. p. delivered to feeders. This would call for a weight of 2,253,450 lbs. of copper, in order that the loss shall not exceed 10 per cent. This loss is deemed both practical and economical. Reducing this copper to cost per mile, we have $\frac{2{,}253{,}460}{20} = 112{,}673$ lbs., which at the present market price of 19.75 cents per lb. amounts to $22,243 per mile exclusive of erection.

The station electrical equipment would consist of 20 dynamo machines, having a capacity of 500 h. p. each, aggregating 10,000 h. p., and driven in banks of five machines from triple expansion engines of 2,500 h. p. each, with a reserve capacity of 10 to 20 per cent. above this. Each of the dynamo machines would be connected to the engines through a countershaft and clutch pulleys and so arranged mechanically and electrically that any single unit of 500 h. p. might be connected or disconnected at will; thus the number of dynamo machines operated at any time may be only that required for the service at the time.

Each car is to be lighted with incandescent lamps as follows: 1 head light, 1 rear red light, 1 rear platform light, and 12 inside lights; total 15 lamps. Total for 212 cars, 3,180 lamps.

Each station is designed to have 10 lamps. This would give, total for 10 stations, 1,050; cars, 3,180; total, 4,230 lamps. This would call upon the power plant for additional 425 h. p. when all are in use, taking on an average 10 lights per mechanical horse-power.

As indicated above, the engines to be employed would be of 2,500 h. p. of the compound condensing type, consuming, say, 3 lbs. of low grade coal per horse-power per hour. The station is to be situated near water, so that no cost will be entailed for water. The price of slack coal at Chicago is about $2.00 per ton, delivered.

The central station expenses per day of 18 hours, with an average load 8,000 h. p. are assumed to be as follows:

| | |
|---|---|
| Coal | $432.00 |
| 3 engineers at $4.00 | 12.00 |
| 3 engineers at $3.00 | 9.00 |
| 4 firemen at $2.00 | 8.00 |
| 2 electricians at $4.00 | 8.00 |
| 2 asst. electricians at $3.00 | 6.00 |
| Oil, waste, etc | 10.00 |
| Total | $485.00 |

It will, of course, be understood that these electrical estimates are merely preliminary in their nature and will no doubt be subject to more or less modification when the details to be adopted are thoroughly worked out. The project is certainly a feasible one and it is to be hoped that Chicago will afford the opportunity of demonstrating the undoubted economy which can be effected by electric traction.—*Electrical Engineer.*

◆

The plan of extinguishing fire by electricity has been successfully introduced by Mr. H. Lufkin, and if it is perfected as promised will no doubt be a popular system among mill and shop owners. He proposes to modify the present system of automatic sprinklers by the use of a motor and pump and a complete system of sprinkler piping. On each floor, or in any number of places on the floor, are placed in convenient positions push buttons for the starting of the motor and pump and the opening of any valve required. The complete and instantaneous control of masses of water thus gained, and the ability to localize their flow, suggest possibilities of fire extinction which will materially increase its ease and certainty.—*Electrical, Mechanical and Milling News.*

[It is exceedingly gratifying to read the above and see that at last a plan has been formed whereby electricity may be employed to extinguish fires. So much has been said lately of fires which have been started or thought to have been started by the electric light wires, that an invention like the above will be warmly received not only as a means of saving property but of dispelling prejudice and correcting erroneous opinions in regard to the safety of the electric light.—ED.]

◆

## AN AGE OF STEEL AND CLAY.*

Long ago, architects recognized that the tombs, the monuments, the temples that are left to us by people long passed out of history, are a sure indication of the habits, manners, customs, religion and the arts of the people who built them, as adapted to the material obtainable. Moreover, these buildings, often magnificent, are but the enlargement in a more permanent material of the homes and the tombs of the prominent citizens, and even of the huts of the common people. The columns of the great temples on the Nile are often but an imitation in stone of bundles of papyrus reeds, and the entire temple shows its origin in a house built of these reeds and clay. Here was at first an age of reeds and unburned clay, and later, as civilization advanced and the nation became powerful, and the government more thoroughly organized, there was an age of stone. Like the old subdivisions of the ethnologist, an age of stone, rude or polished; an age of bronze and an age of iron, which were reproduced over and over again by different people, according to the state of civilization; so the different ages of building—such as the age of

---

* A paper by Mr. W. L. B. Jenney, read before the Chicago Architectural Sketch Club, and published in *The Inland Architect.*

reeds, of clay (unburned and burned), the age of stone and the age of iron have appeared and held sway for more or less centuries, influenced by the environment. The age of reeds still exists in China and among the Malays, and among many savage tribes. The same is true of unburned clay. The age of bricks existed in Chaldea and Assyria, where the broad alluvial plains furnished abundance of clay, while all other building materials were difficult to obtain. So long did these nations exist in a high state of civilization that they invented most of the forms of brick and methods of brick construction known to-day; the unburned brick of clay and straw, the kiln-burned brick of numerous forms, enamelled brick, plain and decorated and of many colours. The old stories that the round arch was of Etruscan invention, and pointed-arch Gothic of the Middle Ages, is here given the lie. Both of these arches are found built in brick with radial joints in the valley of the Euphrates and the Tigris, dating some twenty centuries before Christ, some of them in beauful figured enamelled brick.

The age of stone existed in all its perfection in Central Europe in the Middle Ages. There stone was used in the great cathedrals, with all the skill and all the knowledge that has ever been applied to similar stone construction. The most careful analysis of the construction of such great cathedrals as Rheims, Amiens and Rouen develops a knowledge of the arch and the pier that the architects of to-day could not excel. The entire interior is of cut stone. The arch ribs carry a stone ceiling. The thrusts are taken by an elaborate system of graceful flying buttresses. The walls reduced to piers between great windows filled with painted glass. The least amount of stone consistent with stability; and yet the thirteenth-century work is in good preservation to-day, magnificent monuments illustrating the science and the art of the age.

This age of stone passed away and a more complex age appeared: an age of stone, brick and wood, cheap and quickly constructed, made necessary by the advance of civilization, the increase of commerce and manufactures and the rapid growth of the cities. Brick walls sometimes faced with stone, wooden joists (interior posts of wood or iron), columns in the street fronts of cast-iron. These buildings with their wooden joists, stud partitions and wooden lathing were combustible, and great fires often occurred, at times destroying entire cities and causing great losses. Something more stable was necessary. Iron had long been in partial use. The iron industries were extending, new mines opened, new furnaces and rolling mills established. The demand for structural iron increasing, the I-beam was invented and recognized as the most economical shape for floor joists and girders. Iron, although classed as an incombustible material, is nevertheless, if unprotected, destroyed by the heat of a burning stock of goods. The early fireproof buildings were floored with brick or concrete arches between I-beams. These arches were heavy and left a ceiling not pleasing to the eye beside the lower flanges of the beams, and the columns were not protected. Progress was slow, and but few fireproof buildings were erected in this country.

The hollow terra-cotta fireclay arch was invented—strong, light and of less cost than the old methods, and more effective. With this material it was easy to entirely cover the I-beam and form a flat ceiling that only required plastering and to protect the columns, for it could be readily moulded into the shapes most convenient for each purpose. We then entered upon an age of iron. All important public, and some private buildings were of masonry or of iron backed with masonry. The interior columns, girders and beams of iron; the floors and partitions of hollow fireclay tile. One step more and in the outside walls iron columns inclosed in masonry took the place of the old masonry pier. This was first introduced extensively in the Home Insurance building in New York.

Steel had been long known, but was too costly for building purposes. The Bessemer process had changed the railway rails from iron to steel, and Carnegie rolled some I-beams of steel and sent them with his compliments to be used in the Home Insurance building, instead of iron. This only about four years ago. The advantages of steel were soon recognized. The tensile strength of good, mild steel as compared with iron is 20 to 25 per cent. more, or 60,000 to 64,000 pounds per square inch for steel and 48,000 to 50,000 for iron. Hence steel construction is lighter than iron, and as the price per pound is the same, there is a large saving in cost. Hence as a natural consequence steel rapidly took the place of iron and we entered upon an age of steel, our important buildings becoming literally and completely a steel construction fireproofed. The masonry reduced to the very minimum, not only carrying no weight, but being itself carried by lintels of steel from column to column over each window, as in the Home Insurance building, the Tacoma and the Leiter buildings, the Rand-McNally building, etc., all in Chicago. The steel is only covered by thin terra-cotta, brick or stone. As an immediate consequence of this method of construction, our Chicago buildings rose rapidly from six storeys to sixteen, for the lightness of this construction enabled the architects to find room on Chicago's soft compressible clay for their footings. Steel has now become such an all-important factor in the construction, not only of all our important buildings, but also of all the navies of the world, of the railways, their rails, bridges, stations, rolling stock, etc., that we may fairly claim that steel is to-day an important element of our civilization, rendering possible and profitable what would otherwise be quite impracticable, so that I hope to be able to make interesting a brief account of the manufacture of constructional steel, such as has so suddenly burst from an unknown industry but a few years ago into such universal use to-day. The use of steel in building construction is increasing faster even than the means of manufacture. To-day in Chicago it is impossible to obtain steel beams as rapidly as they are wanted, and many of our buildings are badly delayed. As well as one can judge, the demands for the coming year will be beyond the present output of the mills.

Structural steel is a special kind that experience shows to be best adapted to constructional purposes. It contains a little more carbon than iron, and is known as mild steel. Speaking broadly, wrought iron contains 0·00 to 0·10 carbon; structural steel contains 0.12 to 0.15, about ⅛ of 1 per cent.; high grade steel for tools, machinery, etc., contains 0·18 to 1·15; pig-iron contains 2 per cent. to 5 per cent., or even 6 per cent. Most of the structural steel in use is made by either the Bessemer process or the open-hearth process. Rails and beams in large part are made by the Bessemer process, while boiler and armour plates are made by the open-hearth process, though some beam mills use the open-hearth process, which is becoming cheaper by the ability to use cheaper pig.

It is necessary that the architect should be certain that he obtains the quality of steel upon which his calculations are based. His specifications are substantially as follows in the essential particulars:—From each blow of the converter, or from each charge of the furnace, an ingot shall be cast and rolled into test bars, which shall be pulled and the test sheets sent to the architect with each shipment. The tests shall be as follows:—The elastic limit not less than 3,200 lbs. per square inch. The elongation to be not less than 22 per cent. For all plates, angles and Z bars there shall be in addition to the above a quench test. The bar to be heated to cherry red and plunged into water at 82 degs. Fahrenheit, and then bent cold over a bar of diameter equal to the thickness of the bar to be tested. This bending to be made without any signs of fracture. After the foregoing tests have been made and the metal has been accepted, the rolled material shall be examined for surface defects. All beams, plates, angles, Z shapes or other material shall be free from any injurious surface defects, and shall be straight and true and free from any twisting. All rivetted work shall be put together with hot steel rivets of superior quality, such as are used for steam-boiler work. They shall bend cold on themselves without showing any signs of cracks. All rivetted work shall be true and straight and free from any injurious defects. All columns shall be straight and free from any twist. The seats or bearings of all columns shall be true and square, so that the column shall stand plumb with an even bearing over the entire surface of the connection. Should it be necessary to put in any filling, said filling shall be of plate steel, and shaped to fit exactly, and to bring the column plumb and to the proper level. No material that does not fill these specifications will be accepted.

Structural steel is by no means confined to beams: it includes also plates, angles, Z's and other shapes used for making steel columns, plate girders, etc. The steel column is coming into general use in our new buildings. Only a year ago it was an open question which should be used, the cast-iron columns or the rolled and rivetted steel column. Our specifications for cast-iron columns demanded that from each heat of the cupola or melting-furnace two or three bars should be cast 1 inch square and 5 feet long and tested by placing on firm supports 4 feet 6 inches apart and loading in the centre with 470 lbs. without breaking. This guarantees the metal to be of sufficient strength so that, as far as metal alone is concerned, cast-iron can be obtained of a thoroughly satisfactory quality. The same is true of the rolled steel. A heavy cast-iron column made with all possible care and skill is liable to hidden defects. Our specifications demand that the column shall be drilled twice at right angles, so that the inspector can measure the thickness in two places, from which he can judge of the balance, but it must often be the case that other parts are deficient on one or more sides. Equally dangerous are spongy or honeycomb-like places caused by the gases blowing through the metal, and also what are called cold-shuts, formed by the metal cooling so much as it runs through the mould as not to thoroughly unite, when from two sides it comes in contact. Sometimes defects from either of these causes are readily discovered, at others they are only detected after the most thorough examination an inspector can make by a careful scrutiny and by tapping all over the column with a light hammer, listening for any change in the sound. Sometimes the sound enables the expert to detect a very serious defect, that otherwise would entirely have escaped his notice. As the cast-iron column can only be examined on the outside, one can never be sure of a perfect column; for this reason, architects only load a cast-iron column with one-eighth of the breaking load, supposing the column to be perfect. The rolled steel column is made up of pieces that are all inspected for metal, and on all sides for surface defects before the column is built up, and then after the column is finished the workmanship is again inspected, so that one can be reasonably sure that a steel column is perfect. Hence the architect feels safe in loading the steel column with one-fourth the breaking load. Hence steel columns weigh much less — only about one-half the weight of cast-iron columns. This reduction in weight is an important item in the construction of tall buildings on our compressible soil, which can only be safely loaded with one and one-half tons per square foot on the foundations, for Chicago soil is soft compressible clay of some 60 feet or more in depth, and any greater load per square foot than one and one-half tons causes too great settlement.

It is a very difficult problem to adjust the foundations to the ground so that the weights shall be uniformly distributed for they practically cover all the ground under our tall buildings and spread out as far as practicable under the sidewalk and into the alley. Hence it is easily understood why it is that the steel column is so generally taking precedence. From this day on it will be the rule, and the cast-iron column will only be used in unimportant structures. In conclusion, the question naturally arises, What is the near future of steel? It is probably greater than anyone would have the courage to foretell. Inventions that permit the use of cheap, easily mined ores; improvements that increase the production of a given plant; the inventions of labor-saving appliances for every branch of the work; the concentration into immense plants carefully planned by skilful engineers, running continually 24 hours a day and 365 days a year, increasing the output and reducing the expense of production; and with all this, a steady improvement in the quality of the metal, will make steel cheaper and more and more popular. Its use will be extended in every direction. Before long every hotel, apartment, house, theatre and school-house will be fireproof. Architects have already commenced to design fireproof dwellings, and ere long they will be the rule rather than the exception. Iron railroad ties were used in India years ago, because of the perishable nature of wood in the tropics. We can certainly look forward to steel railroad ties in the near future and to its use for many purposes not thought of to-day.

The interest that the world is taking in the manufacture of steel is well shown by the recent visit of a large delegation of European metallurgists, who were recently entertained in Chicago. They paid many a compliment to the American manufacturer for his admirable system and the many labour-saving appliances, and his methods for increasing production and they left with their note-books well filled with useful hints.

In buildings of all classes steel will supersede all other material for the construction, but steel alone is insufficient; it must be fireproof, and there must be external walls. For the floors and partitions we have made some recent improvements, principally in making better and lighter material. Something new is required for the exterior—light, durable, fireproof, non-absorbent, easily cleaned by the rain and pleasing in appearance, and susceptible of artistic effects. Such a material is clay. We have long used brick and terra-cotta; they were known to the ancients. Brick is too solid, that is, too heavy, and becomes white with alkaline salts and absorbs dirt. Terra-cotta is mostly hand-pressed, and is too costly. We want a terra-cotta made rapidly by machinery at low price, its surface dull-glazed, impervious to moisture, hard-baked, uniform in quality and colour, using handwork for the few carved pieces. There is a great plant now nearly ready to commence operations at the Stickney tract in the south-west part of the city, out on the prairie, that promises to give us just what we require for the cheaper portions. They already have two kilns each, 672 feet long, of the tunnel pattern. They are very ingenious. The material to be burned is piled on steel cars, fireproofed. The car enters the kiln tunnel on a railroad track, and when it leaves the tunnel at the other end the bricks or terra-cotta, are burned and cooled and are ready for shipment.

With cheap steel of a very superior quality, and a light dull-glazed terra-cotta, and a strong light fireproofing, we are ready to build as never before—light, strong and at a reasonable price, within reach of everyone that can afford to build at all; and we enter upon a new age—an age of steel and burnt clay.—*Builders' Reporter and Engineering Times.*

◆

## CENTRIFUGAL ACTION OF AIR.

BY GEO. M. HOPKINS.

That air has sufficient mass to enable it when set in motion to do work is shown by every whirlwind, by the action of the windmill, by the sailing of vessels, and in other ways. The grandest example of the centrifugal action of air is furnished by some of the movements of the entire atmospheric envelope of the earth; the upward currents at and in the vicinity of the equator, the downward movement of the air at the poles, and the winds blowing along the earth's surface from the poles toward the equator are due in part at least to centrifugal force. Any body revolving in air furnishes a partial illustration of this principle, the defect in the illustration being the absence of a force to hold the same body of air always in contact with the revolving body.

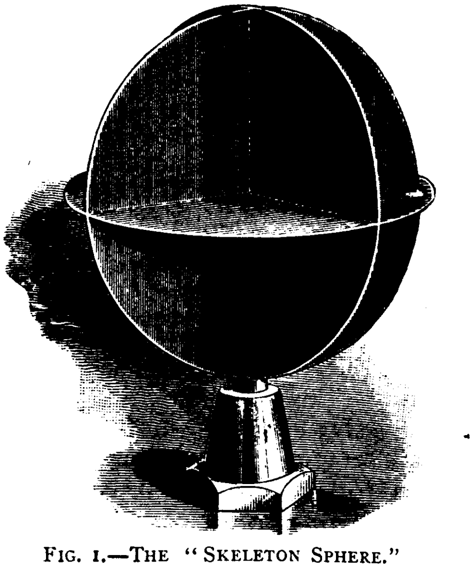


FIG. 1.—THE "SKELETON SPHERE."

A very simple and effective piece of apparatus applied to the whirling table for showing the effect of centrifugal force on air was described some time since in a foreign scientific journal. The writer has applied this apparatus to the scientific top (already described in these columns), in the manner fully illustrated by Fig. 1. The construction of the attachment is shown in Fig. 2, and Fig. 3 shows the direction of the air currents.

The apparatus consists of a metal tube loosely fitted to the stem of the top and provided at its upper end with a tin disk four inches in diameter, with four quadrants of the same material attached to the disk and tube below the disk, and a similar arrangement of quadrants above the disk, thus practically forming a skeleton sphere—if such an expression may be used—of two vertical circular disks intersecting each other at the axis of rotation, these two disks being intersected at the equator by another at right angles to the axis.

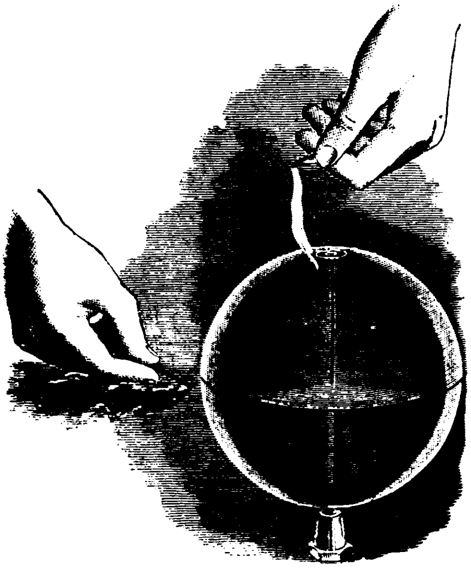


FIG. 2.—AIR CURRENTS SHOWN BY FLAME AND SMOKE.

The top being in rapid motion, the apparatus is placed upon the stem, and being revolved at the same rate as the top, it throws out air at the equator which is continually replaced by air drawn in at the poles. The direction of the air currents is clearly shown by holding a lighted wax taper near the apparatus at the poles, and at the equator, as shown in Fig. 2, or by creating a smoke in the vicinity of the top.

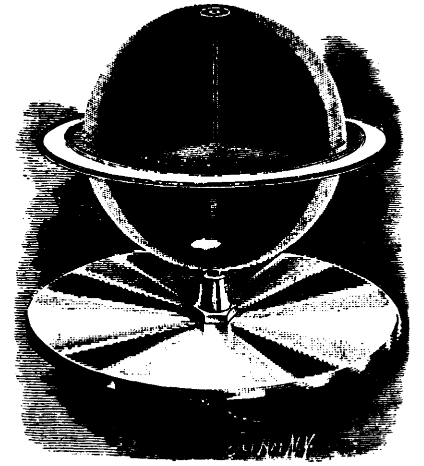


FIG. 3.—PAPER RING SUPPORTED BY AIR.

A paper ring, $\frac{1}{2}$ inch or $\frac{3}{4}$ inch wide, and $\frac{1}{4}$ inch larger in internal diameter than the sphere, is supported by the outrushing air, in a plane nearly coinciding with the equator. If displaced and released, it immediately returns to its original position.

Professor W. C. Peckham, of Brooklyn, who has been experimenting with a large sphere of this kind, thinks that the trade winds could be fairly illustrated by the apparatus, provided it could be inclosed, so as to cause the same body of air to circulate continually from pole to equator, and in the reverse direction.—*Scientific American.*

## BACILLUS OF TUBERCULOSIS.

It is well known that infectious diseases, such as consumption and cholera, have a parasitic origin, and that each one of them has its characteristic micro-organism. In 1878 Dr. Koch published his "Untersuchung ueber die Aetiologie der Wundinfectionskrankheiten," which embodied the results of his investigations in this field of research and formed the basis of future study, the result of which was the discovery of the bacillus of tuberculosis. The course followed by Dr. Koch has been so fully explained in former issues of the SCIENTIFIC AMERICAN that it seems unnecessary to treat the subject again in detail, but we publish to-day two excellent cuts, for which we are indebted to the *Illustrirte Zeitung*, showing the bacilli alone and as they are found in the tubercles.

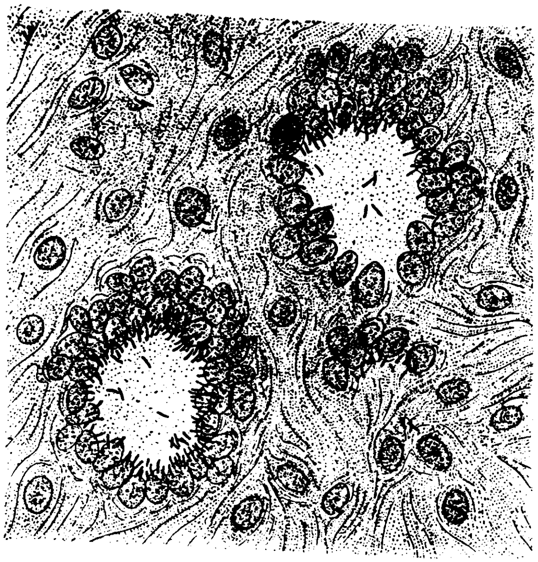


FIG. 1.—SECTION THROUGH TUBERCLES OF THE LUNGS, SHOWING TWO LARGE CELLS WITH NUMEROUS BACILLI.

The specimen having been colored, the bacilli appear as dark dashes. Magnified 900 times.

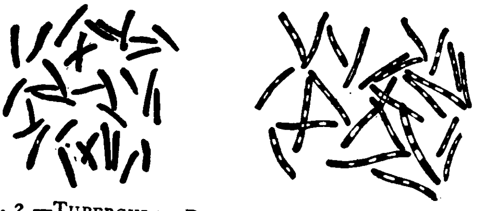


FIG. 2.—TUBERCULAR BACILLI MAGNIFIED 2,000 TIMES.

At the left, bacilli free from spores. At the right, bacilli with colorless places which are supposed to be spores.

Dr. Koch's methods, which have been so strikingly confirmed by his work, have opened new fields in the science of bacteriology, and the results of his work have been felt in every department of medicine.—*Scientific American.*

---

According to Herr Japing, the hourly rate of water falling over Niagara Falls is 100,000,000 tons, representing 16,100,000 horse power; and the total daily production of coal in the world would just about suffice to pump the water back again.

## GOOD DRAUGHTSMEN.

Draughtsmen worthy of the name seem to be a very scarce commodity in the engineering market just now, if the frequent applications of employers to this office be taken as an index to the trouble they have in finding men to suit them, says the *Engineering News*. One bridge engineer said recently that out of eighty-odd answers to an advertisement for a bridge draughtsman, he did not find one that was worth employing. Even a satisfactory "tracer" is not easy to discover, as we know from our own experience. The trouble seems to be that too many so-called draughtsmen think that the art begins and ends in handling a drawing pen and in inking-in a pencil plan practically made by some one else. They are exceedingly limited in their knowledge of mechanics, and know little or nothing of structural details; in other words, they are neither well trained nor thorough in their work, and cannot be left to their own resources for a moment.

There was a time when imported German labor of this class met all demands, and usually met it well; but for some reason that we cannot explain the supply has lately fallen off, and the more valuable men already here are secure in permanent employ. The German technical schools devote much time to the thorough teaching of drawing as an essential adjunct of mechanical and civil engineering, and, as a rule, devote nearer twelve than four years to the careful training of pupils fitting themselves for these professions. While we would not encourage young men to adopt the drudgery of draughting for a life occupation, it is, nevertheless, one of the best schools for the mechanical engineer that can be chosen, provided that he goes at this work well trained in the principles and fundamental laws of mechanics and always works with the combined purpose of making a good machine as well as a good drawing. The same remark applies to bridge draughtsmen and to those engaged in the design of metallic structures of all kinds.

In the time now allotted to "scientific training" in the majority of our technical schools, probably all the time devoted to draughting is such as can be safely spared from other work. But in too many of our schools a little less time devoted to pure mathematics, depending practically upon a retentive memory for any future usefulness, and more time devoted to fundamental laws and to the training of the eye, the hand and the mind combined, would result in a graduate more useful than is usually the case to himself and to his employers. The young man leaving his school must necessarily be an assistant until he has had time to gather that worldly wisdom and experience that will alone fit him to successfully enact the role of a creator or leader. But the better and more thorough the previous training of the graduate, the better assistant will he make and the more rapid will be his advancement. It pays the student therefore, to devote more time to his training, and pays in a proportion that altogether exceeds that of the extra years involved in this training.

Notwithstanding certain prejudices against this occupation, a really good draughtsman in the office of a bridge works or a machine shop, one who thoroughly understands his business in all its details, commands a much better salary than the average engineer on a railroad. And if he is an exceptionally experienced and good man, with individual push well developed, more doors are probably open to his substantial advance than is the case with an equally good man on railroad work. In any event, at the present time there is an army of idle men who call themselves draughtsmen, and will work for $60 to $75 per month, while the really well paid higher positions go begging for the lack of some one to fill them.—*Tradesman.*

## CRYSTALLINE GLASS.

Few trade secrets have been kept so well from the knowledge of the general public as the process of producing the above mentioned species of decorative glass. It is said to be the invention of a French engineer, who called it "vierre gievre," or frozen glass. In the United States, where its manufacture has been brought to a much greater state of perfection than in any other country, it is known under the more common names of chipped or chrystalline glass, and the operation of manufacture "glass chipping." It has a remarkable appearance, being covered with fern-like figures, no two of which exactly resemble each other, differing in both shape and form. To those unacquainted with the method of producing this glass—and there are very few that have any conception of how it is made—the process of manufacturing is very puzzling.

This method of ornamenting glass is so simple that most people, when they have it first explained to them, will hardly believe that such simple means can produce such marvelous results. It is done by covering glass with glue, which adheres to the glass, and when the glue dries it shrinks and draws with it pieces of the glass or chips of glass.

The first necessity in carrying out this process is to have the glass which is to be ornamented ground either by means of the sand blast or by the more troublesome means of grinding by hand. This is done by rubbing a stone with a flat side over the glass till it has lost its polish and become translucent. A thin layer of emery kept wet with water will facilitate the grinding, which should be as coarse as possible, and for which reason grinding done by the sand blast is preferable. After the glass has been ground it should be kept scrupulously clean. Great care should be exercised that the surface is not touched by the hands. Any trace of grease is very apt to make the results uncertain. If the glass has, however, become contaminated, it may be cleaned with very strong ammonia,although glass which it has been necessary to clean is apt to be rather unreliable.

When everything is ready the glass is placed in a room where it is intended to carry on the process, accurately leveled, and flewed with a solution made as follows:

Good glue is placed in sufficient water to cover it and allowed to soak for twenty-four hours. If the water is absorbed during the soaking, more may be added. It is then liquefied over a water bath and is then ready to use.

In practice it makes considerable difference which kind of glue is used. By repeated experiments it has been found that Irish glue is the best for the purpose.

A wide brush is dipped in the glue and applied to the glass. The coating should be a thick one, otherwise it will not be strong enough to do the work required. When the plates are coated they may be placed in racks, and the temperature of the room raised to 95 or 100 degrees F. They are permitted to remain at this temperature till they are perfectly dry, which will be in from ten to twenty hours.

It is at this stage that the uncertain character of glue shows itself. Under certain circumstances the glue will begin to crack and rise of itself without any more manipulations, but most generally it will require to have a stream of cold air suddenly strike it. If the plate is perfectly dry at this period, and of sufficient thickness, the top surface of the glass will be torn off with a noise resembling the crack of a toy pistol. Sometimes the pieces of glue will leap two or three inches into the air, and may even fly into the eyes and injure them. To guard against this it is customary for the workmen to wear a pair of spectacles fitted with plain glass. The glue will come off sometimes at the least expected times, notably if the plate with dried glue is being carried from one room to another. Plates which have shown a decided disinclination to chip have manifested a remarkable and unexpected activity and have jumped into the face of the person carrying them in such a manner as to cause him to drop them.

The strength of the glue is something very extraordinary. If the glass has been coated on the hollow or belly side of the glass, the slight leverage thus obtained is almost sure to break it, especially if the glass be single strength. Even plate glass is not unfrequently broken. It might be a rather interesting mathematical calculation to find out the force necessary to separate the surface of glass in this manner on a piece say 48 by 48 inches.

The result of the operation described may be various. It may be either a design resembling ferns of various shapes and sizes, or it may be a circular design, exhibiting narrow, feathery appearances ; or, if unsuitable glue has been used, it may be of a nondescript appearance.

If, after the glue has been applied, but before it has become any more than set, a piece of stout paper, is pressed over it and it is allowed to dry in this way, the glass will have less the appearance of feathers, but will be much coarser and larger pieces will be removed.

The circular design mentioned occurs under the same circumstances as the other, with the exception that it generally is made during cold weather. Sometimes several weeks may run along and nothing but this formation be made.

Some very elegant designs may be produced by submitting the glass once more to the same operation, covering it as before and allowing the glue to chip. This is known by the name of double chip. If the glass was covered with the small circles in the first place, the second time it will have an appearance very much resembling shells, and for this reason this has been called shell chip.

If, instead of using ordinary glass, colored glass is employed, pretty and original effects may be obtained. The glass may be either colored clear through or it may have only a thin coating on one side. In the latter case in some places the entire layer of colored glass will be removed, and in other places only a very little, and will therefore give all the gradations between those two extremes.

Glass which has been treated in this way may be silvered and gilded and thereby be made still more remarkable in appearance.

Extremely elegant effects may be obtained by what is known as "chipping to a line." The design is ground in the glass by the ordinary sand blast process. After the glass has passed through the machine, the protective coating (wax is generally used) is not removed, but is left on to keep the glue off those parts which are not intended to chip. The glue is then applied in a thick layer to the ground portion and the process is carried on as usual.—NICHAULUS T. NELSSON in the *Scientific American.*

◆

## HOW TO DO PLUMBING ECONOMICALLY.

As the facilities for plumbing are now so convenient and complete, any skilful mechanic who can measure correctly and saw off a board to a true pencil mark, can do the plumbing of a dwelling house in a most satisfactory manner. I never learned the trade of a plumber, yet I can do the plumbing of any dwelling as neatly as any boss plumber, and better than such a job is done by the average plumber. A few years ago I erected a country residence, some 20 miles from New York city. I procured an illustrated catalogue from a dealer in plumbing supplies, in which every appliance was neatly illustrated. I then dressed out a pole 16 feet long and about 1 inch square, for my measuring rule. Then I measured the distances accurately with another small pole, where the water pipe was to be placed. As soon as I had learned by the measure how long the first piece of water pipe should be, a mark was made on the measuring rule. In this way I proceeded from the basement to the attic, ascertaining what lengths of pipe would be required, by first getting the exact length with small poles. Every length was indicated distinctly on the measuring rule. When more than one piece was desired of a given length, the number—2, 3 or 4—showed how many pieces must be cut of that length. Then I noted how many elbows, tees, couplings, unions, bibs or faucets, stop-cocks and drip-faucets would be required in the kitchen, bath-room and other stories of the house. All the holes and recesses were made to receive the wooden poles, about the size of a half-inch iron pipe. Care was exercised, when there was a turn in the direction, to make the holes and gains so that the pipe could be screwed together exactly at a right angle, or at an angle of 45°. After I had noted how many pieces of pipe were required, I went to New York city and bargained for my invoice of pipe and fixtures at a store where they cut and fitted pipe by steam-power. The proprietor asked me sixty cents per hour for a man and machine to cut the pipe of the proper lengths and run a thread on each end. Having my long "rule pole," and assisted by the machinist by way of getting every piece exactly the right length, with my assistance, it took the pipe-cutter about one hour and a half to cut and fit the pipe for my house. It cost me one dollar to have all the pieces cut and fitted neatly, so that I had nothing to do (after the pipe was taken to my house) but to smear every joint with white lead and oil, applied as thick as stiff mud, and screw the pieces together. Every joint fitted perfectly water-tight. Two plumbers working by hand, would not have cut and fitted the same pieces of pipe in two days. More than this, when pipe is cut and fitted by machinery, the work is done, ordinarily, with more precision than it can be done by hand.

I purchased half-inch water pipe, which is sufficiently large for ordinary use in any house. The waste pipe should not be less than two inches in the bore. I found it necessary to purchase a pipe tongs of sufficient capacity to fit any size, from half an inch to two inches in diameter. I purchased the "rustless" plain pipe in preference to the galvanized pipe, as the price of the latter is usually about double the price of the rustless. Most of the iron pipe comes in lengths of about sixteen lineal feet, having a thread on each end and a coupling on one end. It may be of interest to some readers to learn that water pipe cut and fitted in any machine shop in the United States, will fit the couplings, elbows, tees, and other fixtures of any other machine shop where pipe is fitted.

## DETECTION OF FLAWS IN METAL.

An instrument for detecting flaws in metal castings and forgings, which is called the schiseophone, has been invented by Captain De Place, of Paris. The apparatus, says the London *Times*, consists of a small pneumatic tapper worked by the hand, and with which the piece of steel or iron to be tested is tapped all over. Connected with the tapper is a telephone, with a microphone interposed in the circuit. Two operators are required—one to apply the tapper, and the other to listen through the telephone to the sounds produced. These operators are in separate apartments, so that the direct sounds of the taps may not disturb the listener, whose province is to detect flaws. The two, however, are in electrical communication; so that the instant the listener hears a false sound, he can signal to his colleague to mark the metal at the point of the last tap. In practice, the listener sits with the telephone to his ear; and so long as the taps are normal he does nothing. Directly a false sound—which is very distinct from the normal sound—is heard, he at once signals for the spot to be marked. By this means he is able not only to detect a flaw, but to localize it. Under the auspices of the Southeastern Railway Company, a demonstration of the schiseophone was given recently by Captain De Place at the Charing Cross Hotel, in the presence of several members of the Ordnance Committee and other government officials. Some samples of steel, wrought iron, and cast iron, which had been specially prepared and privately marked, were tested, in many cases the flaws therein were correctly localized by the instrument. On the other hand, some bars were broken at points where a flaw was indicated, but where the metal proved perfectly sound. Consequently, however ingenious the invention may be, it can hardly yet be called a practical success.

## THEORY AND PRACTICE.

No expression is more common among mechanics than, "The thing is all right in theory, but when it comes to apply it to practice it won't work." The fact is, that if the theory of a thing is all right, and that theory is correctly applied in practice, it will surely work, and when a thing fails to work, either the theory or the practice, or both, are wrong.

When the theory of a thing has been developed as far as it seems possible to develop it, and it seems to stand the test of mathematics and of all the other sciences which can be brought to bear upon it, including that which has its final expression upon the drawing board, and still the machine, or process, when actually tried, fails to work, the temptation is strong, as we well know, to declare that the thing is perfect in theory but that practically it will not work. It is the frequency of such expressions, no doubt, more than anything else, which has created the very general feeling among practical mechanics of distrust, if not contempt, for what they call the "impractical theorizers," and the belief that mere theory is of no account whatever; whereas, as a matter of fact, correct theory has been in the past, is now, and probably will continue to be, of the greatest importance in the development of the science and practice of mechanics.

It is to be considered that practice is by no means perfect, and the "practical man" needs to remember this when disposed to blame theory for the failures otherwise unaccounted for. No one has ever yet seen a perfect shaft, or gear, or screw, and it is not probable that any one ever will, while it is probable that many theories regarding mechanics are much nearer perfection than practice will ever get.

When correct practice is based upon correct theory in the building of any machine, that machine will be correct, and will work correctly, and when the practice is known to be correct, and the machine will not work correctly, then it cannot be correct in theory. Neither a machine nor anything else can be correct in theory and wrong in practice.—*American Machinist.*

## A NOVEL FORM OF FLEXIBLE TUBING.

BY T. K. ALMOND, NEW YORK CITY.

[*Read before the American Society of Mechanical Engineers.*]

It seemed to me at first rather a wild kind of an idea to make a metallic tube which would be quite flexible, and which could be used for conveying illuminating gas. I have, however, after many experiments, succeeded not only in making a flexible tube for such purposes, but also one which will convey gases, steam, or liquids under considerable pressure. This tube has sufficient flexibility for all practical purposes, with the additional advantages of great strength and durability.

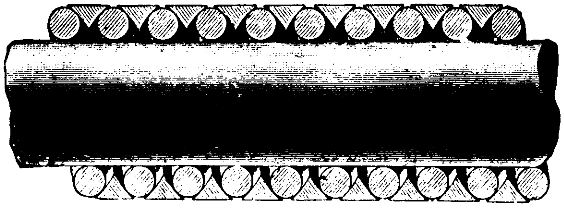


FIG. 1.—TUBE BEFORE THE MANDREL IS WITHDRAWN.

When a tube is formed by coiling a wire around a mandrel, the convolutions may be made to press upon each other with considerable force, and the joint formed at the point of contact of the individual convolutions will be tight in proportion to the amount of pressure exerted. If such a tube be bent, the joints will be broken all around the coils except at one point, and therefore, when bent, it is useless for conveying liquids or gases.

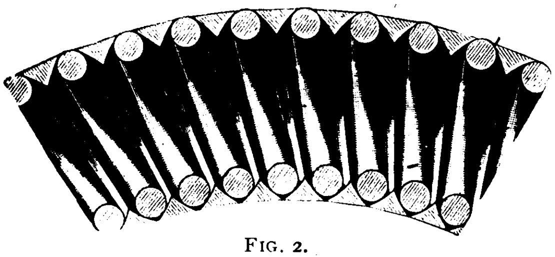


FIG. 2.

Wishing to utilize the peculiar flexibility of spiral spring tubing for the conveyance of gases in cases where a flexible tube is required, I conceived the idea of interposing a triangular-shaped wire between the coils of a round wire, as shown by Fig. 1. When a tube so constructed is bent, the convolutions of the triangular coil adjust themselves to the spaces between the round coils, as shown in Fig. 2. The triangular wire is pressed between the coils of the round wire, during the process of constructing the tube, with sufficient force to spread them apart, so that the contact surfaces are at all times under pressure. The triangular wire serves two purposes—one is to spread the coils apart, so that the pressure will be exerted on the contact surfaces; the other, to fill the irregularly-shaped spaces between the coils of round wire, adjusting itself to the changing form of the spaces due to any given flexion. This pressure brings into play the element of friction to such an extent as partly to destroy the flexibility of the tube, which, when bent, will retain the form given to it. This was an unlooked for and unexpected quality. As the primary object was to obtain a flexible tube, trials were made with wire having a more obtuse angle. Such is shown by Fig. 3. This gave better results, as a more perfect joint was produced with less tension of the inner coil, and the friction became correspondingly less, the result being a tight tube with sufficient flexibility. Fig. 4 shows the shape of the seats into which the round wires are forced by their tension. Reference to Fig. 1 will show that the seat for the inner wire is much more obtuse, and on this account the inner wire will not, under a given tension, be forced into such a seat so tightly as in the sharper V in Fig. 4. It will be seen that the degree of flexibility depends upon the amount of tension put upon the inner coil, or the extent to which the convolutions are forced apart. I have produced a perfectly tight tube with two coils of round wire, in which the outer coil is wound sufficiently tight between the convolutions of the inner coil to spread them apart for the purpose of getting pressure on the joints, substantially the same as with the triangular wire. This makes a very strong tube, but is too bulky for many purposes. Two half-round wires, or even less than half-round, may be used; or the inner wire may be round, and the outer half-round, or much less than half-round. The tube will then be less bulky; and, supposing the outer wire to be considerably less than half-round, the convexity of its surface may be such as to give results similar to the obtuse triangular wire shown in Fig. 4. I have made several tubes in which the contact surfaces of the coils are made to coincide with a circle whose center is the axis of the tube. The joints so formed are practically a series of ball-and-socket joints. Such a tube has smoother outer and inner surfaces than those previously described. A serious objection to such a tube is that the wire changes its shape during the process of coiling, so that the

FIG. 3.

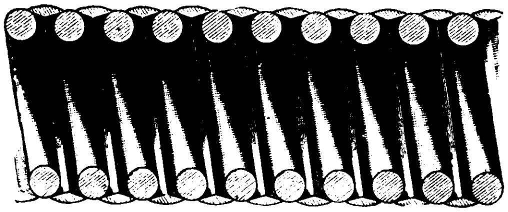


FIG. 4.

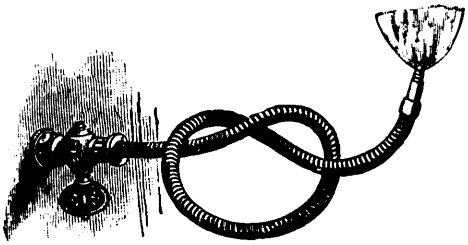


FIG. 5.

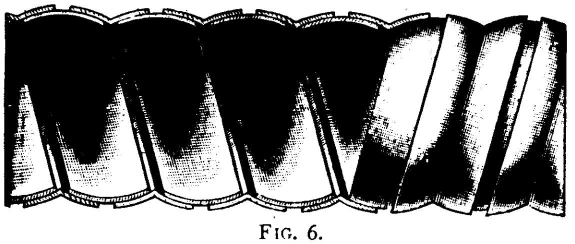
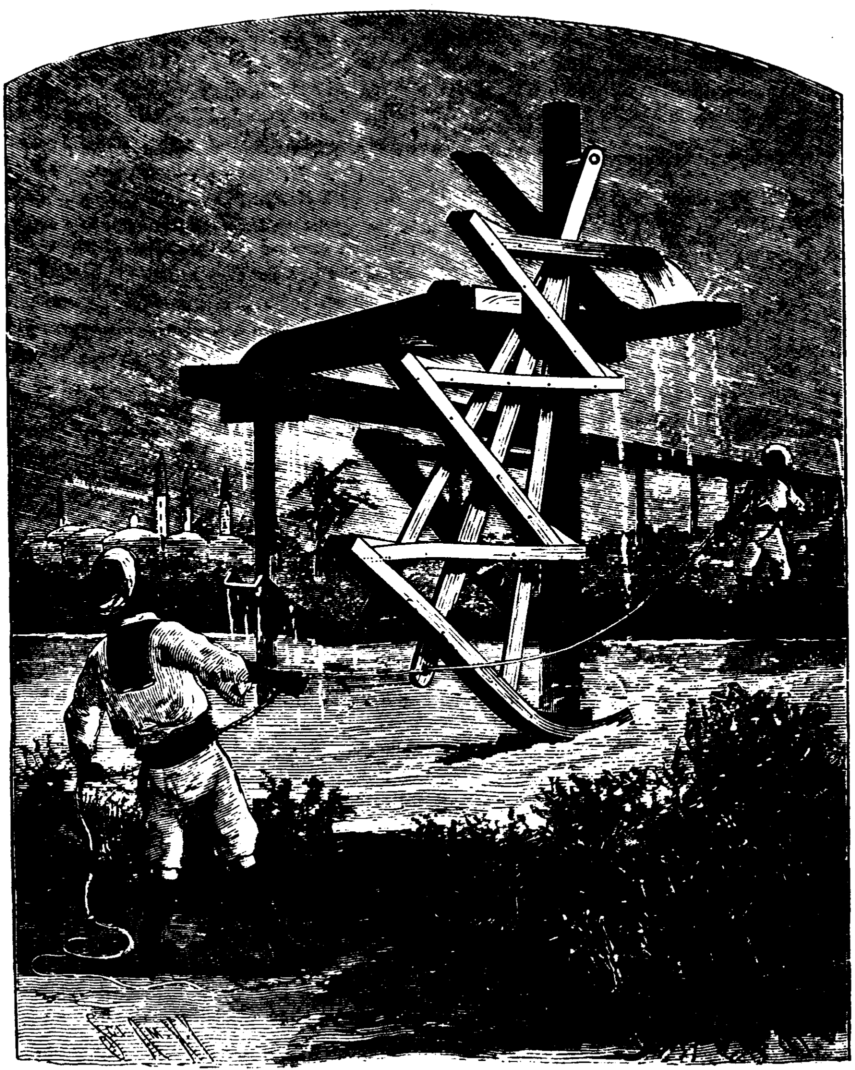


FIG. 6.



Pendulum Water Elevator.

joint surfaces will not make sufficiently complete contact, whereas the forms of wire previously mentioned are of simple construction, and the slight change of form which occurs during the process of coiling will not affect the result.

The extent to which this tubing may be bent without leakage is considerable; a piece of one quarter-inch bore, tied as shown in Fig. 5, has been subjected to a steam pressure of 75 pounds without leakage. The smallest curves of the bent portion corresponded in this case to a circle 2 inches in diameter. I have not yet made any tube larger than five-sixteenths inch bore, but think it possible to make them as large as one inch bore, and strong enough to stand any ordinary steam pressure. For purposes where pressure is not required, the tube may be made of sheet metal, shaped as shown in Fig. 6, which may possibly be made as large as 2 inches in diameter.

◆

## AN ANCIENT WATER ELEVATOR.

In Egypt and other countries where irrigation is practiced to a greater extent than elsewhere, the inventive mind has been alert for centuries, contriving devices of various kinds for elevating water. Some of these are so simple that they must have been obvious, while others show an amount of inventive genius worthy of our own century; in fact, as is well known, the fundamental principles of hydraulics were discovered ages since, and some of the early machines have never been materially changed or improved upon.

The Egyptian shadoof is a form of water elevator that has been in use from time immemorial, not only in Egypt, but almost all over the world. A device fully as simple as this, but not so old, is a gutter, which was made both single and double. It consisted of a trough pivoted at one end above the level of the water, the free end being alternately dipped in the water and raised, so as to cause it to discharge into a sluice leading away from the machine.

The pendulum water elevator shown in the engraving is a curious modification of the swinging gutter. A number of gutters arranged in two series are secured to opposite sides of a swinging frame, each series of gutters being arranged on a zigzag line, and the two series of gutters are oppositely arranged with respect to each other, so that while one end of the lower gutter dips in the water, the lower gutter of the other series discharges into the next gutter above, and a flap valve retains the water while the device is swung in the opposite direction. In this manner the water is advanced step by step at each oscillation, until it is finally discharged into the sluice, which carries it away for use. Each of the gutters, except the first of each series, is provided with a valve, which retains the water as it moves forward and upward.

## SOME RECENT IMPROVEMENTS IN THE CIRCULATION OF WATER IN STEAM BOILERS.*

The question of the best means of producing higher results from the coal consumed in steam boilers is one that at the present time has a special interest for engineers. There is, perhaps, no matter more vitally affecting the advance of scientific improvement, whether it be in the economics of industrialism or the necessities of warfare. From the one to the other, from the humble agricultural engine to the massive machinery of a modern warship, an improvement in this direction means a distinct advance. No question has received greater attention and none more deservedly so. It will be the author's endeavor, while recognizing the efforts and partial success of the past, to point out the direction in which some greater results have been obtained, and will be attained in future.

The controversy that has raged round the merits of forced draught seems to be gradually drawing attention in an indirect manner to the matter which is the subject of this paper. The limits of transmission of heat to the water would seem to have been indicated in the arrangement of modern tubular boilers, and it is now a pretty clearly established fact that the burning out of tube plates and dangerous leakage of tubes in marine boilers is due to the enormous access of heat at one particular point generating steam so unduly as to deprive the metal of the protection afforded by the impinging water. The author is careful to say the limits of transmission by present arrangements, as part of the results to which attention will be drawn are that of the abstraction of a much greater portion of the heat by the water in boilers fitted with the simple device to be described. Quite recently M. Serve has brought out a tube which attempts, and very meritoriously, to deal with the problem on another basis, which is the extention of the metallic heating surface by a ribbed tube, which has shown, under induced draughts, some interesting results. Under forced draught, nevertheless, it is to be feared that it would not offer a serious advance on the result attained with plain tubes.

Under plain or ribbed tubes, under ordinary, induced, or forced draught, however, we are bound to consider the question whether the heat is taken up by the water in a proper degree. There can be but one reply, and that is negative. Of the potential value of coal under combustion in most cases one-half alone is represented in the heat of the water, and making all allowance for heat radiated, there is still a large percentage that is passed over the heating surface, and from which the water derives no benefit.

In a very careful trial of a water tube boiler by Mr. M. Longridge, that gentleman ascertained that from 50 to 51½ per cent. was all the heat that was transferred to the water, while from 13 to 22½ per cent. is lost in products of combustion, etc.; ashes, clinker, and radiation accounting for the remainder.

But on the same boiler, fitted with arrangements which effected a more direct internal circulation, the percentage of transferred heat rose to 68 to 78 per cent.; a more significant change.

Enough has been said to indicate the importance of the subject, and to lead to the immediate consideration of the invention of Mr. Ruffles.

This gentleman, whose experiments the author has had the benefit of closely following, originally conceived the idea of improving the circulation of wet bottom boilers, and more especially those of the Lancashire and Cornish type, and this led the author to a close study of the action of water on metal surfaces exposed to flame, and finally to the conclusion that a steam-bubble in the course of generating does not readily part from the surface from which it takes its birth.

Nature repeats herself in the steam boiler as in the open air, and the law of capillary attraction holds good with a steam-bubble as well as a raindrop. But added to this attraction in the case of the steam-bubble is the resistance of gravity and thus it comes about that each steam-bubble, etc., clings to the metal surface; alternately expanding and contracting until its expansion brings it so much in excess of the retarding forces that it is forced reluctantly to relinquish its hold and rise to the surface of the water.

In just such a manner, since the world began, have the gas-bubbles at the bottom of a pond, slowly warmed into expansion by the sun's transmitted heat, reluctantly quitted the slimy bed of decay from which they generated. The steam-bubble is small in itself, but it covers, nevertheless, an appreciable surface of metal. Let us assume it to be a bubble of a foot square area, and the point the author makes becomes apparent. So long as that bubble, once formed into steam, clings to the metal surface, so long will the transmitted heat be acting on steam and not on water. Now, assuming the large bubble to be maintained in that position for a given length of time, it follows that the action upon it of the transmitted heat will be analogous to that of superheating, and as, furthermore, in actual fact each bubble is enveloped in water, we have this action of superheating taking place under the worst conditions of saturation.

If you will heat water in any receptacle to about a temperature of 140° upwards, and cast a strong light upon any steam bubble visible, you will see with the naked eye that it is constantly expanding and contracting. By observing the bubble under a magnifying glass this will be more apparent.

Here then, the author maintains, is where the lost heat efficiency is used up and wasted. This is what is going on in every steam bubble generated and not immediately detached from the generated surface.

The action and effects of superheating are still somewhat obscure, but some light is thrown on this subject indirectly by the result of these experiments.

The inventor concluded that if these steam bubbles were swept off sideways as promptly as they were formed, the result would be a practical test of this theory that the clinging of each bubble to the metal constitutes a disadvantageous feature. For such a purpose he has designed a very simple means of natural operation. It is only necessary to cover the heated surface, within a very short distance thereof, by a sheet or plate inclined upwards in one direction, in order to give the rising steam bubbles a similar direction, and their action in thus rising in one direction is such as to draw after them a circulation of the water, which thus continuously sweeps over the heating surface. The effects are remarkable, and no matter how or at what angle the heated surfaces are fixed, the same results follow the application of the principle.

In the case of a Galloway tube, it takes the form of an internal socket. On a Cornish flue, it is arranged as a sloping shell or hood. On the locomotive firebox it becomes a series

---

*Paper read before the Civil and Mechanical Engineers' Society.

of louvres. On a tube internally fired, a sleeve formed of another tube sawn partly through at intervals and stretched out takes the proper form, and other arrangements are adapted to special forms of heating surfaces. In all cases the result is the same, and the circulation set up is natural, continuous, remarkable and effective. The author maintains that it is only due to natural laws that it should be so, and several accidental circumstances in ordinary boiler practice point to this conclusion.

The distinct effectiveness of the vertical plates of fireboxes is due to the rapid release of the steam bubbles. In the experiments of Mr. Ruffles this can be clearly seen, and the rush of steam from the vertical front tube plate of a loco firebox is a prominent feature, and is doubtless the cause of many a carelessly designed boiler's priming.

The known, but yet partly unexplained efficiency of the locomotive in evaporation is, the author considers, due very greatly to the continual shaking of the whole machine, whereby the steam particles are released more freely.

In a more moderate sense the marine boiler gains from a similar cause. Mr. R. G. Ruffles is now conducting an experiment to determine this point. The results of the application have been stated to be remarkable and are as follows :—(1.) There is an appreciable increase of heat in the total mass of water in the boiler. (2.) There is a local direction of the heated steam of the steam bubbles and water. (3.) A judicious arrangement of the apparatus will give a great increase of circulating power in any given direction without violent ebullition on the water line. (4.) Priming may be cured thereby.

Particular attention should be given to the adaptation to a locomotive boiler.

This a very interesting arrangement, and can be shown to be extremely effective. The effect of the increased circulation being in the direction of the length of the tubes, the far end of these is really surrounded by hotter water than is usually the case. It can be demonstrated that the effect is beneficial not only upon the water, but on the flame in the tube.

The inventor maintains that the heat being more evenly abstracted from the entire length of the tube, the flame is kept hot to the end of the tube, and is less broken up.

A study of these and other results is extremely instructive to the boiler engineer, and leads one to consider how haphazard is the present method of boiler design, particularly in regard to the internal arrangement of boilers. The author's feeling is that every boiler really requires designing with a distinctive view of its numerous conditions, of fuel, air, draught, method of steam delivery, etc.; and the whole engineering profession would be benefited by a series of careful circulating experiments under visible conditions. This could be attained best in the loco-type boiler, and should include also some experiment on the cause of priming.

One objection may be raised to the application of the system described, on the ground of there being a tendency to scale; but this is met by the fact that the circulating current is too rapid to admit of scale depositing. The sleeve or socket, louvre or sheet, may be trusted to look after itself as to scale upon its surface. As has been shown in the Garret corrugated firebox, the expansion and contraction upon a very moderate inclined surface will prevent scale settling.

One very important detail in the application of the improvement of loco boilers is the diverting of the upward stream of steam from the vertical tube plate, which, in Mr. Ruffles' arrangement, is made to do good work in general circulation.

The difference between the general and even ebullition from the surface of his boiler, and the local and violent ebullition from parts of the ordinary boiler, is very marked.

In demonstration of the fact of the propulsion of the water by this invention, Mr. Ruffles prepared a small loco boiler with removable shields and sleeves. From the smokebox end at the bottom he attached a tube leading to the bottom of the firebox wrapper, and a part of which was made of glass tube. By administering a little bran the flow of water in the tube could be marked. With the improved sleeves, etc., the flow was extremely rapid ; without them it was not perceptible.

To deal with one final objection by anticipation, it may be said that the sleeves in the tubes obstruct the space between, which is valuable for cleaning purposes. The answer is, the less tubes and larger ones will be found to give better results than the present practice. In effect the accumulation of mere heating surface, and the cutting up of the flame into small streams, is only helpless recognition of the difficulty of removing the heat to the water.

As to results the author is diffident about putting forward those attained, on mere experimental apparatus, however carefully constructed, as defining capabilities of the improvement; but he hopes before long to arrange for practical tests to be made under working conditions. As indication, however, it may be mentioned that in an evaporative test of two small experimental boilers of exactly similar proportions, and fired by gas from a common reservoir, the improved boiler showed a gain of over 12 per cent. In temperature the normal gain or advance of one over the other is 15° on the whole body of water.—By Reginald Bolton, in *The American Engineer*.

◆

## HOW TO PRINT PHOTOGRAPHS IN INK.

At a recent meeting of the London and Provincial Photographic Association, a demonstration was given by Mr. L. Warnerke on "Collography." The lecturer expressed his opinion that a wide future is open for photo-mechanical printing. There was a general belief that special appliances were necessary, and that generally all processes of this kind were troublesome to work. The demand for cheapness and quickness of production had proved detrimental to good work. The process he intended to demonstrate was simple, requiring no special apparatus of any kind, enabling amateurs to produce quickly an unlimited number of copies on ordinary paper, with printer's ink, from photographic negatives. For the purposes of demonstration the lecturer had brought with him several sheets of exposed films in various stages. He proceeded to describe the process. A sheet of vegetable parchment, having a film of gelatine on its surface, is immersed for three minutes in a bath of bichromate of potash neutralized with ammonia. The sheet is then squeegeed to a glass plate that has previously been cleaned and polished with French chalk. The plate is now left to dry spontaneously. The drying should be completed in about ten hours, when the film will peel off its support. The maximum of sensitiveness would be reached in from two to three days after sensitizing. The object of drying the sheets on glass is to produce a flat surface, thus giving perfectly even contact with the negative. The sensitized film is exposed in an ordinary printing frame. When sufficiently exposed, the image will be quite visible.

An exposure of the back of the film for two or three minutes to diffused light will cement it to the parchment support. The exposed tissue is now placed in water and allowed to remain about two hours until quite colorless; it is then drained and blotted, and the following solution poured over it:

| | |
|---|---|
| Glycerine | 70 parts |
| Ammonia | 3 " |
| Water | 30 " |

After soaking for an hour, the tissue is stretched upon a frame over a block of wood, and rolled up with printer's ink. For this purpose, the lecturer recommended using first a stiff ink, and afterwards a thinner kind. Authorities differed with regard to the materials for thinning the ink. The lecturer said he preferred lard for this purpose. Sufficient rolling having been given to the surface of swelled gelatine, a sheet of paper is placed on it, and an impression can be taken in an ordinary letter copying press. Mr. L. Warnerke, at the conclusion of the demonstration, pulled several proofs from a sheet of prepared tissue, and passed them round. In answer to several questions Mr. Warnerke said he was unable to state the limit of the number of impressions that could be taken from one sheet; he had taken as many as 300 himself. Any paper might be used. It was necessary in printing to lay strips of paper round the inked image to protect the sides of the sheet of paper receiving the impression.—*Scientific American.*

◆

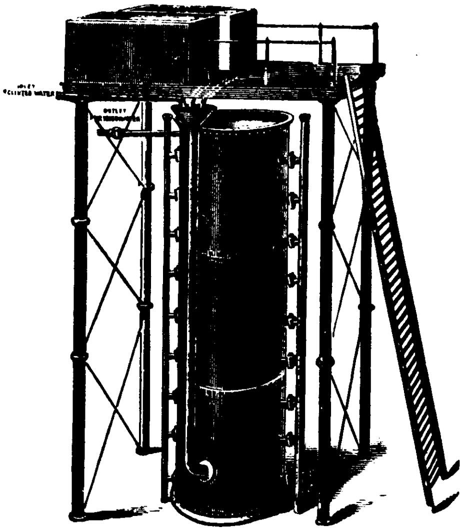
## DETECTING OLIVE OIL, BUTTER AND OLEOMARGARINE.

The reagent employed is a solution of silver nitrate at 25 per 1,000 in ethylic alcohol at 95°. About 12 c.c. of the oil in question and 5 c.c. of the reagent are placed in a test-tube. The tube is then set in a beaker of boiling water, and the changes of color which take place in the liquids are watched through the glass. Unless the oils are perfectly limpid, they must be previously filtered. Olive oils sooner or later take a fine green color, which is lighter in the superior qualities. Pure cotton-seed oil is turned completely black. Oil of earth nuts (*Arachis*) takes first a red-brown color and finally turns green, losing its transparency. Oil of sesame takes a deep red color and remains reddish. Oil of colza takes yellowish green colors and become turbid. Natural butter preserves its natural color. Oleomargarine becomes a black red, which color may be detected even in samples containing as little as 5 per cent. of margarine.—*Raoul Brulle.*

◆

## AN IMPROVED WATER PURIFIER.

We recently inspected an improved water purifier which has been applied with success to the purification of polluted waters produced in manufacturing operations in the Lancashire and Yorkshire districts. The subject of water purification is becoming of increasing importance, as there is a decided tendency on the part of the governing bodies of the above-named counties, to compel manufacturers to clarify their effluents before running them into the streams. The condition of the waters of the Medlock and Irk, for instance, are familiar to anyone conversant with Manchester, and they owe their foulness very largely to the amount of manufacturing refuse which is poured into them. It is important to remember that, from a manufacturers' point of view, cost is a great consideration, and they are not likely to use any apparatus which is very expensive. The purifier shown above is made by Messrs. Slack and Brownlow, Canning Works, Manchester, and consists of a cylindrical drum or tank made of wrought iron, inside which a series of plates spirally arranged are fixed. The plates have a considerable inclination, and are so disposed that the liquids entering at the bottom gradually travel to the top of the tank in a spiral direction. As shown in the illustration, two tanks are fixed above the purifier, into which the necessary chemicals used for flocculating the polluted water are placed, and deliver their contents into a funnel-shaped vessel, into which, at the same time, the water to be purified is also delivered. Thus, in passing down the vertical tube shown, the foul water is thoroughly mixed with the necessary chemicals, and when it enters the bottom of the tank the solid matter is in a flocculent condition. The water gradually rises in the tank, and the solid matter is precipitated on the various plates and falls to the lowest part of the plates. As we have said, the liquid flows in a spiral course, so that there is a large number of points at which the deposit can accumulate. Opposite the lowermost point of the plates and at each side of the tank cocks are placed, by opening which at convenient intervals the sludge is flushed out of the tank. It will be seen that the apparatus has no moving parts and is easily put to work. Samples of the waters from the Medlock and Irk after purification are very clear and have no smell, and, what is very important, are rendered quite soft and suitable for boilers. This is one of the applications of the purifier to which the makers have given special attention, and as a water softener the apparatus is largely used. It is not necessary to detail the numerous advantages arising from this treatment of water, as every manufacturer and steam user is fully conversant with them. An apparatus of this character, 7ft. diameter, will purify 84,000 gallons per day, and an inspection of a number of samples shows that the purification is effectively done.—*Industries.*



◆

## A NEW IDEA IN FOUNDRY PRACTICE.

Some of the English iron founders have adopted a simple practice in making stronger castings, says the *Virginia Manufacturer.* The method is merely the introduction of thin sheets of wrought iron in the center of the mould before casting. The idea was first applied to the casting of thin plates for the ovens of cooking stoves, and a sheet of thin iron in the center of a quarter-inch oven plate renders it practically unbreakable by fire. Recently the process has been applied to the casting of large iron pipes, a core of sheet iron imparting additional strength and lessening the liability to fracture. As an evidence of additional strength that may be imparted by this process, it is stated that a plate of iron one-fourth of an inch thick, cast with a perforated sheet of twenty-seven wire-gauge wrought-iron in the center, possessed six times the strength of a similar cast plate with no core. The quarter-inch plate thus made had the strength of a plate one inch thick.

## ENORMOUS HORSE POWER.

It is a very easy matter to talk about 18,000 or 20,000 horse power, but few persons realize what it means or the enormous force that it exerts. The new White Star steamships, for instance, or the Inman line's City of New York develop from 18,000 to 20,000 horse power. They have twelve boilers and seventy-two furnaces, worked with forced draught. Assuming that the engines will require eighteen pounds of steam per horse power, then 160 tons of feed water must be pumped into the boilers every hour, and 160 tons of steam will thus pass through the engines in the same time. In twenty-four hours the feed water will amount to 3,840 tons, occupying 130,240 cubic feet. This amount of water would fill a length of 493 feet of a canal 40 feet wide and 7 feet deep. Taking the condensing water at thirty times the feed water, it will amount to 4,800 tons per hour, or 115,200 tons in twenty-four hours, or for a six-day's transatlantic run not less than 691,200 tons, or 24,883,000 cubic feet. This amount of water would fill a cubical tank 295 feet on the side—a tank into which the Roman Catholic Cathedral, steeples and all, or the *Times* building, could be put and completely covered up. The coal consumption is not less interesting. Four hundred tons a day are burned on the 20,000 horse power pressure. This would fill 400 wagons. It requires for its combustion 8,609 tons of air, occupying a space of 222,336,000 cubic feet. It is impossible to put these figures in a shape such that may be grasped by the average reader, but enough has been cited to show, nevertheless, that the circulating pumps and fan engine of such ships are a hard-working lot.—*Iron Age.*

## FLY-WHEEL FAILURES.

Some months ago, when we were visited with quite an epidemic of fly-wheel breakages, says the ***Mechanical World,*** we referred at some length to the dangerously high speed at which a large number of rope-driving fly-wheels are now being run. A circumferential speed of 7000ft. per minute is not by any means uncommon, and as this corresponds to a stress of about 1400 lb. per square inch in the rim, it will be seen that, having regard to the various initial stresses which obtain in these structures, such a velocity cannot but be regarded as being dangerously high. Nor is there anything to be gained by adopting such an excessive speed, for so far as the transmission of power is concerned, there is no doubt that a velocity of about 4500ft. per minute represents the economic limit. On the other hand, the adoption of such high speeds is little short of courting disaster, for it will be readily perceived that in the event of failure of the governor to control the engine speed, fracture of the fly-wheel is exceedingly likely to follow. Safety appliances are fitted in many instances, but unless these are kept in order and tested periodically, their provision is calculated to engender a feeling of false security in the minds of the attendants, causing them, perhaps, to be less vigilant than they would otherwise be. The most recent example of failures of the kind referred to, occurred at the Oldham and Lees Spinning Company's mill, Lees, Oldham, on January 30, when a fly-wheel about 25ft. in diameter burst owing to excessive speed, which was brought about by the derangement of the safety appliance with which the governor was fitted. The engine has cylinders 32½in. and 50in. diameter, with a stroke of 5ft., the normal speed being 61½ revolutions per minute. The power is transmitted by a composite rope and belt driving wheel, 25ft. in diameter, 6ft. 6in. broad, one half of which received a belt 3ft. broad, and the other half 15 1¾in. ropes. The wheel was made up of one central boss, 12 cylindrical arms, and 12 rim segments, the total weight being 43 tons 17 cwt. On the morning of the accident it appears that owing to the illness of the engineer, the starting of the engine was entrusted to the engineer's assistant and a fireman. The assistant, it should be noted, had never started the engine previously, although he had worked there nearly four years. Upon opening the valve admitting steam to the high-pressure cylinder, the high-pressure crank did not pass the centre, and another man then opened the blow through valve, admitting steam to the low-pressure cylinder. The speed then rapidly increased, and the safety appliance failing to act, the wheel burst, completely shattering the wall of the wheel race, demolishing the roof, and wrecking part of the engine. The stop-motion was intended to be actuated by any abnormal rise of the governor balls, the total range of the latter being 6⅜in.; the first 4 or 5in. controlling the engine under ordinary conditions. During the remaining 1⅜in. of the rise of the governor, the safety apparatus should have been brought into action, but owing to the accumulation of dirt and spent oil upon the unused part of the spindle, the centre weight became jammed when about 1⅜in. from the upper limit of its traverse. At the inquest it was shown that it required over 7cwt. to move the weight ¾in., and over 2cwt. to bring it back again. There is little doubt, therefore, that the failure was due to the injudicious handling of the starting valve, but principally to the failure of the automatic stop-motion, due to its neglect. This accident indicates the necessity for some periodical inspection of these safety appliances by some independent person, such as a factory inspector. Evidently they are worse than useless unless kept in proper order, for however careful attendants may be, the remote possibility of these attachments being brought into requisition is apt to lead to their being neglected.

---

When Thomas A. Edison was a young telegrapher in Cincinnati he became known to fame as a cockroach annihilator in this wise. The building in which he worked was infested with 'em. There was a couple of sinks in the building where they had high festival. Edison ran a wire about the sinks in such a manner that every cockroach must crawl over it on his way to the folk-mote and turned on an electrical current, not very strong, about cockroach power, in fact. The cockroaches tumbled to it, literally. They were shovelled up by thousands for a few nights, and after that peace reigned.—*Ex.*

MACMILLAN & CO'S.

TEXT-BOOKS FOR STUDENTS.

**BALFOUR. A Treatise on Comparative Embryology.** By F. M. Balfour, M.A., F.R.S., Fellow and Lecturer of Trinity College, Cambridge. With Illustrations. Second Edition, reprinted without alteration from the First Edition. In 2 vols., 8vo. Vol. I., $4.50 ; Vol. II., $5.25.

**COTTERILL. Applied Mechanics: An Elementary General Introduction to the** Theory of Structures and Machines. By James H. Cotterill, F.R.S., Associate Member of the Council of the Institution of Naval Architects, Associate Member of the Institution of Civil Engineers, Professor of Applied Mechanics in the Royal Naval College, Greenwich. Medium 8vo. $5.00.

**DANIELL. A Text-Book of the Principles of Physics.** By Alfred Daniell, M.A., LL.B., D.Sc., F.R.S.E., late Lecturer on Physics in the School of Medicine, Edinburgh. With Illustrations. Second Edition, revised and enlarged. Medium 8vo. $3.50.

"Prof. Daniell's book is unquestionably the best elementary text-book for advanced students that has as yet appeared in the English language, and while written especially with the view of adoption in medical colleges, is a valuable book to any school aiming to present the subject in a scientific and philosophical manner."—*The Chicago Tribune.*

**FOSTER. A Text-Book of Physiology.** By Michael Foster, M.D., Sec. R.S. Professor of Physiology in the University of Cambridge. With Illustrations. Fourth Edition, revised. 8vo. $5.50.

**GAMGEE. A Text-Book of the Physiological Chemistry of the Animal Body.** Including an Account of the Chemical Changes occurring in Disease. By A. Gamgee, M.D., F.R.S., Professor of Physiology in the Victoria University, the Owens College, Manchester. 2 vols., 8vo, with Illustrations. Vol. I., $4.50. [*Vol. II. in the Press.*]

**GEGENBAUR. Elements of Comparative Anatomy.** By Professor Carl Gegenbaur. A Translation by F. Jeffrey Bell, B.A. Revised, with Preface by Professor E. Ray Lancaster, F.R.S. With numerous Illustrations. 8vo. $5.50.

**GEIKIE. Class-Book of Geology.** By Archibald Geikie, LL.D., F.R.S. Profusely illustrated with woodcuts. 12mo. $2.60.

"We have no hesitation in declaring the book an excellent one, containing exactly such material as renders it especially fitted for instruction. More than that, to the person with no geological turn of mind, the whole matter is so well combined, and the explanation so simple, that by reading the volume, nature's action in the past, as in the present, can be better understood; . . . will awaken on the part of the student curiosity and interest, for at once it can be seen how observation, generalization, and induction go hand in hand in the progress of scientific research."—*New York Times.*

**GEIKIE. Text-Book of Geology.** With Illustrations. Second Edition, revised and enlarged. 8vo. $7.50.

"A noble and masterly work."—*Christian Advocate.*

"In all respects a comprehensive and exhaustive text-book of geology; discusses every phase of the science in the light of the latest researches and opinions, and is at once acceptable to the student and general reader."—*Philadelphia Times.*

**MUIR. The Elements of Thermal Chemistry.** By M. M. Pattison Muir, M.A., F.R.S.E., Fellow and Prælector of Chemistry in Gonville and Caius College, Cambridge; assisted by David Muir Wilson. 8vo. $3.25.

**MÜLLER. The Fertilization of Flowers.** By Professor Hermann Müller. Translated and Edited by D'arcy W. Thompson, B.A., Professor of Biology in University College, Dundee. With a Preface by Charles Darwin, F.R.S. With numerous Illustrations. Medium 8vo. $5.00.

**PHILLIPS. A Treatise on Ore Deposits.** By J. Arthur Phillips, F.R.S., V.P.G.S., F.C.S., M. Inst. C.E., Ancien Elève de l'Ecole des Mines, Paris, Author of "A Manual of Metallurgy," "The Mining and Metallurgy of Gold and Silver," etc. With numerous Illustrations. 8vo. $7.50.

"In closing Mr. Phillips's volume we may congratulate him on having enriched our scientific literature with a contribution of substantial value, which will probably remain for many a day a standard work of reference on its peculiar subject. Nor will its use be limited to English students, for the author's wide knowledge of American ore deposits will probably render his book equally acceptable on the other side of the Atlantic."—*London Academy.*

**SMITH. A Dictionary of Economic Plants: Their History, Products, and Uses.** By John Smith, A.L.S., etc. 8vo. $3.50.

**VINES. Lectures on the Physiology of Plants.** By Sydney H. Vines, M.A., F.R.S. 8vo. With numerous Illustrations. $5.00.

**WIEDERSHEIM. Elements of the Comparative Anatomy of Vertebrates.** Adapted from the German of Robert Wiedersheim. By W. Newton Parker. With additions. Illustrated with 270 woodcuts. 8vo. $3.00.

**ZIEGLER. Text-Book of Pathological Anatomy and Patho-Genesis.** By Professor Ernst Ziegler, of Tübingen. Translated and Edited for English Students by Donald Macalister, M.A., M.D., B.Sc., F.R.C.P., Fellow and Medical Lecturer of St. John's College, Cambridge, Physician to Addenbrooke's Hospital, and Teacher of Medicine in the University. With numerous Illustrations. Medium 8vo.

*Part I. GENERAL PATHOLOGICAL ANATOMY. $3.50.*
*Part II. SPECIAL PATHOLOGICAL ANATOMY. Sections I.—VIII. $3.50.*
*Part III. Sections IX.—XII. $3.50.*

**Macmillan & Co.'s new complete Classified Catalogue will be sent free, by mail, to any address on application.**

*MACMILLAN & CO., 112 Fourth Avenue, New York*

## PATENT AGENTS AND ATTORNEYS.

**DETROIT.**

A. Barthel. Jas. Whittemore.

THOS. S. SPRAGUE & SON, Solicitors of United States and Foreign Patents, No. 37 Congress St. West, Detroit.

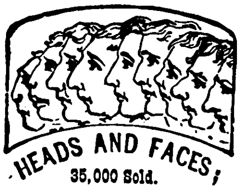
**TORONTO.**

PATENTS PROCURED IN CANADA, UNITED STATES and Foreign Countries. Donald C. Ridout & Co., Solicitors of Patents, 22 King Street East, Toronto.

**WASHINGTON.**

C. A. Snow. E. G. Siggers.

C. A. SNOW & CO., Solicitors of Patents, 710 G Street, N.W., opposite U. S. Patent Office, Washington, D.C.



HEADS AND FACES; 35,000 Sold.
**HOW TO STUDY THEM**
A manual of Character Reading for the people, an intensely interesting and attractive book Every body should read it. 200 pages, 200 fine illus. 40 cts.

**SENT FREE**
A SAMPLE NO. OF THE
**Phrenological Journal,**
A magazine of Human Nature for every body. $2.00 a year, 20c. a no., and a list of **BOOKS** on Phrenology, Physiognomy, Health, Heredity, &c Send address on postal.

**FOWLER & WELLS CO., 775 Broadway, N. Y.**

# Industries!

A Journal of Engineering, Electricity and Chemistry
FOR THE
**MECHANICAL AND MANUFACTURING TRADES.**

**PUBLISHED EVERY FRIDAY.**

ANNUAL SUBSCRIPTIONS.

| | Thick Paper | Thin Paper |
|---|---|---|
| Great Britain, Post Free, - - | $6.00 | $6.00 |
| The United States, Canada, and countries included in Postal Union, Post Free, | 9.00 | 8.00 |
| India, Ceylon, Straits Settlements, China, Japan, &c., Post Free, - | 10.75 | 9.00 |

SUBSCRIPTIONS PAYABLE IN ADVANCE TO

**GEO. CAWLEY, 358 Strand, LONDON, W.C.**

MANCHESTER, 70 Market St.; GLASGOW, 93 Hope St.;
YOKOHAMA, (JAPAN) 32 Main St.

# HELLIWELL'S PATENT.

**GLAZING WITHOUT PUTTY!**
AND
**ZINC ROOFING WITHOUT EXTERNAL FASTENINGS!**

***Direct Importers of Vieille Montagne and Lipine Zinc.***

WATERTIGHT. FREE FROM RATTLE. SAVES ALL OUTSIDE PAINTING. NO DRIP FROM CONDENSATION. OLD ROOFS RE-GLAZED.

30,000 ft. of old Putty Roofs have been Re-Glazed on this System. Extensively used by H.M. Government, and generally throughout the country for STATIONS, MARKETS, PICTURE GALLERIES, and every description of Roof and Horticultural Buildings.

*References to most Eminent Engineers and Engineers of all the leading Railways. For particulars apply to*

**T. W. HELLIWELL, BRIGHOUSE, YORKSHIRE; AND 5 WESTMINSTER CHAMBERS, LONDON.**

**To preserve Wood against Decay, Dry Rot and Fungus.**
**To preserve Ropes and Leather against Weather.**
**To prevent Dampness in Walls,**

APPLY
# CARBOLINEUM AVENARIUS
REGISTERED.

Used with immense success by Military Authorities, Boards of Works, Railway Companies, Tramways, Mines, Engineers, Builders Contractors, Public Gardens, Estates, Breweries, &c.

*For Prices and Particulars apply to*

**PETERS, BARTSCH & CO., DERBY, ENGLAND.**

**Carbolineum Avenarius can only be had from Peters, Bartsch & Co., or their Authorized Agents.**