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TORONTO'S NEW PUMPING ENGINE.

The new Coupled Geared Engine, lately built and put into the water works pumping station at Toronto, has confirmed our predictions of its behaviour.

It has neither pumped the stipulated quantity of water, nor given the guaranteed duty, and in point of satisfaction and efficiency, is a failure.

We heartily sympathize with the contractors, who thought, no doubt, of establishing a reputation for themselves in this question; but they have unfortunately failed, and have nobody but themselves to blame.

They were warned and cautioned against espousing the design, but they persisted in ignoring well-meant advice, and foolishly followed the dictates of prejudice, pride, passion and ignorance.

As the engine has actually been completed and erected, we have no doubt but that, after a good deal of aldermanic jugglery, the contract will ultimately be accepted.

The adoption of this particular engine by the city of Toronto has proved to the whole of Canada, England and the United States that her influential and official advisers are extremely incapable and unworthy of confidence.

Toronto can no longer be looked upon as an example on such questions, but, on the contrary, she has heaped discredit and shame on Canadian engineering, not because her workmanship is inferior, but because Canada's able and well-known engineers and experts were studiously ignored, and their advice and opinions disregarded.

We pointed out that if a correct test was made a duty of 60 millions foot pounds could hardly be obtained, whereas this duty, with modern and well designed engines, could be doubled, which means that Toronto has to pay, during the lifetime of this machine, $1 for water which should cost only one half of this, or 50 cents.

The citizens of Toronto can hardly realize what a loss they will have to suffer, and what an unsatisfactory machine they will possess, by accepting this miserable pumping engine.

Many of Toronto's best citizens had hoped that, in view of the past experience of the water works, and the terrible and continued loss of their present Worthington Engines, that every care and attention would be paid to securing, without the slightest shadow of a doubt, one of the best, most economical working and efficient pumping engines that could be designed and made, but they have been doomed to sad disappointment.

It is, therefore, high time enquiring the why and the wherefore of all this.

◆

From statistics lately gathered in England, regarding the iron trade, it appears that the iron trade manufacture has been steadily declining for years. No doubt this is the case, and caused by the colonies becoming more independent of England, and manufacturers themselves.

Canada is perhaps the largest manufacturing colony of England, but still imports largely from England and the States, etc. She is blessed with rich deposits of iron ore, but has, unfortunately, no corresponding deposits of coal, conveniently located to many of these iron deposits. Time and skill may, however, in part overcome these disadvantages, and we see no reason why the manufacture of pig and finished iron should not become more general, as coal is allowed in from the States free of duty; but one great fault lies in the fact that Canada requires so little iron, and the States could not import from us in the face of such a high duty as theirs—consequently we are forced to allow ore to be mined here and sent over to the States for smelting and manufacturing purposes.

It seems too bad that Canada should throw away so much of her valuable raw material, and only get the small share of profits of the land and the mine; while our neighbours get the material and the large profits of smelting and manufacturing generally.

THEORETICAL MECHANICS OR THE SCIENCE OF DYNAMICS.

Lesson I.

We have to deal in practice with a great variety of forces, of which the following are examples :

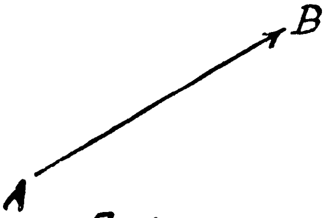
1. The force of gravity or weight as the weights of the different pieces of a structure, or machine, and the loads upon them.
2. The force of the wind.
3. The pull of a bolt, or of a link, etc.
4. The force of steam, etc.

We have also to consider the resistances opposed by bodies to being stretched, or compressed, or bent, or otherwise distorted.

When any of these resistances is called into play, the body is said to be subjected to *stress* which must not be confounded with strain.

The *magnitude* of a force is the number of units of force which it contains, the most common units employed being pounds or tons ; thus if one pound be the unit, a force of 4 pounds has a magnitude *four.*

To reprepresent graphically a force in magnitude and direction, we must draw a straight line in the direction in which the force acts, and lay off upon it as many units of length, as there are units of force in the force.

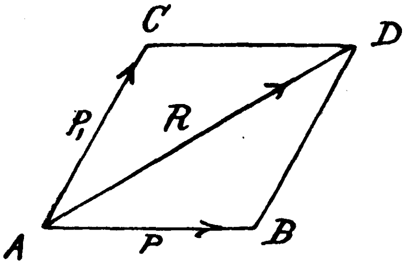


— Fig. 1. —

Thus as in Fig. 1, if our scale be 1 inch per 100 lbs., the line A B whose length is 1½ inches will represent a force of 150 lbs. acting in the direction or parallel to A B. A force is represented graphically in magnitude, direction, and point of application when a straight line is drawn *from the point* where the force acts, *in the direction* in which it acts, and as many units of length are laid off upon the line as there are units of force in the force.

Thus, if the line in Fig. 1, were drawn to represent a force in all three of these particulars, we should conclude that the force was one of 150 lbs. and that it acted at the point A, and in the direction A B.

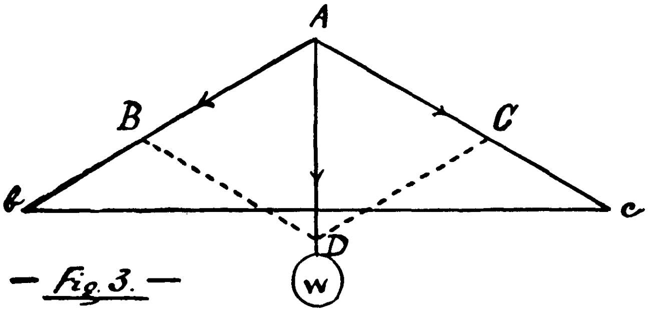
The resultant of a set of forces is that single force which should produce the same effect as the entire system of forces.



— Fig. 2. —

PARALLELOGRAM OF FORCES.

If two forces P and P P, represented in magnitude and directed by A B and A C respectively, (see Fig. 2) be applied at the same point, their resultant will be represented in magnitude and direction by the diagonal A D, of the parallelogram of which A B and A C are adjacent sides. Thus if A D (see Fig. 3) represent a weight applied at A on the roof truss A *b c*, the magnitude of the thrusts, caused by this load, along the rafters A *b* and A *c* will be represented by A B and A C respectively, formed by drawing D C parallel to A B and D B parallel to A C.

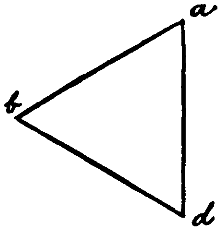


— Fig. 3. —

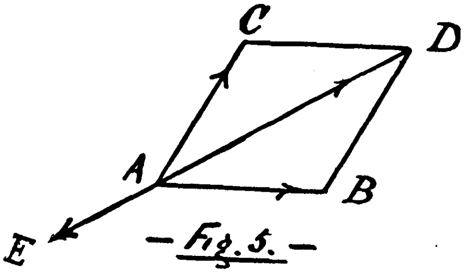
In this particular case we find by measurement that A B = A C = A D, so that if the load be 1,000 lbs. and A D be drawn to scale to represent it, we shall have A B and A C measuring the same as A D or each 1,000 lbs. also.

The pressures A B andA C as shown in the figure, are the forces exerted *by the load* on the *rafters* A *b* and A *c* respectively.

We might however just as well have drawn only one half the parallelogram A B C D, or the triangle A B D, or one equal to it, as *a b d*, (Fig. 4) where *a d* represents the load at A ; *d b* represents the *stress* in the rafter A *c* that is the force exerted at A by that rafter to resist the load, and *b a* represents in the same way the stress in A *b*.

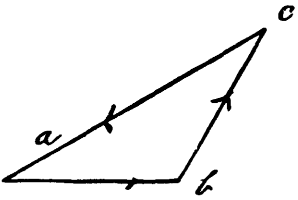


— Fig. 4. —



— Fig. 5. —

Moreover we have that in the following Fig. 5, if A E be drawn equal and opposite to A D, the three forces A B, A C and A E will balance each other. But these are correctly represented in magnitude and direction by the successive side *a b*, *b c* of the triangle *a b c* (Fig. 0) drawn parallel to (in the same direction as) the forces A B, A C and A E.



— Fig 6 —

Hence follows the proposition called the

TRIANGLE OF FORCES.

that is,—if three forces be represented in magnitude and direction by the three sides of a triangle taken in order, these three forces will balance each other when applied at the same point.

For the Canadian Magazine of Science.]

NEW PROCESS FOR THE MANUFACTURE OF CHLOROFORM.

J. H. B.

A new process for the manufacture of chloroform has just been patented in the United States. It has caused quite a revolution in the trade, and bids fair to place the manufacture of the total annual consumption in the United States, which may be estimated as 300,000 lbs., in the hands of the patentee. Although a number of large firms have been working to obtain the same end, viz., the cheap production of chloroform, it has been the good fortune of a gentleman of Albany, to perfect the process, and he will thus reap a large pecuniary reward as the result of much labour and patience.

The invention is based upon the discovery that when a crude Acetate, as of lime, is subjected to dry distillation, only very small quantities of Acetone ($C H_3 CO C H_3$) are produced, while considerable quantities of

Dimithylacetal .	$C_2 H_2 (OCH_3)_2$
Ethylmethylacetal .	$C_2 H_4 (OC_2 H_5) OCH_3$
Methyldimithylketone .	$(CH_3 CO. CH_2 CH_3)$
Methylethylketone .	$(CH_3 COC_2 H_5)$
Diethylketone .	$(C_2H_5 CO C_2 H_5)$
Metacetone .	$(C_6 H_{10} O)$

and other still higher boiling ketones, as dumasin, are the result of the process.

The second part of the invention is based upon the discovery that while pure acetone, when distilled with a hypochlorite, yields only 33%, the above-mentioned ketones, which possess higher boiling points than does acetone, will yield chloroform when freed from water and distilled with a hypochlorite, as above, in the proportion of measure for measure when we consider it deprived of its water, as a basis of comparison.

In practical working of the invention, say a hundred pounds of crude acetate of lime is taken and subjected to distillation in a suitable vessel, at a temperature of 300 ° to 500 ° Centigrade, until volatile products are no longer condensed. The result is then about 32 lbs. of liquid, consisting of an aqueous fluid with an oily stratum floating upon it, the proportions of the former to the latter being as 4 to 1. The aqueous solution is removed and the oily one washed with tepid water and added to it. Acetic acid or acetates may be easily recovered from the residue of distillation, and the acetic acid produced varies from 20% to 25% according to the temperature employed.

In order to obtain crude chloroform from the above distillate, 9 lbs. of it is taken and mixed with 40 lbs. hypochlorite of lime (or other suitable hypochlorite) and about 15 gallons of water, and subjected to distillation in the usual manner. The result, amounting to 4½ lbs., will be found to vary in specific gravity from 1.465 to 1.475, and may be rectified in usual manner.

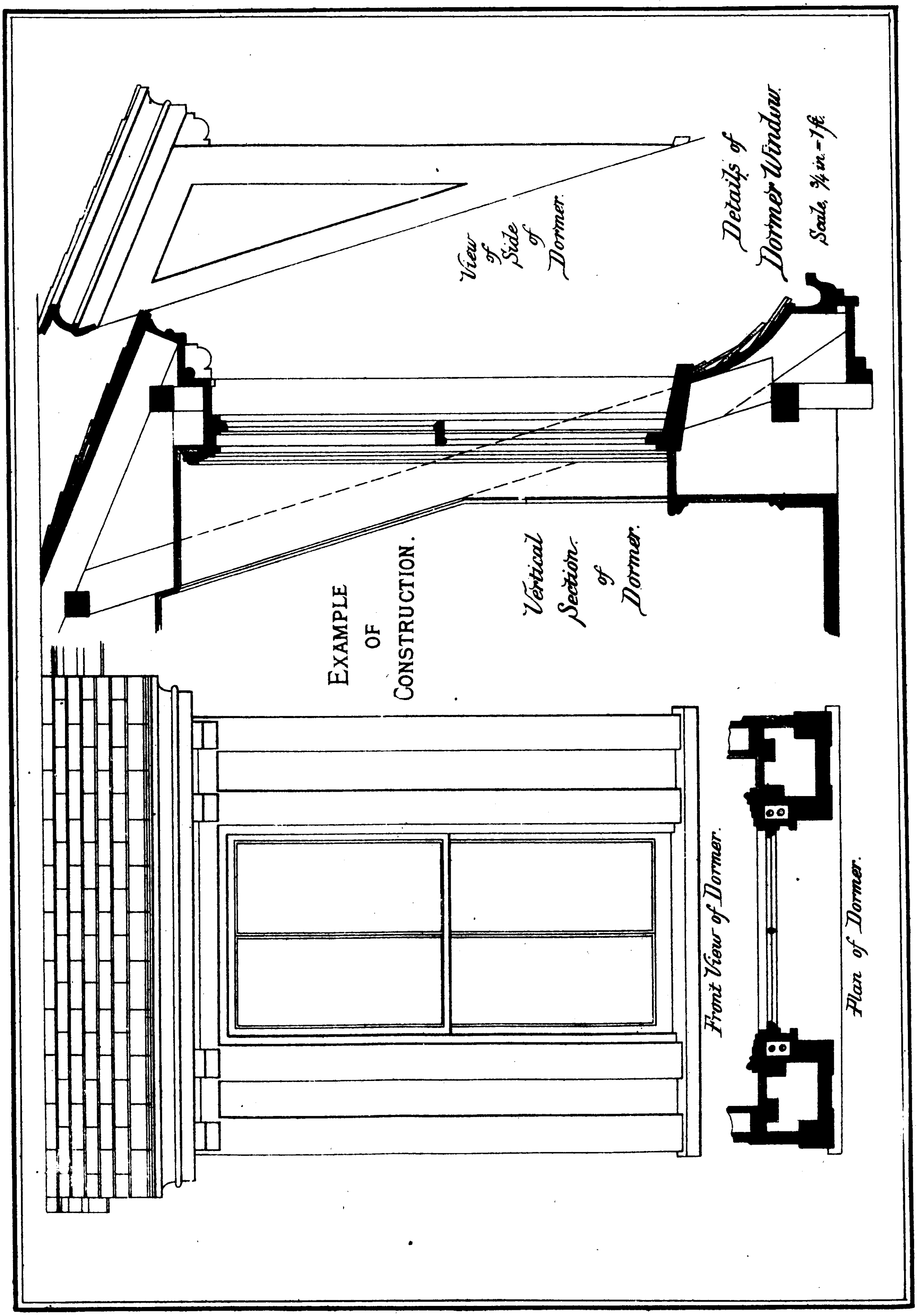
THE "OHIO" WELL DRILLING MACHINE.

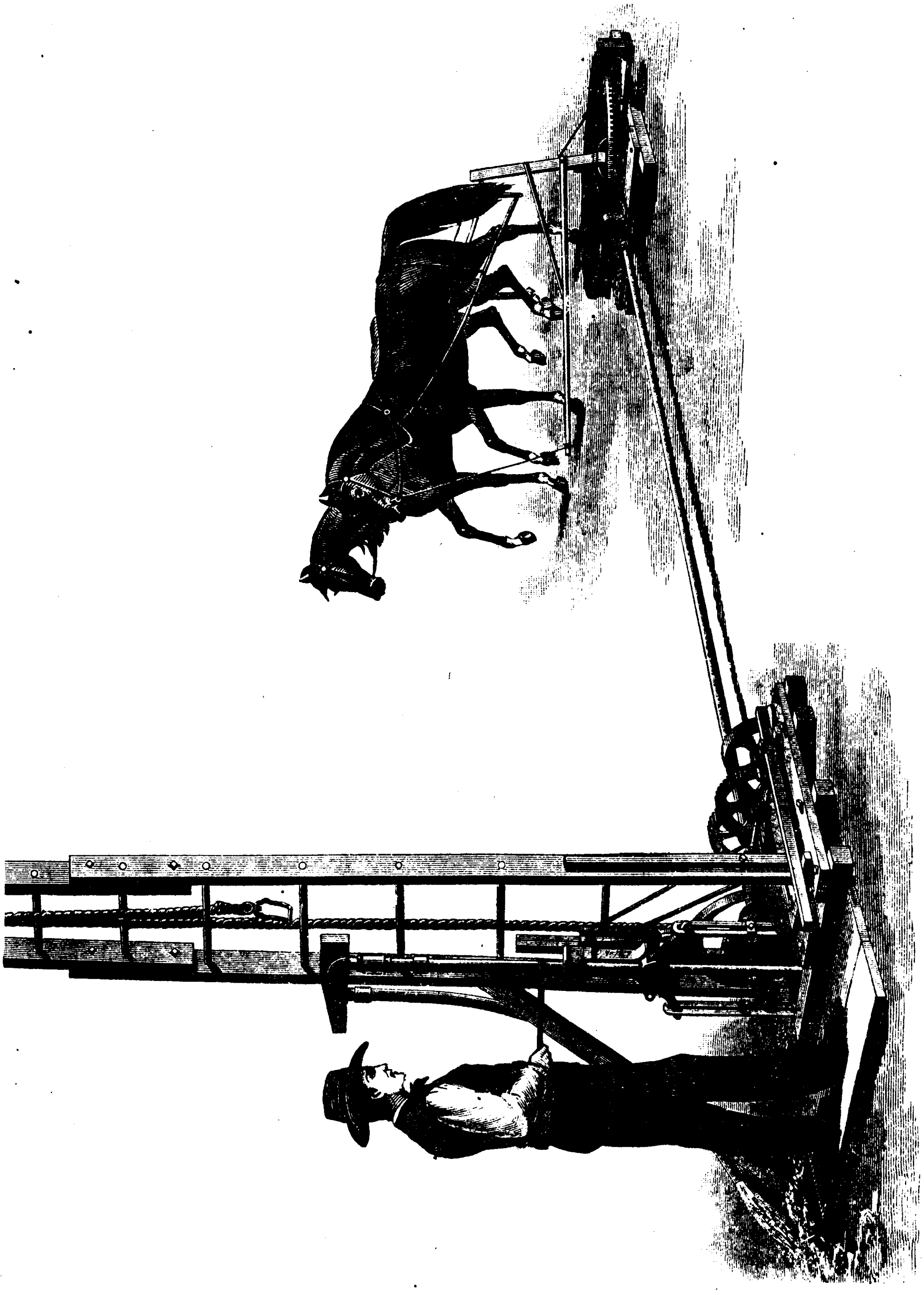
The "Ohio" Well Drilling and Prospecting Machine seems to be the latest novelty in that line. Its advantages being in its quick motion in handling the tools, and in being positively self-cleaning as the work progresses. The remarkable ease with which the machine is operated, and the steadiness of the motion when working heavy tools, are also some of the desirable features claimed for it. It is said to work where all others drills fail, and to allow of the easy determination of the coal or mineral vein when prospecting. The work of the machine is all done by drilling with a lift and drop motion to the tools.

The drill is a compound chisel bit, reamer and sand pump, and is connected to a hollow drill stock which reaches to the top of the well, and which is arranged so that the cuttings of the drill are discharged with considerable force from the end of the rubber hose which is connected to the top of the drill stock by a nonleaking swivel joint. The tools are lifted by being grasped by the concave jaws which are carried up and down very rapidly by the cross head and guide. When the jaws reach the proper height they release the tools and they drop freshly, only to be picked up and dropped again at each revolution of the crank wheel. From 70 to 90 drops of the drill each minute is the usual speed, and there is absolutely no back-lash or jerk on the machine or power when the tools drop. One horse can drill wells from 250 to 300 feet deep operating a set of tools that weigh from 800 to 1,000 pounds, while for greater depths, where two horses are used, a set of tools weighing more than the combined weight of the machine horse power and derrick, can be easily operated. In using this drill the tools need not be taken out of the well so long as the earth does not cave or it becômes necessary to put in the tubing, but the cuttings of the drill are carried up the hollow drill stocks and are discharged from the rubber hose at each stroke of the tools, as shown in the cut. The same drill, etc., used in earth work, is also used in drilling rock, and in material of this kind the tools are only drawn out of the hole when it becomes necessary to dress the drill.

When a vein of water is struck or tapped by the drill, it can be easily tested with the tools before they are removed from the well.—*Chic. Jour. of Com.*

London increases its population by 46,000 every year. It has 1,900 ships and 10,000 sailors in its port every day. Its beer shops and liquor saloons would, if placed side by side, form a row seventy-eight miles long. Thirty-eight thousand drunkards are brought before its magistrates every year, and every Sunday seventy miles of open shops invite the purchaser to enter.


Details of Dormer Window.
Scale, 3/4 in.=1 ft.
View of Side of Dormer.
Vertical Section of Dormer.
EXAMPLE OF CONSTRUCTION.
Front View of Dormer.
Plan of Dormer.



THE "OHIO" WELL DRILLING MACHINE.

WAITING FOR THE VERDICT.

The ultimate day has arrived, when, according to the original Daily bill, all wires, wherever found overhead in cities of 500,000 inhabitants or upwards in the state of New York, were to be removed and placed underground by the authority of the state. At the time the interest awakened in this discussion was greatest, we ventured the prediction that on the first day of November, 1885, there would be more wires overhead than existed at the time of writing. Such is notoriously the case, yet the date mentioned marks a certain amount of progress. Official investigation on the part of the commissioners appointed to enforce the law, has in every particular confirmed the assertions previously made by electrical experts, that there were serious difficulties to be encountered and that strict compliance with the original act would at a blow deprive the business and resident public of the facilities for electrical communication which they have long enjoyed.

The abitrary provisions of the bill which aroused so great an opposition from the various companies interested, as well as from the electrical press, was materially modified by the subsequent act of June 15th, 1885, by which the commissioners are allowed to exercise their discertion in compelling the adoption of subterranean routes, and the solitary subscriber, who has no telephonic neighbor within 18 blocks, may not be called upon to bear the expense of either constructing or paying rental for a mile or more of conduit constructed for his special benefit.

The popular idea of placing wires underground according to the teachings of the daily press, is simply to take them off the poles, tie them in convenient bundles and bury them at the bottom of a ditch. A similar view of the problem was taken by at least two of the inventors who submitted underground plans to the commission. "This is by no means an enlightened view of the situation, as progress is desired above all things, and the electrical condition of aerial wires in New York city to-day is by no means as satisfactory as might be inferred from the opposition of the various companies toward the enforcement of the underground law. They act simply upon the familiar maxium that it is "better to bear the ills we have. than fly to others we know not of." The first subterranean work undertaken some ten years ago by the Western Union company was done voluntarily, in the confident belief that a system of that character would be exempt from the well-known evils which attend aerial electrical communication in densely populated districts. Advantage was taken of European experience in the same line, and while the results have by no means been entirely satisfactory, it is far from the truth to assert, as has been more than once done, that these experiments were made merely to prove that wires could not be successfully operated underground. It will no doubt be admitted that the recent sessions of the New York commission on electrical subways afforded an opportunity for every plan to be presented, and the substantial reward awaiting the successful competitor is no doubt sufficient to bring out the best existing ideas on the subject, yet not a single system was presented which did not have its defects. Of course very many of them were wholly impracticable, either from a mechanical, electrical or financial standpoint, while others might perhaps serve the purpose more or less well but had not received practical endorsement. A large proportion of the plans proposed did not in fact come under the provisions of the law, and might without impropriety have been ruled out altogether.

A gentleman who has given this subject very thorough study for several years, informed the commission that a conduit was merely a hole through the ground, while the *New York Times*, which has perhaps been the foremost advocate of underground schemes, declared editorially a few days since that "nothing is more unreliable than a hole in the ground."

None can be more thoroughly aware of the defects and weaknesses of existing electrical systems than those who have had the greatest experience with them. Knowing the difficulties of maintaining the electric service at a high point of efficiency under its present conditions, they do not feel disposed to admit that any plan is perfect which they have not personally tested, although it may prove better adopted to their purpose than they suppose. An experienced spiritual expert once ventured the opinion that no whiskey was absolutely bad, altheough undoubtedly some brands of whiskey were not so good as others. By the same line of reasoning it may well be argued that no subterranean system is good, although some plans are worse than others.

October 15th, 1885 was the last day for the filing of plans with the Board, and those which were received before the adjournment are to to be examined in executive session and finally passed upon.

Such being the condition of affairs; the evidence all in and under consideration, advice and criticism many properly be reserved until a verdict has been given. From the very nature of the case there will be disappointment and unjust accusations, but if the commissioners give their decision in accordance with what has practically proved the best, so far as they can ascertain, they will have at least performed their duty, and may well content themselves by the reflection, that despairing of any light from the conflicting theories of the various inventors and promoters, they fell back upon their own judgment, and in accordance with the law and the evidence, decided how in their opinion, a hole in the ground could be most economically made and effectually maintained, without detriment to the existing electrical service, while at the same time giving due consideration to future growth.—*The Electrician.*

THE FLOOD ROCK EXPLOSION.

Professor W. A. Rogers, of the Harvard Observatory, has reported to the American Academy of Arts and Sciences, in Boston, the results of his observations on the transmission of shock from the Flood Rock explosion.

The air line distance between the observatory in Cambridge and Flood Rock is 190 miles, and the observations were timed as follows: Disturbance first seen, 11:17:14; instant of maximum disturbance 11:18:03; disturbance ceased, 11:20. The figures are all in seventy-fifth meridian or "Eastern" time. The method used to develop the existence of vibration was the placing of a saucer of mercury on the solid cellar floor. In this mercury was a speak or flaw. Upon this point was brought to bear a microscope of 750 magnifying power, the spider line being in exact coincidence with the flaw.

The first vibration preceived was about a thousandth of an inch, and recurred at intervals for nearly two minutes, the greatest swaying of the mercury being over a space of on five-hundredth of an inch.

In this connection it is interesting to note that General Abbot reported that the shock from 50,000 pounds of dynamite exploded in 1876 at Hallet's Point, was transmitted through the drift formation of Long Island, at the rate of 5,300 feet per second for 13½ miles. Assuming the figures of the Cambridge report as correct, and that the mine at Flood Rock was exploded at 11:14, seventy-fifth meridian time, it took the wave just 194 seconds to travel 190 miles, or at the rate of 5,120 feet per second. This is very near the rate of transmission observed by General Abbot, when the greatly increased distance is taken into account.—*Engineering News.*

THE MANCHESTER SHIP CANAL AND THE TEHUANTEPEC SHIP RAILWAY.

The Manchester Ship Canal Company, recently chartered by the English Parliament, has issued its prospectus, inviting subscriptions to its capital stock fixed at £8,000,000, in shares of £10 each. The matter has been before Parliament for several years and it is stated that the expense of its promotion has not been less than £500,000. This preliminary expense seems very large to one unfamiliar with the fact that all public works in England involving a franchise have to be fully developed and argued before a parliamentary commitee by experts, and in the face of great opposition, as in this case from Liverpool, the expenses of *promoting* alone were very heavy. To those also who have been in the habit of looking upon our annual river and harbor bill of less than one-third the cost of this scheme, for all the waterways and harbors of the country, £8,000,000 for a single channel of a few miles will seem like a very large sum of money although it excites no comment when capitalized in one hundred miles of an American railway.

The canal is to have a bottom width of 120 feet and a minimum depth of 26 feet, or its prism will be cosiderably greater than either the Suez or Amsterdam canals or the *proposed* Panama canal. It is to extend from Eastham on the estuary of the Mersey, above Liverpool, to Manchester, a distance of 35 miles and will include a dockage area of 85½ acres with four miles of quays at Manchester, Salford and Warrington. The elevation of 60½ feet from ordinary tide to the docks at Manchester will be overcome by four sets of locks of three each, the larger 550 × 60 feet, the second, 300 × 40 feet, and the smaller; 100 × 20 feet. The water supply will be furnished by the rivers Irwell and Mersey.

It is expected that vessels will navigate this canal at the rate of five miles per hour and that the locks can be operated in fifteen minutes each. It is estimated that cargoes will arrive at destination in eight hours less time than it takes to tranship at Liverpool and forward by rail. The rates are fixed by the act at one-half existing railway and canal rates and at one-half the dock and town dues charged at Liverpool. Notwithstanding these limitations the net income is estimated at £709,000, after deducting £104,000 for maintenance and operating expenses, on an estimated traffic of only 3,000,000 tons. This traffic is estimated at over 9,000,000 tons in seven years after the opening of the canal.

Unquestionably the days of small canals are past. This fact is strikingly illustrated in France where now an expenditure of over $270,000,000 is contemplated in order to develop more fully the possibilities of its waterway system. It needs but few instances like the Manchester ship canal project to convince the general public that water carriage is cheapest in thickly settled countries or with large traffic. In saying this we have most fully in mind some peculiar evidence set forth by a well-known engineer in recent lectures, in promoting the Tehuantepec ship railway.

Some of our readers will remember that last year Capt. James B. Eads gave evidence before the Parliamentary committee as to this same Manchester ship canal, and that the project as now set forth received his general approval. Although the ostensible purpose of his presence in England, as believed in this country, was to raise funds for his ship railway, very strangely he did not propose its use from Liverpool to Manchester, although it would seem that there could be no better or favorable application for a ship railway than in this instance.

Here we are about to see invested in a canal and accessories very nearly the amount required by the last estimates for the Tehuantepec ship railway, some four times as long and for about the same estimated traffic. It would seem as if all the chief arguments advanced for a ship railway at Tehuantepec would apply with greater force to the route from Liverpool to Manchester and show a large money saving over the canal and may we not infer from some of these same arguments (notably in the suggestion of a ship-railway as more economical than an enlarged Erie canal) that goods could be carried cheaper by the ship-railway. It would seem as if Capt. Eads, as a man of disinterested public spirit, had failed in a great duty to the English people, a failure which his countrymen will hardly attribute to excess of modesty.

If, however, we accept the Manchester ship canal scheme as a valid one, — that the canal can be navigated with reasonable speed, the locks quickly operated without danger, the cost of operating and maintenance comparatively small and water-borne transport in ample channels as cheaper than any other — what shall we say of the statements which have been made by the Tehuantepec promoters in regard to the Nicaragua canal and of their claims for the ship-railway. After we eleminate the advantages of extra distance and fictitious trade winds what have we to commend it?

We would say, only this! If the Tehuantepec promoters succeed this winter in obtaining from Congress (we believe it is not long since they disclaimed the need of it) a guarantee on bonds to go with their Mexican guarantees, an investment in Tehuantepec ship-railway securities may be a good thing even though the railway itself never becomes a commercial success. If Congress does not make a guarantee the ship-railway is not likely to be built. After all, "the De Lesseps of America" may be able sometime to join hands with the De Lesseps of France in the two colossal failures of the age.

— *American Engineer.*

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ELECTRIC MOTOR ON THE NEW YORK ELEVATED RAILROAD.

Preliminary trials of a Daft electric motor, the Ben Franklin, have been in progress for some time past on a portion of the Ninth Avenue Elevated Railroad of this city, extending from 14th to 52d. Streets. The dimensions of the principal parts of this moter are as follows:

Driving wheels, 48 in. diameter; trail wheels, 36 in. diameter; length over all, 14 ft. 6 in.; spread of wheel, 5 ft. 6 in.; diameter of armature, 25 in.; weight of armature, complete with shaft, 850 lbs. Total weight of motor, 8¾ tons. Ratio of armature revolutions to drivers, 1 : 5·5. Ratio of peripheral speeds of armature and drivers, 1 : 2·8.+ The reversing arrangements consist of four brushes attached with compound levers, and so connected that the direction of rotation must necessarily be that best suited to the proper contact and wear of the brushes. There is also abundant provision made for varying the points of contact in proportion to the load, speed, etc. The regulating switch consists of a sliding plate having metallic contacts arranged on its surface in such a manner that a number of spring contacts effect changes in the internal resistance of the machine, so as to regulate the speed without the use of idle resistances, none of which are employed; the highest economy is therefore obtained with light as with heavy loads. The electric brakes are of the pendulum type, which were first used on the Mt. McGregor motor in 1883, and are connected with a switch conveniently arranged to vary their power by variation of internal resistances. The mechanical baker consists of a compound lever attachment operated by a screw shaft through a thoggle mounted nut.

Contact with the third rail, placed between the main rails, is effected by means of a phosphor-bronze wheel attached to a movable frame-work which can be raised and lowered as occasion requires, by means of the lever shown in the side elevation, Fig. 3.

Upon each end of the armature shaft is a small wheel, formed with corrugations on its face which fit in corresponding corrugations on the face of a larger wheel mounted at each end of the driving wheel axle. As will be seen by reference to the drawings, Figs 3 and 4, the electro-dynamic machine is pivoted at one end in resilient bearings and attached to a vertical screw shaft at the other end, so as to enable the operator to vary the frictional contact between the friction gearing at will, and also affording an easy and convenient means for raising the whole machine to effect a change of armatures.

In order to avoid damage to the gearing and other parts of the electro-dynamic machine from shock, the whole machine is maintained in about equal resilience by means of alternating laminæ of iron and India rubber placed over the bearings of the drivers in lieu of the ordinary springs, and again in the pedestals at either end of the electro-dynamic machine. The object of using these laminated cushions is to avoid the too considerable motion which would result from the use of the ordinary springs, and at the same time provide a degree of resilience which enables the machine to run over very rough roads without the least derangement of parts.

The cab contains also a voltmeter, which shows the engineer the difference of potential on the track, just as the ordinary pressure gauge now indicates the pressure in a boiler.

The rails are the ordinary 56 pound steel rail, insulated by means of the Daft insulator, which consists of an umbrella of cast iron with head so formed as to readily admit of locking the base of the rail by means of two cap screws and washers. The standard is formed of any suitable insulating material; the standard now in use on the elevated road consists merely of baked hard wood saturated with asphaltum, which has so far been found to afford ample insulation for all practical purposes —the leakage with four miles of track now involved (two miles of double track), plus the switches, being inconsiderable. The joints are made by drilling holes in the web of the rail, and riveting strips of copper from one to the other; this method has been found entirely satisfactory, both here and on the road now in operation in Baltimore — the resistance having thus been reduced to nearly the calculated line resistance.

No difficulty has been experienced in making the switches, though in some instances a considerable interval has to be bridged by momentum alone, due to the necessity for leaving out the third rail in order to permit the passage of the ordinary steam locomotives; this difficulty would of course be removed in the event of the entire road being operated electrically. The maximum gradient is one of 105 feet per mile between 23d and 34th Streets. This has been surmounted with ease with fairly well loaded trains, and on several occasions an average speed of 20 miles an hour has been attained.

The track is vitalized by dynamos (Fig. 1) situated at the main station on 15th Street, about 200 yards from the track, it having been considered desirable to place the vitalizing machines as near one end of the track as possible, so as to show the influence of distance in lowering the potential.

The effect of these two miles is, therefore, rendered equal to four miles where the station is centrally placed, and the loss of energy at the extreme end is barely observable. The vitalizing

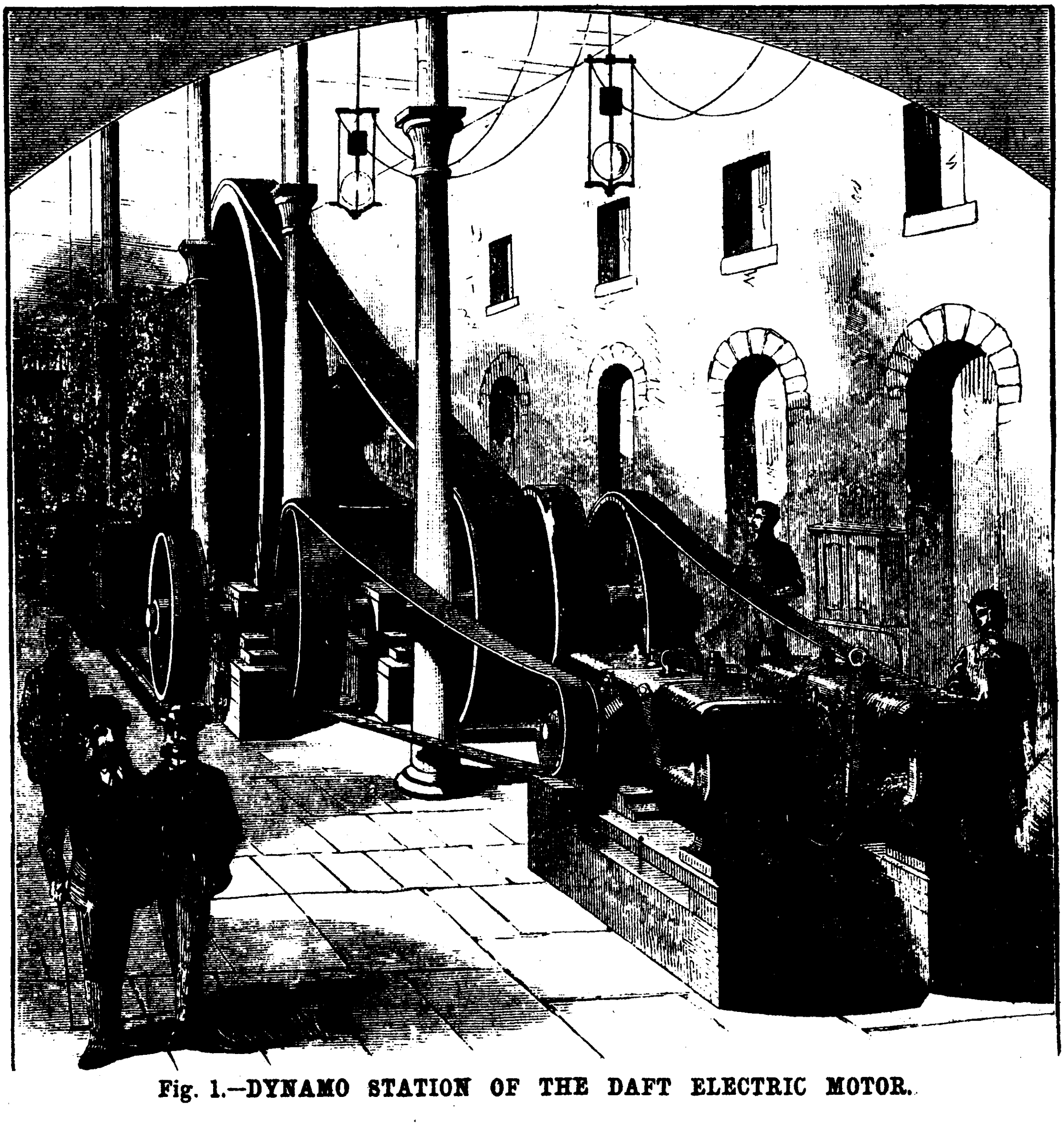


Fig. 1.—DYNAMO STATION OF THE DAFT ELECTRIC MOTOR.

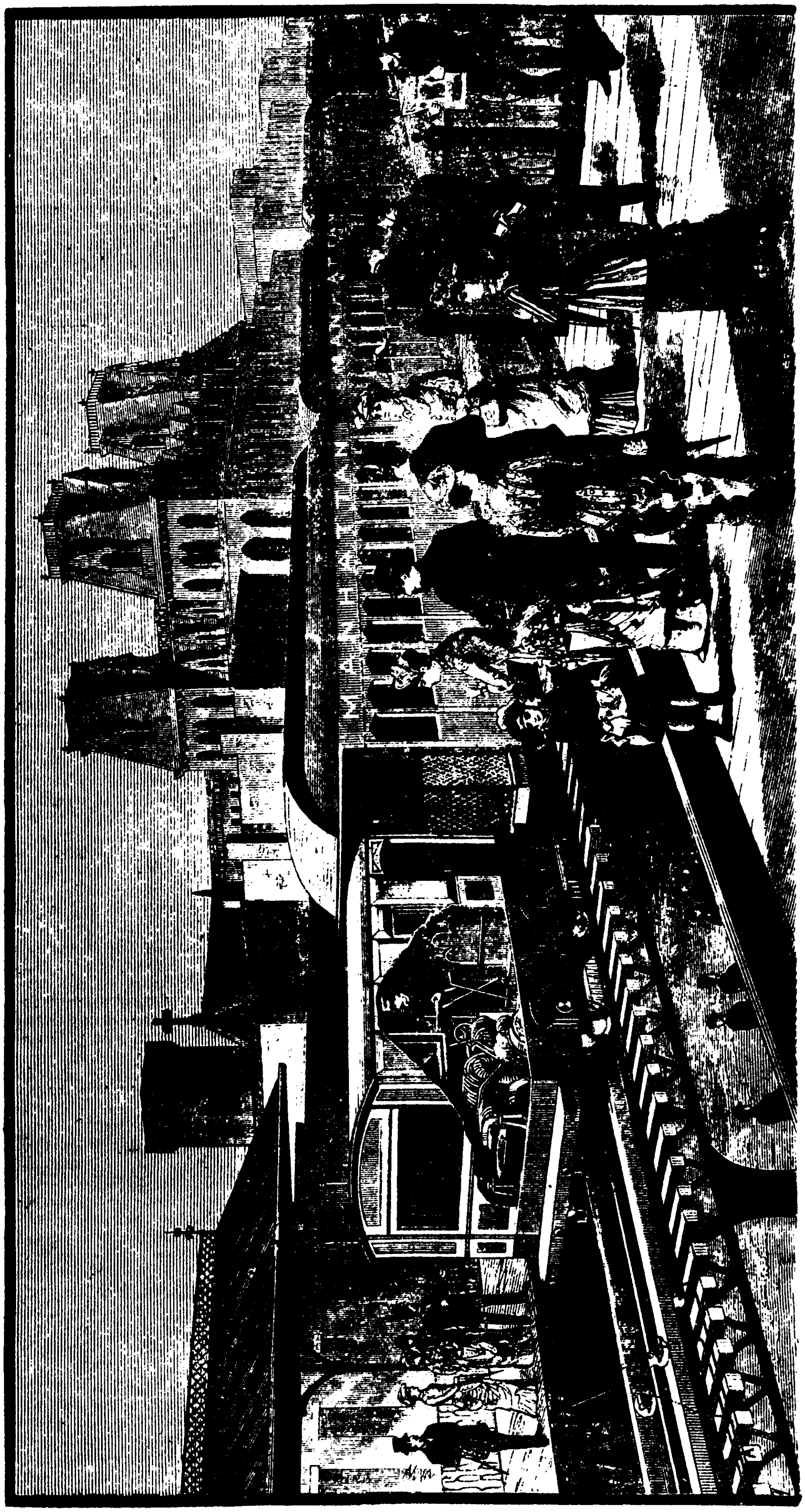


FIG. 2.—A STATION VIEW OF THE DAFT ELECTRIC MOTOR, ON THE NEW YORK ELEVATED R. R.

system at the station consists of three No 5 Daft dynamos, actuated by a Wright automatic cut-off steam engine, having a cylinder 18 x 42 inches and a flywheel 16 feet by 26 inches. There is, in addition, a small arc-light Daft dynamo used for lighting the station and boiler room. The machines are connected with a switchboard, so that they can be placed in "parallel" or "series," as may be desired, and there is in addition an automatic cut-off, which operates in the event of a short circuit on the track, so as to open the circuit at a fixed point, and at the same time give the engineer notice by ringing an alarm. There is also an attachment to indicate when the short circuit is removed. The machines are connected to the track by means of 0000 copper wire, with Underwriter's line insulation suspended upon poles.

The motor has already run several hundred miles on the short track at 14th Street, making many hundred stops and starts, involving much severe work, hauling four cars for a considerable portion of the time, and also a two car train, for the purpose of making close observations as to the difference in consumption of fuel. With regard to this all-important question, the tests are as yet necessarily incomplete ; but so far as they have gone, the indications are claimed to be satisfactory. The extraordinary adhesive properties of a locomotive operated in this manner are evident. This feature is well illustrated on the line in Baltimore, which at one point has a curve of 75 feet radius on a gradient of 353 feet, and yet no difficulty has been experienced by the motor in ascending this grade with a loaded train. So successful has been the working of the Baltimore road that two more motors have been ordered, making a total of four. — *Scientific American.*

INDIRECT ADVANTAGES OF INVENTION.

Every year there are numerous mechanical devices brought out that are to "fill long-felt wants," and "revolutionize" matters in their particular line ; apparently the wants are just as many as ever, and revolution progresses slowly. An inventor almost always makes more wants than he fills ; the value of his invention is generally more in this fact than in the real worth of what he invents—in this fact and in the fact that it stimulates others to exertions. A few years ago the automatic cut-off steam engine was to take the place of all others ; there are a great many throttling engines built in these days, and apparently always will be. That this is true does not argue any fault with automatic engines. Since the advent of automatic cut-off engines, great improvements have been made in throttling engines that have enabled them, for some purposes, to hold their own. But these improvements are largely due to the invention of autômatic engines. The automatic engine cuts off short, and it was discovered that a plain slide could be made to cut off at half stroke, or shorter. The automatic engine governor closely, and this fact had a good deal to do with the invention of better throttling governors.

So it will be found in a hundred other things. If Smith or Jones makes an improvement in steam engines or printing presses, the world is chiefly advantaged in the improvements, and every one else who builds steam engines or printing presses is moved to make to avoid falling behind in his business. The fact that some are progressive prevents the possibility of conservatism, in a bad sense, in the others ; comparatively a few progressive men in any line of manufacture will keep all the rest alive to the necessity of progress. And this operates advantageously in two ways : Besides inducing progress in others, it prevents the possibility of anything like monopoly that will keep prices at an exorbitant figure. An instance of this is seen in electric lighting. Although a new field to almost every one a few years ago, there have already been so many inventions relating to it, made by different individuals, that competition is sharp enough to keep prices to consumers low ; and there is apparently but little danger of a combination that shall change this. A combination to this end would be sure, in its stimulating effect, to result in further invention that would defeat it. This invention in relation to electrict lighting, in which hundreds have been and are engaged, was largely induced by the efforts and invention of one or two men, the indirect advantages of which outweigh many times over the direct.

Another instance of the influence of the invention beyond what is originally intended, is seen in the steel industry. As soon as a beginning is made with Bessemer steel castings, and the "want" indicated, attention was turned to the subject, and at the present time steel castings of all qualities, and at comparatively cheap prices, are common enough to suit everyone, with the prospect that further efforts will better the product and reduce the cost. But the effect of the use of steel castings has already gone farther than this ; it has had a good deal to do with improving methods for forging by which the product has been improved and the cost reduced ; it has also had the effect to wake iron molders up to the exercise of more judgment and study, that is, to make better iron castings than ever before, and to make them at less cost.

Instances like those mentioned might be multiplied indefinitely. Competition of this kind can be, except in some cases, depended upon to reduce and keep down prices and to further improve the quality of the product ; as invention must be of starting novelty to insure the inventor being allowed to quietly gather abnormal profits for any great length of time. Something new, or the adaptation of old means, is reasonabley sure to interfere with any plans in that direction. Many times inventors have a false sense of security in their ability to control prices, but an unpleasant awakening is reasonably certain to follow. Their rewards are likely to be fair, but not disproportionately great.—*American Machinist.*

THE EFFECT OF FIRE ON IRON COLUMNS.

Some interresting and instructive experiments have been lately undertaken by Professor Bauschinger, of Munich, in reference to the safety of cast-iron columns when exposed to the action of great heat. The professor having arranged some cast and wrought iron columns heavily weighted, exactly as they would be if supporting a building, had them gradually heated first to three hundred degrees, next six hundred degrees, and finally to red heat ; then suddenly cooled them by a jet of water, just as might happen when water is applied to extinguish a fire. The experiments showed that the cast-iron columns, although they were bent by the red heat, and exhibited transverse cracks when the cold water was applied, yet supported the weight resting on them ; whilst the wrought-iron columns were bent before arriving at the state of red heat, and were afterwards so much distorted by the water by re-straigthening them was out of the question. In fact if supporting a real building they would have utterly collapsed under the weight they had to sustain. The Professor therefore concludes, as the results of his experiments that cast-iron columns, notwithstanding cracks, and bends, would continue to support the weight imposed upon them, whilst wrought-iron columns, would not. In experimenting on pillars of stone, brick, and cement concrete, the last was found to be the best, cement concrete pillars withstood the fierce action of fire, for periods varying from one to three hours ; brick pillars, as well as those of clinkers set in cement mortar, displayed great resistance ; whilst natural stone-granite, limestone and sandstone were not fire-proof. It would therefore appear that of the several materials for pillars supporting weights, the best for fire resisting purposes were the cast-iron and cement concrete. But the concrete to be perfectly fire-resisting should be made from sulphate of lime (gypsum), not ordinary building or carbonate of lime, nor Portland cement, as neither of these are fire-resisting substances.—*From the Theatre.*

SCIENTIFIC SYSTEMATIC METHOD IN ORDINARY MECHANICAL OCCUPATIONS.

From advance sheets of the *Journal of the Franklin Institute*, we reproduce the principal part of a lecture delivered by Coleman Sceller before the Franklin Institute, of Philedelphia, November 6 :

I propose, this evening, saying a few words to you on the part that systematic, scientific method plays in the most ordinary mechanical occupations, and to point out the need of orderly method in the advancement of all the arts. I had occasion, the other day, to watch the operation of a mechanical shoemaker, at work in the Novelties Exhibition. Boots and shoes were being sewed on this machine, the stiches made with brass wire ; brass staples were selected, automatically, of the proper length, and were inserted in place. My attention had been criticallly drawn to this machine in acting as judge in the class to which it belonged ; not very far away were books, which, in binding, were sewed with wire staples, and between the two were many devices to enable hand-sewing with wire staples to be done with ease. My mind naturally grouped these objects and processes, and even flew back over many, many years to days of childhood, when I had learned one of my first lessons in mechanics from my father, who held me in his arms, so small was I, as he showed me the then great wonder of fine steel wire bent in a machine into staples and driven through thick leather in rapid succession, to form the fine teeth of the cards used in carding wool and cotton fiber. I was not at, say, four years old, too young to remember the lesson when it was facts that were given me to think over. He took good care to point out that the fine wire forming the staple was driven through the leather with unerring precision, and without any holes having been pierced for it by more rigid needles. The card clothing machines at Cardington were driven by water-power, but this mechanical shoemaker at the Novelties was driven by a steam-engine of the highest type. That steam-engine had its lesson to teach; a life, too, could span much of the period of transition from the first crude machines that grew out of Oliver Evans' notion of a high-pressure engine to the work of Corlis and others of to-day. It had made but little advance, even as early as I can remember, as compared to the result of to-day, and its slow growth had been after the manner of the survival of the fittest. Its history is cumbered with a vast amount of negative information, by years of mistakes, the results of empirical methods as against the systematic mode of more modern research. As the steam-engine grew towards its present state of perfection, in spite of the many drawbacks, the theory of thermo-dynamics took shape. The practical mechanic, who prides himself on the grand fact that he has drawn all his information, as it were, through the handle of the hammer he has worked with, has a holy horror of all that savors of science, and, what is more, he holds in contempt the scientific engineer. It was one of these practical men who presented a contrivance of his to a railroad company for trial; some of the directors thought it would be well to investigate, and the trial was made. The inventor afterwards said that the failure was due to the scientific experts who conducted the trial. He suspected they had put some thermodynamics, or some other scientific stuff, into the boiler, on purpose to prevent his device from operating. Now, thermodynamics is the name given to the science that takes into consideration the co-relation between heat and work. The designers of the great engines of to day have the advantage of a pretty thorough knowledge of the laws that had been found to govern the commission of heat into motion, and of motion into heat. Could a knowledge of thermo-dynamics have preceded the steam-engine, there is no telling how much farther we would have been now in our motive-power department of the world's industries.

We are living in an age when the Baconian inductive system of research is relied on; the rapid progress of modern times is due to the results of the inductive system. In old times, the philosophers contrived theories to account for known facts. Lord Bacon was the one who clearly pointed out the need of obtaining many facts and finding the laws that govern matter through and by the study of the facts, but going beyond the range of the facts that we can obtain for the purpose of investigation.

The old philosopher stood on a hill and saw the land spread out before him as a mighty plane, and, as he watched the movements of the heavenly bodies, he saw them rise in the east and sink below the horizon in the west. Upon this visible fact he concluded, with the more modern colored preacher in Virginia, that "the sun do move," because he saw it move; and so, from this visible fact, he proceeded to build up a theory and astronomy, and hunted for other facts to sustain his theory.

A more modern philosopher, under the same conditions, perhaps, notices that objects floating on the surface of the sea sink out of sight at the horizon, and as these bodies are moving, hence infers that the surface of the world is round, and, gathering many more facts, he then draws conclusions from his observation that enable him to look farther ahead and foretell, as it were, greater discoveries.

The wonderful progress of modern times is due wholly to the method that has been pursued of grouping facts in proper order, working out laws that govern matter, and proving that the laws are correct by finding no exception to them. An established law is what explains all phenomena bearing on it, and when no known fact offers any contradiction to it. Established laws are many, and the knowledge of these laws makes the wisdom of the modern scientific mechanic. There are laws that can be so thoroughly trusted that we no longer need investigate, and we follow them with confidence, knowing that we cannot change them, if we would do so. Gradually the knowledge of the world has become formulated, and we have in simple form, ready for work, the accumulated knowledge of all who have preceeded us. We have before us, it is true, a vast field of experimental research, but we are in position to guide our work systematically by the lights we now have. The day for empiricism in mechanics has gone by, and I wish to show you this with a few simple illustrations.

I have here a ball attached to the end of a piece of string; the string seems strong enough to carry the ball—at least, it does not break under the strain. I whirl the ball in a circle, and past experience leads me to infer that if I whirl it rapidly enough the string will break under a strain, due to the centrifugal force incident to the rotation. This fact is so well known to all of you that it is not needful for me to prove it by trial. We hear of fly-wheels and grindstones breaking when revolved too rapidly. If, for any reason, I should desire to keep up the rotation of the ball at the end of the string with safety, I must know the force exerted on the string during rotation and I must know the ultimate strength of the strain. I have only to know the weight of the ball and its velocity in feet per second during rotation, and calculation will give me the strain on string more actually than I could obtain it by experiment. Now, on the other hand, no amount of calculation will tell me if this particular string is strong enough to bear the strain with safety. To find out the ultimate or breaking strength of the strain, I must load it with an increasing weight until rupture takes place, and the information thus obtained can be used with some degree of certainty with the balance of the twine on the ball from which this was taken, or can be used to predicate the strength of another string of similar size and construction. This homely illustration will convey to your minds what I want to make clear, namely, just where we can rely on calculation, and where experiment must be resorted to continually. Let me now give you an example of the working of the scientific method in actual practice, covering a case involving calculations and experiment. Steam boilers have been made to serve the purpose of death traps from the most culpable neglect of ordinary precautions for safety, coupled with gross ignorance of Nature's laws, until the authorities were obliged to step in and define by laws certain precautions that must be taken for the welfare of the community. Steam boilers are made of sheets of iron or steel bent into shape and joined by rivets. As the strength of the weakest individual part of the structure, it is of moment that the true value of any particular kind of riveted seam be known by actual experiment. There is no way of making the riveted seam as strong as the body of the metal. It is now usual, to so proportion the number and size of the rivets to the thickness of the plates to be joined, that the metal remaining between the rivet holes, shall about equal the strength of the rivets that unite them. In determining the pressure of steam a boiler already made can be permitted to work under, a calculation is gone into as to the strength of the seam, as measured by the area in section of metal between the rivets, and also measured by the size and number of the rivets, and the strength of the seam is assumed to be the lowest result of the calculation. After this, it may be necessary to know the strength of metal that forms the boiler, and just here is where the lesson of the ball and the string comes into play, and our present illustration is as readily understood. It does not require a very high order of talent to master the calculations that are resorted to, to determine what strain will come on this or that part of the boiler, and we have to rely wholly on calculation, for that information. The boiler must be made much stronger than its ultimate or breaking strength of the metal to insure its safety in use, and to allow for deterioration. The difference between the ultimate or breaking strength and the strain that it is subjected to in practice, is regulated by what is termed the factor of safety. All well-considered specifications for structural metal work, for instance, call for the material to come up to some established standard of ultimate or breaking strength, and the amount of metal to be used in the structure is determined by a factor of safety specified. This factor of safety may be as low as four, in some cases of boiler and bridge construction, when the known character of the material used warrants the course, or it may be as high as thirty, in the case of matter subjected to shock or blows, as in the case of rapidly-revolving gear wheels. That is to say, it may be considered safe to strain the structure to one-fourth of what would cause it to break, or the case may require that we dare not strain it beyond one-thirtieth of its breaking strength. The question now presents itself, how can every sheet of iron or steel to be

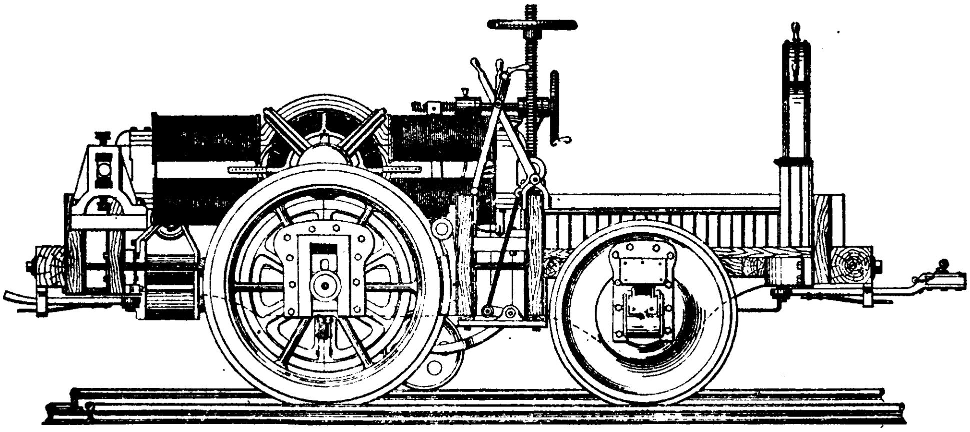


Fig. 3.—SIDE ELEVATION OF THE ELECTRIC MOTOR

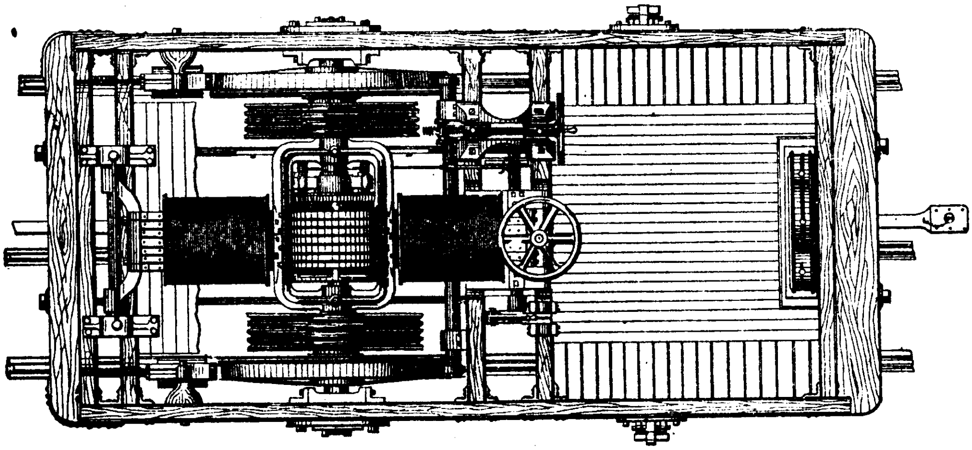


Fig. 4.—PLAN VIEW OF THE ELECTRIC MOTOR.

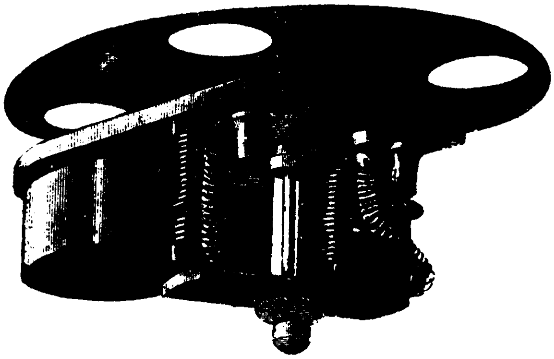


FIG. 1.—LIGHT INTERRUPTER FOR THE MICROSCOPE.

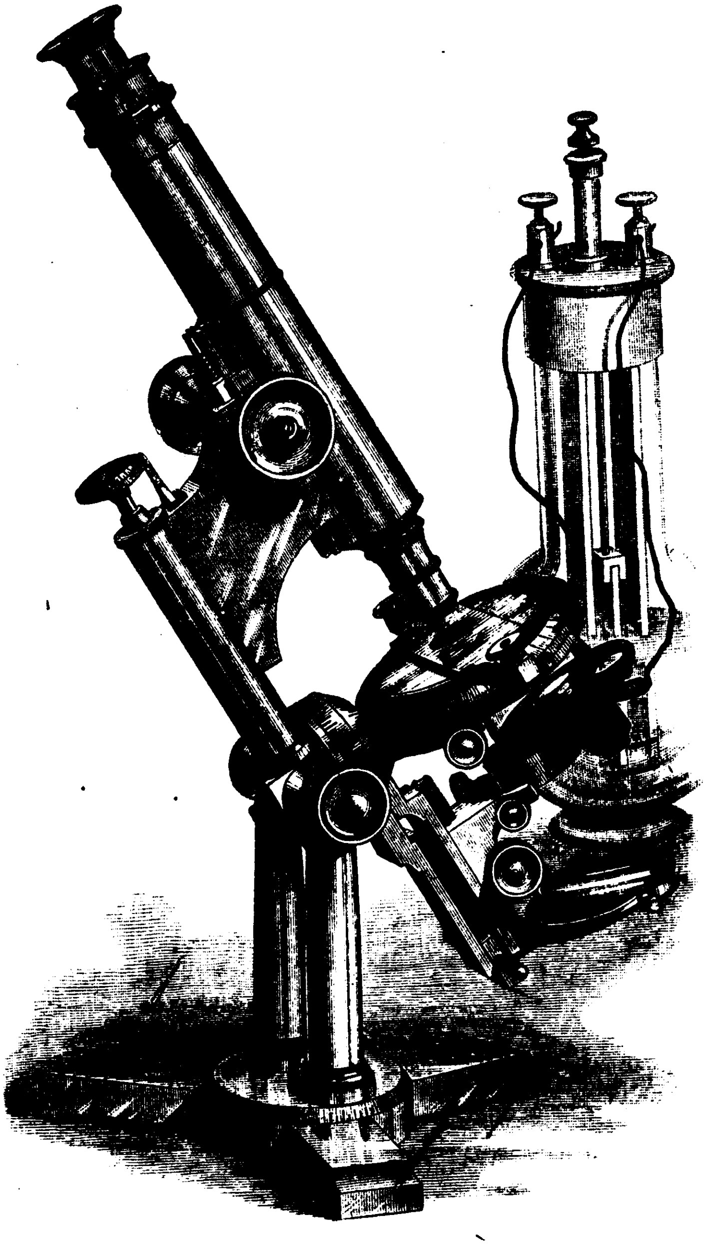


FIG. 2.

MICROSCOPIC EXAMINATION OF CILIATED ORGANISMS BY INTERMITTENT LIGHT.

used in the construction of a boiler, for instance, be tested, when such sheets are usually ordered from the mill of the exact size that is required, and to test a part of such sheet would destroy it for use. This furnishes me with a suitable example of the scientific method carried out with ease and certainty in every-day practice.

Steam boilers of locomotives are worked at a rather high pressure, say 120 or 130 pounds to the square inch, and the metal now mostly used in their construction, is steel of a low grade as regards hardness, that is, steel of considerable ductility. From the specification for boiler and fire-box steel issued by the General Superintendent of Motive Power of the Pennsylvania Railroad, December 1, 1882, I extract the following ;

(1.) A careful examination will be made of every sheet, and none will be received that show mechanical defects.

(2.) A test strip from each sheet, taken lengthwise of the sheet, and without annealing, should have a tensile strength of 55,000 pounds per square inch, and elongation of thirty per cent. in section originally two inches long.

(3.) Sheets will not be accepted if the test shows a tensile strength less than 50,000 pounds, or greater than 65,000 pounds, per square inch, nor if the elongation falls below twenty-five per cent.

(4.) Should any sheets develop defects in working, they will be rejected.

(5.) Manufacturers must send one strip for each sheet (this strip must accompany the sheet in every case); both the sheet and strip being properly stamped with the marks designated by this company, and also lettered with white lead to facilitate matching.

Now let me explain this specification to you, as it has been explained to me in the admirable test-room of the shops at Altoona:

There are many makers of steel boiler plate in the United States, and without referring by name to any one, I can state that the Pennsylvania Railroad has decided on a set of arbitrary signs to indicate each maker. One is designed by a triangular stamp, one other by a circular stamp that marks a ring of about one inch in diameter, another by a square of like size, and so on. Sheets of steel come from the rolls with a more or less irregular outline and of a size that will permit the tests strip to be cut off from one or the other edge without difficulty. The plate in the rough is, when cold, scribed to the required size of sheet that it is to be sheared to, and on the shear line two marks are made by the prescribed stamp, one mark being made at one blow of the hammer and the other by the same punch or stamp at another blow, and atany convenient distance from the other, but in no case are the two marks made by a twin set of punches or stamps at any fixed distance one from the other. This irregularity of the stamping renders the after matching of the strip, or coupon as it is called, an easy matter, with the sheet from which it has been cut, the shear cut being made directly through the marks. The matching is still further facilitated by numbers or signs in white lead.

After reception by the proper inspectors on the road, the samples, or coupons, are stamped with corresponsing numbers after verification, and the test piece goes into the shop to be dressed to the proper width for the test, and the sample is then broken in a testing machine, and, in a book kept for that purpose, entry is made of every particular connected with the test, and the sheet received or rejected on this record. Suppose, however that a sample shows a higher tensile strength than the maximum allowed, namely, 65,000 pounds per square inch, and that such specimen has an elongation or ductility as great as can be desired, it may be well asked why it should be rejected. In the book of record, I have seen some such cases, and reference is there made to the book of the chemist, into whose hands such sample is sure to go. His chemical test had in all cases, up to the time I saw the book, indicated too much carbon in the steel, and a simple physical test of heating and plunging the hot steel into cold water has shown it to be capable of being hardened. It is not deemed wise to employ any metal that has hardening qualities in the construction of steam boilers. After many such trials, the officers of the road have come to consider the tensile and ductility tests as final, and as expressive of the quality wanted. Thus you see every sheet in every boiler has its physical quality when new recorded, and its marks enable its after history to be noted. No sheet of steel can meet with mishap afterwards, without having the report of the mishap recorded on the page that marked its acceptance, and its life or durability also noted. Such, in brief, is the account of the admirable scientific investigation into the quality of the material used in boilers, as reduced to practice, and so persistently persued by this one company as to be now no longer a subject of comment. This method of test, however, is the outgrowth of systems that preceded it. Practice and theory must agree. The scientific engineer can lay claim to the title only when he is abundantly fortified by sound experience, and has learned to view all things evenly

In the specification of the Pennsylvania Railroad, as already cited, stress is laid on the percentage of stretch before rupture takes place in the required test. The date of the printed specification I have referred to, is 1882. On January 8, 1881, I had a letter from the superintendent of Motive Power, in which he describes other tests which had been used for a long time. These were bending tests.

(1) Bending cold.—A strip from each sheet must stand being bent over double, and being hammered down flat upon itself without fracture.

(2) Bending after being heated and dipped.—A strip from each sheet must stand being bent over double, and being hammered down flat upon itself, after having been heated to a flanging heat and dipped into cold water, without sign of fracture.

He informed me that the bending tests had been insisted on for several years, but that the certainty of the ductility test had caused them to make it the final mode of determining the quality of the steel submitted to them. In order to make the bending as uniform as possible, they adopted the plan of holding the strip to be bent between rigid jaws and striking the projecting end with a ten-pound sledge until it is deflected about 135°, when it was removed from the jaws and held with tongs while it was hammered down flat on an anvil. The bending after heating and dipping was added to protect them against acceptance of hard sheets, by reason of the test strips being annealed, accidentally or otherwise by the manufacturers. He said that for some time past they have been testing tensiley, to obtain ultimate strength and ductility, a piece from the strip send with each sheet, and had established a tensile test, which supplanted the bending test, but covered the same ground that it did. This was done on account of the greater regularity and uniformity of the results in tensile test, and because by it they obtain figures to show the exact quality of the steel; so that even in 1881 they were working under the specification I have already mentioned, as furnished me in 1882. Time is an important element in tests, particularly so in bending tests. An expert giving testimony in a trial in which the reliability of the steam-engine indicator was in question said: "I believe in the result of the use of the indicator when I know who works the instrument." . The bending test is good, when you see it done in a proper manner, or know who does the bending.

Hurry the bending of good metal and it may break. Proceed with the bending of poor metal with caution, let it rest a bit between each blow, and a skillful man can bend a strip of brittle steel, so that the specimen will deceive the most expert. It is a very curious property of wrought iron and steel, that after being strained above the limit of elasticity and near to the point of fracture, rest will restore its strength. The story is told of some tests being made on beams for structural work before some officers of the Government. One maker strained a beam up to a point near to the breaking point,and then invited the Board to test some champagne, saying that he was willing to let the beam remain under its heavy load until after lunch. When the test was resumed, a strength was shown that could not have been reached had the rupture been hurried to completion and the metal had been allowed no time to accommodate itself to the strained condition.

Let me now go back to the consideration of material used in boilers. During the latter part of Mayor Stokley's administration, say about 1880, he, at the instance of the City Inspector of steam-engines and stationary boilers, and of the officers of an insurance company for inspection and insurance of steam boilers, appointed a commission to devise some fixed rules, whereby some uniformity of rating could be insured as to the pressure at which boilers may be worked. I had the honor of serving on that commisson, and am thus enabled to tell you that we found a set of rules in force which gave to all boilers of the same diameter and the same thickness of metal the same pressure per square inch, regardless of the quality of the metal employed in construction and of the nature of the riveted seams. Fortunately, however, our City Inspectors of steam boilers were practically boiler-makers and were familiar with the requirements and could refuse to pass boilers manifestly unfit for use, for men long familiar with work of this kind come to learn what is right by experience and good common-sense.

The ordinances passed by councils, at the suggestion of the commission, made it imperative that all the conditions that exist in each boiler as to nature of seams, thickness and quality of the metal used, should be considered, and the boilers rated accordingly, giving the great latitude to good workmanship and good quality of material combined with judicious proportioning of the parts. At the time to which I allude, but a few years ago, the United States laws in ragard to the testing of boilers used in the marine service, called only for a knowledge of the tensile strength, and no notice was taken of the softness or ductility of the metal combined with great strength. I know a case in which a sheet had to be selected of higher tensile strenth than could be obtained at the time, coupled with much ductility, to repair a boiler so that it would pass the inspectors under United States laws. A lower ultimate tensile strength with high ductility would have made a safer job of the repair. We have come to the time now, when to hold our place in the world in competition with others, we should waste as little of our energies as possible in cutting and trying in any hap-hazard way and endeavor to avail ourselves of the acquired knowledge of the world generally, and make scientific application of the knowledge in our daily work.

MICROSCOPIC EXAMINATION OF CILIATED ORGANISMS BY INTERMITTENT LIGHT.

BY GEORGE M. HOPKINS.

Every observing person has noticed that moving objects appear stationary when viewed by a flash of light; examples of this are seen during every thunder storm occurring in the night. The wheels of a carriage, a moving animal, or any moving thing, seen by the light of the lightning, appears perfectly stationary, the duration of the light being so brief as to admit of only an inappreciable movement of the body while illumination lasts.

If by any means a regular succession of light flashes be produced, the moving body will be seen in as many different positions as there are flashes of light. If a body rotating rapidly on a fixed axis be viewed by light flashes occurring once during each revolution of the body, only one image will be observed, and this will result from a succession of impressions upon the retina, which by the persistence of vision become blended into one continuous image. In this case no movement of the body will be apparent; but if the flashes of light succeed each other ever so little slower than the rotatory period of the revolving body, the body will appear to move slowly forward, while in reality it is moving rapidly; and should the light flashes succeed each other more readily than the revolutions of the body revolving the body will appear to move slowly backward, or in a direction opposite to that direction in which it is really turning. These curious effects are also produced when the number of the light flashes is a multiple of the number of revolutions, or *vice versa*.

The combined effect of interrupted illumination and persistence of vision may be practically utilized for examining objects under motion which could not otherwise be satisfactorily studied. To apply intermittent light to the microscopical examination of ciliated organisms, the writer has devised the electrically rotated apertured disk shown in Fig. 1, which is arranged to interrupt the beam of light employed in illuminating the object to be examined.

The instrument consists of an electrict motor of the simplest kind mounted on a plate having a collar fitted to the substage of the microscope, as shown in Fig. 2. The shaft, which carries a simple bar armature before the poles of the magnet, also carries upon its upper extremity a disk having two or four apertures, which coincide with the apertures of the stage and substage two or four times during the revolutions of the disk.

The shaft carries a commutator, and the course of the current from the battery through the instrument is through the spring touching the commutator, through the shaft and frame of the instrument to the magnet, thence out and back to the battery. There are two methods by which the speed of rotation of the apertured disk may be varied; one is by plunging the elements of the battery more or less, and the other is by applying the finger to the shaft of the motor as a break, the motor in the latter case being started at its maximum speed, and then slowed down to the required degree by the friction of the finger. Experiment shows that the period of darkness should be to the period of illumination about as three to one for the best effects. Closing two diametrically opposite holes in the disk represented in the cut secures about the correct proportion.

Various rotifers examined by intermittent light showed the cilia perfect stationary. The ciliary filaments of some of the infusoria, Vorticella and the Stentor, for example, when viewed by intermittent light, appeared to stand still, and their length seemed much greater than when examined by continuous light. The interrupted light brings out not only the cilia around the oral aperture, but shows to good advantage the cilia disposed along the margin of the body. What interrupted light may reveal in the examination of flagellate or ciliated plants the writer is unable to say, as no objects of this character have been available. It is presumable, however, that something interesting will result from the examination of Volvox and other motile plants, by means of this kind of illumination. Although it is necessary to interrupt the beam of light regularly, for continuous observation, the effect of intermittent light may be exhibited to some extent by an apertured disk like that above described, twirled by the thumb and finger or revolved like a top by means of a string; or by using a large apertured disk fitted to a rotator, and placed between the source of light and the mirror of the microscope.—*Sc. Am.*

MODERN LOCOMOTIVE CONSTRUCTION.

BY J. G. A. MEYER.

FOURTEENTH PAPER.

LEAD WILL AFFECT THE POINT OF CUT-OFF.

In Fig. 55 the valve had no lead; if, now, in that figure, we change the angular advance of the eccentric so that the valve will have lead, as shown in Fig. 56, then the point of cut-off will also be changed. How to find the point of cut-off when the valve has lead, is shown in Fig. 56.

Example 19.—The lap of valve is 1 inch, its travel 5 inches; lead ¼ of an inch (this large amount of lead has been chosen for the sake of clearness in the figure); stroke of piston, 24 inches; at what part of the stroke will the steam be cut off?

On the line *A B*, Fig. 56, lay off the exhaust and steam ports; also on this line find the center *c* of the circle *a b m* in a manner similar to that followed in the last construction, namely, by placing the valve in a central position, as shown by the dotted lines, and marked *D*, and then adopting the edge *c* of the valve as the center of the circle *a b m;* or, to use fewer words, we may say from the outside of the edge *s* of the steam port, lay off on the line *A B* a point *c* whose distance from the edge *s* will be equal to the lap, that is, 1 inch. From *c* as a center, and with a radius of 2½ inches (equal ½ of the travel), describe the circle *a b m*, whose circumference will represent the path of the center of eccentric. The lead of the valve in a locomotive is generally $\frac{1}{32}$ and sometimes as much as $\frac{1}{16}$ of on inch, when the valve is in full gear, but for the sake of distinctness we have adopted in this construction a lead of ¼ of an inch. Draw the section of the valve, as shown in full lines, in a position that it will occupy when the piston is at the beginning of its stroke, and consequently the distance between the edge c^2 of the valve and the edge *s* of the steam port will, in this case, be ¼ of an inch. Through c^2 draw a straight line perpendicular to *A B*, intersecting the circumference *a b m* in the point *y;* this point will be the center of the eccentric when the piston is at the beginning of its stroke, and since it is assumed that the circumference *a b m* also represents the path of the center of the crank-pin, the point *y* will also be the position of the same when the piston is at the commencement of its stroke. Through the points *y* and *c* draw a straight line *y x*, to represent the stroke of the piston, and divide it into 24 equal parts. Through the point *s* draw a straight line perpendicular to *A B*, intersecting the circumference *a b m* in the point *g*, and through *g* draw a straight line perpendicular to *y x*, and intersecting the latter in the point *k*; this point will be the point of cut-off, and since the distance between the point *k* and 19 is about ⅛ of the space from 19 to 20, we conclude that the piston has traveled 19⅛ inches from the beginning of its stroke when the admission of steam into the cylinder is suppressed.

Here we see that when a valve has no lead, as in Fig. 55, the admission of steam into the cylinder will cease when the piston has traveled 20 inches; and when the angular advance of the eccentric is changed, as in Fig. 56, so that the value has ¼ of an inch lead, the point of cut-off will be at 19⅛ inches from the beginning of the stroke, a difference of ⅞ of an inch between the point of cut-off in Fig. 55 and that in Fig. 56. But the

MODERN LOCOMOTIVE CONSTRUCTION.

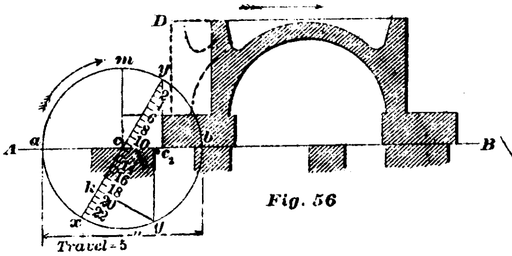


Fig. 56

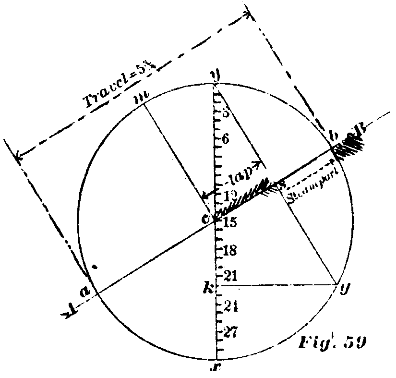


Fig. 59

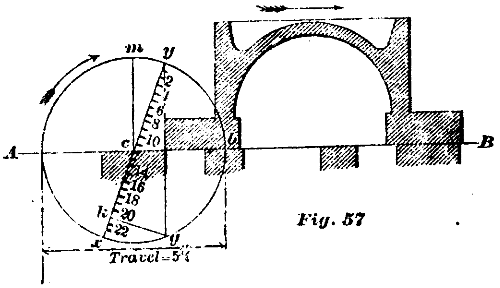


Fig. 57

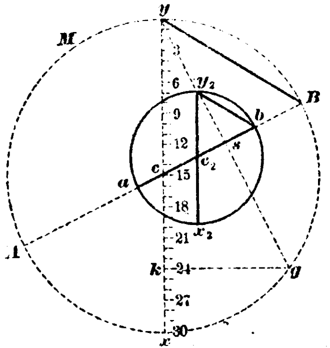


Fig. 60

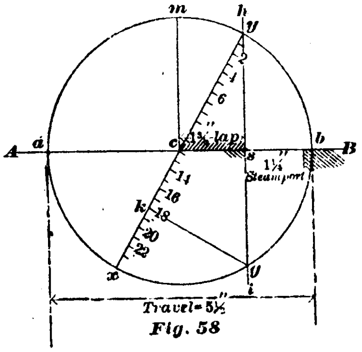


Fig. 58

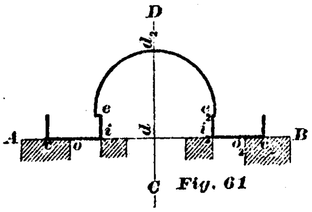


Fig. 61

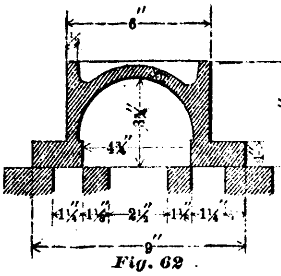


Fig. 62

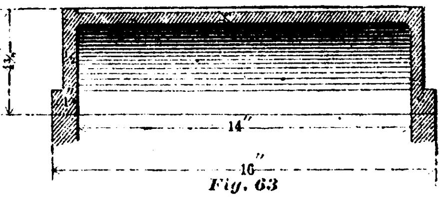


Fig. 63

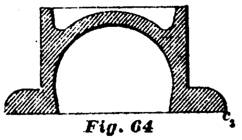
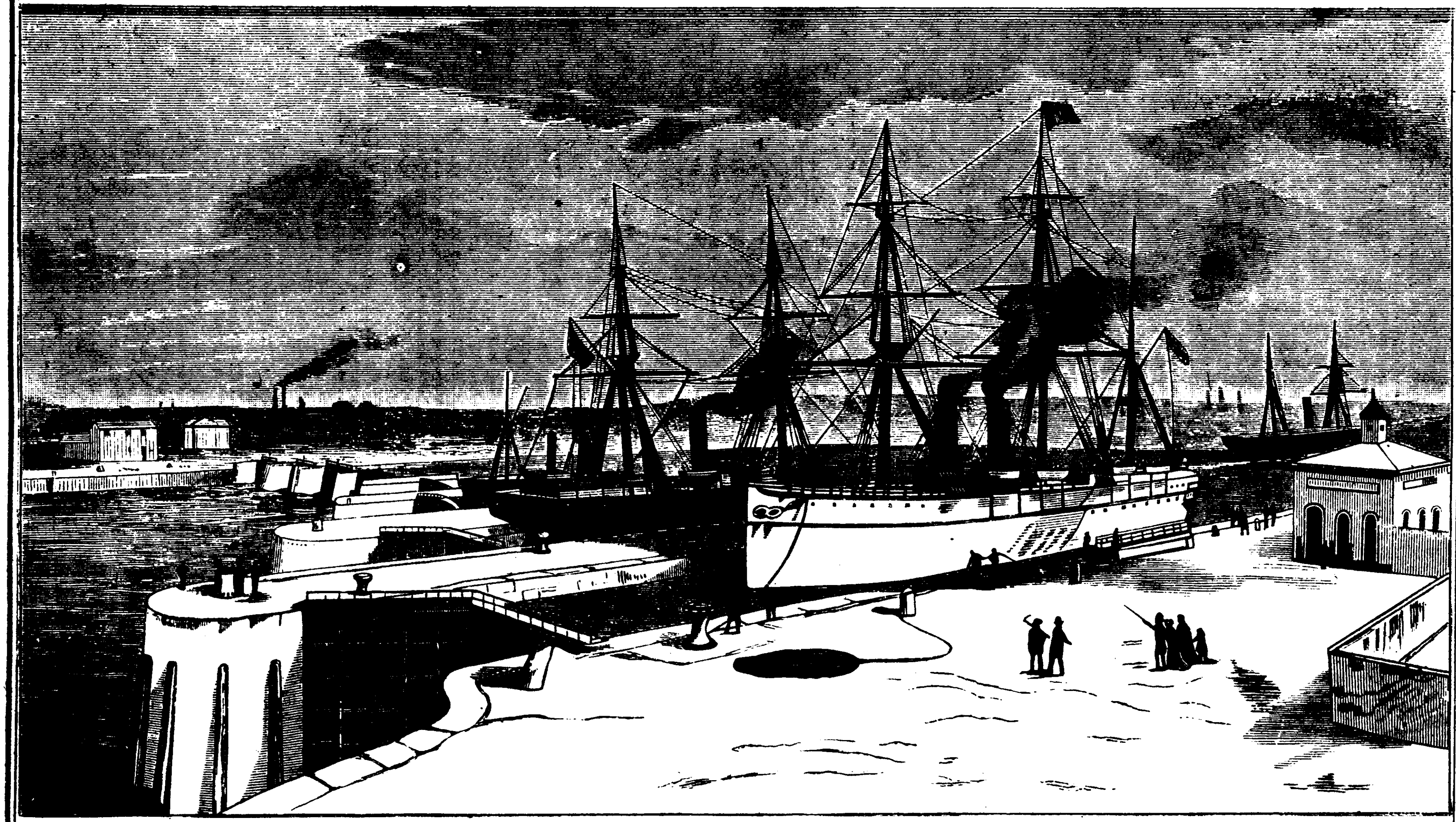


Fig. 64



LOCKS OF THE MANCHESTER SHIP CANAL.

lead in locomotive valves in full gear is only about $\frac{1}{32}$ of an inch, which will affect the point of cut-off so very little that we need not notice its effect upon the period of admission, and, therefore, lead will not be taken into consideration in the following examples.

THE TRAVEL OF THE VALVE WILL AFFECT THE POINT OF CUT–OFF.

Fig. 57 represents the same valve and ports as shown in Fig. 55, but the travel of the valve in Fig. 57 has been increased to 5¾ inches. The point of cut-off *k* has been obtained by the same method as that employed in Figs. 55 and 56, and we find that this point *k* coincides with point 21. Now, notice the change caused by an increase of travel ; when the travel of the valve is 5 inches, as shown in Fig. 55, the admission of steam into the cylinder will cease when the piston has traveled 20 inches from the commencement of its stroke, and when the travel of the same valve is increased ¾ of an inch, as shown in Fig. 57, the admission of the steam will not be suppressed until the piston has traveled 21 inches. Here we notice a difference of 1 inch between the two points of cut-off. But it must be remembered that when the travel of a valve for a new engine is to be found or established, the point of cut-off does not enter the question ; we simply assign such a travel to the valve that steam ports will be fully opened, or slightly more, when the valve is in full gear ; and how to find this travel has been explained in a previous paper. The point of cut-off is regulated by the lap and position of the eccentric.

In order to find the point of cut-off it is not necessary to make a drawing of the valve, has been done in Fig. 55. The only reason for doing so was to present the method of finding the point of cut-off to the beginner in as plain a manner as possible. In order to show how such problems can be solved without the section of the valve, and, consequently, with less labor, another example, similar to Example 18, is introduced.

Example 20.—Lap of valve is 1⅜ inches ; travel, 5½ inches ; stroke of piston, 24 inches ; width of steam port, 1¼ inch ; find the point of cut-off

Fig. 58. Draw any straight line, as *A B ;* anywhere on this line mark off 1¼ inch, equal to the width of the steam port. From the edge *s* of the steam port lay off on the line *A B* a point *c* the distance between the points *s* and *c* being 1⅜ inches ; that is equal to the amount of lap. From *c* as a center, and with a radius equal to half the travel, namely, 2¾ inches, draw a circle *a b m ;* the circumference of this circle will represent the path of the center of the eccentric, and also that of the crank-pin. Through *s* draw a straight line *i h* perpendicular to *A B*, this line *i h* will intersect the circumference *a b m* in the points *y* and *g*. Through the points *y* and *c* draw a straight line *y x ;* the diameter *y x* will represent the stroke of the piston. Divide *y x* into 24 equal parts ; through the point *g* draw a straight line *g k* perpendicular to *y x*, and intersecting *y x* in the point *k*, and this point is the point of cut-off. Since *k* coincides with the point 18, it follows that the piston had traveled 18 inches from the beginning of its stroke when the flow of the steam into the cylinder ceased.

Now, we may reverse the order of this construction and thus find the amount of lap required to cut off steam at a given portion of the stroke.

Example 21.—Travel of valve is 5¾ inches ; stroke of piston, 30 inches ; steam to be cut-off when the piston has traveled 22 inches from the beginning of the stroke ; width of steam port, 1⅜ inch ; find the lap.

Fig. 59. Draw a circle *a b m* whose diameter is equal to the travel of the valve, viz., 5¾ inches. Through the center *c* draw the diameter *y x*. In this figure we have drawn the line *y x* vertically, which was done for the sake of convenience ; any other position for this line will answer the purpose equally well. The circumference *a b m* represents the path of the center of the eccentric, also that of the crank-pin ; the diameter *y x* will represent the stroke of the piston, and, therefor, is divided into 30 equal parts. The steam is to be cut-off when the piston has traveled 22 inches from the beginning of the stroke, therefore through the point 22 drawn a straight line *g k* perpendicular to *y x*, the line *g k* intersecting the circumference *a b m* in the point *g*. Join the points *y* and *g* by a straight line. Find the center *s* of the line *y g*, and through *s* and prependicular to the line *y g*, draw the line *A B* ; if the latter line is drawn accurately it will always pass through the center *c*. The distance between the points *s* and *c* will be the amount of lap required, and in this example it is $1\frac{7}{16}$ inch.

It sometimes occurs, in designing a new locomotive, and often in designing stationary or marine engines, that only the width of steam port and point of cut-off is known, and the lap and travel of the valve is not know. In such cases both of these can be at once determined by the following method :

Example 22.—The width of the steam port is 2 inches ; the stroke of piston, 30 inches ; steam to be cut-off when the piston has traveled 24 inches from the beginning of its stroke ; find the lap and travel of the valve.

Fig. 60. Draw any circle, as *A B M*, whose diameter is larger than what the travel of the valve is expected to be. Through the center *c* draw the diameter *y x*, and, since the stroke of piston is 30 inches, divide *y x* into 30 equal parts. Steam is to be cut off when the piston has traveled 24 inches ; therefore through point 24 draw a straight line *g k* perpendicular to the diameter *y x*, intersecting the circumference *A B M* in the point *g*. Join the points *y* and *g* by a straight line ; through the center *s* of the line *y g* draw a line *A B* perpendicular to *y g*. So far, this construction is precisely similar to that shown in Fig. 59, and in order to distinguish this part of the construction from that which is to follow, we have used dotted lines ; for the rest full lines will be used. It will also be noticed by comparing Fig. 60 with Fig. 59 that, if the diameter *A B* had been the correct travel of valve, then *c s* would have been the correct amount of lap. But we commenced this construction with a travel that we knew to be too. long ; hence, to find the correct travel and lap, we must proceed as follows ; Join the points *B* and *y*. From *s*, towards *B*, lay off on the line *A B* a point *b ;* the distance between the points *s* and *b* must be equal to the width of the steam port plus the amount that the valve is to travel beyond the steam port, which, in this example, is assumed to be ⅛ of an inch. Therefore the distance from *s* to *b* must be 2⅛ inches. Through *b* draw a straight line *b* y^2 parallel to *B y*, intersecting the line *y g* in the point y^2. Through the point y^2 draw a straight line y^2 x^2 parallel to the line *y x*, and intersecting the line *A B* in the point c^2 as a center, and with a radius equal to c^2 *b*, or c^2 y^2, describe a circle *a b* y^2. Then *a b* will be the travel of the valve, which, in this case, is 7⅝ inches, and the distance from c^2 to *s* will be the lap, which, in this example, is $1\frac{11}{16}$ inch.

PRACTICAL CONTRUCTION OF THE SLIDE-VALVE.

It should be obvious, and, therefore almost needless to remark here, that the foregoing graphical methods employed in the solutions of the problems relating to the slide valve are applicable to every-day practice, the writer belives that these methods are the simplest and best to adopt for ordinary use, and without these it would be difficult to construct a valve capable of performing the duty assigned to it. Of course, when a graphical method is employed, great accuracy in drawing the lines is necessary.

We will give a practical axample, in which one of the objects aimed at, is to show the application of one of the forgoing methods to ordinary practice.

Example 23.—The width of the steam ports is 1¼ inch ; length of the same 14 inches, thickness of bridges 1⅛ inch ; width of exhaust port 2½ inches ; travel of valve 4¾ inches ; stroke 24 inches ; steam to be cut-off when the piston has traveled 20¾ inches from the beginning of its stroke ; the edges of the exhaust cavity are to cover the steam ports, and not more, when the valve stands in a central position ; construct the valve.

Fig. 61. Draw a straight line *A B* to represent the valve-seat through any point in *A B ;* draw another line *D C* perpendicular to *A B ;* the line *D C* is to represent the center of valve. Draw the exhaust port, bridges and steam ports as shown.

The question now arises : How long shall we make the valve ? Or, in other words, what shall be the distance between the outside edges of the value *c* and c^2? If the valve had to admit steam during the whole stroke of the piston, or as the practical man would say, "follow full stroke," then the distance between the edges *c* and c^2 would be equal to the sum of twice the width of one steam port plus twice the width of one bridge plus the width of the exhaust port, hence we would have $2\frac{1}{2}+2\frac{1}{4}+2\frac{1}{2}=7\frac{1}{4}$ inches for the length of the valve. But, according to the conditions given in the example, the valve must cut-off steam when the piston has traveled 20¾ inches therefore the valve must have lap, and the amount of lap that is necessary for this purpose must be determined by the method shown in Fig. 59, and given in connection with Example 21. Following this method, we find that the required lap is $\frac{7}{8}$ of an inch, therefore the total length of the valve will $7\frac{1}{4}+(\frac{7}{8}x2)=9$ inches: or, we may say, that the distance between the edges c and c_2 must be equal to twice the width of one steam port plus twice the width of one bridge plus the width of the exhaust port plus twice the lap, consequently we have $2\frac{1}{2}+2\frac{1}{4}+2\frac{1}{2}+1\frac{3}{4}=9$ inches for the length of the valve. Through the points c and c_2 (each point being placed $4\frac{1}{2}$ inches from the center line $D\ C$), draw lines perpendicular to $A\ B$; these lines will represent the outside surfaces containing the edges c and c_2. These surfaces must be square with the surfaces $A\ B$, because, if they are not so, but are such as shown in Fig. 64, the distance between the edges c and c_2 will decrease as the valve wears, and when this occurs, the valve will not cut off the steam at the proper time. Now, in regard to the cavity of the valve. One of the conditions given in our example is, that the edges of the cavity must cover the steam ports, and no more, when the valve stands in a central position, therefore the inner edges i and i_2 of the valve must be $4\frac{3}{4}$ inches apart, which is equal to twice the width of one bridge plus the width of the exhaust port; consequently, when the valve stands midway of its travel, the inner edges of the valve (being $4\frac{3}{4}$ inches apart), the inner edges of the steam ports coincide. Through the points i and i_2 (each being placed $2\frac{3}{8}$ inches from the center line $C\ D$), draw the straight lines $i\ e$ and $i_2\ e_2$ perpendicular to $A\ B$. These lines will represent the sides of the cavity containing the inner edges i and i_2 of the valve, and these sides must be square with the surface $A\ B$; if these are otherwise, for instance, such as shown in Fig. 64. the distance between the edges i and i_2 will change as the valve will not perform its duty correctly. The depth $d\ d_2$ of the cavity is generally made from $1\frac{1}{4}$ to $1\frac{1}{2}$ times the width of the exhaust port. The writer believes that making the depth of the cavity $1\frac{1}{2}$ times the width of the exhaust port is the best practice. In our example the width of the exhaust port is $2\frac{1}{2}$ inches, and $2\frac{1}{2}+1\frac{1}{2}=3\frac{3}{4}$ inches, which will be the distance from d to d_2, that is, the depth of the cavity. The curved surface of the cavity is generally a cylindrical surface, must be represented in Fig. 61 by an arc of a circle. The sides $i\ e$ and $i_2\ e_2$ must be planed, not to do this conveniently, these sides must extend a a little beyond the curved surface, toward the center $C\ D$. Consequently, through the point d_2 draw an arc whose center is in the line $C\ D$, and whose radius is such that will allow the sides to project about $\frac{1}{16}$ of an inch. Here, then we have lines which completely represent the cavity of the valve and the valve face. If we now add to these lines the proper thickness of metal as shown in Fig. 62, this section of the valve will be complete.

Fig. 63 shows a section of the valve taken at right angles to that shown in Fig. 62. Since the ports are 14 inches long the the cavity of the valve must be 14 inches wide, as shown. The amount that the valve overlaps the ends of the steam ports must be sufficient to prevent leakage. For a valve of the size here shown, 1 inch overlap is allowed, and the thickness of metal around the cavity is generally one-half of an inch. For smaller valves the overlap at at each end of the steam port is from $\frac{3}{4}$ to $\frac{7}{8}$ of an inch, and the thickness of metal around the cavity is $\frac{3}{8}$ of an inch.

The valve here shown is suitable for a locomotive cylinder 16 inches in diameter. and a piston speed of 525 feet per minute, and the dimensions here given agree with those of the valves that are at present in use.

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LOCKS OF THE MANCHESTER SHIP CANAL.

At Latchford, some 15 miles from the Manchester dock, it is intended to construct a dock for the accommodation of Warrington; and there are to be coal docks at Irlam and Barton. The canal locks at these places are of compound design; at Latchford there will be a group of three locks of different sizes, placed side by side. The largest will hold several ships at once, but they will have intermediate gates to allow a part of the lock to be used without waste of water. Hundreds of vessels may thus pass these locks in a day. The Irlam and Barton locks are to be similar in design, but without tidal gates. The gates and sluices will be worked by hydraulic power, but steam power will also be provided. In other respects, the locks on the Manchester Ship Canal will be constructed very similar to each other, so that in illustrating one of these locks from the engineers' designs, a very good representation of the various locks on the canal route is afforded to the reader, so that we need only add that in its course the canal will send five of these locks. —*Engineering Review.*

AN AUTOMATIC STEAM HEATING PLANT FOR PRIVATE DWELLING AND PUBLIC BUILDINGS.

The use of steam as a heating agent is no longer an experiment, but has been thoroughly tested in practice, and is now largely used. The convenience and economy of the system are now so generally known that it is steadily growing in popularity. There is, therefore, naturally an increasing demand for improved heaters of this kind which shall combine the elements of durability, simplicity and economy in the use of fuel, which will run the longest time and keep up steam without care or attention, and at such cost as to bring them within the reach of the general public.

We have lately had the opportunity of inspecting the operation of a steam heating plant designed in such a manner as to be adapted for private dwellings and public buildings, and which appears to possess a number of meritorious features. We shall call attention to these, in what follows, referring therein to the two cuts (Fig. 1, a perspective view, and Fig. 2, a sectional view) in connection therewith.

The apparatus which is employed in connection with the usual steam heating coils, or radiators, is known as the Fiske Automatic Steam Heater. The makers claim for this steam heating plant, that it fully realizes the most exacting demands that may be made upon it, in respect to compactness, economy in first cost, and low cost of running, and invite the careful investigation of these claims by architects, builders, and others interested in the subject.

An examination of the sectional view (Fig. 2) will enable the reader to understand the following detailed description of the steam generator. An extended heating surface is provided, which is entirely surrounded by, and in immediate contact with water—the object sought to be attained thereby, as stated by the makers, being to secure for it the rapid and economical steaming qualities so well known and fully demonstrated in the locomotive and other forms of internally fired boilers. The deep fire pot has ample capacity to carry a heavy fire for zero weather, and can readily be fed with sufficient coal to last twelve to eighteen hours in moderate weather, and, we are informed, the boiler requires but little more attention than ordinarily when worked to its fullest capacity. The heat from the fire impinges directly against the water-covered sides of the furnace and the convex head of the center section of the generator, thence passing upward into the combustion chamber, the unconsumed gases are ignited and the heat imparted to the double walls of the combustion chamber, before reaching the flues and baffle plate, through which copper flues—only sufficient in area to furnish proper draft—admit the waste heat to the hood which surrounds the steam superheater. This hood is so arranged as to bring the gases in contact with every part of the superheater, by which it is designed to utilize as much as possible of the remaining heat before passing it to the chimney. In this way, it is claimed, all the advantages sought for in passing the waste heat outside of other forms of boilers on its way to the chimney are secured, and the expensive brick setting required with most steam heaters is avoided.

From the foregoing description, our readers will be enabled to properly estimate the claims of the makers to marked superiority for their apparatus in the following points: Great economy in fuel, its construction being based upon the best ascertained practice in respect to the relative value of different kinds of heating surfaces in steam boilers; simplicity of construction and economy, providing a large capacity at a moderate cost; the absence of all inaccessible joints, long flues, or heating surfaces difficult to keep clean; case of management, in that no more care, and less labor, to run it is called for than with the simplest hot-air furnace; no coal to lift to the top of a large magazine heater, and no excavation of cellar floor is needed, which is often required to obtain room to feed such a heater; excellence of mechanical construction—all material used in its construction is the best of its class, and the workmanship superior.

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The Czar of Russia has bestowed upon Alvan Clark of Cambridge, Mass., the golden honorary medal of the empire "in acknowledgement of the excellent performances of the great object glass" made by Mr. Clark for the chief telescope in the Pulkowa observatory. This medal is given very rarely, and only for extraordinary merits. Only one other has been granted by the present Emperor.

DUPLEX AUTOMATIC STEAM HEATER.

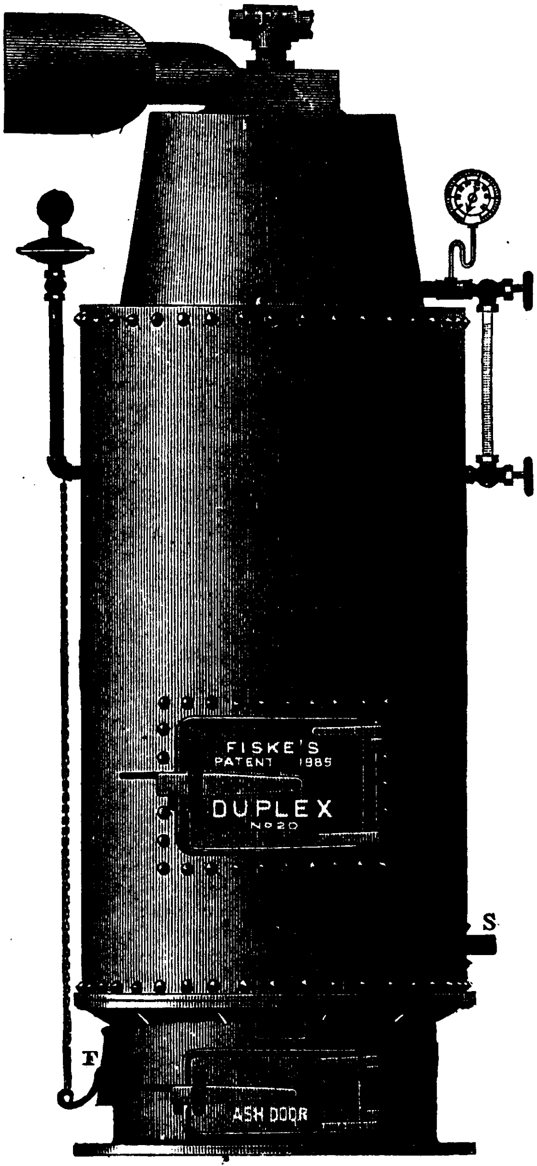


Fig. 1.—Duplex Automatic Steam Heater (Exterior View).

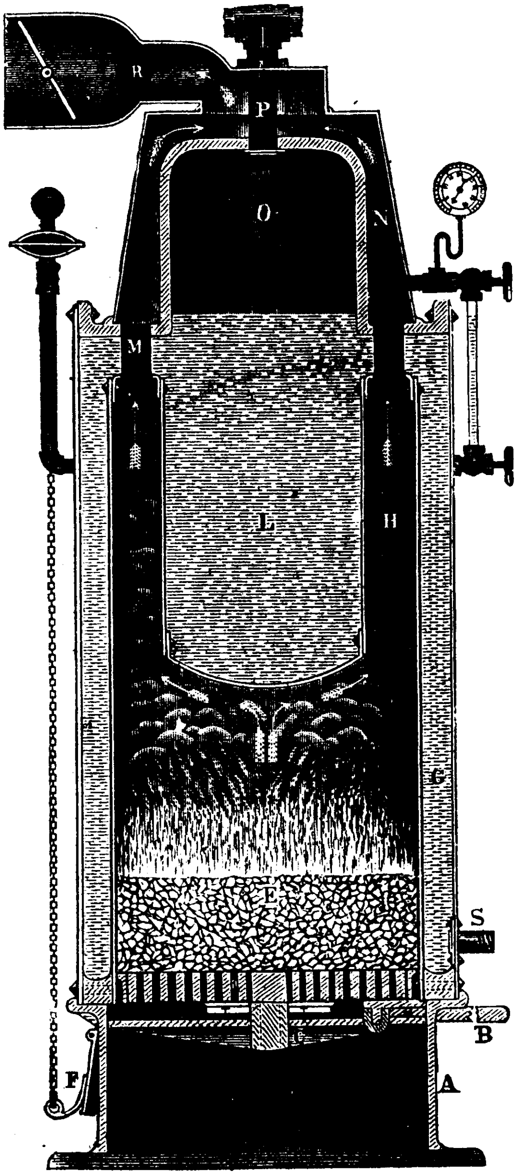


Fig. 2.—Duplex Automatic Steam Heater (Interior View).

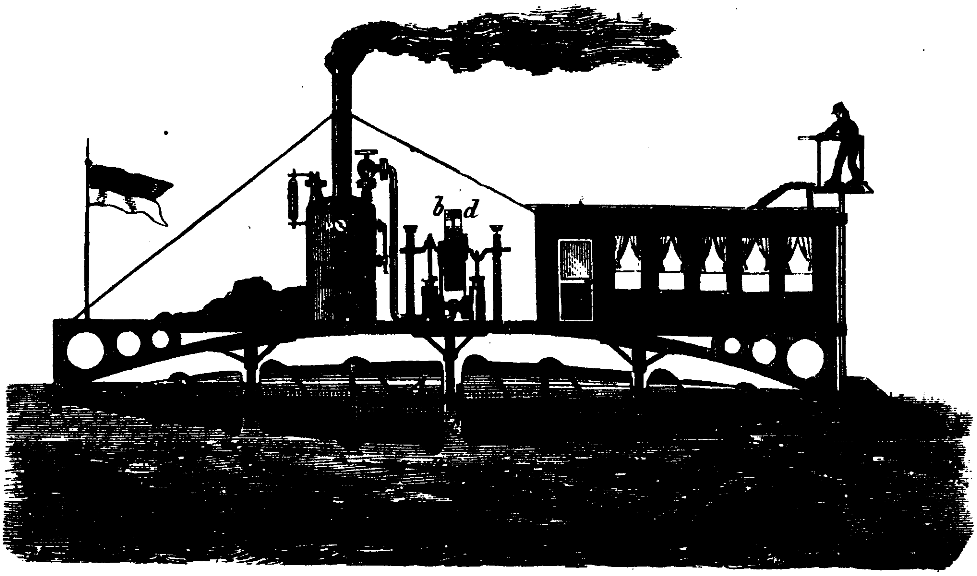


FIG. 1—A NEW STEAMBOAT.—SIDE VIEW.

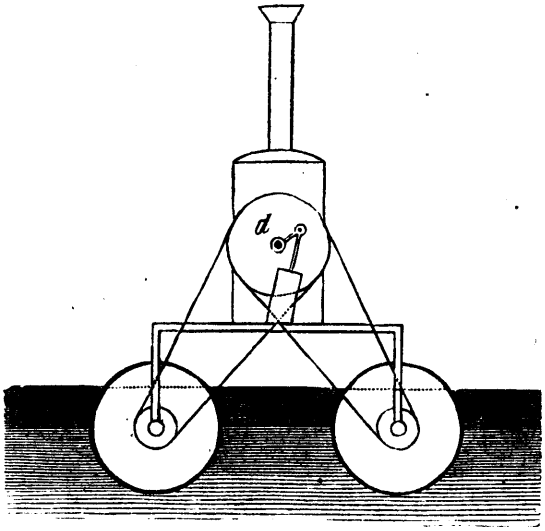


FIG. 2.—END VIEW.

A NEW STEAMBOAT.

The annexed cut represents the model of a new steamboat constructed by Mr. Emil Adam, of Prague, Austria, and with which astonishing results were obtained. According to the *Erfindungen und Erfahrungen*, from which we copy, the inventor set out to reduce the resistance of the water as much as possible, and for this purpose constructed the hull of his vessel of two hollow cylinders, which are tapered from the middle toward both ends, whereby a shape resembling that of a cigar was obtained.

Each cylinder is provided on its outer surface with a screw thread, formed of metal plates riveted on the cylinder, the line of inclination of the thread being about 45° to the longitudinal axis of the cylinder. Annular recesses or breaks are formed in the cylinders at suitable intervals for the bearings supporting the frame of the vessel. The cylinders are rotated by a suitable engine, of any desired construction, on the deck or platform of the vessel. The water in which the cylinders revolve acts as a nut for the screw threads, whereby a rapid motion in either direction is obtained ; especially as the frame, decks, etc., are entirely above the surface of the water, and thus offer little or no resistance.

Fig. 1 is a side view of the vessel, and Fig. 2 is an end view of the same, the latter figure showing the belts for transmitting power to the screw cylinders. In the vessel shown, the two cylinders act the same as the two vessels forming a catamaran.

If desired, a third cylinder may be provided, or the number may be still further increased. —*Scientific American.*

THE NORDENFELDT SUBMARINE BOAT.

The following is taken from the London Times, and gives a description of the boat and experiments which took place late in September :

The interest excited by the recent trials of the Nordenfeldt submarine boat is sufficiently shown by the presence at Landskrona, Sweeden, of 39 officers representing every European power, together with Brazil and Japan. Such a boat if successful, will exercise a powerful influence both on naval warefare and on coast defence. Its possible uses are manifold, its moral effects unquestionable. Against its operations no system of defence at present suggested seems adequate. The introduction of fast torpedo-boats has supplied a new factor in warfare, and, pace Hobart Pasha, their influence will some day make itself powerfully felt. But the torpedo-boat has been met actively by the machine gun, capable of delivering an extremely rapid fire of small shell at ranges far beyond the usual limit of Whitehead, and passively by the steel-wire netting with which it is proposed to surround ships. Again, the torpedo-boat can be met and fought on the sea by similar boats, faster, better handled or better armed. On the other hand, a boat which can maintain a fair speed under water for several hours, which need only rise to the surface for brief periods, and can sink at will if discovered, which can lie perdu and direct a steered torpedo, or run up to close quarters and fire the Whitehead at 10 feet below the surface, is undoubtedly an exceptionally dangerous antagonist. If the problem of producing such a boat can be solved, the largest ship would be secure only when in rapid motion, no port could be satisfactorily defended, and no system of submarine mines could be regarded as safe. Mr. Nordenfeldt has addressed himself to the solution with a measure of success that will be discussed later.

It is no new problem. Submarine boats were employed in the American war, where some successes were claimed for them, and considering the enormous advantages to be obtained it is not surprising that at least one European power has devoted both time and money to experiment. But there has been a natural tendency to preserve secrecy on the subject, since to create vague suspicion of the possession of a submarine boat would be a more desirable object than to proclaim the existence of one with known imperfections and limitations. Besides, the past record of the performances of these boats has not been free from disaster. Several have sunk with their crews to rise no more ; others have remained fixed and helpless at the bottom for long periods, to be saved only by exceptional coolness and exertion on the part of the crews. It would be clearly unwise to create an antecedent impression of the exceptional danger involved in their service at a time when such danger might be due chiefly to structural imperfection and want of knowledge, for the problem is no easy one when its conditions come to be realized. Power to sink and rise rapidly at will, fair speed under water, horizontal and vertical steering-power under full control, endurance of motive force and air supply for the crew are only some of the many requirements on the fulfilment of which success is dependant.

The Nordenfeldt boat, the first of its class, was built at Stockholm about two years ago. The boat is car shaped, with a coffin-like projection on the top amidships, formed by vertical combings supporting a glass dome or conning tower, 1 foot high, which enables the commander to see his way. The dome, with its iron protecting cover, stands on a horizontal lid which can be swung aside to allow the crew of three men to get in or out without difficulty. The lenght of the hull is 64 feet and the central diameter 9 feet. It is built of Swedish mild-steel plates ⅝ inch thick at the center, tapered to ⅜ inch at the ends, supported on angle iron framing, 3 inches by 3 inches by ⅜ inch. The arrangement for sinking the boat are of a special nature, for which the inventor claims important advantages. Practically, such a boat can be sunk in three ways, singly or taken in combination. It may be forced down by power applied from within, weighted down by taking in sea-water sufficient to destroy the buoyancy, or it may be steered down by the application of its ordinary motive-power modified by a horizontal rudder. Mr. Nordenfeldt has adopted the former arrangement, placing sponsons on each side of the boat amidships, in which are wells for the vertical propellers capable of working the boat up or down. In order to prepare for action enough sea-water is taken in to reduce the buoyancy to 1 cwt., which suffices to keep the conning tower well above the surface. In order to sink the boat further the propellers are set in motion, and by their action it is held at the required depth. Thus, to come to the surface again it is merely necessary to stop the vertical propellers, in which the reserve of buoyancy at once comes into play. This principle is rightly regarded as important, even if not essential, in a safe submarine boat. A break-down in the engines does not entail danger, since the reserve of buoyancy is never lost for a moment. As a still further safeguard, however, Mr. Nordenfeldt has provided an automatic check on the downward motion. A lever with a weight which can be adjusted so as to counter-balance any desired head of water is connected with a throttle-valve supplying steam to the engine working the vertical propellers. Thus, directly the desired depth is exceeded, the increased head of outside water overcomes the weight and the vertical propellers are stopped.

The motive-power is steam alone generated in a boiler of the ordinary marine type with a forced draft. So long as the boat runs on the surface this boiler can be stoked and a constant head of steam maintained. The smoke is driven out through two channels which pass partly round the hull and point aft. For submarine work no stoking is, of course, possible, and the firebox has to be sealed. It is therefore necessary to store the requisite power, before hand, and this is done by heating the water in two tanks, placed fore and aft and connected by circulating tubes with the boiler, till a pressure of about 150 pounds per square inch is attained. With about this initial pressure it is stated that the boat has been driven for 16 miles at a speed of 3 knots. The greatest surface speed attained is a little over 8 knots, and the boat has been run for 150 miles without recoaling. There are three sets of engines, one of which drives the propeller, an ordinary four-bladed screw, 5 feet in diameter, with a pitch 6 feet 6 inches. The other engines drive the blower and the horizontal propellers respectively.

One of the principal difficulties of submarine navigation is to preserve an even kneel when under water. Should a boat turn downward when in motion under the surface, it might easily strike the bottom, or reach a depth at which it must collapse before its course be arrested. On the other hand, if the bow took an upward turn under the same circumstances, the boat would rapidly come to the surface and be exposed to view and to projectiles. It is evidently, therefore, of the utmost importance to provide ample steering power in a vertical direction. In the Nordenfeldt boat two horizontal rudders are placed, one on each side, near the bows, and are acted upon by a pendulum inside the hull. This pendulum, coming into play the instant the boat takes a cant in either direction, actuates the horizontal rudders and causes her immediately to return to an even keel. By this means it is claimed that the boat is automatically kept with her axis horizontal, while, since the bow rudders are entirely beyond the control of the crew, there is no danger of accident due to neglect or loss of nerve. In the event of a break-down of the above arrangement it is necessary at once to stop the boat and let her return to the surface. No compressed air is carried, and the crew depend, therefore, for existence on the amount of air sealed in the hull. With this amount of air only, four men have remained for a period of six hours without any especial inconvenience. The above are the main features of the invention which Mr. Nordenfeldt has just made public, and which has received the careful consideration of experts of many nations. In a subsequent article it is proposed to discuss the results obtained in the recent experiments, as well as the measure of promise these afford.

A REASON WHY BOILERS EXPLODE.

Notwithstanding all the progress of modern mechanical science and steel engineering the number of disastrous boiler explosions seems to be increasing every year. We are told by certain philosophers, in the mechanical line, that these disasters are caused mainly by carelessness in managing the boilers, growing out of the ignorance of the parties owing them. No doubt this is the cause of many explosions, but it is even doubtful if it is the chief cause of such disasters. The buyers of boilers comprise parties in so many different pursuits that it is impossible with all the spread of mechanical knowledge that a large part of them should not be dependent upon others for ordinary mechanical information. These parties are not likely to apply to a disinterested mechanichal engineer for advice, especially if there is a fee to be paid, and nine times out of ten they accept the dictum of the boiler maker as conclusive. If the boiler maker is thoroughly conscientious and prizes his reputation as well as the profit to be made on the contract, his advice will be safe to follow, but such is not always the case. A safe and reliable boiler will cost more than one built of poor material and slighted in workmanship. The latter appears about as well to the inexperienced buyer, and the difference in price, backed with some persuasion on the part of the maker, often determines the sale. These are the boilers that do most of the blowing up, and most of the destruction to life and property, and the men that build them know their liability to disaster.

It is an interesting study to examine the record of boilers sent out from different shops. Some shops there are with a record of hundreds, even thousands of boilers made and sold without a single explosion being heard of among the whole number. Others with a large production extending over many years can discover but one or two cases of explosion. Again we find boiler making establisments that have been quite frequently brought to public attention through disasters to boilers of their manufacture. It is impossible to believe that all the boilers from one builder go into competent and careful hands, while a large part of those from another shop in the same section of the country go into charge of careless and incompetent engineers. It is not mere chance that causes boilers from certain shops to explode, when those of certain other shops remain in service without disaster.

It is a usual thing when a boiler blows up, to try and fasten the blame upon the engineer or fireman. Failing in this, the proprietor is generally charged with the whole responsibility. The maker of the boiler is the last person thought of for censure, and in most cases goes scott free, even though the boiler was never a safe or strong one.

The maker of inferior boilers, at low prices, is likely to excuse himself on the ground that he supplies a definite demand that could not be met with safe boilers at higher prices, and that if he does not supply that demand others will do it. This is equal to the logic of the footpad who relieves the traveler of his valuables because another theif is lying in wait for him. If the traveler is certain to be robbed, he will be no poorer than if plundered by the second thief, hence the first one quiets his conscience by the thought that he is causing no extra distress. The average grade of engineers is being elevated every year, but we doubt if the average grade of boilers is being elevated in the same proportion. — *American Machinist.*

The crop of raisins grown in California has increased from 1,000 boxes nineteen years ago to 400,000 the present season.

It is easy to prevent rust within show cases. It is well known that the rusting of bright steel goods is due to the precipitation of atmospheric moisture upon the metal. This may be obviated by keeping the air surrounding the goods in a dry condition; and a saucer of powdered quicklime placed in an ordinary show case will usually suffice to prevent the rusting of the cutlery exhibited therein, as the lime will take up the moisture.

APPARATUS FOR THE RECOVERY OF TAR AND AMMONIA FROM BLAST FURNACES.

One of the most important questions of the present day in connection with blast-furnace practice is that of the recovery of tar and ammonia from the furnace. This was evidenced at the recent meeting of the Iron and Steel Institute, at Glasgow, by the interest shown in the paper on that subject by William Jones. In that paper reference was made to the apparatus for dealing with this subject designed and patented by Mr. John Dempster, of the firm of R. & J. Dempster, of Newton Heath, Manchester, and which is now in operation at Messrs R. Heath & Son's works, near Stoke-on-Trent, being the only works which has yet attempted the recovery of tar and ammonia from blast-furnace gases in England. This apparatus is illustrated in our present issue, where Fig. 1 represents a perspective view of the works, our illustration having been engraved from a photograph. Fig. 2 shows a plan of the works, the various details of the plant being indicated thereon. Mr. Dempster, being a gas engineer and constructor of gasworks, has adopted apparatus generally used in ordinary gasworks, but adapted to the special requirements of blast-furnaces. The blast-furnaces of Messrs. Heath are situated close to the forges, mills, and collieries of the firm, and the gases from the furnaces raise steam for these. Therefore, Mr. Dempster had to keep in mind that these gases were valuable, and that he must use every economy in reference to them. The gases are conveyed first to the ammonia still, and the flues of this still are made three times the size of the other pipes, Mr. Dempster's object being to cause the gases to flow slowly round the still, and, by reducing the speed, to allow the dust to fall to the bottom of the flue, where, by an arrangement of scrapers, he collects this in a well at the end of the still. The well can be shut off from the flue by dampers, and the dust removed without having to stop working the still. The temperature of the gases being much higher than boiling point, the NH_3 from the liquor is driven off without any expense for fuel. The still is 40 feet long and 7 feet diameter, and holds about twenty-fours' hours make of liquor, and the ammoniacal liquor is continually being pumped in, and, having baffle plates in the still, it flows on to the other end and out. As the still holds twenty-four hours' make of liquor, the liquor is twenty-four hours under the influence of the heat, and all the NH_3 is driven off. By an arrangement of valves the gases can be shut off from the flues of the still if required. The gases then flow on to what Mr. Dempster terms dust boxes, owing to their purpose being to arrest the remaining dust that may have passed the flues of the ammonia still, but they are really washers. They are two wrought iron vessels, each vessel being divided into four compartments, and in each compartment a plate with serrated edge depends from the top and dips into the liquid; the bottom of the vessels slope toward the front. The gases are thus caused to pass four times under water, and it is found that most of the tar is given off at these vessels, and that they answer the purpose of arresting the dust. These vessels arranged so that either can be shut, off for cleaning (if this should ever be required) while the gas is passed through the other.

The gases at the outlet of the dust boxes are found to be very much reduced in temperature, and are then brought down to the temperature of the atmosphere by two pipe condensers. These condensers consist of 100 wrought-iron pipes, 40 feet long and 20 inches in diameter, placed in five rows of twenty each upon a cast-iron box, which contains the necessary division plates for shutting off each row from the other, while allowing the condensed matters to flow underneath. This cast-iron box has also a sloped bottom similar to the dust boxes. Valves are fixed at the end of each row of pipes, so that any row can be shut off; and by taking off the blank flanges from the top, each pipe can be cleaned if this should ever be required. Arrangements are made at the top of these pipes so that cold water is directed on to them, and thus the condenser is rendered very effective. The gases are then drawn through the exhausters, which consist of four of Root's blowers, driven by a pair of horizontal engines. The blowers have valves fixed at the inlet and outlet, so that they can be shut off for repairs if necessary. Following the exhausters come four washers, the gas dividing through the first two, and then again dividing through the other two. These are arranged in plates in pairs, with valves, so that they can be shut off and cleaned if required without stopping the whole of the apparatus. The interiors of these washers are fitted with four plates with holes varying in size and getting smaller toward the outlet, the last plate of the

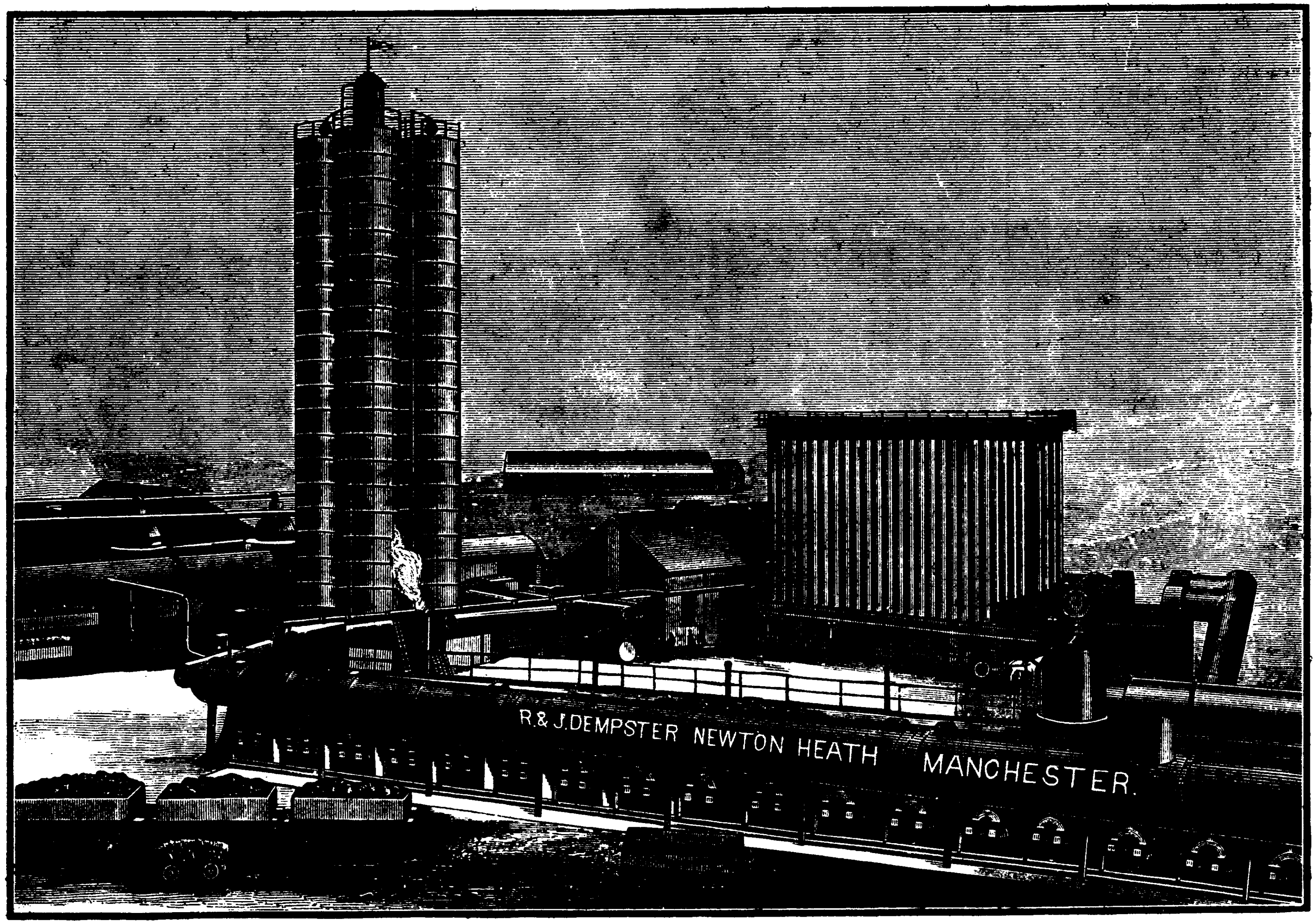
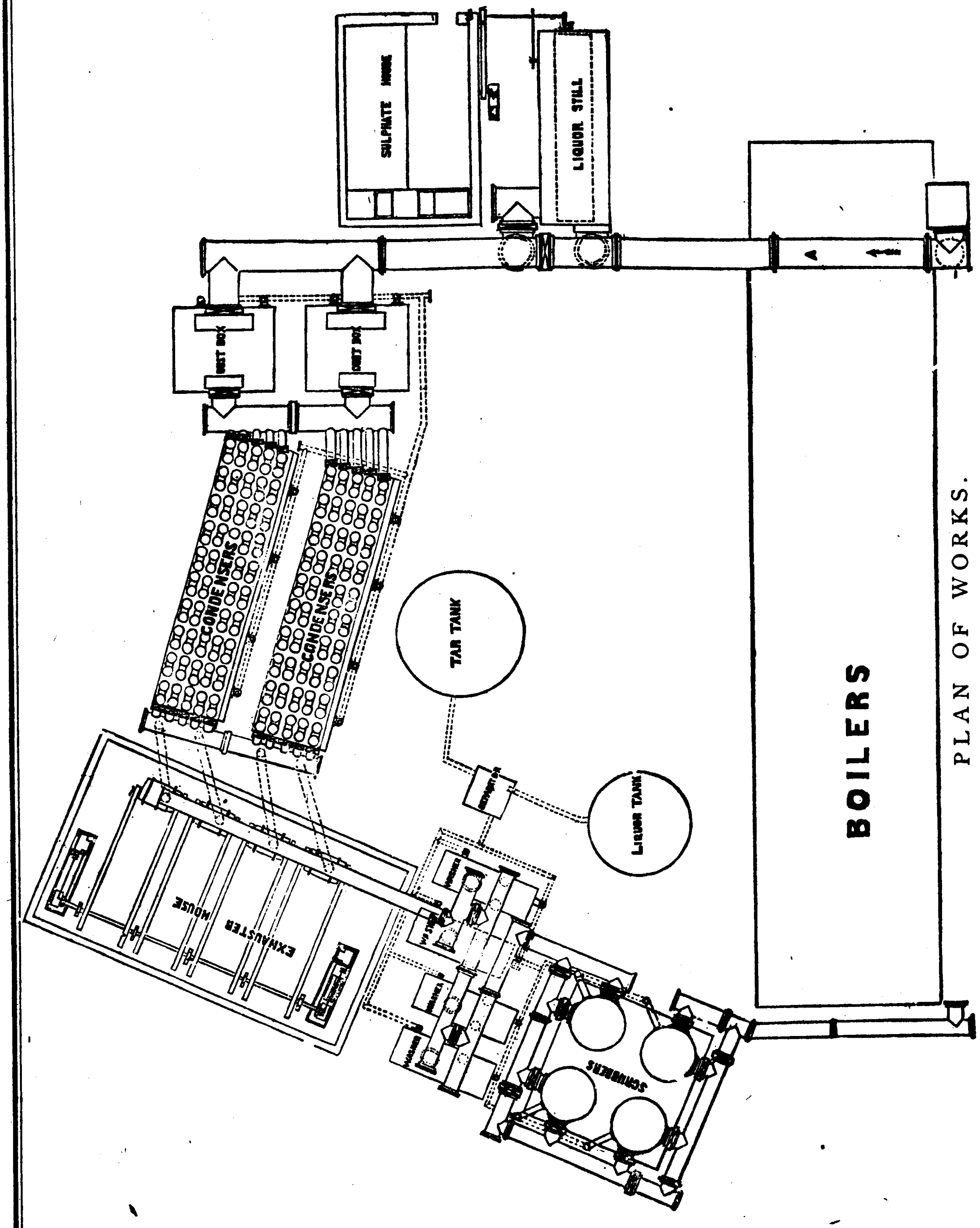


FIG. 1.—APPARATUS FOR THE RECOVERY OF TAR AND AMMONIA FROM BLAST FURNACES.



PLAN OF WORKS.

last washers having holes $\frac{1}{16}$ inch diameter. The object of these is to take out the last traces of tar before the gas gets to the scrubbers, and this they do very effectually.

The gas then enters four round scrubbers 100 feet high and 12 feet diameter, which are filled with about 300 tons of wood boards, and on the top of each of the first three scrubbers is an apparatus for distributing the liquor over the boards. This apparatus is self-acting, each scrubber having a large steam pump which pumps the ammoniacal liquor through all four scrubbers alternately. The last one has clean water pumped through it, though in much smaller quantity than through the others. This scrubber takes out the last trace of ammonia, and the gas then passes on to the boilers. The scrubbers, being set in a square, stand very firm; in the center between them is a spiral staircase. The scrubbers are made in rings of plates 5 feet deep and in each ring of plates is a flap valve, held to its face by a heavy weight, so as to give immediate release in case of an explosion. These valves also act as manholes to the scrubbers, being 18 inches in diameter. Mr. Dempster has also placed these valves in numerous places about the apparatus, so that each section of pipe or apparatus shall have safety explosion valves. Between the scrubber and the boilers is introduced a box, which is partly filled with water, and has a plate dipping into it, so that the gas can be forced through the water. This is only intended to be used when the plant may have been standing and is being again put into operation, as, if the gas should be sent on to the boilers too soon, any explosion would only strike back as far as this box.

This apparatus has been at work about two months, and from its first being put into operation has continued to give every satisfaction. The wheel arrangement was so well considered beforehand that no alterations have yet suggested themselves as being required. The firm are now erecting plant to deal with the tar, it being the intention when the present plant was designed to sell the tar to the neighboring tar distillers. The price of tar, however, has fallen so low that it is considered most profitable to distill the tar on the premises, and thus save any cost of carriage. Mr. Dempster claims as the advantages of this apparatus, first, that he does not consume any of the gases in working the plant, nor does he injure the quality of the gases in any way, no vapor being carried along with the gas, or any acid vapors; and secondly, that he gets his ammonia liquor up to a good strength of NH_3, and that the labor is very small, two men for day and two men for night being all that are required to work it. The cost of this apparatus is we understand, about £6,000 per furnace. The sulphate of ammonia, paraffin wax, heavy paraffin, and light oils recovered by this process from the blast furnace gases at Messrs. Heath's works are of excellent quality, as evidenced by the samples inspected by us. The products from the tar given off from the furnace gases are stated to be more valuable than the products obtained at the present time from the ordinary gasworks tar.—*Iron.*

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THE GRESHAM AUTOMATIC RE-STARTING INJECTOR.

We present with this a perspective view and sectional elevation of this injector complete, and full size, of No. 24 instrument. It will be seen to be of very simple construction, no other parts than those shown being required. All that is necessary in working is to open an ordinary valve in the steam and one in the water pipe.

The automatic principle involved in their construction enables these injectors not only to start instantly, but to work equally well at any steam pressure. It also enables them to be placed in any position either above or below the water supply, lifting the water, if required, sixteen feet. They will also take up feed water of a high temperature.

Another and important feature of the automatic principle is the capacity of the injector to start again without any manipulation, after having been stopped by temporary interruption of water supply. On traction and farm engines the water supply is likely to be suddenly stopped by running over stony and uneven ground; also, on tugboats and steamers, the supply is likely to be inconstant. This is also frequently the case when water is taken from service pipes of city water works. With these injectors no attention is paid to inconstant supply; as soon as the water supply is restored, they take it up and begin working as if there had been no interruption. This is accomplished by the action of the single loose piece inside. With the injector at work the pressure underneath keeps this piece up, completing the connection for the direct delivery of water to the boiler. If, now, the water supply fails, this piece drops down, giving an ample escape to the steam through the over-flow. The escaping steam, by induction, exhausts the air, keeping up a partial vacuum or constant suction on the water pipe, which, raises the loose piece and the injector resumes feeding. Steam never blows through the water pipe, hence it is never warmer than the feed water, or the air.—*Am. Mach.*

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THE HENWOOD DUPLEX PUMP.

The Henwood duplex pump, manufactured by Henwood, Whittaker & Co., Philadelphia, Pa., is made with the plain slide-valve in the steam end, and the compensating packing arrangement in the water end.

These pumps were designed especially to overcome the faults and simplify the construction of pumping machinery in present use. For all cases where dirty or gritty water is pumped, they are particularly adapted. By the packing arrangement about the plungers, fluid containing as high as 20 to 30 per cent. of sand or grit may be pumped without injury to the cylinders. The plunger has no metallic contact, but works through hemp or elastic packing in the internal stuffing-box. Fastened to the junk ring is a wrought-iron stem, passing through the back cylinder head and ending. in a square After loosening the lock-nut, a wrench may be applied, the junk ring be turned and the cage forced forward, compressing the packing equally about the plunger. In this way the packing may be "set up" whenever necessary without stopping, as it is done on the outside of the pump. The packing lasts from two to six months, according to the character of the water, amount of grit, etc. Where the water is very gritty, rubber packing is used. To repack requires several rings of hemp or rubber packing, and about ten minutes' time. In a number of tests made, the pump is said to have discharged from 25 to 35 per cent. of river sand.

The steam end is provided with the plain slide-valve, made with the necessary lap to expand the steam from 15 to 40 per cent., so that the advantages of compound pumps are secured without sacrificing simplicity or increasing the cost of the pump. The slide-valve is worked by a lever and eccentric, which has one half the throw of the valve. The engines are geared at right angles, thus overcoming all trouble of dead centers, and the pump will go to work whenever steam is admitted to it. Being a crank pump, it has a positive motion and positive length of stroke through all variations of speed. It can be run at as high rate of speed as a single pump, which makes it of great value in hydraulic pumping where speed is an object.

In the horizontal view, *A* is the steam cylinder; *B*, the piston; *D*, direct rod from piston to plunger; *E*, cross head; *F F*, connecting rods; *G*, turn-crank working above the piston and pluger rod; *H*, flywheel; *K*, water cylinder; *M*, junk ring *N*; cage by which the packing is set up, extending through the back cylinder head and in a wrought-iron stem, secured by locknut on the outside, and at the other end screwing in the junk ring *M*, whereby the packing may be compressed about the plunger, *D*; *V*, the rubber valves.—*Am. Mach.*

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IRON TELEGRAPH POLES.

A metallic telegraph pole has been adopted, it is said, by the Canadian government for its telegraph lines on the Northwestern prairies. The pole is constructed of malleable galvanized iron, and is only 1½ inches in diameter at the top and 2½ inches at the bottom, and weighs less than 50 pounds. The bottom of the pole is set into a claw plate, upon which the earth is closely packed to a height of about 2 feet. Then another plate is put into place around the pole, and the earth packed upon it to the level of the ground. The claw plates take a hold in the ground at once, so that the pole becomes solidly fixed immediately after being set, which desideratum is only obtained by the ordinary wooden pole after it has been in the ground for at least a year. A recent test is said to have shown the great strenght of the pole, as a heavy No. 6 government wire was strung and the poles subjected to the greatest possible strain, but without moving them in the least.

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A great deal of land around Winchester, England, may be leased for 25 cents and acre.

IMPROVED COMPOUND CONDENSING PUMPING ENGINES.

We present herewith perspective and outline elevations of the improved compound condensing duplex pumping engines, manufactured by the Knowles Steam Pump Works, of Boston, and New York. As will be seen, the perspective view shows an engine with independent air pumps and condenser, while the outline elevation shows one with the air pumps, condenser, feed pump and heater, and steam traps, etc., attached.

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THE INTEROCEANIC PROBLEM AND ITS SCIENTIFIC SOLUTION.

[Abstract of an address before the American Association for the Advancement of Science, at its 35th annual meeting, Ann Arbor, Mich., August, 1885, by Elmer L. Corthell, C.E.]

By the advancement of Science, and particularly through the means furnished by the Science of this age it is possible to solve this problem in such a way as to meet the demands of Commerce. The wants of man increase, but his power to supply them increases also.

The ocean steamship, the locomotive, the telegraph and the ocean cable have accomplished wonders in bringing together the scattered countries of the earth, but this very accomplishment has brought greater demands upon Science.

It should be a source of pride to the representatives of Science, that it can furnish the means for overcoming an obstacle that turned back both Columbus and Cortez from their earnest search for the Pacific countries.

The most serious obstacles to commerce have yielded to the science of man—all except this one that lies here in the centre of the world—a narrow neck of land uniting two continents and thus presenting an unbroken barrier, extending from the north nearly to the south pole.

In order to fully appreciate the necessity for Interoceanic communication, information is needed on all subjects that affect humanity—Industry, Commerce, Politics and Religion. We must know what each country has for the demands of the others and by what routes the products of the world move. The more we investigate the more will it appear that free interchange is seriously hampered by the Interoceanic obstacle before us.

The Transcontinental Railroads have crossed the continent, but they cannot afford to carry many bulky products.

Still less can the Panama Railroad do it on account of the great expense of transshipment. The cereals of the Pacific still go around Cape Horn on a voyage of 16,000 miles, and other agricultural, and also manufactured products, traverse routes equally long and expensive. Our manufacturers, who turn out over five billion dollars worth every year, exporting only two per cent.—cannot participate in the two billion dollars worth of trade of the far Pacific countries.

The goods cannot go Eastward, for there they must compete with cheaper goods, going on shorter routes.

For four hundred years the attention of the world has been turned towards the American Isthmus. Governments, companies and individuals have examined, surveyed, planned and projected, but nothing has resulted. Our own statesmen, from Jackson to Arthur, have urged the importance of and necessity for this work.

The many routes examined have resolved themselves into three only, viz.: Panama, Nicaragua and Tehuantepec.

Asstming it practicable to make the crossing at Tehuantepec, no one will question the assertion that it is much the most advantageous route. Its great commercial advantages are evident from two facts, first,—it lies nearer the axial line of productions, which may be assumed as passing through Hong Kong, San Franscisco, New York and Liverpool. Second,—the nautical conditions are much more favourable than at the other locations, calm and baffling winds prevailing on either side of the Isthmus near its southern end, making it almost impossible for sailing vessels to navigate in those waters.

The true scientific method is that one which performs the work of transferring ships from one ocean to the other most promptly and most economically. This method is the Ship Railway.

This method is, in general, to lift the vessel from the water by well known means and transport it 134 miles over the country and place it in the opposite ocean by the same means. The details embrace a lifting dock, with a spstem of hydraulic rams, so aaranged as to hold up and perfectly distribute the weight of the vessel, and a system of carriage supports conforming to the position of the rams and actuated by them, so as to be placed under the hull of the vessel.

The roadbed will be built of the best materials at hand, which the surveys show can be found on the whole length of the railway. The superstructure will be long steel ties on which will be laid heavy steel rails, weighing about 100 pounds per lineal yard. Powerful locomotives will haul the ships across the Isthmus. The locomotives built recently by the Baldwin Works are sufficiently powerful to do this work. These engines weigh when ready for service 102 net tons and their capacity is 3,600 gross tons on a level. Three of these will haul the maximum load of 5,650 tons at fifteen miles an hour on grades up to twenty feet to the mile.

The railway follows a succession of broad valleys, so that it is often necessary to make changes of direction to avoid the heavy excavations that would be required by employing the ship railway curves of twenty miles radius. These abrupt changes of direction are made by great floating turn-tables which float in segmental basins around a central pivot, though they do not rest on anything but the water, which is pumped into the surrounding basin from the turn-table to give it flotation.

The harbours, both on the Gulf and on the Pacific, are excellent and commodious and the entrance to them can be deepened with small expense.

The large number of practical experts who have carefully examined the plans have given unequivocal testimony to the entire practicability of the method and also to its economy.

This is not the only Ship Railway that has been projected. They have been designed for Honduras, Egypt and Nova Scotia. The time is passed when it is necessary to prove to practical men the feasibility of the Ship Railway method, therefore the next important subject is taken up more in detail, viz.: the superior economy of the ship railway over the ship canal, both in construction and operation.

The history of canal and rail transportation, going back to the earliest days of railways shows how quickly the latter took the lead in every respect, economy as well as despatch.

Experience and experiments, both in this country and England, are found in abundance to prove this.

If we compare ship canals and ship railways we find a greater difference in favour of the latter. The restricted channel in which the ship moves in a canal is the cause of the greater expense required to push the vessel through the water. The boat or ship practically creates a hill up which she is continually climbing; the faster she is urged through the water the steeper is the hill and the greater is the power required, which increases as the cube of the velocities.

An historical examination of the actual cost of moving freight by canal and by railroad shows that the latter is far in advance of the former in economy, and if the time lost on the canal is taken into account there is a still greater difference.

Some of the more importont details of the comparison are here given. The constant improvements in railroad transportation have reduced the cost of hauling to 6-10 mill per ton per mile.

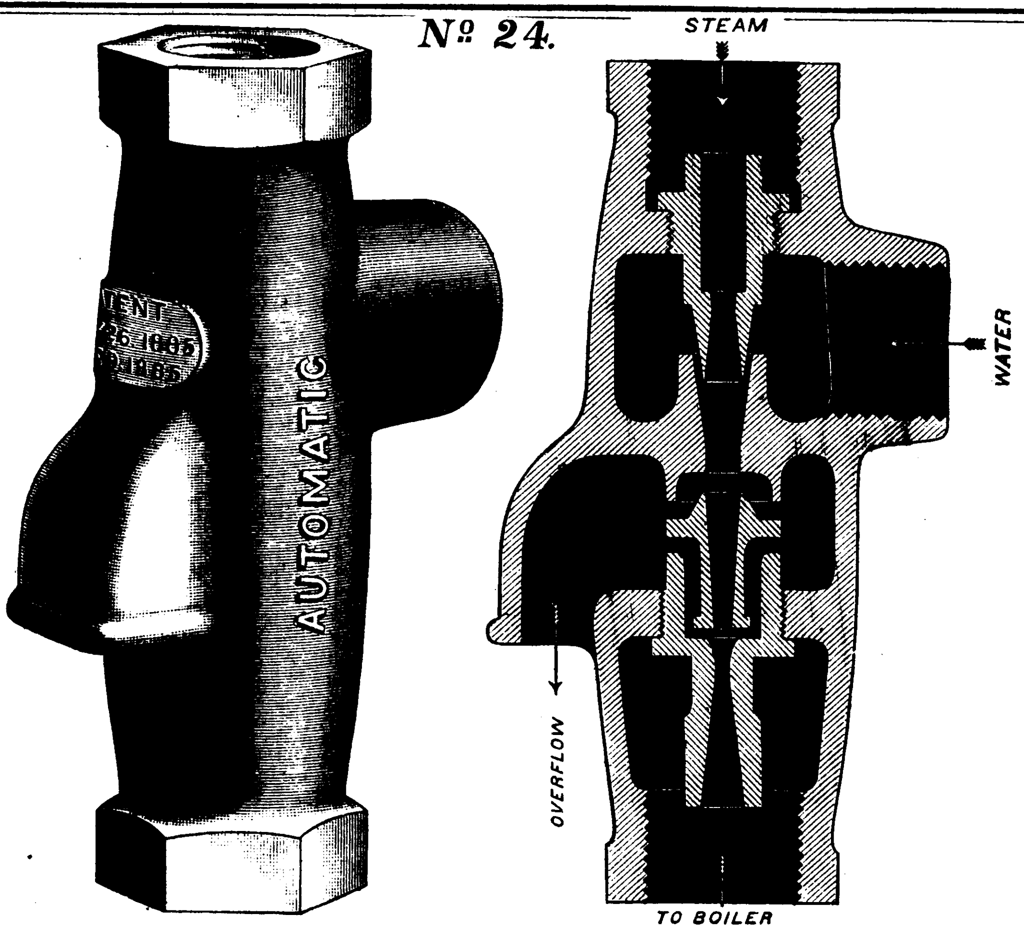
The load has increased from 20,000 pounds to 60,000 pounds in the last ten years, while the weight of cars has only increased 2,000 pounds. The increase of capacity in cars and power in locomotives, the introduction of steel rails and better system in operation, are the principal causes of the cheap and effective transportation of the present day.

Now, carry out these tendencies to their legitimate extent, as they will be in the Ship Railway; instead of 15 tons the average, or 30 tons the maximum, moving on two rails, put on 1,800 tons, moving on six rails, and then with great concentratev motive power, the freight willl be hauled for 2-10 of a mill per ton.

Then, compare speeds; two miles on barge canals is the economical and average speed, one mile per hour on ship canals is the customary speed, and not over two miles on the Suez canal.

On railroads it is 15 to 20 miles and on the Ship Railway 10 miles. The relative cost of transporting a ton of freight on a canal by steamer and in the free waterway of the ocean is as six to one. The total cost of docking and hauling from ocean to ocean on the Ship Railway will be 12 cents, but the cost of steaming the Nicaragua Canal will be 60 cents.

The immense cost of construction and maintenance of the canals, excavated, as the Panama is below sea level, through a



The Gresham Automatic Re-starting Injector.

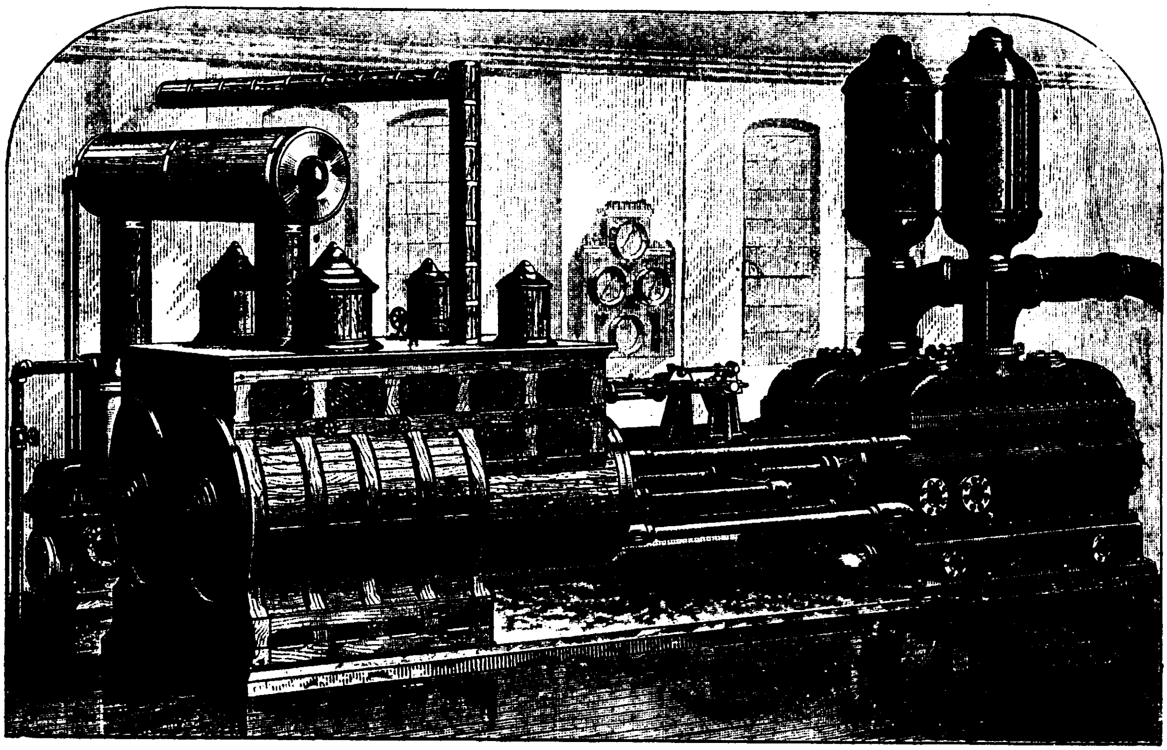


FIG.. I.—IMPROVED COMPOUND CONDENSING DUPLEX PUMPING ENGINE.
With Independent Air Pump and Condenser.

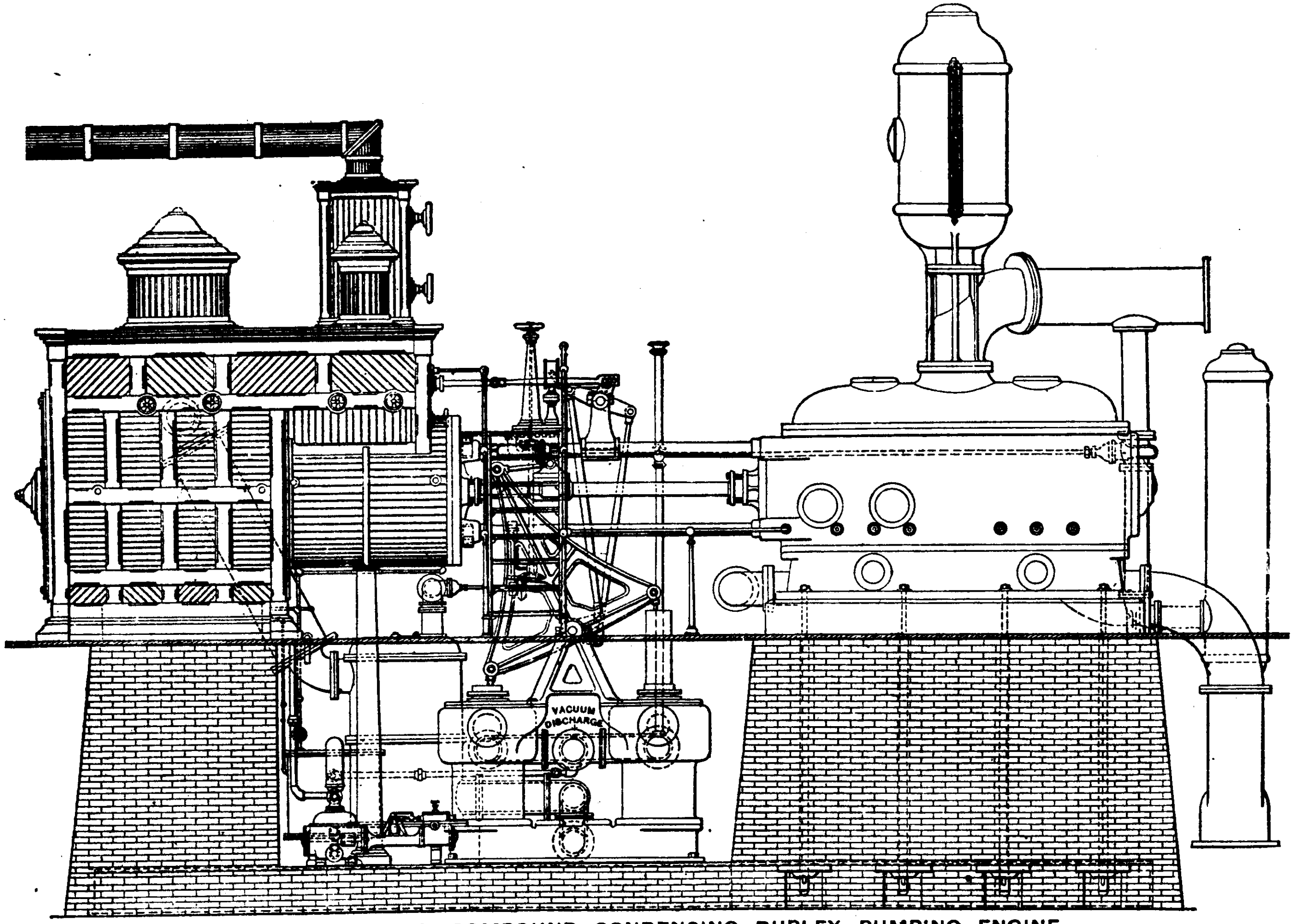


FIG. 2.—IMPROVED COMPOUND CONDENSING DUPLEX PUMPING ENGINE.
With Connected Air Pnmps, Condenser, Feed Pump and Heater, Steam Trap, Etc.

country of excessive rainfall; the long detour required for commerce; the instability of the governments and people through which they pass; these are some of the objections to the canals-

The strategic advantages of the Ship Railway are very important- Mexico and the United States together can protect the railway against any foreign power. Our navy can hold the approaches to the Gulf; there is a capacious and protected harbour in the contzaconcos on the Gulf and in Lake Superior on the Pacific, and two railroads leading into Mexico from the United States could quickly concentrate a large army at the Isthmus.

7,000,000 tons of freight are in sight for transmission over the railway in 1889. The railway can be built and equipped in four years' time. $50,000,000 in cash will complete everything ready for business. The estimate in stock and bonds, allowing for all possible contingencies, is $75,000,000

Even with only 4,000,000 tons the net profit would be 14½ per cent. The beneficial results cannot be overestimated.

Industry, commerce, society and religion, in fact in all his relations, will man be benefitted.

The success of the projector of the Ship Railway in his other important works—iron clads during the war, the magnificent bridge at St. Louis, the Mississippi Jeaties and other works, gives standing to this new work and leads to confidence in the ability of Mr. Eads to carry it through to a successful conclusion.

The address, printed in full, is illustrated by plates of the plans and by maps of the world and the Isthmus.

FEED-WATER PURIFIER.

This is a device for removing impurities from the feed-water by submitting it to the same heat as the water in the boiler, by which means the impurities are precipitated, and prevented from entering the boiler.

The water is feed in at the upper pipe *D*, passes down and up the central pipe, as shown, being highly heated in its passage. It is then sprayed from the top of this central pipe, falling down over the spider-like projections by which it is subdivided and thoroughly subjected to the temperature due to the pressure of steam in the boiler, precipitating the foreign matter. The whole mass then passes down through the concentrating pipes shown in the lower section of the feeder to the mud-well at the bottom. The separation of the foreign matter from the water is here completed, the deposit remaining in the mud-well, from which it is from time to time blow off. The purified water rises and passes to boiler through pipe *C*.

The advantages claimed for this purifier are, that it will keep boilers from scaling, and that from feeding water free from scale-making ingredients, any scale that is on the boiler will be gradually removed that it will prevent forming, because purified water only enters the boiler; that there will be no leakage from unequal expansion and contraction caused from conparatively cold water coming in contact with the sheets; all the water entering the boiler will be of a temperature nearly equal to that of the water already in the boiler.

The purifier can be readily cleaned, either by washing or blowing out; by closing valves on pipes *B* and *C*, and opening blow-off *E*, it can be washed out, or by closing valve on *C*, and opening *E*, it can be blown out.—*Am. Mach.*

ELEVATOR INSPECTION.

We have frequently called attention to the fact that more people were killed by elevator accidents than by boiler explosions, and expressed the opinion that there was even more need of regular inspections of elevators than of boilers. At length the authorities in this city have stirred themselves in the matter to the extend of orderring that passenger elevators shall be inspected once each three months. According to the rules to be enforced, manufacturers of elevators must furnish the Superintendent of Buildings a list of the elevators made by them and put into buildings, and shall not permit them to be used until duly inspected. Any person employed to run a passenger elevator shall be over eighteen years old, sober and trust worthy and shall have had not less than one month's instruction in his duties.

This is all very well, so far as it goes; but, in taking account of passenger elevators only, it stops short of the desired end. Accidents from passenger elevators are of comparatively rare occurrence. It is the ill constructed; out of the way, uncared forfreight elevator that is dangerous to life; that never receives any attention from any one until it "lets go" some day with disastrous results. It is these elevators that especially need "inspecting," and to which the Bureau of Buildings should have its attention directed. Until this is done, elevator inspection will not amount to much.—*Am. Mach.*

A FEW FACTS REGARDING VACCINATION.

Sir,—In view of the dangers which now threaten us, I think the people ought to be informed in reference to certain facts in connection with vaccination. Many who think they are safe because, after the operation for vaccination they had a very sore arm and can show "a large scar," may find to their sorrow that they have only passed through what medical men have called the "spurious" or "imperfect" vaccination. Permit me therefore to point out to your readers the characteristics of the genuine and the spurious vaccine disease.

1st. In the genuine vaccine disease there is little or no inflammation until or after the third day from the time matter is inserted.

2nd. About the fourth or fifth day a small point of inflammation appears, which gradually enlarges, and in about two days later a small vesicle is formed, which is depressed in the centre, and without inflammation in the adjoining skin. The vesicle enlarges, remains circular, with a regular and well defined margin, more depressed in the centre, and a small crust begins to form in the centre of the depression by the seventh or eight day.

3rd. Between the seventh or eighth days there is an aureola or blush of inflammation formed around the margin of the pustule.

The circle of inflammation enlarges, and frequently by the ninth day it will be two or three inches in diameter, but remaining circular. The crust in the centre grows darker, the turgid margin shining as if the lymph were assuming the character of pus.

4th. The vesicle generally reaches its acme by the eleventh day, when the surrounding inflammation begins to subside, first immediately around the pustule, and gradually declines towards the circumference, where it leaves at last a mere ring.

5th. The fluid in the vesicle becomes thick and turbid, and soon forms into a smooth crust of a dark brown mahogany colour. The crust, in many instances, does not loosen and fall off under three weeks. It leaves a permanent circle or cicatrix about five lines in diameter and a little depressed, the surface being marked by many little pits or indentations, denoting the number of cells of which the vesicle had been composed.

The constitutional symptoms attending the course of the vaccine disease are generally very slight, especially in children. In some instances there are chills and fever and headache, which may need some attention, though generally they soon subside without any treatment.

The glands under the arm are apt to be swollen and sore, and care should be taken to avoid lifting a child with the hands under its arms, as is the usual practice.

Characteristics of spurious or imperfect vaccination:—

First, there is generally considerable inflammation and raising of the skin, on the second day after the matter is inserted.

Second, the scabbing commences by the third or fifth day from the commencement of the inflammation, and runs its course se in a much shorter time than genuine.

Third, there is no depression in the centre of the pustule; it is raised up high and has an irregular margin.

When the inflammation commences on the formation of the vesicle, and assumes an erysipelatous character early, with much swelling, and the pustule assumes a blue appearance, it should not be considered genuine. Genuine cowpox—that which was first considered the protection against small pox—was gotten by inserting the lymph from the udder of the cow or heifer. It is very fair to conclude that most, if not all the bad effects following vaccination have been when the matter has been used from the arm of some diseased or scrofulous person. The safe plan is to use only the lymph obtained from a healthy animal.

Only one pound in ten of what is sold as butter in Chicago, according to the Health Commissioners of that city, is the genuine unadulterated article.

THE TOOL MAKER.

The tool maker has within the past few years (says the *American Machinist*) come to be a permanent fixture in most machine shops. The machinist twenty-five years ago was of all mechanics, except, perhaps, the blacksmith, the one who made his own tools. Now, as a natural result of the subdivision of the trade, the tool maker makes them for him. Notwithstanding a great proportion of the small tools, such as taps and reamers, that were formerly made in the machine shops are now had from the manufacturers who make a specialty of such work, there are still many for peculiar uses that must be made in the shop, while special appliances and fixtures for different jobs are made and used where their use would never have been thought of a few years ago. One advantage of having a skilled man — that is, speacially skilled in this kind of work — to make these tools and appliances, is that they are much better made than they were formerly. Not only does the tool maker acquire special skill in designing and making tools for expediting work, but his tools are a record of his efficiency as a mechanic, and his reputation in this respect stands or falls by their quality. When such tools are made indiscriminately by anyone of a shop full of men, no one has much interest in them ; their making is looked upon in the sense of a drudgery, to be done without much preparation, and got through with as easily as possible. Tools made and got together in this way in a shop lacked character, so to speak. Nobody was much interested in studying principles. Making the tools was a secondary matter, for which no one assumed any particular responsibility. The end at which the machinist aimed, and upon which his reputation as a mechanic rested, was something quite different from tool making. Many shops that before the advent of the tool maker could count up time equal to that of two or three men constantly engaged in making tools, find upon employing a skilled tool maker, and giving him the necessary machinery to work with, that he not only makes all the tools, but devises special ones for lessening time on many classes of work. In other than machine shops the tool maker is of still greater importance ; in such businesses as button making and kindred branches of manufacture, where new desings are constantly demanding new tools, and where the operations must be quickly performed the wages he is able to command are frequently three times as much as those of an ordinary mechanic. But he must be a highly skilled man. While in one sense the work is not hard, it is exacting, calls for a good deal of thinking, and the ability to think correctly and quickly. If a machinist — a young man — has a decided talent in the direction of devising and making tools, it is worth cultivating ; mere copying does not amount to much, but the ability to originate is valuable.

Miscellaneous Notes.

The tin deposits of New South Wales are estimated by the colonial geologist to cover an area of 5,440,000 acres, but it is supposed that the area is realy much greater than that, as new fields of tin are continually reported.

A good many miles are offered for sale in sections of the country where the wheat crop was nearly or quite a failure, this year. Without doubt, some of them are offered for sale solely on that account. We believe that in many instances parties with capital could make money by purchasing the property of the despondents, where the crop failure is the real cause of selling. Parts of the country have little or no wheat this year, where for years a failure has been unknown. Another year will doubtless see plenty of wheat in such sections, and with a cheap mill on his hands prosperity may come his way. Wheat-raising will not be abondoned in such States as Illinois and Missouri on account of one failure.—*American Miller.*

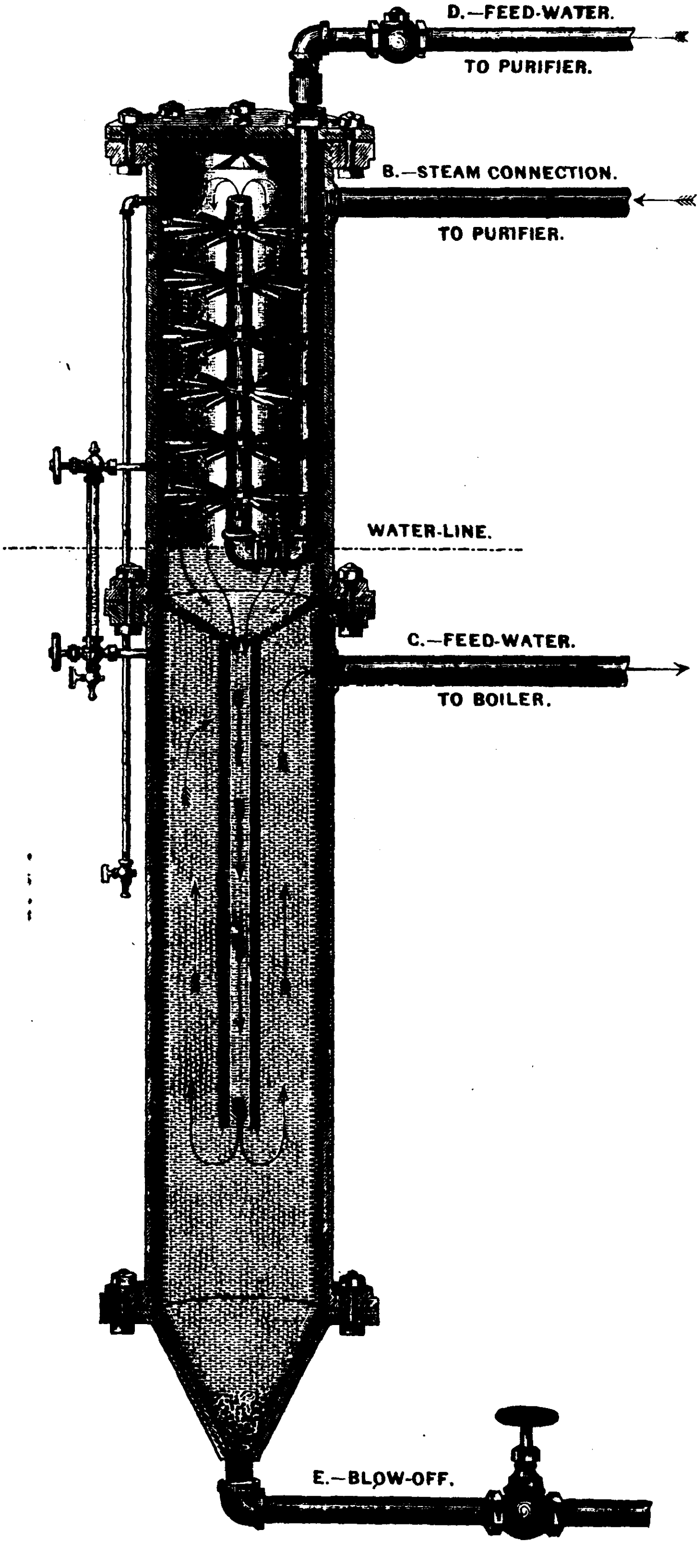
"Midget locomotives" for plantation use are said to be superseding mules. One of them weighs only 3 tons, and they are used on rails which weigh 12 pounds to the yard. The cylinders are only 10 inches long. These little engines are not confined to wood for fuel. As lumbermen, they burn wood. As plantation engines, they frequently burn refuse sugar-cane. In a different form, but with the same diminutive cylinders, they are used in coal mines for hauling cars, and burn either soft or hard coal or coke. In their smallest sizes they are only 10 feet long over all, 4½ feet high and 5 feet wide. A few bushels of coal and a few pails of water keep them running all day. One of these mules in a coal mine at Brookfield, Ohio, pulls 20 cars, weighing nearly theree-quarters of a tone each, up a grade 1,360 yards long that rises at the rate of 105 feet to the mile.—*Railway Age.*

The making of celluloid is an interesting process. A roll of paper is slowly unwound, and at the same time saturated with a mixture of five parts of sulphuric acid, and two parts of nitric, which falls on the paper in a nice spray. This changes the cellulose of the paper into a fine pyroxyline (gun cotton). The excess of acid having been expelled by pressure, the paper is washed with plenty of water, until all traces of the acid have been removed ; it is then reduced to pulp, and passed to the bleaching trough. Most of the water having been got rid of by means of a strainer, the pulp is mixed with from twenty to forty per cent. of its weight of camphor, and the mixture thoroughly triturated under mill stones. The necessary coloring matter having been added in the form of powder, a second mixture and grinding follows. The finely divided pulp is then spread out in thin layers on slabs, and from twenty to twenty-five of these layers are placed in a hydraulic press, separated from one another by sheets of blotting paper, and are subjected to a pressure of 140 atmospheres, until all traces of moisture have been got rid of. The plates thus obtained are broken up and soaked for twenty-four hours in alcohol. The matter is then passed between rollers heated to 140 or 150 degrees Fahrenheit, when it issues in the form of elastic sheets.

The operation of sharpening band saws is both slow and tedious, and demands considerable skill on the part of the workman. It has therefore been an object with inventors to produce a machine which should supersede hand labor in this respect, and the perspective view on the present page illustrates an arrangement invented in Denmark by the owner of a saw-mill, and afterwards modified, as shown in Figs. 1, 2, and 3, by Mr. Edward Rasmussen, of the firm of Rasmussen and Sons, of Slagelse, Denmark, for this purpose. The patents are in the hands of Mr. Carl Mortensen, of the same place.

The machine consists of a cast-iron bed-plate upon and below which the working parts are arranged. The cutting tool is a 5½ in. or 6 in. taper saw file carried in the support L (Fig. 1), which is moved backwards and forwards in the guide C by means of the connecting rod K and a crank, the whole being set in motion by the pulley T. A is a vice in which the band saw blace is held by means of a horseshoe spring P. During the operation the saw rests upon two steel stops Q, which by a mechanism clearly shown in Figs. 1 and 2, can be so adjusted that the blade has only its teeth above the vice. The up-and-down movement of the saw file, bombined with the feeding of the saw blade by the pawl G, is effected by means of a two armed lever S, placed below the bedplate in the following manner: The eccentric disc O, driven through the pulley T and the mitre wheel U, produces a pressure upon the friction roller M resting in the bearing N. This pressure is transmitted to the end of the lever S, and produces in the adjustable support F- resting on the other end of the lever, a reverse motion. Now, upon the head of F there rests the guide C, which is pivotted at I, and which, therefore, follows F in its up-and-down motions. Supposing the movement to begin when the file commences its advancing stroke, then the disk O has its shortest radius turned toward the roller M ; this being at its highest point, the support F, with the guide and the file, are consequently in their lowest position, *i.e.*, the file is touching the saw blade. The file stroke being ended the eccentric disc O assumes the position in which it has its largest radius against the roller, and the motion of the lever S, and consequently of the guide, the file, and its carrier, is reversed, the file being kept raised above the saw blade during its back motioh. Just before the file touches the saw blade the pawl G commences to retire, but when the file has made its stroke and is returning above the saw blade the pawl pushes this latter one tooth forward. The length of the movement of the pawl is adjustable by the index attached to disc O. The spring B is applied when the file is nearly worn out to increase the pressure of the saw blade. By means of the screws X X the steel springs Y Y can be pressed more or less against the guide, and thus a very exact sideway adjustment of the file upon the saw blade can be obtained.

The machine takes very little power and is so extremely simple to manipulate that a boy can work it. It is designed to run about 80 revolutions per minute, and will sharpen band saw blades from 2¼ in. broad down to the slenderest blades.—*Eng.*



FEED-WATER PURIFIER.