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# The Canadian Patent Office Record and Mechanics' Magazine

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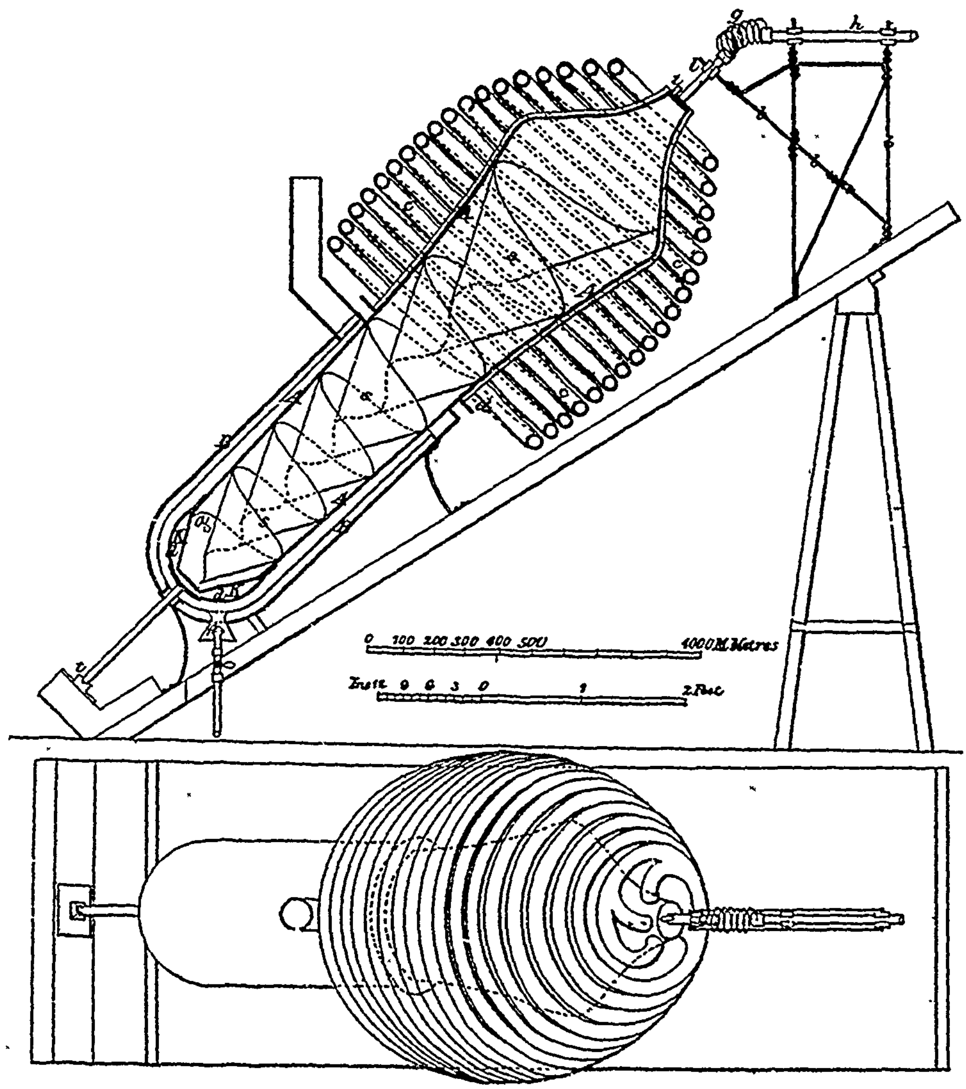


SIEMEN'S NEW STEAM MOTOR.

## SIEMENS' STEAM MOTOR.

Mr. Friedrich Siemens, of Dresden, has recently designed two motors one of which—the caloric—we have already described. The second is a steam motor equally simple and ingenious. It consists of a casing of sheet iron A, Fig. 1, which is cylindrical at one end and pear-shaped at the other. The whole is maintained in an oblique position by means of an iron support *b b*. The inner portion A is free to revolve round its axis of motion *l l*, while the exterior B is stationary; *d* is a second casing surrounding the lower projection of it, and *c* a condenser. Around the interior of A a helix, also of sheet iron, is wound so as to present to the eye the appearance of a series of interplaced funnels. The inner surface of B is lined with fireclay, as in ordinary furnaces. The condenser consists of a pipe of convenient diameter encircling part of the motor a sufficient number of times. One end communicates with the upper portion of A, and the other with a vessel of water. The space *k* between A and its second casing *d* may be called the boiler of this apparatus; it is filled with water by means of a small opening in the superior part of A. A Bunsen burner placed beneath supplies the heat, which converts the water into steam. When the steam is generated, it passes through circular orifices perforated in the under surface of A, and rises in the interior of the motor. The force with which it impinges upon the sides of the helical sheets is at first insignificant, but it gradually increases with the continued generation, and consequent pressure of steam, so as to overcome the inertia of the motor, and to impart to it a comparatively rapid movement. When the steam is circulating through the upper part of A, it enters the condenser, and is converted into water, which descends and feeds the boiler. The products of combustion escape through a flue inserted in the outward fixed casing, and which communicates with the cylindrical space B. To obtain a motive power of 16 lb. it is necessary to increase the supply of heat, and for this purpose a series of Bunsen burners is employed. The movement is transmitted by means of the shaft *h*, which is connected with the axis of the motor either by bevel wheels or, in case of easy work, by a spring *g*.

When once rotating, this motor requires but very little attention. As both water and steam are confined within the revolving casing, and as there is no communication whatever between the interior and the exterior, there is but little friction, and therefore a considerable gain of power Instead of a safety valve, the inventor has adopted a small plug of fusible metal, which is inserted in the upper part of A. This safety plug is also used as a hermetical stopper for the water aperture. The only object attained by this twofold office is greater simplicity in the general mechanism.

The chief difficulty in the construction of this motor is to prevent the circulation of the water through the spiral spaces *s*, and approximately to maintain the horizontal level of the water, notwithstanding the movement of rotation. Of course absolute horizontality could not be preserved on account of the centrifugal force caused by the rototary motion, for it may easily be seen from the figures that the water revolves with the cylinder A. This inconvenience has been considerably diminished by making the spirals present extensive conical surfaces. This disposition affords a free downward passage to the water, and permits only the steam to circulate through the helices.

When the motor is constructed for maximum power, the condenser is suppressed, and a funnel-shaped vessel, providing the water supply, is fitted into the upper part of A.

Mr. Siemens thinks that other fluids than water may be advantageously used in his motor. He specially recommends oil and mercury. The latter would give more power than water on account of its greater density and lesser specific and latent heats.

The principal advantages of this invention are the direct action of the steam, a simple mode of condensation, utilisation of the full expansive force of the steam, and a gain of power corresponding to a great diminution of friction.

Like the caloric, this motor is only the realisation of a scientific idea. It is a germ which time perhaps may develop and cause to fructify.

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Russia now has more than ten thousand miles of railroad, which has grown from only eight hundred and twenty-nine miles in 1857.

## PRINCIPLES OF SHOP MANIPULATION FOR ENGINEERING APPRENTICES.*

By John Richards, M.E.

(*Continued from page* 74, vol 3.)

### WIND POWER.

Wind power, aside from the objection of uncertainty and irregularity, is the cheapest source of power. Steam machinery, besides costing a large sum as an investment, is continually deteriorating in value, consumes fuel and requires skilled attention. Water power also requires a large investment, greater in many cases than steam power, and in most places the plant is in danger of destruction by freshets; but wind power is cheap in every sense, except that it is unreliable for constancy except in special localities, and these, as it happens, are for the most part distant from other elements of manufacturing industry.

The operation of wind wheels is so simple and so generally understood, that no reference to mechanism need be made here.

The force of the wind, moving in right lines, is easily applied to producing rotary motion, the difference from water power being mainly in the weakness of the wind currents and the greater area of the surfaces required to act upon. Turbine wind wheels have been constructed very much the same as turbine water wheels.

In speaking of wind power, the propositions about heat must not be forgotten, in fact the apprentice should so school his mind and habits of thinking that, whenever the subject of power is to be considered in any way, he will at once trace out the connexion with heat.

We have seen how heat is almost directly utilised by the steam engine, and how the effects of heat are utilised by water wheels, and the same connexion will be found with wind wheels or wind power, because currents of air are due to changes of temperature, and the connexion between the heat that produces such air currents and their application as power is no more intricate than in the case of water power.

### MACHINERY FOR TRANSMITTING AND DISTRIBUTING POWER.

To construe the term, transmission of power, in a critical sense, it should, when applied to machinery, include nearly all that has motion; for, with the exception of the last movement, or where the power passes off and is expended upon the work to be performed, all machinery, of whatever kind, can be regarded as machinery of transmission. Custom has, however, confined the use of the term to such devices as are employed to convey power from one place to another, without including the organised machinery through which power is applied immediately to the performance of work.

Power is transmitted by means of shafts, belts, friction wheels, gearing, and in some cases by water or air, as the conditions of the work may require. Sometimes such machinery is employed as the conditions do not require, because there is, perhaps, nothing of equal importance connected with mechanical engineering about which there exists so great a diversity of opinion, or in which there is a greater diversity of practice than in devices for transmitting motion.

I do not refer to questions of mechanical construction, although the remark is equally true if applied in this sense, to the kind of devices that are best in special cases.

### Shafts for transmitting power.

There is no use in entering upon explanations of what the learner has before his eyes. He sees shafts wherever there is machinery; he may also see the extent to which they are employed to transmit power, and the usual manner of arranging them; he can read in various text books of the exact data for determining the amount of torsional strain that shafts of a given diameter will bear; that their capacity to resist torsional strain is as the cube of the diameter, and that the deflection from transverse strains is so many degrees, with many other matters that are highly useful and proper to know. I will, therefore, not devote any space to these points here, but treat of some of the more obscure conditions that pertain to shafts

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* This, and the succeeding articles under the same title, were published simultaneously in the *Journal of the Franklin Institute*, Philadelphia and in *Engineering*.

such as are demonstrated by practical experience rather than deduced ftom mathematical data. What is said will apply especially to what is termed line-shafting, for conveying and distributing power in machine shops and other manufacturing establishments.

The strength of shafts is governed by their size and the arrangements of their supports.

The capacity of shafts is governed by their strength and the speed at which they run, taken together. The strains to which shafts are subjected are the torsional strain of transmission, transverse strain from belts and wheels, and strains from accidents, such as the winding of belts.

The speed at which shafts should run is to be governed by the nature of the machinery to be driven and the nature of the bearings in which the shafts are supported.

As the strength of the shafts is determined by their size, and the size fixed by the strains to which the shafts are subjected, the strains are to be first considered. There are three kinds of strain mentioned—torsional, deflective, and what was termed accidental strains.

To meet these several strains the same means have to be provided, which is a sufficient size in the shafts to resist them; hence it is useless to consider each of these different strains independently. If we know which of the three is the greatest, and provide for that one, the rest of course may be disregarded. This, in practice, we find to be the accidental strains to which shafts are subjected, and they are always made in point of strength far in excess of any standard that would be fixed by either the torsional or transverse strain due to the regular duty the shafts have to preform.

This brings us back to the old proposition, that for structures that do not involve motion mathemetical data will furnish dimensions, but the same rule will not apply in machinery.

Experience has demonstrated that for ordinary cases, where the power transmitted is applied with tolerable regularity, a shaft 3 in. in diameter, with its bearings four diameters in length, placed 10 ft. apart, and running at a speed of 150 revolutions a minute, is a proper size to transmit 50 horse power.

The apprentice, by assuming this or any well-tried example, and estimating larger or smaller shafts by keeping their diameters as the cube root of the power to be transmitted, the distance between bearings as the diameter, and the speed inversely as the diameter, will find his calculations to agree with the modern practice of our best engineers.

Shafts as a means for transmitting power afford the very important advantage that power can be easily taken off at any point throughout their length by means of pulleys or gearing, also in forming a positive connexion between different machines. Shafts are also the cheapest means of transmitting power within limited distances.

The capacity of shafts in resisting torsional strain is as the cube of their diameter, and the amount of torsional deflection in shafts is as their length. The torsional capacity being based upon the diameter often leads to what may be termed tapering shafts, lines in which the diameters of the several sections are diminished as the distance from the driving power increases, and as the duty to be performed growsless.

This plan of arranging line shafting has been and is yet quite common but certainly was never arrived at by any of the processes of reasoning that have been so continually alluded to in the course of this treatise.

Almost every plan of construction has both its advantages and disadvantages, and the best means of determining the excess of either, in any case, is to first arrive at all the conditions, as near as possible, then form a "trial balance," putting the advantages on one side and the disadvantages on the other, and foot up the sums for comparison.

Dealing with this matter of shafts of uniform diameter and shafts of varying diameter in this way, we find in favour of the later plan a little saving of material and a slight reduction of friction, so advantages; the saving of material relating only to first cost, because the cost of fitting is greater in constructing shafts when the diameters of the pieces are varied; the friction, considering that the same velocity throughout must be assumed, is scarcely worth estimating.

For disadvantages, there is the want of uniformity between fittings that prevents their interchange from one part of the shaft to the other, a matter of great importance; a shaft, when constructed in this way, is special machinery, adapted to some particular place or duty, and not a standard product that can be regularly manufactured as a staple, and thus afforded at a low price. Pulleys, wheels, bearings and couplings have to be all specially prepared, and, in case of change or extension of lines of shafting, this causes annoyance. and frequently no little expense. The bearings, besides being of varied strength, are generally in such cases placed at irregular intervals, and the lengths of the different sections sometimes varied to suit the diameter of the shafts.

Going next to shafts of uniform diameter, everything pertaining to the line is interchangeable; the pulleys, wheels, bearings, or hangers can be placed at pleasure, or changed from one part of the works to another. The first cost of a line of shafting of uniform diameter, strong enough for a particular duty, is generally less than that of one consisting of sections that vary in size, and all the above-named objections of diminishing are avoided.

I have called attention to this case, as one wherein the conditions of operation obviously furnish the true data to govern the construction of machinhry, instead of the strains to which the parts are subjected, and as a good example of the importance of analysing mechanical conditions.

If the general diameter of a shaft was predicated upon the exact amount of power to be transmitted, or if the diameter of a shaft at various parts was based upon the torsional stress that would be sustained at those points, such a shaft would not only fail to meet the conditions of practical use, but would cost more by such an adaptation.

The regular working strain to which shafts are subjected is inversely as the speed at which they run; a strong reason in favour of arranging shafts to run at a maximum speed, if there was nothing more than first cost to consider; but there are other, and more important conditions to be taken into account. Principal among them is the required rate of movement when power is taken off, and the endurance of bearings.

In the case of line-shafting in manufactories, if the speed varied so much from the first movers on the machines as to require one or more intermediate or countershafts, the expense of fitting in this manner would be very greatly increased; on the contrary, if countershafts can be avoided, there is a great saving of belts, bearings, machinery, and obstruction.

The practical limit of speed is in a great measure dependent upon the nature of the bearings, a subject that will be treated of in another place.

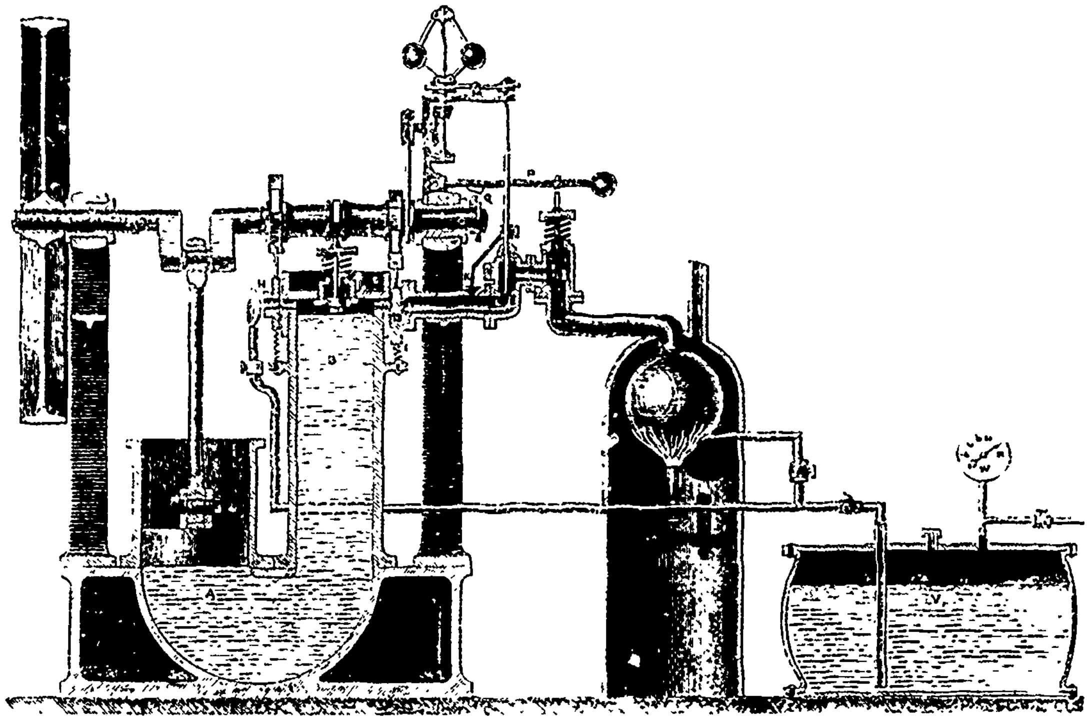
## IMPROVED WATER WHEEL GOVERNOR.

The apparatus illustrated on page 132 is used in connection with the governor, where there is a variable head of water and when it is desirable to keep up the head though at the sacrifice of speed. Its greatest utility is realized where steam power is employed in connection with water power. The water governor being speeded to run the line a trifle faster than the steam governor, the engine is relieved of its weight so long as there is an available head for the supply of the wheel; but when the water is drawn down to a given point, say from three to twelve inches, the governor automatically closes the gate sufficiently to allow the water to regain the lost head, and, when at the available point, automatically resumes its natural action. All this is accemplished by very simple means, as shown by the engravings. The reservoir is placed so that the high water line in the flume is within three inches of the top of the reservoir.

Our engravings represent opposite sides of the apparatus; and in Fig. 2 is shown the reservoir and float in connection.

The operation is as follows: Water is admitted from the flume through the pipe, I. The float, B, in the reservoir A, rises with the water, and the cord is slackened, which leaves the governor to the natural action. As soon as the water lowers to any given point (regulating according to length of cord), the pawl shifter, C, is drawn down, throwing the closing pawl, F, into action, and the water is closed off. Tho machinery being all in motion, the gate would become closed, with a tendency to go beyond, but for a stop motion which limits the hoisting and closing of the gate, and which is simply a sliding bar inside of the bracket D, and operated by the worm, E.

Another feature of the governor is an adjustable weight connected to an arm of the pawl shifter, C, but not shown in the engraving (other parts of the machine being in front of it). By means of this sliding weight the speed of the governor may be changed from 140 revolutions to 165—a great convenience



NEW FORM OF GAS-ENGINE.

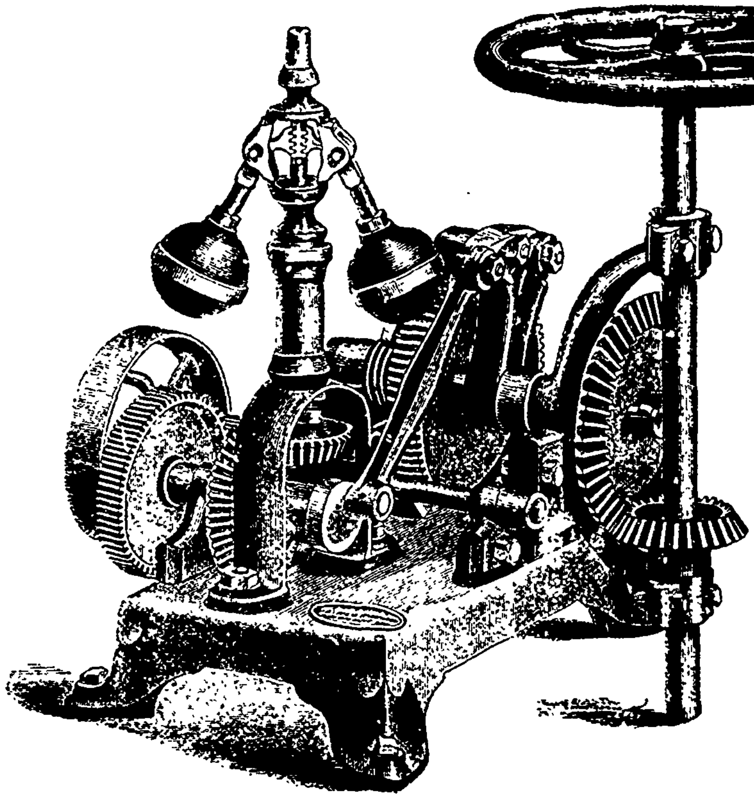


Fig. 1.

SNOW'S STANDARD WATER WHEEL GOVERNOR

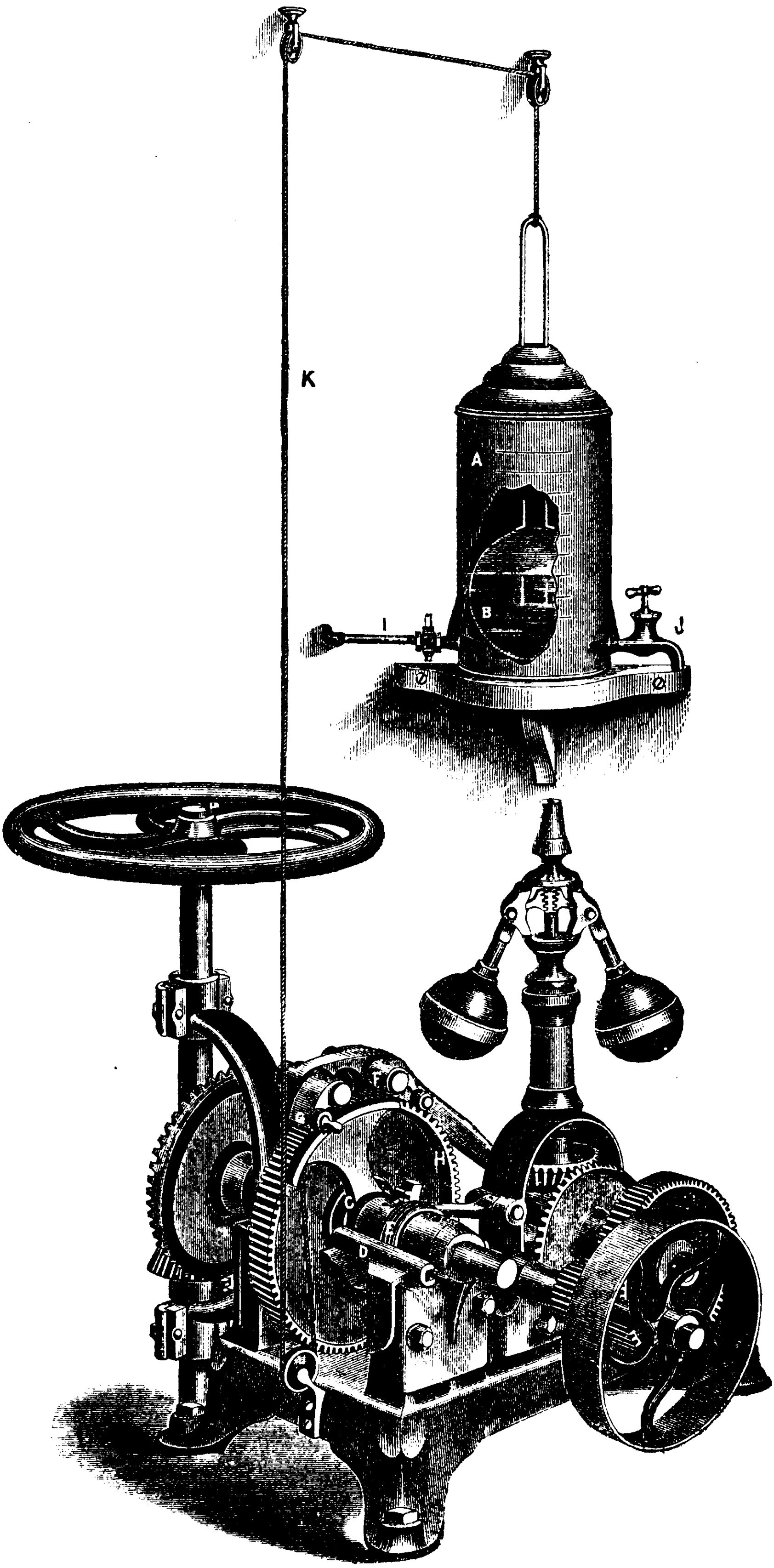
in many establishments, particularly in the case of wheels driving paper machines, where an adjustable speed is indispensable.

These governors have been in use, it is stated, now about six years, in some of the largest as well as in the smallest establishments, and attached to all kinds of wheels (even overshot and breast wheels), with heads varying from seven feet to seventy-eight feet, including the largest cotton mills in the world, in iron rolling mills, and down to one set woolen factories. The manufacturers add that they have yet to learn of the first complaint of them. —*Scientific American.*

## NEW FORM OF GAS-ENGINE.

Motive power obtained from the explosion of a mixture of gases is at first thought so economical that is is only after an irritating experience of the advantages and defects of gas-engines that many power-users, can be convinced of the superiority of the steam-engine under ordinary circumstances. Those who reckon the horse power of their engines by tens are not likely to discard steam for gas, but there is a large class of small power-users who would be glad to have something less costly than the steam boiler, and a much larger class who would be glad to use motive power if they could but have it at a cheap rate and at intervals. It is, perhaps not overstating the matter to say that a very large number of the steam-engines in use in this country are in reality idle for half the time that they are under steam, i.e., while coals are being consumed. In many cases this is due to the nature of the work for which they are employed, but in all cases there is a considerable waste, or perhaps we should say loss, in getting up steam to commence work, and in letting it off at the close of the day's labours. It is chiefly in consequence of this, and not from the superior "duty" performed by gas-engines, that so many of that class have found their way into the workshops of England. They are undeniably handy, although larger in proportion than steam-engines; and under conditions which prevail extensively they are economical, for they do not consume fuel while standing idle.

A patent has been recently secured in this country for a gas-engine, the invention of Mr. Thos. B. Fogarty, of Warren, Massachusetts, which is adapted for use with ordinary coal-gas, or, where that is not obtainable, with the explosive vapours obtained from any of the distillates of petroleum, shale oil, or coal: in fact, the requisite apparatus for converting a hydrocarbon into gas forms a portion of the invention, although it is not, of course, essential to the gas-engine itself, and is not the foundation of the advantages the new engine is




SNOW'S STANDARD WATER WHEEL GOVERNOR.—Fig. 2.

asserted to possess. Mr. Fogarty's gas-engine has a cylinder, crank, flywheel, &c., similar to other machines of its class, the piston being raised by the effects of the explosion of gas, and being forced down again by the pressure of the atmosphere The cylinder, however, is connected by a tube, or rather is continued or prolonged into another cylinder forming the gas-chamber, the connecting piece being of the same diameter as the cylinder, while the gas chamber is of smaller area. Both are arranged in a vertical position, to avoid the wear of side friction common in horizontal cylinders: and, as will be seen from the engraving, from a large U tube, one leg of which is longer than the other. The upper portion of the gas-chamber is made smaller in area than the cylinder, in order to obtain a longer range within which to regulate the supply of gas. Suitable valves and other appliances for the admission of the gas-chamber, and also a valve for the admission and discharge of water, together with the waste products of the explosion. The explosion may be effected by means of electricity, although the ordinary jet flame is shown in the engraving. The gas-making apparatus consists of a tank containing the hydrocarbon to be volatilised, which is forced by means of an air-pump into a boiler heated by Bunsen burners consuming a portion of the hydrocarbon, which is also burnt in the igniting jet. The admission of the gas and its admixture with air is controlled by a poppet valve in connection with a spring lever, which is moved by a cam on the shaft; while the quantity of gas admitted is regulated by a needle valve capable of being shifted automatically by the governor of the engine.

Referring to the engraving, A is the cylinder containing the piston, and B is the explosion-chamber full of water, and connected to the cylinder as shown. V is the tank containing the hydrocarbon liquid, which is forced into the vaporiser or retort T by means of an air-pump connected to the pipe of the gauge W, showing the pressure existing in the tank. To set the engine to work, the burners beneath the retort are lit, and when the hydrocarbon is being vaporised, the jet seen near the top of the explosion-chamber is ignited. A partial turn of the flywheel then brings the cam Q to bear on the lever P, and the vapour in T rushes through the poppet valve O, and the needle-valve L, into the gas-chamber, the slide-valve I having been brought to the proper position for admitting the gas, which in its passage has become mixed with the requisite quantity of air entering through the valve K. The slide-valve H now opens, and the mixed gases communicating with the flame of the jet explode, and, expanding, drive up the piston in the cylinder A. A vacuum being thus created, the pressure of the atmosphere forces the piston down, the waste gases, which are now condensed, escaping by the valve C, which also admits water to completely fill the explosion-chamber. The engine is now fairly started, and it will be readily understood that the momentum of the flywheel keeps the shaft in motion, and it actuates the requisite valves. The details of the engine may, of course, be modified in a number of ways, but, as shown in the engraving the double poppet-valve O is kept to its seat by the lever P, the spring serving as a cushion to present any damage from the upper part of the valve striking forcibly against its seat. The valve is shown without a stuffing-box, as the inventor says it is not necessary; but it may be desirable, in some cases, to have the security afforded by a stuffing-box, which would render a slight modification of the valve advisable. The needle-valve L and the air-valve K are connected, as shown, to the governor, and the inventor claims that when once adjusted, they will respectively admit the requisite proportions of gas and air, notwithstanding the action of the governor shifting their positions. The valves C, H and I are operated by eccentrics or cams on the shaft, and the cam Q, as before mentioned, lifts the lever P and admits the gas to the mixing pipe through the valve L.

When coal gas is used the vaporizing apparatus is detached at the junction shown between O and L, and the gas admitted through an orifice, which is shown closed by a screw plug A uniform quantity of water is always maintained in the cylinder and chamber, which serves to condense the gases to expel them when exploded, and to keep the parts cool. The hydrocarbon may be supplied to the retort or vaporiser by gravity, the inventor, however, prefers to use compressed air, but it will be understood that an equilibrium always exists between the liquid in the retort and that in the tank so that the pressure can be read on the gauge. The burners beneath the retort may be supplied with vapour from the latter as soon as sufficient heat has been imparted to the hydrocarbon to vaporise it, but the inventor prefers to take the supply of liquid for this purpose before it reaches the retort.—*English Mechanic.*

## A NEW SOUTH WALES RAILWAY.

It will be interesting to our readers in Canada, whose already existing and vast projected railways form so important a feature of the political and commercial commonwealth, to notice how a sister colony has overcome extraordinary natural obstacles in furthering a similar undertaking. The following description and the illustration on page 137 are from the London *Graphic.*

The view we have engraved represents that portion of the Great Western Railway of New South Wales which crosses the Blue Mountains, near Mount Victoria. These mountains form part of the main dividing range of Eastern Australia, which extends nearly north and south about 600 miles, from the northern to the southern extremity of the colony. Mount Victoria is distant about eighty miles from Sydney, and the Blue Mountains are crossed at an elevation of about 3500 ft above the sea-level. A few months ago the railway was completed to the city of Bathurst, about 130 miles from Sydney The rich agricultural districts around Orange, Wellington, and Mudgee, and the pastoral districts still further to the west, have received the benefit of such improved means of communication.

In 1812, thirty years after the foundation of the colony, it was reported to Parliament that no one had been able to penetrate the inland country across the Blue Mountains. Since that time many attempts have been made to find a practicable road. In 1813 Messrs. Wentworth, Blaxland, and Lawson, after incredible hardship, by heroic efforts, found a possible track across the mountains. They were rewarded by discovering the splendid pasture country extending for hundreds of miles into the far interior. A practicable road for stock was soon made, and in May, 1815, Governor Macquarie travelled over the mountains. Upon the plains beyond, till then untrodden by the white man, he fixed upon the site of a future town, named Bathurst. Effort followed effort in an undaunted spirit to find a better road. Bell's Line was succeeded by the Main Western Road, which was constructed by Mr. Bennett, C.E., engineer for roads. But many have been the casualties in crossing Mount Victoria, and many a life has been lost owing to the steepness of the gradients, which could not be lessened.

About 1850 surveys were commenced by a party of Royal Sappers and Miners, under Capt. Hawkins, R.E., to find a route practicable for a railway to Bathurst. The Bathurst people offered a bonus of £5000 on its satisfactory determination. But it was reported to be impracticable.

Under the direction, however, of Mr. John Whitton, C.E., engineer in-chief of the colony for railways, assisted by Mr E Barton, the present line was determined upon. This line crosses the mountains on a gradiant of about one in forty throughout. Some idea of the difficulty of its construction may be given when it is stated that Penrith, at the foot of the mountains, is thirty-four miles from Sydney and 88 ft. above sea-level; but in thirty-three miles further, or seventy-seven miles from Sydney, the summit near Mount Victoria is crossed at an altitude of 3426 ft. above sea-level, being a rise of 3338 ft. in thirty-three miles, or upwards of 100 ft. per mile, average. The sharpest curve is eight chains radius. It was possible to cross the summit by means of a zigzag only for about three miles. This line is in the form of a flattened letter Z., and at each extremity are reversing points. The line is worked with the greatest ease and safety. It is literally constructed upon the sides of precipices. When the trial survey was being made, and the heights of the cross sections taken, the men had to be lowered over the edge in baskets to hold the level-staff. In places, 1500 ft. of dark chasm were beneath them. The contractors also had the greatest difficulty in fixing the scaffolding-poles necessary for the travelling-crane to rest upon. Much ingenuity and great daring were exhibited, and but few lives were lost. In some places the face of the rock did not project sufficiently to bear the line, with the weight of a train, and a viaduct became necessary There are seven such viaducts and two bridges, of an aggregate length of 2225 ft., varying in height from 10 ft. to 70 ft; also three tunnels, of a total length of 391 yards, in addition to the Clarence Tunnel, which is 539 yards in length. The fifteen-mile contract, of which the zigzag forms part, shows excavation to the extent of 1,144,284 cubic yards, of which 747,710 cubic yards were out of solid rock. The amount of this contract for works only—ballasting and laying rails (exclusive of cost)—was £328,284, one third of a million of money.

In travelling along the upper portion of the zigzag, the spectator observes, many hundreds of feet beneath him, two lines of railway, apparently distinct. He finds it hard to believe that the train will really pass over those lines; but by gradients and curves so admirably disposed he will find the train arrive at the bottom of the valley with an ease almost incredible. As from the bottom he looks across those dark and gloomy ravines up to those precipitous walls of rock, and sees the lines, like a wire, suspended as it were, in mid-air, he will still have considerable doubt, that the train really travelled over those two lines. Every spectator has felt this in his first journey. The masonry throughout is of the best possible description, and the railway as it stands is one of the finest pieces of engineering work in the world. The whole of the works have been carried out with consummate ability by Mr. Whitton.

We may add that in each direction, to the north, south, and west the respective railways are opened to a distance of about 150 miles, and further extensions are rapidly being carried forward, by which means the vast resources of New South Wales in minerals, wool, and every agricultural product will be brought within a few hours' steaming of the metropolis.

## THE HISTORY OF THE COMPOUND ENGINE, WITH AN EXPOSITION OF ITS ADVANTAGES.

The following abstract of M. A. Mallet's "Etude sur les Machines Compound" will be found to contain a brief history of compound engines, and a clear exposition of their advantages. The history of compound engines, says M. Mallet, has heretofore been little known; we are able to make it tolerably complete by means of documents that enter into minute details, containing matter instructive and interesting, and shedding light upon points hitherto obscure. The idea of employing the expansive power of steam is generally attributed to James Watt. This is shown by the evidence of a patent of January 5, 1769, No. 913. The process consisted in arresting the introduction of steam a little before the termination of the stroke of the piston, thus reducing the pressure at the moment of the reverse stroke; it was not until some time after that it was perceived that a certain quantity of steam was thus economised.

Jonathan Hornblower, who built the Newcomen engines, patented the use of two cylinders to effect the expansion, on the 13th of July, 1781, No 1,298. He said that he employed the steam after its action in the first cylinder in order to employ it in the second expansively. Here is the original:—"I use two vessels in which the steam is to act, and which in other steam-engines are generally called cylinders. I employ the steam after it has acted on the first vessel to operate a second time on the other, by permitting it to expand itself, which I do by connecting the vessels together and forming proper channels and apertures, whereby the steam shall occasionally go in and out of the said vessels."

Hornblower's engine met with small success. As it used steam at low pressure it had but a limited expansive power and the advantages became of no account; on the contrary, they became negative on account of the resistances due to the use of two pistons. Besides, he could not use his engine without borrowing most of the parts of Watt's engine, such as the separate condenser, &c. So Hornblower got by means of his invention only the enmity of the friends of Watt, who accused him of indirect plagiarism, and created a bad reputation for him, of which traces are found in the early histories of the steam-engine. At this time the use of two cylinders turned out unsuccessful.

But when higher pressure was employed, Woolf did for the engines of Trevithick, Evans, and others what Hornblower had done for those of Watt; he applied to them the principle of the double cylinder. As he could make use of high pressure, there was promise of success for the invention, and it did succeed, so that he has given his name to engines having two cylinders. Woolf's patent was taken out in 1804. It contained, as has often been remarked erroneous notions about the expansive power of steam.

The fact that contributed to the success of Woolf's engines was that although the expansion was not sufficient to yield much advantage over ordinary engines, the division of the work of the steam between the two pistons diminished the differences in pressure and the loss of steam. This was an important matter in the early constructions. Engines of this kind need little repair. We could mention two instances in an industrial centre in Normandy, of engines with two cylinders which have been in action for nearly fifty years.

In 1805, Willis Earle took out a patent for engines composed of a large and small cylinder superposed with two pistons mounted on the same rod, a device frequently repeated since that time.

The first Woolf engine was set up in a London brewery. Afterwards Hall made a large number. In 1815 they were introduced into France by Edwards, and they rapidly came into use, without much change in construction. Edwards' engine of 1817 differs hardly at all, even in details, from those that are to-day put up in some of the manufacturing towns. In 1820 the English engineers, Aitken and Steel, built engines with three cylinders, two small and one large.

In 1834 Joseph Eve patented a compound engine, in which the steam, after acting in a high-pressure engine, passed into a low-pressure engine, where it acted expansively. He employed rotary engines. Here was the first idea of a mode of action different from that of Woolf's engines.

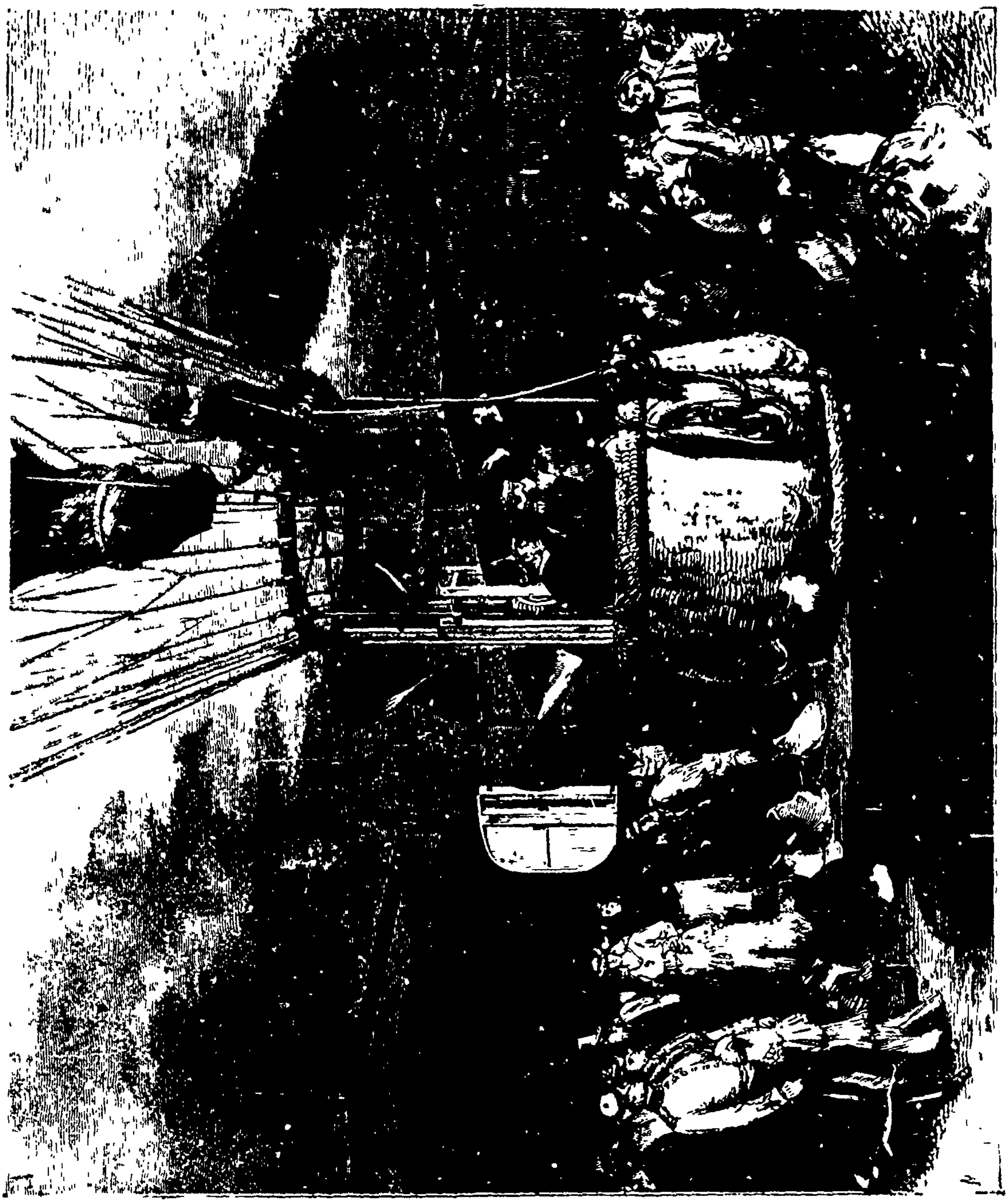
In 1834 Ernest Woolff (a German, we infer, from his name), took out a patent (No. 6,600) of an engine, described as compound, as nowadays constructed, which indicates the possibility of modifying existing engines so as to adapt them to the new mode of action. This patent is very interesting, and it is singular that English authorities hardly refer to it. It is certain that compound engines with two cylinders and intermediate reservoir, to which the name of Woolf has been given, though they have not the same mode of action, should be called "Woolf engines."

We give the essential part of this patent. "The invention consists of the combination of two or more engines, each complete in all its parts, and so disposed that while the first receives steam at one, two, or more atmospheres of pressure, the next engine is moved by the steam that escapes from the first. In the last engine the steam is condensed in the ordinary way, or escapes into the atmosphere. The work supplied by the several engines is applied to the same shaft, or to several combined or to independent shafts. As in steam-vessels and other applications, two conjoined engines are generally employed. The present invention is especially adapted for this purpose, as it presents economic advantages, and reduces the expense of the apparatus without increasing its complication. It is sometimes useful to have between the cylinders an intermediate reservoir to regulate the pressure, this may be placed with advantage at the base of the chimney, so as to maintain or raise the temperature and the pressure of the steam in its passage from one cylinder to the other. Indeed, if necessary, the heat may be supplied a special fire-box. It is often necessary to employ a special pipe with a stopcock to admit the steam from the boiler to an intermediate reservoir, in order to give to the machine the power of starting any crank. This direct introduction may be employed to increase for a time the power of the engine."

The writer then explains a method of modifying old engines by adding to a high-pressure engine a low pressure cylinder; or, in the case of a marine engine, by substituting for one of the low-pressure cylinders a high-pressure cylinder.

In 1837, William Gilman patented an engine consisting of two cylinders placed one on the other, one of them having an annular piston with a single cut-off, with multiple ports disconnecting the two cylinders. This disposition has been often reproduced, and is frequently employed nowadays, especially in Sweden. Gilman also describes an engine of three cylinders in which the steam acts in succession.

In 1837 Jonathan Dickson patented (No. 7,439) engines in which the steam acts successively by means of boilers with decreasing pressure, or parts of boilers constituting a compound boiler. This contrivance has also been made use of since the time of the invention. In fact, it is nothing more than Woolf's patent; for this proposed to re-heat the intermediate reservoir by a special fire-box, a process which constitutes in a certain way a low-pressure boiler. Dickson proposed the use of feed-pumps to serve as guides to the piston cranks, and to control the slide-valves of each engine by the other engine.



MILITARY BALLOONING

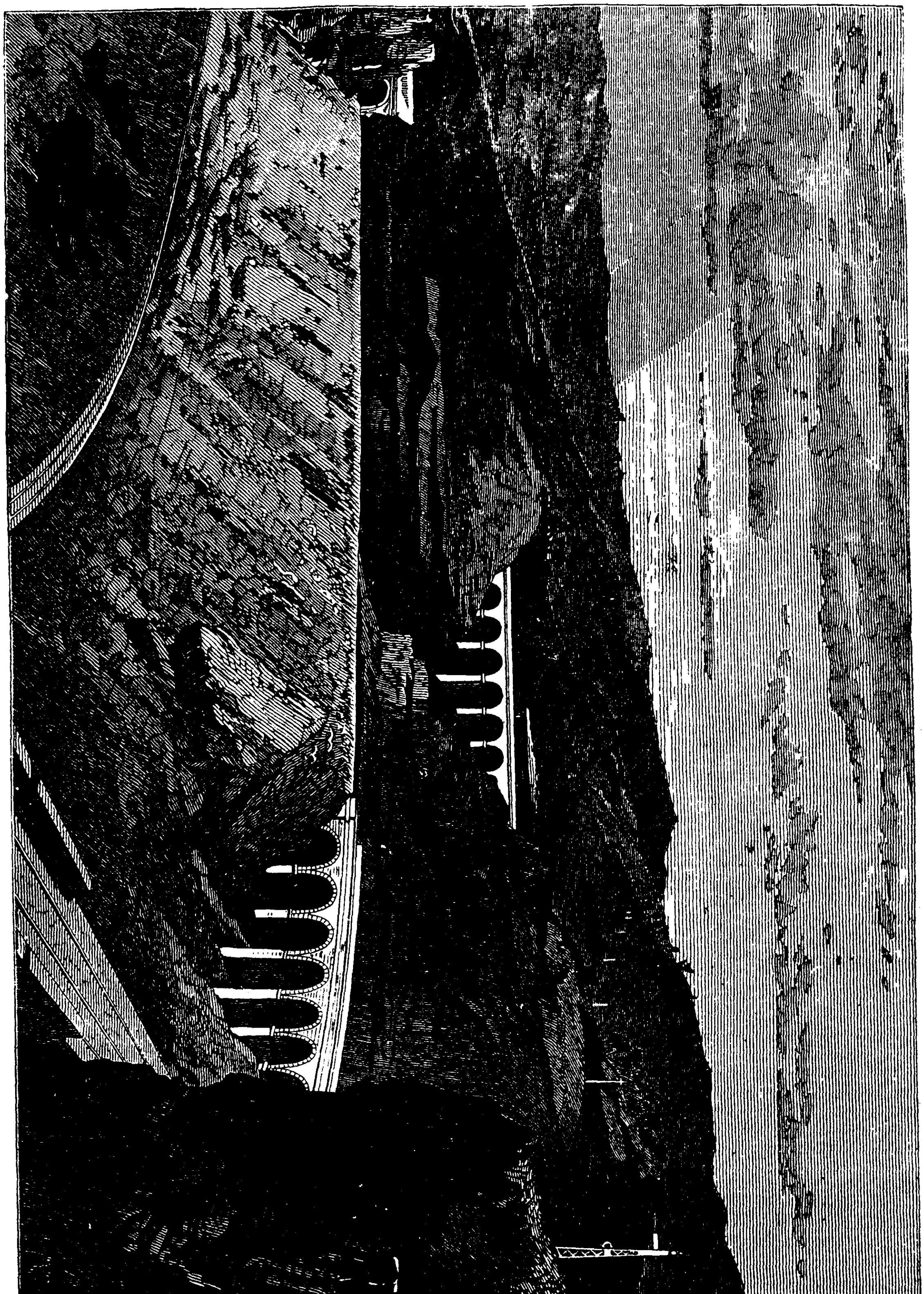
In the same year James Slater, patented (No. 7,467) engines acting in the same way, with an intermediate reservoir, employing a low-pressure boiler. He describes a regulating valve designed to keep the steam pressure at a fixed point, and also to start the engines This is nothing more than Woolf's invention—the valve, perhaps, excepted

William Whitman, in 1839, patented an engine which the piston has a trunk on one side only, so that the cylinder has two different capacities. The steam first acts in the annular space, then expands into the other portion of the cylinder This disposition, applied with some success by the inventor, has been frequently reproduced. It is probably the simplest way of applying the Woolf method of action.

In 1841 James Sims patented an engine of two superposed cylinders, with pistons on the same rod; with this special distinction, that the bottom of the smaller piston is in constant communication with the top of the larger.

In 1842 Hinrik Zander took out a patent No. 9,516) of an engine in which the steam acts in the first cylinder expansively, to a certain extent, then passes into two others which are larger, and expands. The three cylinders are connected to the same shaft, so that their motion may be as uniform as possible. The low-pressure cylinders are provided with jackets which contain the steam from the boiler. Zander describes intermediate reservoirs, and proposes to introduce into them, or into a communicating pipe supplying their place, a float-valve to allow the escape of condensed water.

Octavius Henry Smith patented in 1844, an engine acting on the Woolfian principle, consisting of a high-pressure and a low-pressure cylinder, both oscillating and having their rods attached to the same crank. Afterwards we find many patents of expansion engines. We mention only those of Perkins. 1844; McNaught, 1845, who modified old engines by the addition of a high-pressure cylinder; of Thomas Craddock,



ZIGZAG RAILWAY ACROSS THE BLUE MOUNTAINS, NEW SOUTH WALES.

1852; Daniel Adamson and Leonard Cooper, 1852, who superheated the steam in its passage from the high to the low-pressure cylinder by means of tubes set in the smoke-box of a tubular boiler.

We shall not go further in our examination of these patents. It is perceived that, since 1852, all the essential elements of the action of steam by expansion, in separate cylinders, have been pointed out, and that there remains nothing to be invented even in perfecting details. We shall look further back for applications.

The *Cricket* engine was built in 1847, by Joyce and Co., of Greenwich. It exploded the same year. Bramwell speaks of a boat built at about the same time by Spiller, in which was placed an engine consisting of a high and low-pressure cylinder. We have found no document concerning it.

According to the authority of "Zeitschrift des Oesterreichische Ingenieur und Architektur," 1867, Mr. Roetgen of Rotterdam, has built engines, since 1840, composed of cylinders inclined towards each other, and acting on the same pair of cranks, the same steam being successively used in the two cylinders. We do not regard the date 1840 as exact. If, as is probably the case, these engines are those made according to the plans of Zander, they were evidently built after his patent of 1842.

*Engineering* of September 9, 1870, contains a description and drawing of an engine built in 1848 by the Sterkerador Hutte for the Rhine boat *Kron-Prinz von Preussen*. This engine had two cylinders, one 508 metre in diameter and 800 metre long; the other 914 metre in diameter, and 914 metre in length. Each acted on a crank, the two cranks were connected so that the effect was the same as if the cylinders acted at right angles upon the cranks, while the angle between the axes was 130°. There was no special intermediate reservoir. The connecting-pipe ·254 metre in diameter, acted in its stead. There were no steam jackets, and, as no precaution was taken to prevent the condensation of steam in its passage from one cylinder to the other, economical results could not be expected.

Still it is a fact that Feyenoord's works at Rotterdam, where these engines were first constructed, have never given them up. We ourselves saw at Rotterdam in 1860 a steamboat of 70 h.p. nominal, the *Wilhelem II.*, which has served as a pleasure boat for the King of Holland. The engine, with low-pressure cylinder, has been modified by the addition of a high-pressure cylinder inclined to the other, acting on the same crank, the same steam working successively in the cylinders.

It would be unjust to omit mention of Carillon, a Paris builder, who succeeded (1842) in making a low-pressure engine work with the discharged steam of one at high pressure. This was set up at the St. Louis Glass Works. The essay seems not have been repeated, being abandoned, we think, because of the failure of a surface condenser.

In 1852 James Samuel applied the principle of continuous expansion to locomotive engines. This consists of a simultaneous action of steam upon the two pistons. Suppose two pistons whose rods are at right angles to the crank. The steam works at full pressure during half the stroke of the first. At this moment admission ceases, and the first cylinder is put into communication with the second while its piston is at the begining of its stroke. Expansion occurs simultaneously in the two cylinders until near the ends of the stroke of the first, then in the second only till near the end of its stroke.

This system, related to that of Milner, has been again taken up by Stewart and Nicholson, and applied in the tugs on the Thames. Though simple, it has the disadvantage of not avoiding great depression of temperature so well as those of Woolf and Woolff, since the two cylinders communicate with the discharge ports or the condenser.

The experiments of Samuel, reported in the Memoirs of the Institution of Mechanical Engineers," 1852, were made on a freight and a passenger engine on the Eastern Counties Railway. In the first there were two equal cylinders; in the second the larger cylinder had a section twice as large as that of the smaller. Though the results seemed quite favourable, the essays were abandoned until the time when they were again resumed by Stewart and Nicholson. This is inferior to the other kinds of compound engine.

The first noted applications of double-cylinder engines were made at Glasgow, in 1856, by Randolf and Elder. A little after, Rowan and Horton constructed three-cylinder engines; one high-pressure feeding two others. There were six cylinders in the machine. The steam was supplied at a pressure of eight atmospheres by boilers of a special form. One of these engines, according to Rankine, should not consume more than ·5 kilo of fuel per horse-power hourly. This would seem doubtful; but it would be useless to discuss the point, for the engines have not stood the test of service. The boilers are rapidly destroyed, and the construction is too complicated. The condensers were surface condensers of a particular pattern.

In 1861 Normand changed to the Woolff the engine of the small steamer *Le Furet* built by Penn. The engine worked at six atmospheres with intermediate reservoir re-heating, and monhydric condensation. The results were excellent. Afterwards Normand altered in the same way several other engines and still constructs them.

The Imperial Marine made essays moderately successful with three cylinders. The expansion was not great enough, the cylinders being of the same diameter, so that the economic advantage was not important.

Escher, Wyss, and Co., of Zurich, have built, from the plans of their engineer, Murray Jackson, marine engines with a low and high-pressure cylinder, set side by side and acting perpendicularly to the cranks. One of these engines was exhibited at Paris, in 1861, but it was out of sight under a shed. They have no special intermediate reservoir, the connecting pipe of the cylinders acting in its place. This firm have constructed a large number for the Swiss and Italian lakes, for the Danube, Rhine, and other rivers. Their engines are of the Woolf system. One with four cylinders was exhibited at London in 1862; it is now upon a boat upon Lake Lucerne. The compound marine Woolff engine is at present built in many English shops; though some maintain the Woolf type, with superposed cylinders. In France all engines are of the first kind.—*English Mechanic*.

## BOILER BURSTING.

A series of experiments is being conducting by the Manchester Steam Users' Association, at Mr. Beeley's Works, Hyde Junction, with a view of determining, by experiments carried out on a large scale, the effect that cutting openings in the shells of cylindrical boilers has upon their strength. Sometimes these openings are introduced at the base of steam domes, and sometimes for carrying down ake flues through the outer shell. In the French or "elephant" boiler these openings are inherent at the connecting necks, between the lower and upper cylinders. In other therefore to test the effect of these openings a full-sized boiler of the Lancashire type, having a diameter of 7 ft. in the shell and 2 ft. 9 in. in the furnace tubes, has been constructed, and is now undergoing a series of tests, which it is intended to carry up to the bursting point, to ascertain the ultimate resistance of the boiler.

The first of these tests was made on Wednesday the 9th instant, when the boiler had rivetted to it a small wrought-iron steam dome of the same size and strength as many of the connecting necks now in use in the French or "elephant" and other types of boiler. In preparation for this test the boiler was very carefully gauged in every direction, and six observers took measurements at various points of its movements, under the gradually increasing pressure. It was found that the furnace tubes, which were strengthened with flanged joints at each of the seams of rivets, were quite immovable, which is satisfactory, inasmuch as their sufficiency for high pressure was impugned at the recent explosion at Blackburn. The ends of the boiler breathed outwards very slightly, and resumed their original positions as nearly as may be upon the pressure being relieved. The longitudinal seams in the outer shell exhibited no movement. The steam dome or neck, however, burst when the pressure reached 250 lb. on the square inch, showing that it formed the weakest part of the boiler.

On the following day the boiler was again submitted to hydraulic pressure, the wrought-iron steam dome having been removed, the opening blanked up, and a cast-iron manhole of very substantial pattern applied. At a pressure of 200 lb. on the square inch the cast-iron mouthpiece ripped asunder, the rent extending right across the plate at each side, and into those adjoining. A wrought-iron raised manhole mouthpiece, with which the boiler was fitted, resisted both tests without the slighest signs of distress, though repeatedly gauged.

The tests show how weak those boilers must be in which manholes are altogether unguarded, while for high pressures, mouthpieces made of cast iron must give place to wrought, and also that the openings at the base of steam domes have a decidedly weakening effect, so that they should always be dispensed with whenever it is possible to do so. It is proposed to push the experiments still further under other conditions, so as to detect any weak points that may still lurk in the systems of construction now adopted for high-pressure boilers of the Lancashire type.

In addition to the above a trial was made of the discharging power of a low water safety valve. The importance of an investigation on this subject was suggested by the recent explosion at Hull, which was attributed to shortness of water, though the boiler was fitted with a low water safety valve. The experiments seems to show that the discharging power of these valves is not so high as it is desirable it should be, that they will not reduce the pressure of the steam as rapidly as has been supposed, so that their construction requires further consideration at the hands of the makers. It is intended to extend the experiments on this subject to low water safety valves of different constructions.

When the investigations are finished, both as regards the strength of the boiler and the operations of the safety valves, the particulars will be given to the public in detail through the medium of the Association's monthly reports.

It may, perhaps, be of interest to state that the last letter of Sir W. Fairbairn, the late President of the Association, addressed to it shortly before his death, has reference to the boiler tests described above. He wrote warmly approving the idea of the test and urging that it should be made at once. This letter shows how strong an interest he entertained to the last in the progress of the Association, of which he was one of the foremost founders and warmest supporters.

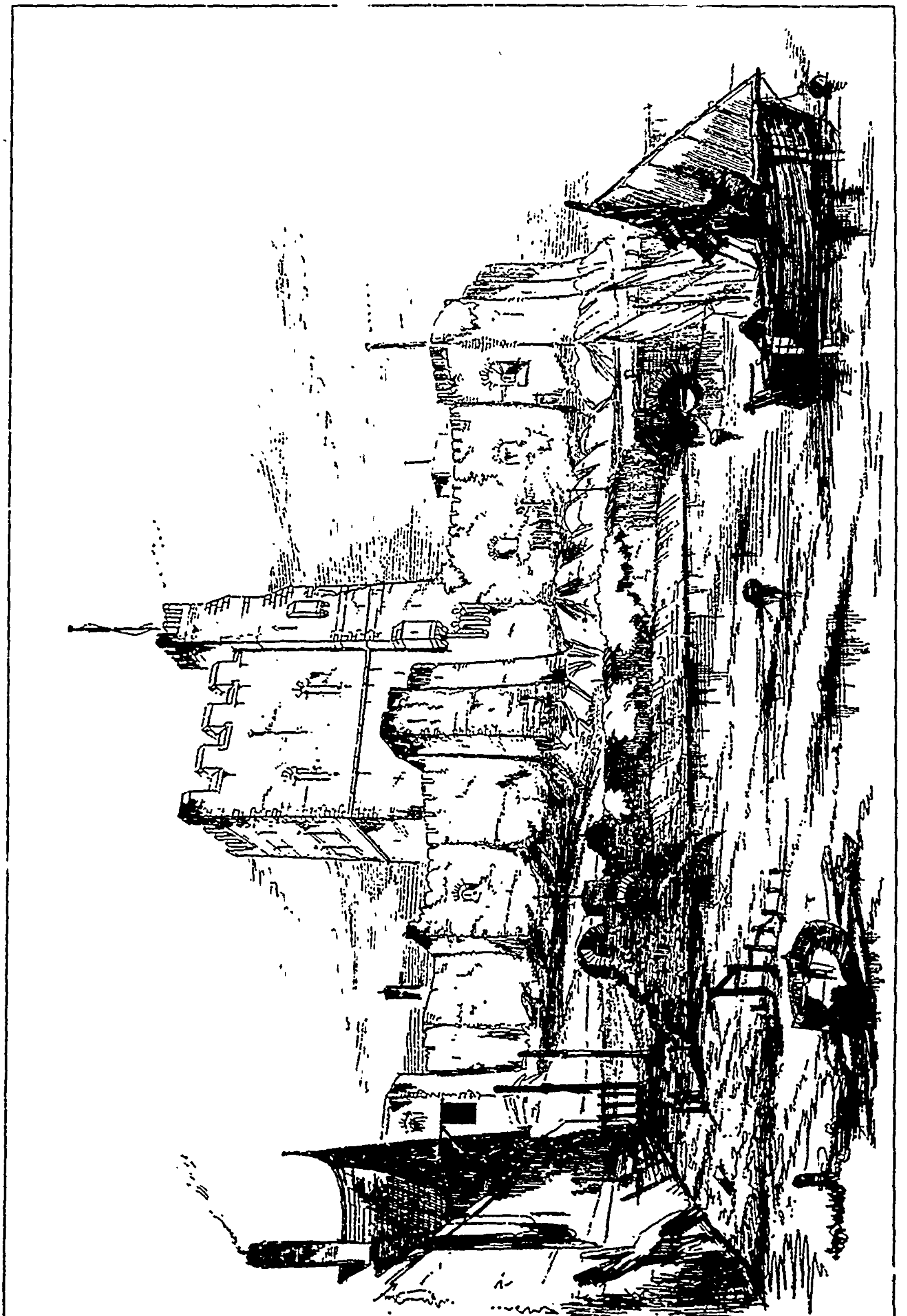
## FRANCE RUINED ON THE STAIRCASE.

The last paroxysm of that curious fever for reform that seized upon France at the end of the war, is a determined Parisian movement against staircases. A legion of social doctors are using very strong microscopes to discover the causes of the national degeneracy, and this is the last explanation of Sedan that has been found—the Frenchman mounts too many staircases in his life The exercise has weakened the race, and it is adduced in proof of this statement that the health is better, the stature higher, in those departments where the houses are composed at most of three stories. M. Foussagrives, a popular scientific writer, is one of the chief promoters of the movement, which is about to have an association, a committee, secretaries, officers, all the paraphernalia of a modern crusade. He has written three or four chapters on the subject, advocating the general adoption of mechanical lifts of a cheaper and simpler pattern than those actually working in many of the new houses in the western quarter of Paris, but giving some practical information concerning the danger and disadvantages of the ordinary Parisian staircase. His remarks are not uncalled for Whoever is familiar with the interior of un-Haussmannised Paris must have retained some vivid recollections of the perilous ascents he has been compelled to undertake. Except in the most modern houses the staircase—which is practically the street in Paris—appears to have been an afterthought of the architects. The space has been grudgingly bestowed; and as for light, some of the most aristocratic hotels of the Saint-Germain quarter are pierced by a narrow shaft, in which it is difficult to read a letter at noon. In the best houses of the Boulevards, the escalier de service, or servants staircase, is dark and narrow as a subterranean spiral, and by this way furniture, luggage the heaviest and most cumbersome loads,—are introduced into the house. Consequently, scarcely a day passes without some accident happening to porters, water-carriers, or tradesmen. The movement of which M. Foussagrives is the head, has for object the generalisation of simple lifts, and the procuring of Governmental intervention in the matter of staircases The crusaders desire that every landlord and builder be compelled to observe certain rules in the construction or alteration of staircases. The landing-places should be spacious enough to admit of three or four steps being taken on their surface; the staircase should be lighted laterally, a vertical light in most French houses being only advantageous to the topmost flat. The height of each step should never exceed sixteen centimetres, the width should be of twenty-five at least. The length should never be less than one metre fifty. Metal and waxed wooden stairs should be carpeted. In the later portion of his programme, M. Foussagrives quotes a curious observation of Louis Lavor, a medical writer and doctor to the King of 1673. Lavor considered that instead of a flat surface, or an outward incline, there should be in each step a gentle drop inwards, so that the ball of the foot be always lower than the heel. This lessens the tension on the posterior muscles of the leg. The same author advises that the edge of each step be of a lighter colour than the step itself.—*The Builder.*

## CLEANING WITH BENZINE.

Scouring with benzine has proved to be undoubtedly one of the very best methods, since the end is perfectly accomplished without shrinkage or injurious effect upon the colour or finish, so that the most elegant garments need not be taken apart, nor lace or velvet trimmings be taken off, while with men's clothing it is not noticeable that they have been washed. The articles, freed from dust and dirt by beating them while dry, are first simply thoroughly moistened with benzine in a tinned-copper or stoneware vessel, and well squeezed in it with the hands, silk pieces, ribbons, and heavier portions that may require it being brushed well on a zinc-covered table supplied with a tube beneath for re-collecting the benzine. The deepest stains are marked and treated more thoroughly. The articles are similarly treated in a second bath of benzine, and then carefully dried in a centrifugal machine for ten to fifteen minutes, the benzine being re-collected in a vessel beneath On removal from it they are smoothed out and hung in a warm drying-room, with access of air. It will require ten to twelve hours after they are dry to remove the odour completely. Since benzine acts principally upon fatty matter, stains of street mud, meal, &c., may remain, and must be removed by gently rubbing with a soft sponge dipped in cold water to which a little alcohol has been added, and then drying with a soft silk cloth. Sugar, champagne, and egg stains are also removed with cold water, and the colour is brought up again with a little acetic acid and alcohol in water, the spots being well rubbed out. Blood spots are treated similarly In all these cases the formation of marginal stains around the spots must be prevented by thorough use of the soft sponge and soft silk cloth. An article that still retains decided stains is brushed with a cold decoction of soap-bark, to which some alcohol has been added, and is then rapidly passed through water, and then through water slightly acidulated with acetic acid, and dried rapidly. Kid gloves are well rubbed with the hands, separately, in benzine, and each finger then rubbed on a stretcher with a rag, and after being blown up are hung up to dry. Articles treated with benzine need but little subsequent finishing, and this may be accomplished by applying a solution of gum-arabic in water, and a little alcohol, uniformly with a rag, and ironing. Portions of coats that have been taken apart need simply to be stretched and moistened uniformly with alcohol, and allowed to dry rapidly. Heavy cloth, velvets, &c, after being well steamed, are treated on the wrong side with so little dressing (best of tragacanth) that it does not go through and are then placed on the finishing frame or warm drum. White furs and angora tassels are passed immediately from the benzine through pulverised chalk, and allowed to dry, and are then beaten out, when the leather will remain elastic and the fur look well. Benzine that has become turbid by use may be purified by stirring ten drops of oil of vitriol thoroughly into about two bucketfuls of it, and allowing it to settle. The operations must, of course, not be conducted near the lamp or fire, on account of the combustibility of benzine.

The scheme advocated by M. Lesseps for the construction in Algeria of an immense lake connected by a canal with the Mediterranean, was challenged lately by M. Fuchs, at a meeting of the French Academy of Sciences. He asserts that the two mountain passes through which a canal is supposed to have formerly passed are ve considerably above the level of the Mediterranean, and con st of a bed of calcareous rock; while the so-called basin is a so much above the sea level. His conclusion is that the Mediterranean waters never reached the Chotts, and that the scheme would involve a trench of 150,000,000 cubic metres, half of it through hard rock, and costing at least 300,000,000f.



CARRICKFEROUS CASTLE.

WATER-PRIVILEGES ON THE MAGOG.—General View of the Mill-Dam.

# MECHANICS' MAGAZINE.

MONTREAL, AUGUST, 1874.

ILLUSTRATIONS :



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## THE BRITISH ASSOCIATION.

The forty-fourth annual meeting of the British Association for the advancement of science held last month at Belfast was very successful—more so, indeed, than had been anticipated. The attendance of men of science was large and most of the papers read were, as usual, of great interest.

The address of the President, Dr. Tyndall, excited much remark in the religious and scientific world. He claimed that religious theories, schemes, and systems, embracing notions of cosmogony, or which otherwise reached into its domain, must, in so far as they did so, submit to the control of science, and relinquish all thought of controlling it. Acting otherwise had proved disastrous in the past, and was simply fatuous to-day. Every system which would escape the fate of an organism too rigid to adjust itself to itself to its environment must be plastic to the extent that the growth of knowledge demanded. In closing, Professor Tyndall said he had touched on debatable questions, and gone over dangerous ground, partly with a view of telling his audience, and through them the world, that, as regarded those questions, science claimed unrestricted right of search. It was not to the point to say that the views of Lucretius and Bruno, Darwin and Spencer, were wrong. With that statement he should agreed, deeming it indeed certain that those views would undergo modification. But the point was that, whether right or wrong, scientific men claimed freedom to discuss them. The ground which they covered was scientific ground; and the right claimed was one made good through tribulation and anguish, inflicted and endured in harder times than theirs, but resulting in the immortal victories which science had won for the human race.

One of the most interesting papers was that of Sir John Lubbock on "Wild Flowers and Insects." The following extract serves to show how progress in the knowledge of the realms of nature is being made outside the realms of pure physics :—

"Many flowers close their petals during rain, which is obviously an advantage, since it prevents the honey pollen from being spoilt or washed away. Everybody, however, has observed that even in fine weather certain flowers close at particular hours. This habit of going to sleep is surely very curious. Why should flowers do so? In animals we can understand it; they are tired, and require rest. But why should flowers sleep? Why should some flowers do so and not others? Moreover, different flowers keep different hours. The daisy opens at sunrise and closes at sunset, whence its name—day's eye. The dandelion — *leonted or taraxacum* — opens at seven and closes at five ; *arenani imbra* is open from nine to three ; *nymphsa alba* from about seven to four; the common mouse ear hawkweed is said to wake at eight and go to sleep at two ; the scarlet pimpernel—*anayallis arvensis*—to wake at seven and close soon after two; while *tro opogon pratensis* opens at four in the morning and closes just before twelve, whence its English name, "John go to bed at noon." Farmers' boys in some parts are said to regulate their dinner hour by it. Other flowers, on the contrary open in the evening. Now it is obvious that flowers which are fertilised by night flying insects, would derive no advantage from being open by day, and, on the other hand, that those which are fertilised by bees would gain nothing by being open at night. Nay, it would be a distinct disadvantage, because it would render them liable to be robbed of their honey and pollen by insects which are not capable of fertilising them. I believe, then, that the closing of flowers has reference to the habits of insects, and it may be observed also in support of this, that some fertilised flowers never sleep, and that some of those flowers which attract insects by smell, emit their scent at particular hours; thus, *hespien matronalis* and *dychins vespertino*, smell in the evening, and *orchis bifolia* is particuliarly sweet at night. I have been good-humouredly accused of attacking the little busy bee, because I have attempted to show that it does not possess all the high qualities which have been popularly and poetically ascribed to it. But if scientific observations do not altogether support this intellectual eminence, which has been ascribed to bees, they have made known to us in the economy of the hive many curious peculiarities which no dolt had ever dreamt of, and have shown that bees and other insects have an importance as regards flowers which had been previously unsuspected. To them we owe the beauties of our gardens, the sweetness of our fields. To them flowers are indebted for their scent and colour ; nay, their very existence in its present form. Not only have the brilliant colour, the sweet scent, and the honey of flowers been gradually developed by the unconscious selection of insects, but the very arrangement of the colours, the circular bands and radiating lines, the form, size, and position of the petals, the arrangement of the stamens and pistil are all arranged with reference to the visits of insects, and in such a manner as to insure the grand object which renders these visits necessary. Thus, then, I have attempted to point out some of the relations which exist between insects and our common wild flowers. The whole subject is one, however, which will repay most careful attention : for, as Muller has truly said, there is no single species the whole history of which is yet by any means thoroughly known to us?"

The Association will meet next year at Bristol under the presidency of Sir John Hawkshaw.

Among other places of interest visited by the members at Belfast was the ancient castle of Carrickfergus situated about nine miles from Belfast on the north side of Belfast Lough. It stands upon a bold rock projecting into the sea, elevated about 30 feet above the water level. The rampart walls and turrets following exactly the natural irregular outline of the rock.

The erection of this castle has been ascribed to some of the English settlers who came over to Ireland during the reign of Henry II., or John; most probably John De Courcy, as he it was who established a colony here, and secured his conquests by building many castles and forts throughout Ulster.

## MILITARY BALLOONING.

Some experiments were made the other day at Woolwich to test a new balloon-steering apparatus, the invention of Mr. Bowldler. The apparatus consists of a rudder and two fans or propellers and will be easily understood by reference to our illustration on page 136. The rudder is of canvas with strengthening bands and is worked like any ordinary rudder. The fans or propellers are of very light sheet-iron; one is vertical and the other horizontal, and they are made to rotate by multiplying gear at the rate of from 600 to 720 revolutions per minute. The horizontal propeller is, of course, to propel the balloon and the vertical to raise or lower it without loss of gas or ballast. The balloon used on the occasion was lent by Mr. Coxwell and was regarded by Mr. Bowldler as too large to suit the apparatus tried.

The experiment was carried out under the personal direction and orders of Major Beaumont, R.E. The official programme was as follows:—(1) The balloon to be balanced carefully, and when in a captive condition to be raised to about 150ft., and lowered repeatedly by the vertical propeller in order to test its efficiency. (2) The balloon to be released, and as soon as the course be shown to be steady and the direction ascertained by means of Mr. Croxwell's indicator, maps, &c., the horizontal propeller to be worked at right angles to the course of the balloon, and its maximum effect thus obtained carefully noted. (3) The balloon then to be raised and lowered by the vertical propeller, without throwing out ballast or discharging gas. After attaching the gear to the side—as shown in the engraving—Major Beaumont, Mr. Coxwell, Mr. Bowldler, and a sergeant of the Royal Engineers entered the car, and the first part of the programme was commenced, a series of small pilot balloons being sent off in succession to ascertain the direction of the wind and probable course of the balloon when liberated.

The balloon was fairly balanced and the vertical propeller worked, and the balloon raised to a height of about 40ft. and lowered again. The vertical propeller when worked hard produce a decided effect; probably the maximum rate of ascent did not exceed 50ft. per minute, but it was not far short of it. There was no great accuracy, speaking critically, in the arrangement of the conditions. For example the line which held the balloon captive was held by hand, and thus every foot the balloon rose it had an additional foot of line to carry. This would tell on a height of 40ft., although the line was slight; and had 150 feet laid down in the programme been adhered to the effect would have been very considerable. A mean rate of ascent and descent might correct the error. After a few trials, however, the gear broke, and the vertical propellor became for the time disabled. Shortly after this the balloon was liberated for the trial of the horizontal propeller and the remainder of the trip was visible only to those in the balloon. The result of the experiments must be left to Major Beaumont's report, but they are hardly considered generally to have been satisfactory. It is difficult to imag[illegible] how a hand apparatus of this kind can give power enough [illegible]ectually move a large balloon which moves in a moving medium, especially when we consider that it may at any moment find itself in a current of air moving at ten miles an hour or faster.

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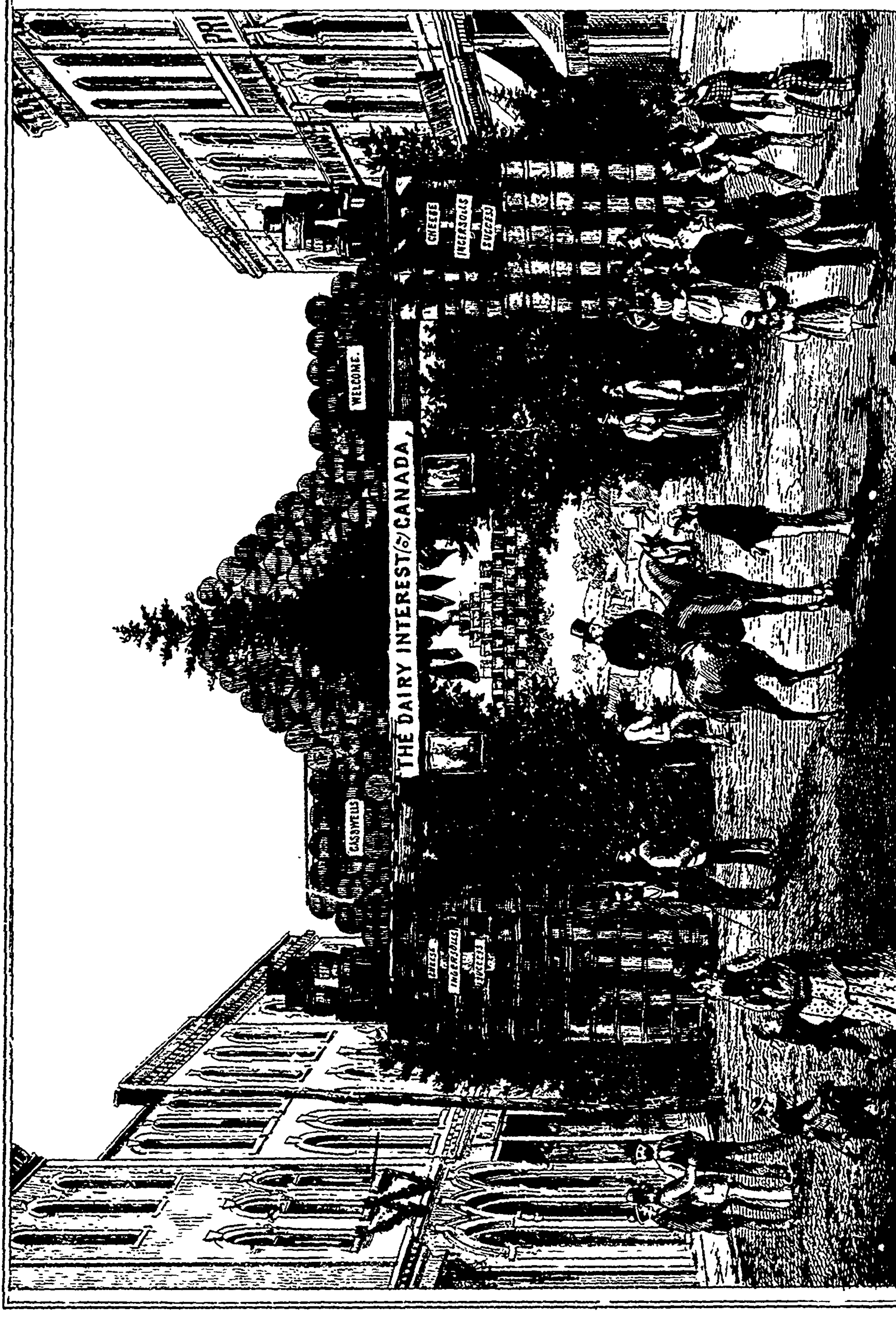
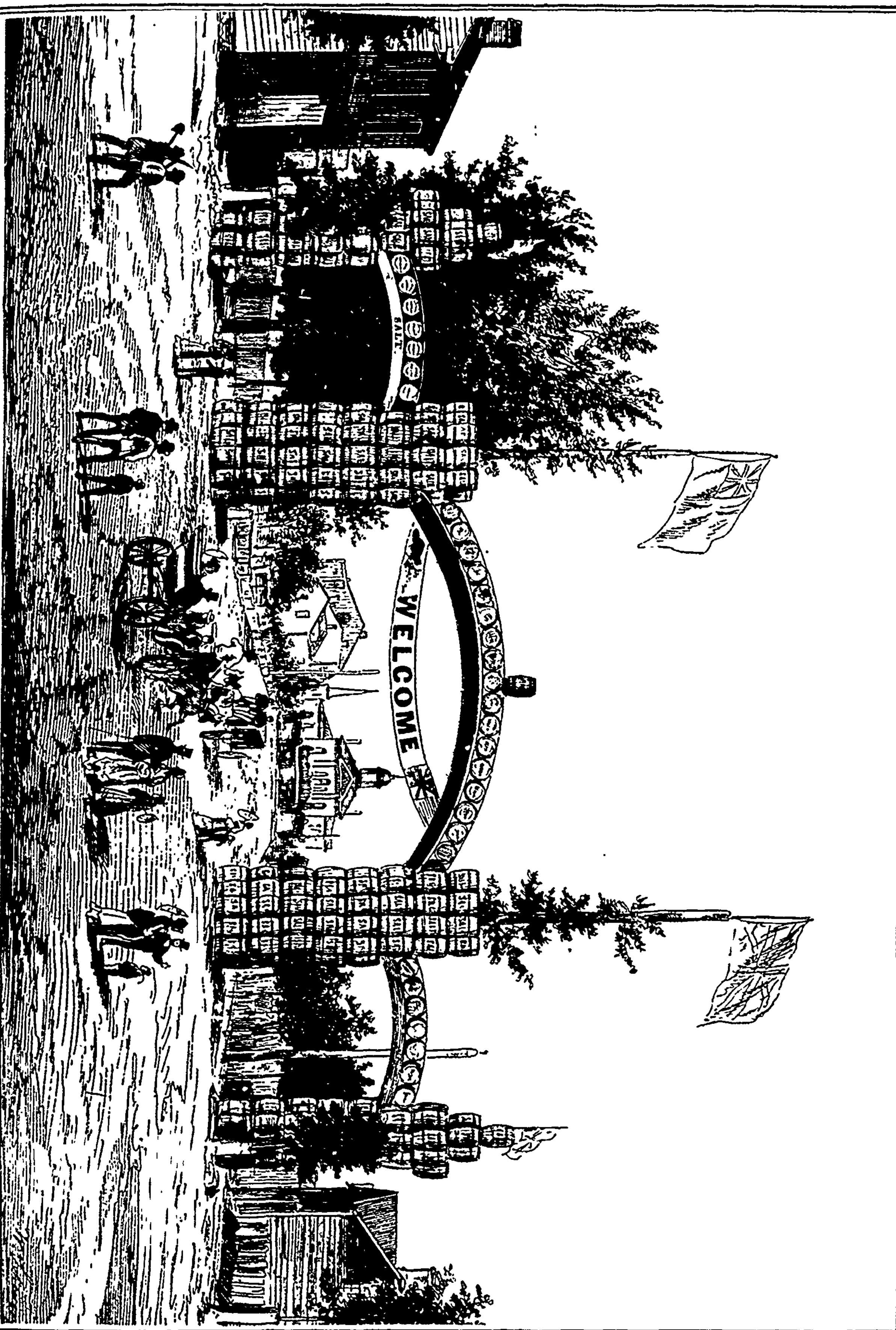
## WATER-POWER ON THE MAGOG.

On the 3rd inst. a number of merchants and manufacturers visited the Magog River at the invitation of Mr. Knight, a large proprietor in the neighbourhood, to inspect the water privileges owned by him at the outlet of Lake Memphremagog. The buildings at this spot consist of two saw-mills, one grist-mill with three run of stones, two lathe machines, two shingle machines, one plaining-mill, one clapboard machine, and one door and sash fac[illegible]ry. All of these are in working order. The water-pow[illegible] employed upon them, however, is but a part of that whic[illegible] belongs to the property, which extends down the stream fo[illegible] a distance of nearly three miles. In three-quarters of a mile [illegible] this distance the fall is thirty-five feet. It appears from calc[illegible]tions made by Mr. Francis, the eminent hydraulic engineer [illegible] Lowell, Mass., that the average flow of the Magog River, d[illegible]d[illegible]ced from the water-shed, is 816 cubic feet per second. [illegible]t the flow will be much above the average in spring, and below during the dry seasons. The variations are, however, less than on ordinary streams, on account of the equalizing effect of the lake; and if the dam could be raised nearly to the usual level of the lake this equalizing effect would be far greater. His present opinion is, that it would be safe to take it one half the usual flow, or at 408 cubic feet per second. He goes on the say that as most manufacturing establishments are run only during the daytime, the flow of water during the night can be retained, enabling a quantity equal to double or more of the uniform flow to be used during the working hours. Raising the present dam permanently would probably be objected to by some of the shore owners on the lake, but the main advantage of raising it could be obtained without affecting them, by means of flash-boards put on top of the dam during the dry season, to be removed during the high water. With this arrangement the night flow could be retained, and double the uniform flow, or say 16 cubic per feet second, be used during the working hours. The entire fall from the usual level of the lake to the foot of the rapids is about 35 feet. As to the precise fall that can be made use of below the existing mills he is not informed, but has no doubt that fifteen feet at least can be economically used by means of another dam. At the present dam the fall used on the north side is about eight feet on the average, the power during the dry season, with good arrangements, being 246 horse-power, night and day, or double during the day-time only, the night flow being retained. At a fall of fifteen feet at a new dam below the present dam the power would be 462 horse-power, night and day, or double if used during the day only, which would drive 50,000 cotton spindles with all the accompanying machinery, or about 100 sets of woollen machinery. The advantages of this power are, obviously, freedom from ice and great floods, and the purity of the water. Ice, in most water-powers, is a serious drawback. In some the difficulties arising from it unfit them for regular operations. Here interruption from ice is almost unknown. This is a rare advantage in this latitude and adds largely to the value. Floods are often the cause of loss to mill property, and on most rivers the works required to guard against their disastrous effects are expensive, and not always effectual. The great area of the lake effectually prevents disastrous floods here, and of course prevents the necessity of expensive works to guard against affect the amount of power, but it obviously fits the locality in this effects. The purity of the water, of course, does not affect the amount of power, but it obviously fits the locality in a high degree for manufactures requiring uniformly pure water. Apart from the inability to retain the night flow, which can be remedied, the only disadvantage that occurs to Mr. Francis is to distance from railroad communication, which will probably be remedied at no distant day, inasmuch as a road of nine miles to the Passumpsic Road would put the place in connection with Boston at a distance of 209 miles, and one of ten miles with the Stanstead and Chambly Railway, and so




ARCH OF CHEESE BOXES, INGERSOLL, ONTARIO.




ARCH OF SALT-BARRELS, GODERICH, ONTARIO.

with Montreal at a distance of 87 miles. The sketch of the proposed mill-pond, on page 141 is by Mr. Henry Sandham who accompanied the visitors.

## VASE FOR THE PARIS OPERA HOUSE.

The Sèvres Vase represented by the engraving on page 148 is in the Exposition of National Manufactures now open in the Palace of Industry, Paris. It was designed by M. Garnier, architect, and is intended to stand in the saloon of the new Opera-house.

## COVERED STREET IN MILAN.

The Victor Emmanuel Gallery, represented in our illustration on page 149 is, as is plainly seen, merely a covered street. These covered streets are somewhat common in the cities of Europe but none are equal in magnificence to the one illustrated. It is a broad, lofty, glass roofed street, transected by a similar glazed street, a huge cupola crowning the place of junction. These places are, as one would expect, generally the fashionable promenades of the towns, forming rain-proof lounging places where those who can afford the time are sure of meeting similarly favoured ones in spite of rain and storm. In our inclement climate such places would be doubly valuable. Our streets are, it is true, well crowded even in the coldest weather, but there are two periods when walking becomes a veritable passage of the "slough of despond" viz, just before the snow has determined to stay and just before it has gone. In Montreal for instance were St. James and Notre Dame streets thus covered in and joined by covered passages they would form a splendid covered promenade—the only one accessible at certain seasons and, as a consequence, the shops so situated would command an enormous rental. It would undoubtedly be difficult to accomplish this satisfactorily in a climate where three or four feet of snow may fall at any time, but once accomplished the benefit would be greater in proportion to the difficulty.

During the recent progress of the Governor General through the towns of Ontario, the loyalty of the inhabitants of some towns, expressed itself in a very happy and characteristic manner The triumphal arches, a seemingly indispensable feature on these occasions, were not constructed as usual of evergreens but served in themselves as indexes of the industry on which the prosperity of the places depended. We illustrate two of these—that at Goderich constructed of salt-barrels and that at Ingersoll, of cheese-boxes. The effect produced was very good in both cases and the sentiment—so far as sentiment can be associated with such crude material—very natural and correct. There is no better way of saying God Save the Queen than by loyally building up flourishing industries which cannot fail to extend and prolong the influence of our empire.

On page 148 we illustrate a very useful new instrument, the invention of Mr Toselli. This instrument, whose construction and application are easily seen from the engraving, is a wrecking machine and is capable of seizing and raising to the surface of the water barrels, cases &c., in fact anything it can grasp up to the weight of ten tons. When the weight exceeds its capacity it instantly relaxes its hold upon the exertion of the maximum power. One of the most importants feats yet accomplished by this instrument was the raising of a skiff loaded with pig lead which had sunk in the harbour of Marseilles. The skiff had sunk about 300 feet from the wharf. M. Toselli was sent for and bringing one of his machines he succeeded in gripping the skiff on the first trial and in raising it and the lead bodily to the surface.

## THE MOON'S FIGURE AS OBTAINED IN THE STEREOSCOPE.*

In a paper published some time since in the *Cornhill Magazine*, entitled "News from the Moon," a singular argument, and to my mind a singularly fallacious one, is put forth in confirmation of the figure of the moon as deduced from the calculations of the Continental astronomer Gussew, of Wilna The article referred to is without signature, but, as the author alludes to his correspondence with Sir John Herschel, he no doubt speaks *ex-cathedra* (Our readers will, we think, experience little difficulty in guessing the name of the author alluded to.)

The figure of the moon should be, as proved by Newton, an ellipsoid, her shortest diameter being her polar one, her longest diameter that turned towards the earth, and her third diameter lying nearly east and west, a diameter intermediate to the other two. Newton further found that her shortest diameter would not differ more than 62 yards from her longest—an insignificant difference, surely, in a body whose mean diameter is about 2,100 miles.

Gussew, however, comes in at this point with an assertion based upon measurements of De la Rue's photographic copies of the moon at her extreme librations, and upon ocular demonstration derived from viewing these different perspectives of the moon's image, combined by the aid of the stereoscope, undertakes to subvert his great predecessor's theory, and to substitute one of his own, founded on this very unreliable testimony. He asserts not only that the moon is egg-shaped, its smaller end being turned earthward, but that the point of this colossal egg rises 70 miles above the mean level of its surface. Now, it is to the proof of this as derived from stereoscope evidence that I take exception, for reasons hereinafter set forth.

The stereoscopic views of the moon are, as already stated, taken in the opposite stages of her librations, in order to obtain greater differences of perspective than would be obtained if taken in the ordinary way, where the separation of the two pictures corresponds with the average distance between the eyes of adults—4½in.; for this, it is evident, would give no more spheroidal appearance when viewed through spectroscopic glasses than is obtained by viewing her by unassisted vision, in which cases she appears as a disc only, and not as a sphere. With the same object—that of increasing the stereoscopic illusion (for illusion only it is)—it is not uncommon for photographers, when taking stereoscopic views of distant scenery, to avail themselves of the same means—that of unnaturally increasing the base of operations—and thus effecting a much greater apparent separation of the various planes of distance than really exists. The effect of this is to distort the picture painfully, advancing the middle distance boldly into the foreground—similar points being combined by the stereoscope much nearer the eyes than if the pictures had been taken in the normal way—whilst the foreground is seen so near that one feels it in his power almost to reach it with his hand. Another and more objectionable feature of this exaggerated perspective effect is that all near objects are dwarfed; men become pigmies; imposing mansions are reduced to baby-houses, and lofty trees become insignificant bushes—the reason being that those objects, though seen at points much nearer the eye, subtend, nevertheless, the same visual angles as those seen at more distant points—points corresponding with their true position in the landscape—for the photographic representations of them are no larger, and therefore appearing nearer, and subtending no greater visual angles, the impression upon the mind is that of smaller objects. Every one, I think, who has viewed stereoscopic pictures of distant objects, combining middle distance and foreground, must have witnessed this distortion.

Now let us apply this principle of optics to De la Rue's exaggerated stereoscopic perspectives of the moon, and what is the result?

* By G. J. Wister, in the *Journal* of the Franklin Institute.

Sir William Herschel says, in illustration of the effect of stereoscopically combining images of our satellite taken at opposite stages of her librations, "it appears just as a giant might see it, the interval between whose eyes is equal to the distance between the place where the earth stood when one view was taken, and the place to which it would have been removed (the moon being regarded as fixed) *to get the other.*" Now, this would be very well, provided the picture produced were for the use of giants formed after the pattern proposed, for they would see the stereoscopic image under exactly the same circumstances as they would seen the moon herself in the natural way with their widely separated organs—no great change being required in the direction of the optic axis in combining *similar points of the two perspectives than is required in* viewing corresponding points of the moon's surface by unassisted vision; but when these exaggerated perspectives are presented in a stereoscope to finite beings like ourselves the effect is magical indeeed. Then do near points of the moon protrude in a most alarming manner, threatening to punch us in the eyes, the whole presenting the appearance of an unusually elongated turkey's egg. Neither the modest 62 yards of the immortal Newton, nor the more pretentious 70 miles of Guessew, would satisfy her claims now: nothing, indeed, less than several thousand miles would represent the difference between her longest and shortest diameters thus distorted.

Indeed, for a pretty scientific toy, with which De la Rue has supplied us, this distortion of the moon's image is of little moment. The curious are, no doubt, more pleased with it than if it appeared in its true proportions—for figures generally are more admired the less nearly they conform to nature's lines—but that men of science, even great men, should accept this delusive and distorted image as a basis for serious investigation of the figure of our satellite, conscious of the manner in which pictures producing this image are taken—and, though forwarned, should not be forearmed—passeth my understanding. *It is but another instance of the too great avidity with* which world-renowned philosophers seize upon the most unreliable evidence from which to draw conclusions most important to science, thus shaking the faith of those who have hitherto looked up to them as infallible.

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## SOME OF THE USES OF MICA.*

The increased demand for gas stoves has naturally introduced to a wider notice the really valuable and useful mineral known under the name of mica. Every schoolboy can pick out the mica in a lump of granite, but it is not so well known that the "glass" forming the front of many kinds of gas stoves is also mica. The minerals which form the group of micas divide readily into two divisions: those which are silicates of allumina and an alkali, and those which are silicates of magnesia. They are all notable for their lustre and for their distinct cleavage, which permits of their being separated into thin sheets. In granite, the plates are rarely seen of a useful size, although in the coarser descriptions of that rock plates are occasionally found a foot and more in width; but, in limestone formations, it is often found in masses of considerable size, plates having been met with in Siberia several feet in diameter. The micas chiefly met with in commerce are Muscovite and Lepidolite (or lithia mica) of the first division, and Phlogopite (rhombic mica) and Biotite of the latter division, or magnesian micas. Of these, the most extensively used in the arts are Muscovite and Phlogopite. The former is mainly a silicate of alumina and potash, with traces of iron, fluorine, chromium, etc., which impart colour to the otherwise gray or silver-white plates of mica. The crystals of Muscovite are usually six-sided—the colour varying from black through gray to green, chromium being invariably present in the crystal of the last-mentioned tint. This variety of mica is proof against acids, is very refractory, the thin edge only fusing before an ordinary blowpipe, while the laminæ are very tough and flexible. Phlogopite or rhombic mica, as it is sometimes called, is mostly found in limestone, and is composed mainly of silica, alumina, and magnesia, with traces of iron, potash, or soda, and fluorine. Its colour varies from brown, through brownish yellow, to gray. If it is previously reduced to fine powder, it is attacked by hot sulphuric acid, but like Muscovite, although it whitens in the blow-pipe flame and fuses on the thin edges, it is virtually refractory to anything short of an intense heat. These extraordinary properties, combined with toughness and elasticity, and the peculiar facility with which it splits into thin sheets, some of which approach closely to transparency, led naturally to the use of mica for windows, and especially to its employment in lanterns. For many years it has been used in Russia for windows, and in some parts is still to be found, though it is of course rapidly giving way to the more transparent glass. So common, however, was its employment for this purpose at one time in Russia, that it was frequently called "Muscovy glass." It is found in Siberia, Sweden, and Moravia, which also supply the Lepidolite, or lithia mica In America it is found in various parts, as North Carolina, New Jersey, and Canada. In some coarse granite rocks of the first-named State the mica is found in considerable abundance, and there are unmistakable evidences that it was worked many years ago. The commercial value of mica varies through a wide scale. the large, sound, and clear sheets being naturally the highest priced, fetching as much as 40s. a pound. In the United States, where large quantities are used for what is called "stove glass," that is, for the fronts of gas and other stoves, the utilisation of mica has been carried further than in this country. The small and waste stuff is there made into a coarse powder and sprinkled over tar in roof-making, finely ground, it is used as a lubricant, and is sometimes used in packing deed-boxes and safes to render them fireproof. The finer sheets are used for such purposes as the dials of compasses, for the letters of fancy signs, and the very finest and thinnest pieces are sometimes employed in lieu of enamel for covering photographs, but one of the principal uses to which the better qualities are put is the construction of shades for lamps, the nature of the material rendering its decoration a comparatively easy process: chromo-lithography being extensively employed in this manufacture. The preparation of the mica is very easy. When first obtained it is in plates and crystals of various sizes, from a quarter of an inch to even occasionally a foot in thickness, and from six inches to a foot and upwards in diameter. These plates are dull and opaque, and when taken to the workshop they are split sufficiently thin to render them semi-transparent, when they are examined for flaws, and sorted into different qualities. The comparatively thick plates are then taken by the workman and split into the thinnest sheets, a stout knife and skill being all that is required for the purpose. These thin laminæ are easily cut with a pair of shears into any desired form, and are then ready for any further process necessary to fit them for the purpose for which they are intended.

The facility with which they can be bent into various shapes, and the power they possess of resisting heat, together with their transparency and naturally beautiful appearance, make these thin sheets of mica of peculiar value in many situations. They have been used as reflectors for some years, and a patent has recently been obtained in the country for an improved process of silvering plates of mica, the inventor being a resident of Philadelphia. The flexible nature of the material to be silvered will probably insure its introduction into the arts and industries to a greater or lesser extent, and it is perhaps not *impossible that it may be employed in the manufacture of telescopes*, although it must be confessed that its utilisation for that purpose is rather improbable. In the process recently patented, sheets of mica, as free from metallic deposit as can be obtained, are thoroughly washed in nitric acid, and then rinsed in water. They are then placed upright in suitable vats or baths, being arranged in pairs, back to back, so as to expose *only one side to the coating solution. This latter is tolerably* well known, and is made by dissolving 1oz. of nitrate of silver in a quart of distilled water, and in a separate vessel 1oz. of glucose in a quart of distilled water. When the silver has dissolved, a small quantity of liquor ammoniæ is added, and the solution becomes cloudy, the cloudiness disappearing on the addition of a little more ammonia. When this stage has been *arrived at, the two solutions are mixed together and poured* into the bath containing the mica plates, the bath being placed in a warm room, to facilitate the deposition of the silver. When the mica plates are sufficiently coated they are withdrawn from the bath, thoroughly rinsed in water and stood away to dry, after which they may, if deemed necessary, be coated with spirit varnish.

*The mica plates thus prepared may be mounted on frames* of tin, sheet iron, paper, or plastic composition. Many other applications of these mica reflectors will suggest themselves to our readers though their principal use is undoubtedly for

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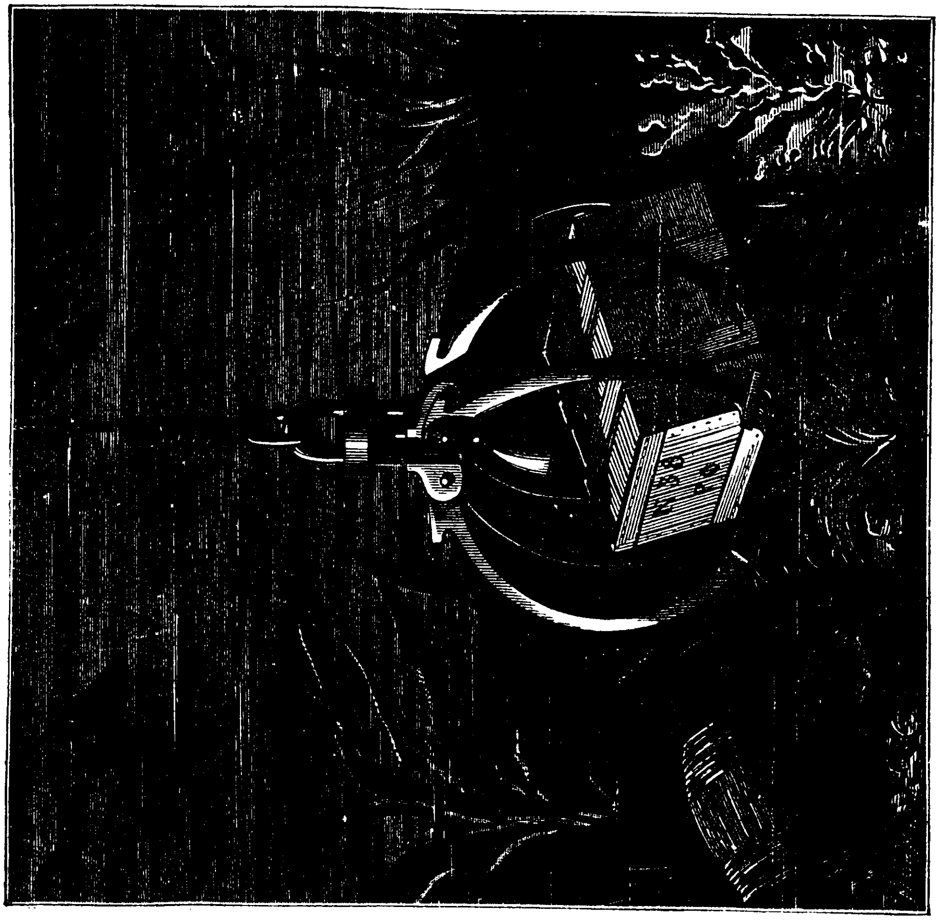
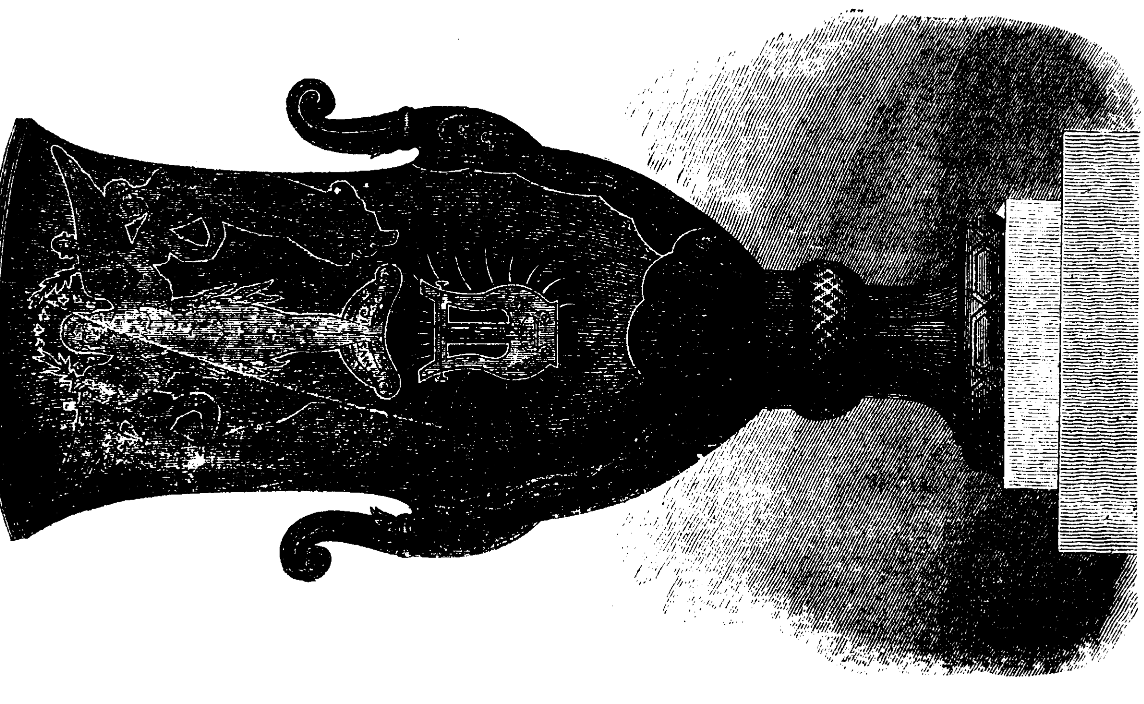
* *English Mechanic.*



TOSELLI'S WRECKING APPARATUS.



SEVRES VASE.—(See page 146.)

THE VICTOR EMMANUEL GALLERY—THE GREAT COVERED STREET IN MILAN.

illuminating purposes. The inventor of the process claims the right of constructing reflectors and shades in the manner described, but, inasmuch as the method of silvering is certainly old, and reflectors made of mica have been known for years, we doubt whether he could succeed in upholding the validity of his patent.

## THE CHANNEL TUNNEL

The *Standard* says that the actual position of this scheme at the present time is that the *projet de loi* has been prepared, and will be presented on the re-assembling of the French Chamber in November by M. Caillaux, now Minister of Public Works, and formerly a member of the Channel Tunnel Committee—the aspect of this Channel Tunnel scheme having thus changed from adverse under the Government of M. Thiers to conditions not unfavourable under that of Marshal MacMahon. Nothing further can be done until then to advance matters beyond their present position.

To ascertain the nature of the chalk and other rocks through which the tunnel is proposed to be constructed, numerous soundings and borings of the sea-bed have been made in a most ingenious manner by means of an iron tube, over which a hollow shot, fitting loosely, is raised and let fall upon a flange attached to the tube, the end of which is in this way driven into the substance of the sea-bottom, the core thus obtained giving the required sample of the rock perforated Some hundreds of these borings have been made, and a complete geological chart of the Channel constructed from the data. These accurate details of the strata and their outcrops have enabled the most promising line of route to be selected, and which is accidentally very nearly of the Dover and Calais Submarine Telegraph Cable The plan and construction of the proposed tunnel has the joint approval also of M. Duroich, M. Bergeron, M. Lavallay, and other associated engineers of eminence. The line of the main tunnel, which is to be large enough for a double line of railway, is drawn straight from St. Margaret's Bay, South Foreland, to a point very nearly midway between Calais and Sangatte. In longitudinal section the proposed tunnel presents a slight fall of 1 in 2,640 from the centre towards either extremity, and the vertical depth of the highest points of its floor is 436 feet from Trinity high-water mark, and 200 feet beneath the sea bottom itself. From the land levels of the existing railways the two approaches make long descents of over 4 miles, each with gradients of 1 in 80, into the tunnel ends, over 2 miles being under the sea, the total of the whole amount of tunnelling amounting to 30 miles. The geological section given by the engineers is made to show white or upper chalk above the grey chalk, unbroken and horizontal, for the whole distance, and the tunnel boring rather above the meridian line of the grey chalk beds. The greatest depth of water over the sea-bed above the tunnel is stated to be 180 feet.

Below the railway approaches, and continuous with the floor of the submarine tunnel itself, there will be at each end a driftway leading to vertical shafts ashore for drainage and ventilation. These terminal shafts and driftings are the preliminary works which it is intended to make as tests for the practicability of the general undertaking, and of which, when completed, they will form essential portions The drawings and specifications for them have been duly prepared, but the tenders will not be let until the financial arrangements are completed. The shafts will be 19 feet in diameter, built round with 24 inches of brick laid in cement, and the headings, which will be driven by machine, probably Brunton's, will be lined with 14 inches of brickwork, and have internal diameters of 4 feet. Their form will be horseshoe, with straight sides, and a flat inverted arch below the floor. The estimate for the entire preliminary works—which, to satisfy the *amour propre* of both nations, will be carried on simultaneously in both counties—is, with all expenses contingent on their execution, someting less than 160,000*l*, including the two pumping engines, of 2,000-horse power each. The total cost of the whole tunnel and its accessories is, for the present, put at 10,000, 000*l*.; but there are those among the engineers who think the preliminary works will afford data for a much lower estimate.

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Fine gold is found in the bars of Little Salmon River, about 25 miles from Fort Shepherd, where from $10 to $15 a day to the hand is being made with rockers. Quite a number of claims have been taken up.

## HOW TO READ THE BAROMETER.

The barometer, says M. Henri de Barville, in the *Journal des Débats*, is only an extremely sensitive balance, or a manometer showing the variations of atmospheric pressure. The early makers of one form of the instrument had the unfortunate idea of making certain points on the dial with the words "fair," "rain," "storm," &c.; their example has been followed blindly, and hence the bad reputation of the barometer. The passage of dry winds over our heads naturally causes the barometer to rise, while damp winds have the reverse effect; but it must not be forgotten that rainy winds in Europe come from the south west, and are ascendant in latitude—they raise the air, and in the same degree lighten the barometer; on the contrary, dry winds come from the north and east, are cold and descendant in latitude—they drive the air towards the surface of the earth, and cause the barometer to fall. He protests against the dictum to be found in modern books that the barometer is not made to indicate the coming weather, declares that it shows very well the great atmospheric perturbations—the only condition being that we should learn how to use it The diurnal course of the sun above the horizon exercises its influence on the barometer, it heats the atmosphere, causing ascending currents of air, which create a fall in the level of the mercury in the afternoon, and a return towards the former level in the evening. It is evident that the barometer may vary from three distinct causes, by change of altitude, under the influence of dry and moist winds, and under the action of the solar rays dependent on the hour of the day These premises being stated, it is not astonishing that two excellent instruments, one placed, for instance, on the lower and the other on the upper part of a house, should never agree. Proprietors of certain instruments declare that theirs are the only barometers to be trusted, old friends will dispute about them—M. de Barville tries to set the matter right. With the present mode of graduation it is rare to find two barometers in the same house marking even the same division of the dial, the instrument which marks "variable" on the ground-floor will incline to "rain" on the fifth story, for in a house 60ft high the difference in the height of the column of air is about 2m[illegible] Take a small aneroid wheel barometer in your hand says M. de Barville, and walk up or down a street with a sharp ascent, and you will find the needle deflect towards "fine" as you descend, and fall as you rise, every 30ft. representing about a millimetre in the barometric variation.

French barometers are generally graduated for Paris, and cannot possibly be correct in places of different altitudes The position of the index is altered. The barometer is affected much by latitude, and a little by longitude; the oscillation is altered, and no change in the index will correct the error.

Suppress the deceptive indications on the dial, and the barometer may be consulted anywhere with profit. When the mercury is rising or falling, the indication of the same foretells faithfully the probable weather to be expected. The only exception occurs when two opposing currents are struggling against each other; in such a case the barometer will be scarcely affected, yet the rain may fall suddenly.

Generally, rapid variations of the instrument indicate change, when the fall is rapid, rain may be expected; when very rapid, storms. The importance of the atmospheric perturbation is in proportion to the rapidity of the fall of the mercury, but the duration of bad weather is in general long in proportion as the fall has been gradual and continuous. If the mercury mount very rapidly, the weather is not completely changed; it mounts more rapidly than it falls, but still there are differences to be observed. In testing the condition of the mercury by tapping gently with the finger, it is not safe to accept the rising of the index as a sign of fine weather, it must be remembered that the barometer, unless acted upon by a tolerably energetic current, has a marked tendency to rise between 5 o'clock in the afternoon and midnight, to fall between midnight and 5 o'clock in the morning, and to rise again between 5 a m. and mid-day.

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Importation of Cars.—Railway carriages to the value of 260,568 dols. were imported into Canada from the United States during the fifteen months previous to April, 1874 Importation of horse cars during the same period amounted to 21,448 dols. To these sums a duty of 15 per cent. must be added to give the total cost.

## SCIENTIFIC NEWS.

To dissolve india-rubber, no better agent can be employed than sulphuret of carbon, to which must be added 5 per cent. of anhydrous alcohol, a product is thus formed which, when subjected to evaporation, leaves a residuum of rubber possessing all its primitive qualities. It may also be dissolved by any of the essential oils, but the material which results from their evaporation is oily and viscous, so that their use has been entirely abandoned.

The new product of petroleum to which the name "Vaseline" has been given promises to come into use as a vehicle for various emollient preparations, for which it appears to possess some peculiar advantages. It is a solid, semi-transparent jelly, neutral and free from taste or odor, and it is said to undergo no change by keeping. It becomes liquid at a temperature of 93 deg. Fah. The manufacturers state that it is prepared simply by the evaporation of crude petroleum, and filtering the residue through animal charcoal.

Mr. T. Sterry Hunt of Boston, introduces improvements in the precipitation of metallic copper from solutions, so as to obtain a utiliseable material from the agent used. Compound solutions of the protochloride of copper, with sodic sulphate or other base, are treated with tin-plate scrap or waste, whereby the copper is precipitated; the adhering tin being saved and recovered by a method of solution and precipitation in the form of an oxide of tin.

From careful experiments, Dr Richardson concludes that since the red blood globules of the pig, ox, red deer, cat, horse, sheep and goat "are all so much smaller than even the ordinary minimum size of the human red disc, as computed in my investigations, we are now able, by the aid of high powers of the miscroscope and under favourable circumstances, positively to distinguish stains produced by human blood from those caused by the blood of any one of the animals just enumerated; and this even after a lapse of five years—at least—from the date of their primary production." This will be important in criminal trials.

Huizinga opposes the opinions of Burdon Sanderson as to spontaneous generation. He objects to hermetically sealed tubes, which, he says, contain but a small quantity of air, and are, consequently, not in a condition favourable for the development of life. He prefers to use porous earthenware stoppers, or plates fitted closely to the tubes. In a mixture of potassium nitrate, magnesium sulphate, calcium phosphate, starch, peptones, and grape sugar, exposed to a temperature of 212 Fahr., bacteria appeared; but when a similar mixture was exposed to 220° and 230° Fahr, no organisms made their appearance.

Two plants have recently been found possessed of useful medicinal qualities. One is a plant of Brazil, named *Jaborandi*. It has a sudorific virtue unequalled by any medicament hitherto known. It is very suitable for those maladies which are treated by cutaneous exhalations, such as rheumatism, sciatica, chills, and virulent diseases like smallpox and measles. The second plant is tuberous Ailantus, which is capable of checking stubborn diarrhœa, and especially dysentery. It is the bark of the root which has this virtue in the highest degree. This is bruised in a mortar, with a little hot water, and after sifting, the extract is administrated in teaspoonfuls.

It has been proved by M. Paul Bert (says *Les Mondes*) that meat does not oxidise and putrefy in compressed air, it only undergoes a change of colour, consistency, and taste. But, on the other hand, muscular and nervous excitability disappear very rapidly in compressed air. Thus the conditions of the two phenomena are different. Again, certain fermentations may be arrested by oxygen at high pressure, the mycoderm of vinegar is destroyed or killed by the action of compressed air. Wine may be preserved from acetous fermentation by submitting it to compressed air. It is necessary, then, to distinguish in fermentation various phenomena belonging to chemical actions, and those belonging to the action of ferments properly so-called. M. Bert adds that compressed air stops the putrefaction of meat even where the latter has been impregnated with putrid germs.

Mr. Atkins, of the Cambridge Street Works, Birmingham, has invented a process which admits of the filling of articles of brass with molten iron. The balance weights for chandeliers, pillars, columns and imperial weights may be made, advantage being taken of this process, at a much diminished cost. It is simply necessary to immerse the brass shells in water, and the molten iron is then poured in. The shell cannot of course attain a higher temperature than 212 deg., the boiling point of water, while the temperature of its contents may be about 3000 deg. In making imperial weights the shells are embedded in iron filings, the high conducting power of which is thus turned to account. This process, simple though it be, is, from a commercial point of view, one of very great importance, as will be readily understood.

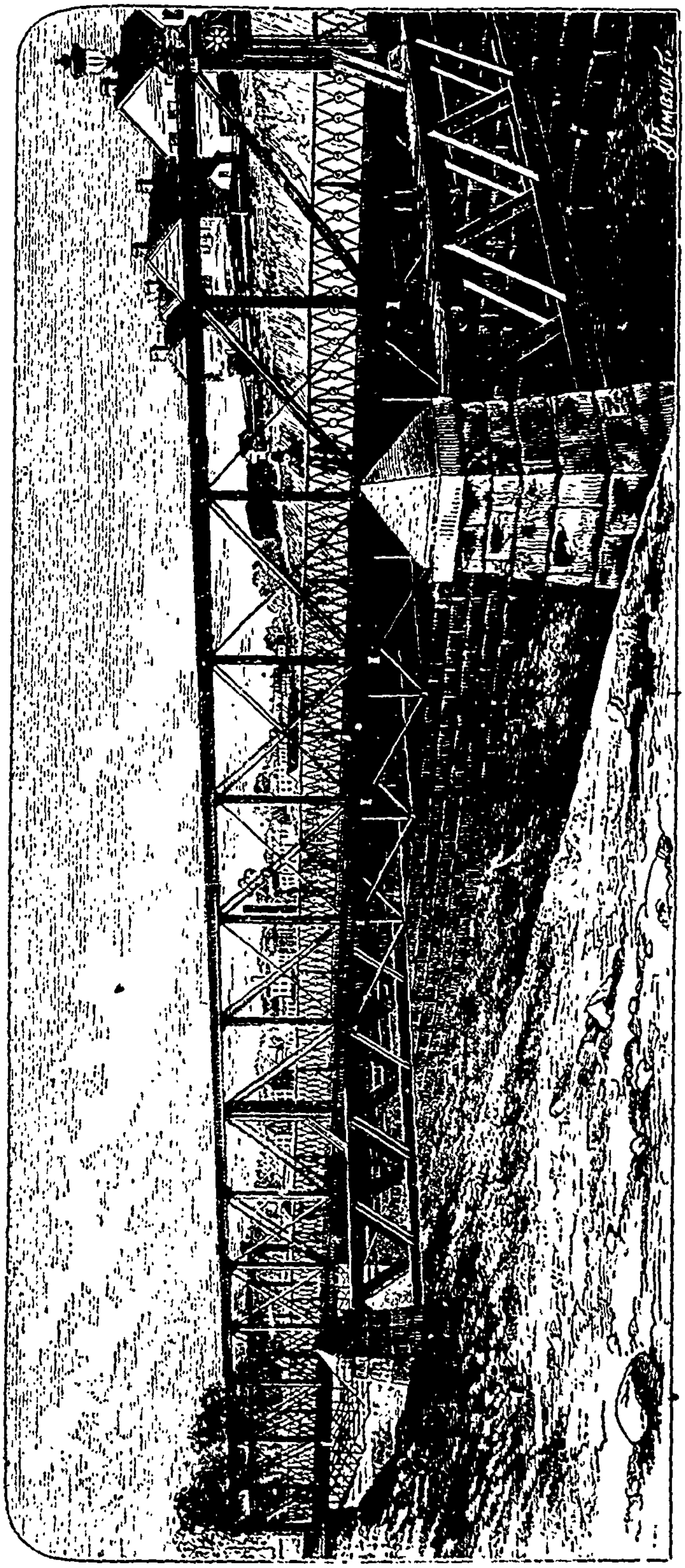
Spectroscopic observations of the recent comet appear to have shown that the tail is formed of stratified layers of solid particles, and the nucleus seemed partly surrounded by several concentric layers of cometary matter. Apropos of these phenomena, M. Barthelemy has called attention to what occurs when a spherical body is moved along the surface of a still liquid. In front of it there are several concentric folds; behind, arcs of waves tangent to the body at its anterior part, and these arcs are limited at the sides by straight waves converging in the direction of motion. The presence of a retarding medium in space may, he thinks, explain the formation of the comet's tail and its stratified arrangement.

A report from the Bureau of Statistics, Washington, gives an account of the population of the various countries of the world. Amoung other details, it gives the following as the populations of the 25 largest cities of the world:—London 3, 254.260; Sutchan (China), 2,000,000, Paris, 1,851,792; Pekin, 1,300,000, Tschants-chau-fu, 1,000,000; Hangtschau-fu, 1,500, 000, Siangtan, 1,000,000, Singnan-fu, 1,000,000; Canton, 1, 000,000, New York, 942,292; Tientsin, 900,000; Vienna, 834, 284, Berlin, 826,341, Hangkau, 800,000; Tschintu-fu, 800,000; Calcutta, 794,645; Tokio, (Yeddo), 674,477; Philadelphia, 674,022, St. Petersburg, 667,963; Bombay, 644,405; Moscow, 611,970, Constantinople, 600,000; Liverpool, 493,405; and Rio de Janeiro, 420,000.

A friend of the late Dr. Priestley (Mr. Hugh Bellas) wrote: "In the summer of 1800 I called on Dr. Priestley to return some books I had borrowed, when he told me he had just received a very curious present from Europe, which he would show me. He took me into his laboratory and pointed to a small pile of plates of silver and zinc, in alternate layers, with pieces of wet flannel interspersed, each plate about the size and form of a common playing card. A piece of small wire was inserted at the top, and another piece near the bottom, and the other ends of the wire were brought together, and there underwent decomposition. 'Now, this is called the pile of Volta' said the Doctor, 'and here is the electric fluid destroying the ends of the wires. Put the joint of your thumb to these points and you will feel a slight electric shock. You need not be afraid; it will not be severe.' I did as he directed, and received successive slight shocks upon repeated applications to the points." This was the first electric machine brought to America.

Secretion of tears.—According to Darwin, the phenomenon of weeping is probably the result of some such chain of events as follows:—When wanting food, or suffering in any way, children cry out loudly, like the young of most other animals, partly as a call to their parents for aid and partly from any great exertion serving as a relief. Prolonged screaming inevitably leads to the gorging of the blood-vessels of the eye, and this will have lead, at first consciously and at last habitually, to the contraction of the muscles round the eyes in order to protect them. At the same time, the spasmodic pressure on the surface of the eye and the distention of the vessels within the eye, without necessarily entailing any conscious sensation, will have effected through reflex action, the lachrymal glands. Finally, through the principles of nerve force readily passing along accustomed channels, association, which is so widely extended in its power, and of certain actions being more under the control of the will than others, it has come to pass that suffering readily causes the secretion of tears, without being necessarily accompanied by any other action.

A new machine, which, by the use of artificial heat, turns out peat fuel in forty eight hours, has for some months been in successful operation in Connecticut, and a contract with a railroad company for one lot of 5,000 tons is in process of fulfilment.



VIEW OF BRIDGE SHOWING ARRANGEMENT OF GIRDER PIERS.

## CENTRAL AVENUE BRIDGE, NEWARK.

The engravings on page 152 & 153 illustrate a bridge recently completed at Newark, New Jersey, U. S. A., somewhat remarkable, not for any novel features of construction, but on account of the peculiar conditions which were involved by the site. The engravings are from *Engineering*.

Central Avenue, one of the main new avenues leading out of Newark, is intersected by the Morris Canal, which, following the crest of the hill west of Newark, to a point north of the avenue, takes a sudden bend and passes through the city, on its way to the Passaic river. It is at this bend that the avenue intersects the canal, and at such an angle, that the boundary lines of the avenue at the point of crossing, measures 270ft. in length on the south, and 113ft. on the north side.

The avenue is 80ft. wide, and one point of the commence ment of the bridges is 50ft in advance of the other. Besides this at the point of crossing the canal, two streets intersect the avenue.

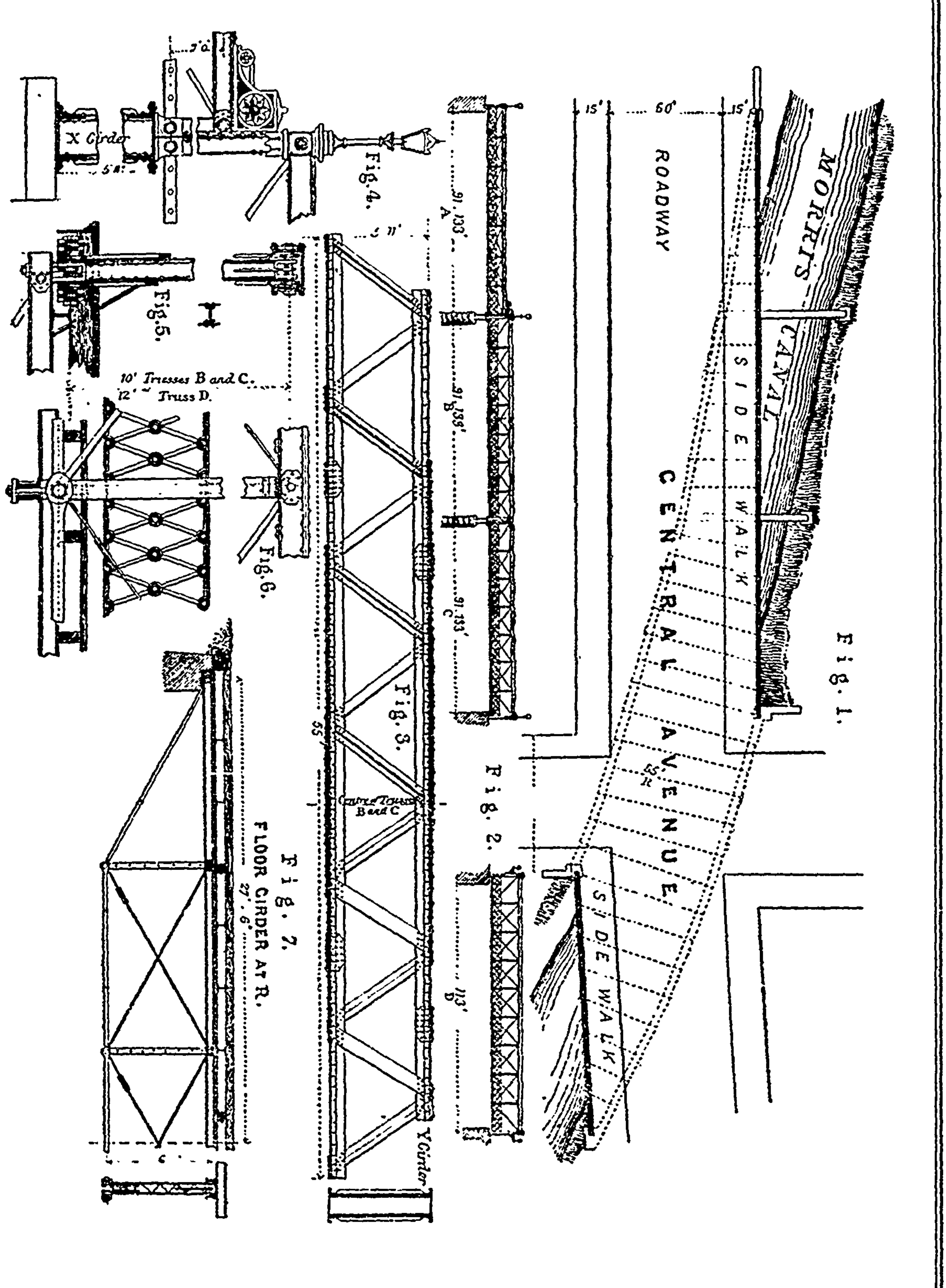
No pier was permitted to be built in the canal, and a clear headway of 10ft. over the towing-path was prescribed as one of the necessary conditions. It was necessary, therefore, to construct an unbroken platf rm the full area of the streets to be carried, and to do this without interfering with the canal authorities.

It was first proposed to effect this object by the erection of two large girders, but the cost of this plan placed it out of the question. A second design was then prepared, and carried out as shown in the drawings, the mode being to erect on the longer sides girders resting on independent piers and to employ these girders as bearings to carry the main trusses on one side.

The perspective sketch, as well as the detailed engravings, will clearly explain the mode of construction. In the latter the abutment walls on each side of the canal are shown in parallel dotted lines, and in the plan, Fig. I, the position of the two piers and pier girders carrying the main trusses of one side of the bridge are shown Fig 3 is an enlarged view of one of these girders, which is 55ft. in length, and 5ft. 11in. deep. Both are double Warren girders, and 2ft. wide; the point were the main trusses B and C take their bearing upon these pier girders is shown in Fig. 3. It will be seen that the widest opening across the canal is divided into three spans by trusses each 91,133ft. in length, whilst the smaller opening is traversed by one span of 113ft. in length. Fig. 7 is a detail of one of the largest floor girders, which is 55ft. long. It will be noticed that but few of these girders are of the same length, and that none of them are parallel. The flooring is carried by I-rolled joists 6in. deep, placed about 3ft. apart under the roadway, and 4ft. apart under the side walks. To these joists the planking of yellow pine, 3in. thick, is secured.

Figs. 4, 5 and 6 are details of the main trusses; it will be seen that they are entirely of wrought iron, and that pin connexions are used at all the joints.

In conclusion we may state that the design was prepared and carried out by the Phillipsberg Manufacturing Company, and that the cost of the superstructure was a little less than $40,000.




PLAN OF GENERAL ARRANGEMENT AND DETAILS OF IRONWORK.

## METHOD OF TREATING FURS AND SKINS.

At a recent meeting of the Society of Arts Mr. Joseph Tussaud read a paper on a method of Treating Furs and Skins, which enables him to utilise both fur and skin separately, the fur being stripped from the skin and fastened to a prepared backing, while the skin is left for use as leather. We give the description in the author's words:—My attention was first drawn to this invention in the course of my profession as modeller. It happened thus: I felt much annoyed that, owing to the eyebrows of my models being altered from time to time in the process of recolouring, the artist sometimes varied them in a manner which affected both the expression and the likeness, and I became anxious to have the hair inserted in such a way that it could be done under my own superintendence, and remain a fixture so long as the model lasted. In attempting this it was found that the operation was too delicate, and I was foiled, but the difficulty only made me more anxious than ever to succeed. In doing this, I little thought that my search would lead me, step by step, to the discovery of a new trade

I noticed by chance in passing a butcher's shop that the hair on a calf's head was particularly sleek, and I thought if I could take a piece of hair out bodily, with the roots attached, and place the roots in the wax, I should obtain the desired end, but how to do this was the puzzle, but the solution ultimately came. I noticed that the soap which dried on my razor after shaving held the stubble it had taken off somewhat firmly, and then it dawned on me that all I required was to with sufficient firmness place something on the hair which would imbed it to enable me to draw the hair out and expose the roots. I succeeded in finding a means which would hold the hair whilst I poured hot wax on the roots. I then dissolved off the medium in which the hair was imbedded, and those pieces are now lying on the table for inspection, as the first specimens of hair trans-ferred to a foreign substance, and yet held in its natural position.

My brother and co-inventor, Mr. Francis Tussaud, suggested indiarubber as a flexible means to hold the roots and I then saw the advantage of using such a medium to hold the hair as would not injure the skin, and thus to obtain two articles from one, viz., the fur and the leather.

I showed the result to the late Mr. Nicholay. He very generously told me that I had opened a very wide door; but it has taken many years to find the cheapest means, as well as to simplify the process, and to make the material a lasting one.

The invention may be thus described. We introduce in a liquid form on the outside of the skin a solution of some matter adapted, when the solvent thereof has evaporated, or the matter employed has solidified, to form an artificial skin close upon the natural one, by which to hold the feathers, or hair, or other covering thereof at or near the roots, and in their desired relative position, in order that the skin may be removed without its necessarily being destroyed. We first lay the skin inside downwards upon a board or other suitable surface, and then apply thereon the solution of matter, which after the evaporation of the solvent, or the solidification of such matter, will, by acting as a temporary artificial skin, serve to hold the feathers, hair, or other covering in position during the removal of the natural skin, taking care that such matter is introduced among the feathers, hair, or other covering of the skin as near as possible to the roots. A solution of shellac in alcohol answers well for the production of the artificial skin. When the shellac has become dry by the evaporation of the solvent, the skin may be drawn off the inner ends of the feathers, hair, or other covering, leaving such held by the shellac. We then cleanse the projecting roots of any remaining fatty or animal matter, and apply upon such inner ends a coating or solution of indiarubber, or other suitable adhesive matter. A lining of any suitable fabric is then laid over the projecting roots, so as to occupy the place in which the pelt originally was. To facilitate the removal of the natural skin from the roots, we prefer to steep it for a time in lime water, as is practised by tanners. When shellac is used as the first holding medium, we remove the same again for re-use, or otherwise, by applying thereto a suitable solvent.

Subsequently we improved on this process, not finding the shellac solution to answer commercially, and we now use other means acting first on the hair on the natural skin previous to the application of the temporary holding means, and use glue, size, or gelatine applied in solution, so as to form, when cool, a body to hold the hair or other covering in position during the removal therefrom of the natural skin and the application to the roots thereof of a substitute for such skin.

In carrying out our improvements we operate upon the hair or other covering and natural skin previous to the application of such temporary holding means, for the purpose of loosening the one from the other, by subjecting them to the action of lime-water or other suitable means, as practised by tanners. If desired the skins may then be washed in water to free them of the superabundant lime or other means by which the hair or other covering has been loosened from the skin, and then, when required, they may be hung up for a time to drain off excess of moisture. The glue, size, or gelatine is then applied to the hair or other material by pouring it thereon in a fluid or semi-fluid condition, and in sufficient quantity, or by immersion of the skin in a bath of such matter. When a sufficient coating of the glue, size, or gelatine has been applied to the skin to hold the hair or other such covering thereof in correct relative position during the removal of the natural skin, such skin with this temporary holding means applied, is then laid so as to prevent the holding means from running off until it has become sufficiently cool or set to hold the hair or other such covering in position, when the natural skin may be pulled from the roots or the hair or other such covering, leaving the hair or other such covering held by the glue, size, or gelatine employed as the temporary holding means with the roots of hair or other such covering projecting therefrom. The matter or composition with any suitable fabric to form the artificial skin, will then be applied in a liquid state to such roots of hair or other such covering whilst the hair or other such covering is being held by the glue, size, or gelatine.

The artificial skin may be formed of indiarubber, guttapercha, or compounds thereof (vulcanised or otherwise prepared), boiled or other oils capable of being rendered suitably dry, or other suitable adhesive matters which may be strengthened if desired by woven fabrics. When employing boiled linseed or other oil, its adhesiveness may be increased by the combination therewith of a small quantity of litharge or other suitable drying or adhesive matter.

In order to render the caoutchouc and guttapercha more lasting and less affected by changes of temperature, we combine with them sulphur in any suitable manner capable of producing those results, preferring to apply to the artificial skins of caoutchouc or guttapercha a solution of chloride or hypochloride of sulphur in bisulphuret of carbon (or other suitable solvent of caoutchouc or guttapercha.) When using bisulphuret of carbon, we take 40 parts thereof, and add to it one part of chloride or hypochloride of sulphur prepared as neutral as possible, and we allow the solution to remain in contact with the artificial skin of caoutchouc or guttapercha a longer or shorter time, according to the thickness or substance of the article, but we find that for general purposes a thin sheet is generally sufficiently charged in less than a minute.

When the caoutchouc, guttapercha, or compounds thereof, with the fabric or backing used to form the artificial skin, has become sufficiently set to hold the hair or other such covering firmly by the roots thereof, and the process of vulcanisation or preparing as above referred to has been effected, then the artificial skin with the hair or other such covering thereon is well washed in hot water, by which the glutinous or gelatinous matter which has been employed as the temporary holding medium may be readily removed, or it may be removed before the process of "vulcanisation" or "preparing" is effected. We, however, prefer that the fabric forming the artificial skin should be well washed in water after the vulcanisation or preparing above referred to has been completed

In some case we employ carbonate, sulphate, sulphite, phosphate, acetate, or hyposulphite of soda as a substitute for the animal glue or gelatine. In such cases the salt is employed in a state of fusion or as a saturated solution, such that when cool it will set to a sufficient degree of solidity to hold the hair or other covering in correct relative position.

It is well known in the fur trade that large numbers of valuable furs are constantly lost by decay and decomposition of the skins, but by this invention all such may be preserved and utilised; besides this, the good pelts are thus rendered available for leather, whilst the fur is as useful as before. A good fleece, if such a term is allowable, may be made up by this means out of a number of imperfect ones; and there is a still further advantage, that the fur thus transferred to an artificial backing is moth and mildew proof, a matter of no small importance, as all fur dealers will admit. The result gives us a fur, without the hard and thick and heavy leather, placed upon a texture in its nature pliable and impervious to damp, mildew, and to moth; and with flannel or other warm material for a lining, a great convenience is attained.

## ACCUMULATOR BOILERS FOR STEAM TRAMWAYS

The engraving on page 156 is explanatory of a system o boilers introduced by Mr. Todd. The engraving is from the *Engineer*. The principle upon which the boiler is constructed is described as follows by Mr. Todd.

An easy way of making a furnace boiler which can take care of itself for a considerable time, is simply to give it a great water capacity and water area. This water, in the most perfect and natural manner possible, acts the part of a heat accumulator, as during a long time it goes on storing up heat within itself, and but very slowly raising the pressure gauge; and again during a lengthened period it gives off heat from its store, while yet only slowly reducing the pressure and water levels. Now, this invaluable action of water within a boiler is not carried to any great extent in ordinary locomotives, as there is in them no particular use for it, although on undulating lines it is well known to be of great importance that a boiler should contain a large amount of water. Now, locomotive boilers contain 5 cubic feet of water, and 3ft of water area for each foot of grate, and never require attention oftener, nor indeed so often, as each ten minutes. It is evident, then, that if we give six times as much water capacity and water area, while still keeping the same size of grate, that then as far as safety goes we need only attend to the boiler once in sixty instead of ten minutes. For the given size of grate can only develope a certain amount of heat, and as the water is six times greater in one case than the other, it follows that this grate will take six times as long to raise it to a certain pressure; or, again, that for a certain work the water level will take six times as long to fall as before. Now, the above conclusions are simply indisputable, and so we have thus a certain means of constructing a boiler which, as far as its safety is concerned, shall only require attention each forty or sixty minutes; and yet which during this time will give off the most variable amounts of power. Of course this principle, even would it answer any useful purpose, cannot be applied to large locomotive boilers; but for the production of the very few horse-power required for a street car, it can be used with the greatest ease and convenience.

The power required to propel a 44 seat car, including the weight of the propelling mechanism with this large quantity of water, will not on level lines exceed 10 indicated horse-power, although more than this will be required to work heavy roads. Then small boilers and engines will give 10 horse power from each foot of grate, but we had better allow the grate of the car boiler to contain 1·5 ft., and with 30 cubic feet of water and 18 ft. of water area—both six times the ordinary locomotive allowance—we get 45 cubic feet as the water capacity, and 27ft. as the area of water level. The furnace should be of considerable depth, not less than 2ft. below fire-hole, so that before commencing a run it could be filled with fuel, and then left to sink down as it burns away. There must be a water grate to prevent clinkers, as the bars of this narrow deep furnace could not otherwise be cleaned, and as the steam car must work for fifteen or eighteen hours without ever stopping longer than, say, ten minutes at a time. The fuel must be coke or stone coal, to prevent smoke; and as such hard fuel will not burn without a strong blast, a blowing fan must be used, as the ordinary funnel blast cannot be allowed in a street. This combination of a fan and hard fuel is also another reason for using a water grate, as otherwise the fire bars would run together or burn out in a few hours.

This accumulator boiler will be worked as follows:—Before commencing a run the driver will pump his boiler full, and raise steam well up, say, to 130 lb., fill up the furnace, and then with the greatest confidence allow the boiler to look after itself during the half hour or so required to run his journey, during which it may hold its own, but, from its small grate, will most probably and usually lose a little pressure during the run, so that at the terminus there will generally be only, say, 110 lb. or 120 lb. of steam. And it is impossible that the pressure of such a boiler can dangerously rise while running, as however intense the action of the 1½ft of grate may be, yet it cannot supply heat both to drive the car and also dangerously to raise the temperature of the 45 cubic feet of water surrounding it. So also is the boiler safe from danger arising from lowness of water while running, as suppose that not a single drop of water enters it during the journey, yet still the 27 ft. of water level area is so great, that the total evaporation required for the entire run will only bring it down 2in. or 3in. For at 40 lb. of water per indicated horse-power per hour 3in. of evaporation will give more than 20 horse power for half an hour, which is an outside allowance. It might, and of course would, be a matter of convenience to keep the feed pump always partly on while running, yet this is not of the slightest consequence as regards safety, for without any feeding whatever this accumulator boiler will steam a whole run, and even two whole runs, and yet still be as safe from lowness of water as any ordinary boiler. In short, provided that the driver only starts each run with his accumulator boiler full of pure town water, it is almost absolutely impossible that accident can occur from either excess of pressure or lowness of water, and, of course, the inspecting engineer should see that this simple precaution is most rigidly adhered to. And thus we can have the very great convenience of an always powerful furnace boiler, combined with a degree of safety which is practically equal to a fireless receiver.

In the engraving, Fig. 1 shows a boiler for a steam tramway car, that is to say, a car the driving power of which is self contained. Figs 2, 3 and 4 represent a boiler such as would be fitted to an engine, used for drawing a train of cars.

## BAND SAW FOR IRON.

On page 157 we illustrate from *Engineering* a band saw for cutting iron, constructed by Messrs. J and J. Rieter, engineers, of Winterthur.

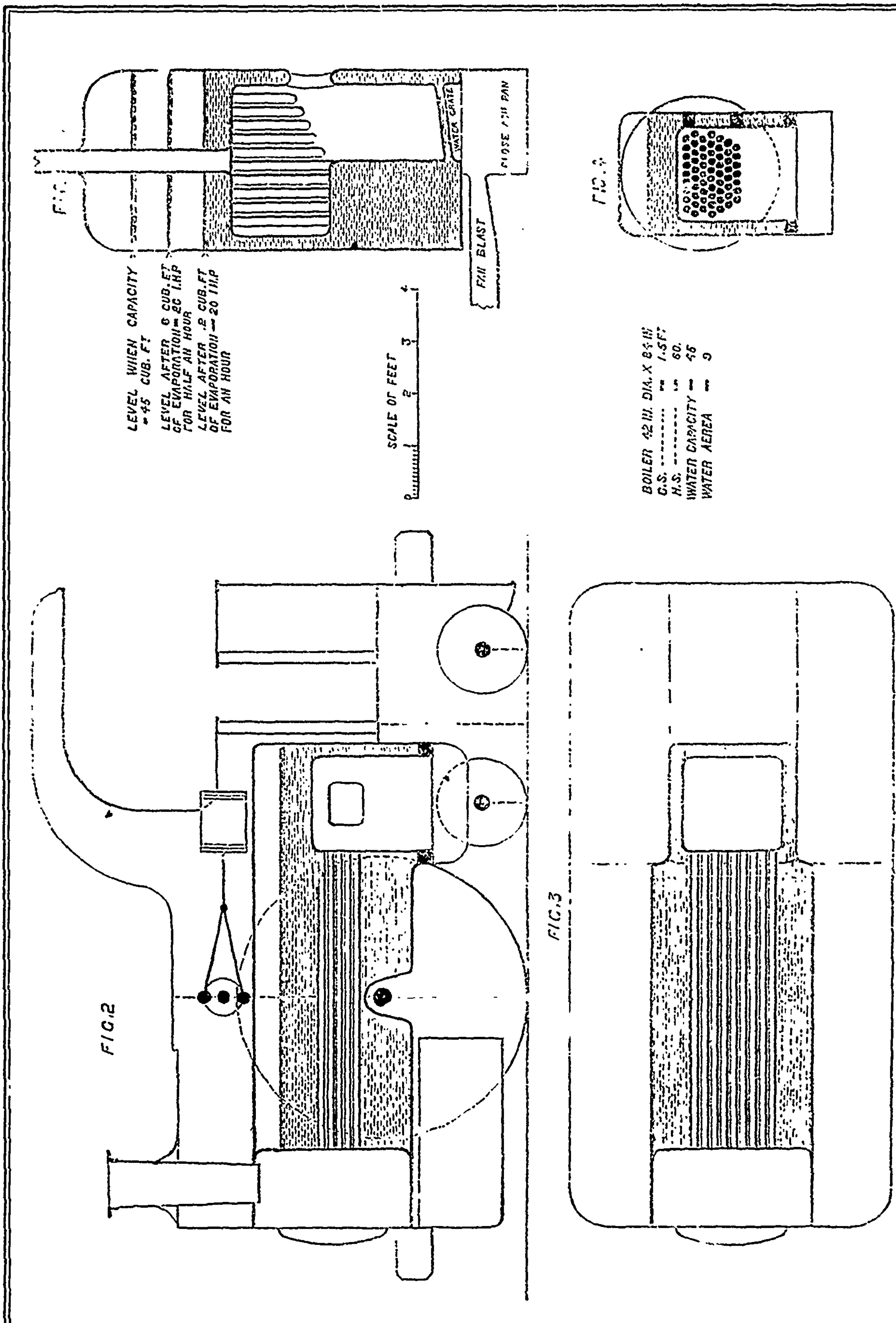
The arrangement of the machine, which is simple, is clearly explained in the drawings. The saw band is maintained at the desired tension by means of the vertical screw, turned by the hand wheel, and on which is mounted the sliding block carrying the upper wheel. A further adjustment is also provided at the back of the machine.

It will be seen that the saw is driven by gearing off a second shaft, to which motion is given by a strap and pulley.

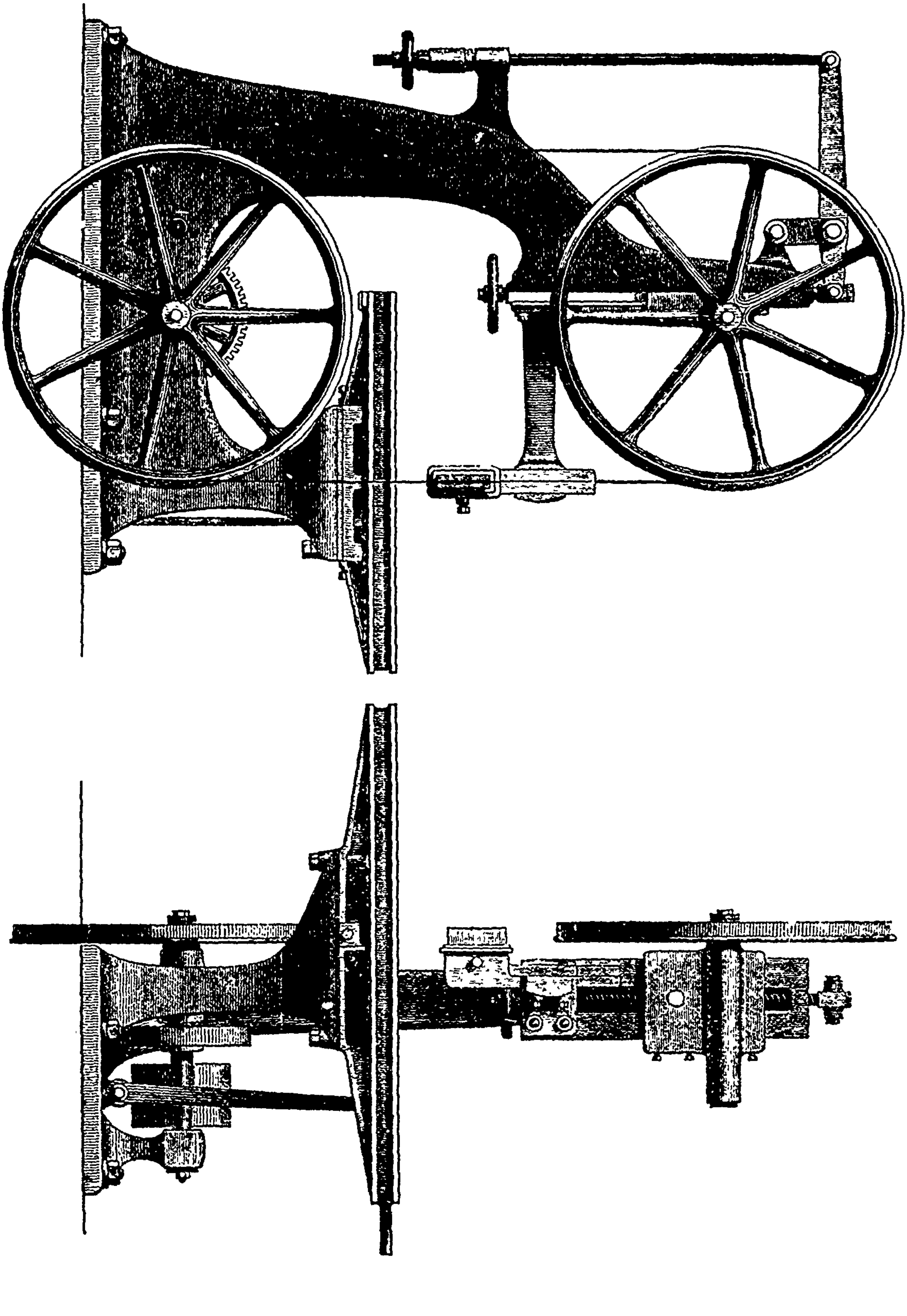
## ECONOMY OF FUEL IN FURNACES.

M. Foucault, in a report to the Industrial Society, at Rheims. combats the idea that the smokelessness of a fire can effect a notable saving in the amount of fuel burnt. He alleges also, on the other hand, that a considerable loss of economy is produced by smoke-consuming apparatus. He brings in support of his opinion the long series of observations made by the Industrial Society of Mulhouse, which have proved that, with the ordinary boiler furnaces, it is only necessary to consume from 125 to 150 cubic feet of air for each pound of coal, while for the most part furnaces pass twice that quantity If the draught be reduced in quantity much smoke is evolved, but the products of combustion, circulating more slowly, part with their heat more readily to the boiler flues It is further proved that the best means of reducing the loss of heat by the chimney is by the use of feed-heaters in the flue, so as finally to reduce to 200 deg. the products of combustion, which are often discharged as hot as 400 deg. Feed-water heaters, well set, will produce an economy of from 11 to 20 p. cent. with a reduced draught. The conclusion is that furnaces with large area and suitable feed-heaters are the most economical in all respects. But in order to obtain the best results much care is needed in stoking. A little at a time and often should the coal be spread over the front of the fire, and the bright coal pushed back to the bridge. At the same time, the least possible quantity of cold air should be admitted.

The works of the United States Iron and Tin Plate Company, McKeesport, Pensylvania, are in successful operation, manufacturing tin and tern plate. They are the only works of the kind in America, and are under the superintendence of W. O. Davies, formerly manager of one of the largest tin-plate works in England.




ACCUMULATOR BOILER FOR STEAM TRAINWAYS.—(See page 155)



BAND SAW FOR IRON.—(See page 156.)

## THE BAMBOO.

A pamphlet has been bublished at Cairo by the Agricultural Department of Egypt, on the Indian Bamboo, which, it is said, is being acclimatised there with great success. The following notes are taken therefrom .—The gigantic bamboo, which is of colissal dimensions, growing to the height of 20 mètres, with a circumference of 40 to 50 centimetres at the base (say 65 feet high and 15 to 18 feet in circumference), from the joint of which, especially those of the middle and upper parts, grow numerous branches with long leaves, is the most vigourous species of the arborescent plant. It was introduced some years ago into the gardens of the Khédive of Egypt, at Ghézireh, from whence it has been multiplied in two or three other gardens of Egypt. It was so much admired by the Emperor of Brazil, on his visit to the gardens of the Khédive last autumn, that he expressed his determination to import it into Brazil, and to cultivate it upon the Imperial estate as a shade for animals during the heat of summer. The gigantic bamboo originates in India and China, and is highly appreciated wherever it is cultivated, being used for posts in pavilions and the houses of the inhabitants. The hollow joints are utilised for carrying liquids, for flower-vases, &c.; and in China, and especially India, for bottles and tobacco-boxes, highly wrought and polished, and sold at great prices. The larger stalks are also used for bridges, water pipes, and carts and other vehicles. In fine, the wood is employed in the arts, in a multitude of industries, and for implements of agriculture. This species of bamhoo vegetates with such rapidity that it can almost be said that one can see it grow. Its progress may be seen from day to day, and at Ghézireh, it has been known to grow 9 inches in a single night. In China, criminals, condemned to death are subjected to the atrocious punishment of impalement by means of the bamboo. A humid soil, is congenial to the gigantic bamboo, although it suffers under a prolonged inundation. It is proposed in Egypt to cultivate it upon the borders of the canals in the vast domains of the Khédive. There is also in the gardens of Egypt another species of bamboo, believed to be the *Bambusa arundinacea* of Wildenow. It presents the following characteristics:—The stalks are smaller and shorter than the gigantic bamboo of India; it attains about 12 mètres (39 feet) in height; it forms larger tufts or clusters than the great bamboo, and throws out a greater number of stalks, which are furnished with numerous slender and flexuous branches, bearing ordinarily tolerably large thorns, a little arched at the joints or articulations, and the leaves are smaller than those of the gigantic species, being rounded at the base, lance-shaped, tapering to a point, and a little downy. There is also another species of bamboo which it is proposed to cultivate in Egypt. It attains the height of 5 or 6 mètres, produces enormous clusters of canes, about the size of the finger, and makes excellent props for use in horticulture. A plant of two or three years' growth will furnish a hundred stalks, forming a cluster of vast size. This species is the *Bambsua edulis*, so called from the fact that its young shoots are ed ble, and in China regarded as very nourishing. There is still another species of bamboo to which the attention of the cultivators in Egypt is called. It is the black bamboo (*Bembusa nigra*). It is distinguished principally by its slender branches, which are of a fine black colour, and from which canes are manufactured extensively for exportation. Pens are made from the smaller stems, which are commonly used for writing in Egypt.

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An Ill-fated Boiler.—For the following narrative of a wasted life we are indebted to an American contemporary. It is difficult to imagine a greater concatenation of woes than those which affected this wretched steam generator. " In a steamship boiler worked with a surface-condenser, after a week's use, *both fire-flues collapsed simultaneously, although there was* plenty of water present. New York engineers had attributed the accident to want of circulation in the water, and altered the construction of the boiler to that end; but on the return trip the very same thing happened again. To help this soda has been employed, thereby preventing injury from the grease, but producing a violent priming over. Finally, sea water was principally used for feed, and the boiler was no longer injured by the deposit of grease, but was destroyed by incrustation."

## DOMINION.

The Detroit Tunnel.—Work has been discontinued upon the tunnel proposed to be carried under the Detroit river for the purpose of uniting the Michigan Central and the Great Western of Canada Railways. Difficulties which were developed by a small experimental tunnel undertaken for the purpose of ascertaining what obstacles were to be met with, have been found to be so great as to force upon the minds of the directors of the Michigan Central a conviction that, if practicable at all, the tunnel would be too expensive for a private company to undertake its construction. A bridge at Detroit appears to be the only alternative, if the business of the various railroads interested is to find its way across the river without a ferry.

The Northern Colonization work is to be commenced on the bridge over the Gatineau immediately. The right of way has been granted over the property of Mr. Scott and Mr Leamy. There seems to be some trouble about the right of way between Hull and Aylmer, owing to the company neglecting to deposit the plans of survey. Only the plans to the township line of Templeton have as yet been handed in, and it is said the county bonds will not be signed until they are deposited.

A movement is on foot to sink an artesian well in the village of Tiverton, and already some $700 have been subscribed for the purpose. At a recent meeting a proposition was made to bore to the depth of five hundred feet, for $1,000, and after a personal canvass of the citizens and farmers, the work will probably be proceeded with. At present the demands for water are great, as not only families suffer from the scarcity, but mills and factories cannot properly carry on their work. The village is also in immident danger from fire, having nothing in the shape of water-works.

A great improvement is taking place in the salmon fisheries of Quebec, and in some localities the yield has increased 300 per cent. This result, the Commissioner, Mr. Whitcher, attributes entirely to protecting the fish whilst breeding, and in reducing the number of nets used. The river Moisic has improved greatly, and the beneficial effects of decreasing the netting is proved by the fact, that with 15,000 fathoms of nets in 1859, the Moisic yielded 75,000 pounds of salmon, whilst in 1873, with only 2,500 fathoms of nets, it yielded 204,000 pounds.

The Nanaimo *Free Press* says:—Mr. Hazlewood, C E, has examined about two thirds of the route between French River and Pembroke, and has found a line very favourable for railway purposes, offering very few railway obstacles. The route examined so far passes through a country well wooded with hardwood, and well adapted for agricultural purposes. The opening up of this country by railways will render available for settlement a district far superior to the free grant lands. The examination of the balance of the country along this line will be completed in a few days.

Captain Bennett is expected to arrive from England shortly to take charge of the copper-works at Bruce Mines. The smelting-works formerly erected are to be put in operation and the mines worked upon a larger scale than heretofore. Some years ago an immense quantity of scrap-iron and salt were taken up for these smelting-works, but no use was made of them. Capt. Bennett will utilize this material, and if the process proves successful it is expected Bruce Mines will have a lively time next season. About ten miles from the Bruce, Mr. Leckie, of Montreal, has discovered an extensive mine of very rich iron ore. Mr. Leckie represents a Montreal company who own 5,000 acres of mining land on the north shore, and the iron mine will be thoroughly explored and tested at once. Mr. Bell, of the steamer Cumberland, brought down a fine specimen of iron ore from the Silver Lake Mine, which is also to be opened and worked. They are down 180 feet in the Shuniah Mine, and the silver ore is richer than ever. This mine promises to eclipse even the Silver Islet.

Geological.—Mr. Richardson, geologist, returned to Victoria on the 5th inst., from Sooke. He discovered indications of coal deposits in several places. He visited the old copper mines, found the tunnel at Beechy Bay filled with water, secured a few specimens and pronounces the vein of little or no value. He will go next to Burrard Inlet, Cowichan, etc.

## RAILWAY MATTERS.

M. GIFFARD, of injector fame, has invented a method of fitting railway carriages which eliminates oscillation. The carriage is suspended by powerful springs at each end; and at the trials recently made in the presence of some members of the French Association for the Advancement of Science, the carriage was found to be so steady that reading and writing could be easily carried on.

WESTINGHOUSE BRAKE.—Up to a recent date, the Westinghouse brake has been under the exclusive control of the engineer, now it can be applied to the entire train by any person, in any car, while the train, in case of derailment, also applies the brake to itself, adding an immense impeding force to the obstacles which it encounters.

AN engine on the New Jersey Midland road has been fitted with a smoke-burning arrangement in the fire-box. On one of the early trips of the engine as the fireman opened the furnace door to throw in a shoveful of coal, the gas burst out with such volume and force as to throw him entirely off the engine. In falling the struck on his head in a culvert and was killed. Another fireman was put on in the dead man's place, and in a short time he had his face terribly burned. One would suppose it would now be rather difficult to find a fireman for that engine

EXPERIMENTS recently made by Mr Forney, of New York showed that the temperature in the smoke-box of a locomotive when first starting was 270 deg, and when working at its maximum capacity on a steep grade and with a heavy train it was as high as 675 deg. The average temperature while running was, in three trials on different parts of the road, as follow.—Average steam pressure, 98 8 lb; average temperature, 499 8 deg. Average steam pressure, 106 lb.; average temperature, 535 1 deg Average steam pressure, 112 2 lb.; average temperature, 554 deg.

THE *Albany Express* of recent date says:—"It may be noted as an extraordinary occurrence that no less than 3650 tons of steel rails for the New York Central tracks arrived here last week. The rails are manufactured in Wales, and are of the Barrow and Landworth brands. The following is the order and load of each boat as they arrived: Barge Watson, 425 tons; Evertsen, 420 tons; Town, 200 tons; Freeman, 300 tons; Clay, 250 tons; Ogden, 300 tons; Thomas, 480 tons; Austin, 600 tons, Van Stautford, 675 tons. Total 3650 tons." The *Bulletin of the American Iron and Steel Association* adds, "Only a few miles from Albany the Troy Bessemer Steel Works are standing idle for want of orders."

AMONG the various articles deposited in the corner stone of the New York New Coal and Iron Exchange, which was laid a few weeks ago, was a document containing the following curious scrap of history.—"The first locomotive that ran on a railroad on this Continent was imported from England by this company, was ordered in England by Horatio Allen, assistant engineer, was shipped from Liverpool, April 3rd, 1829, on board the packet ship John Jay; arrived in New York 17th of May, 1829; was sent up the river to Rondout, and arrived the 4th of July, 1829; from thence was transported by canal, and arrived at Honesdale, July 23rd, 1829, and on the 8th of August made the trial trip. This locomotive was built at Stourbridge, England, and the boiler is now in use at Carbondale, Penn'a."

RAILWAY accidents in England are tame affairs compared with those which occur in our Indian Empire. In Bombay a train has lately been driven into a river torrent. An up goods train which left Bir station shortly before midnight on July 25, arrived about half an hour afterwards at the Sewjee Nullah bridge, and without any warning of danger "the engine and thirty-one vehicles next to it went bodily into the Nullah." The bridge had been previously injured by the flood, and the weight of the train caused its immediate desfruction. The driver Miller and the guard Harris were drowned, but a European fireman, Joyce, managed to save himself by clinging for seven hours to the branches of a tree. It is scarcely to be expected that a catastrophe of this kind could frequently reward the negligence of English railway officials. Until the interlocked system of signals is established companies must be satisfied with collisions with luggage trains.

## A NEW TUBULAR BOILER WITH INTERNAL FURNACE.

We are not aware of another form of boiler which so nearly fulfils the essential conditions of economy that have been laid down by our best scientific authorities, viz., that the products of combustion should travel in opposite direction to the current of the water, and combine at the same time the advantages of internal firing. There can be no doubt that the tendency to priming to which vertical boilers as a type are given, is due to restricted evaporating surface, increased by the great distance of the hottest part—the furnace—from the same, thus generating the mass of the steam below, and compelling it to travel a great distance before reaching the steam space, and so dragging up with it a quantity of water. This is admirably obviated in the internally fired horizontal boiler, which, apart from avoiding the considerable loss of heat from an external furnace, makes the formation of scale less injurious, by presenting a convex surface to any deposit in such places where the heat is most intense. The opposite effect is found in all externally fired boilers, and experience has taught it to be a very serious drawback. But the horizontal—Cornish or Lancashire—boiler is decidedly somewhat deficient in circulation of the water, particularly when the feed-water is introduced above the flues, near the evaporating surface, as is now recommended by the associations whose only object is the "security of boilers" from explosion Apart from this, that type of boiler is deficient in effective heating surface when compared with the bulk of water it will hold, and therefore must be made of large diameter, which is unsuited to high pressure. Multitubulars, however, which overcome this difficulty most completely, impose in many cases difficulties to cleaning. By a combination of the four features, viz, the horizontal, the vertical and multitubular character, with the internal furnace, these difficulties are overcome, and we can readily believe that with the boiler of which we illustrate two types above—and of which a number of various sizes are now working in France and Germany—a very marked economy over the "elephant" boiler has been obtained.

With the very inferior coal used in Alsace and its district an evaporation of nine or ten pounds of cold water per pound of coal is by no means an ordinary result, yet this is the ordinary working data which we receive from reliable sources, not that of mere trials with careful stoking and clean surfaces, which are very apt to mislead. With good coal in a set trial, and the result reduced to evaporation at and from atmospheric pressure, the above quantity would not be far from being doubled. Our illustrations represent a view of one of the small boilers, and a section of another of larger size, and it will be seen that in the former no brickwork setting is required, while in the larger one it is very much simplified. The latter also shows a superheating apparatus, E F G It will be seen that an important feature in the boiler is that the top and bottom covers, R, have bolted joints, and are readily removed, thus affording access to the tubes, B, for cleaning by passing a brush, or something similar, through them. That the deposit in these tubes must be very insignificant from their position, and the current of the water, is fully borne out in practice, for most of the impurities are precipitated on the loose plate, L, when the water begins to rise and becomes heated. K and S are the blow-off and feeding pipes respectively, C is the outlet for the products of combustion, after having circulated round the tubes in their descent, and H is a manhole to facilitate examination and cleansing of the tubes outside.

We doubt the advisability of the present tendency to introduce the feed at the hottest part of the boiler, viz., close to the evaporating surface. This practice must undoubtedly give rise to priming, and also check combustion to some extent by cooling the furnace unnecessarily. In the Cornish type this is done to avoid risk of leaky back-pressure valves, and to equalise the difference in expansion and contraction between the top and bottom in the boiler, which latter is, of course, a very good reason. But the type of boiler here illustrated would not be affected in the same way, and, therefore, the entrance of the feed below its gradual rise, and the heated envelope of the internal flue through cold water being kept away from it, must act very beneficially in point of economy.—*Iron.*

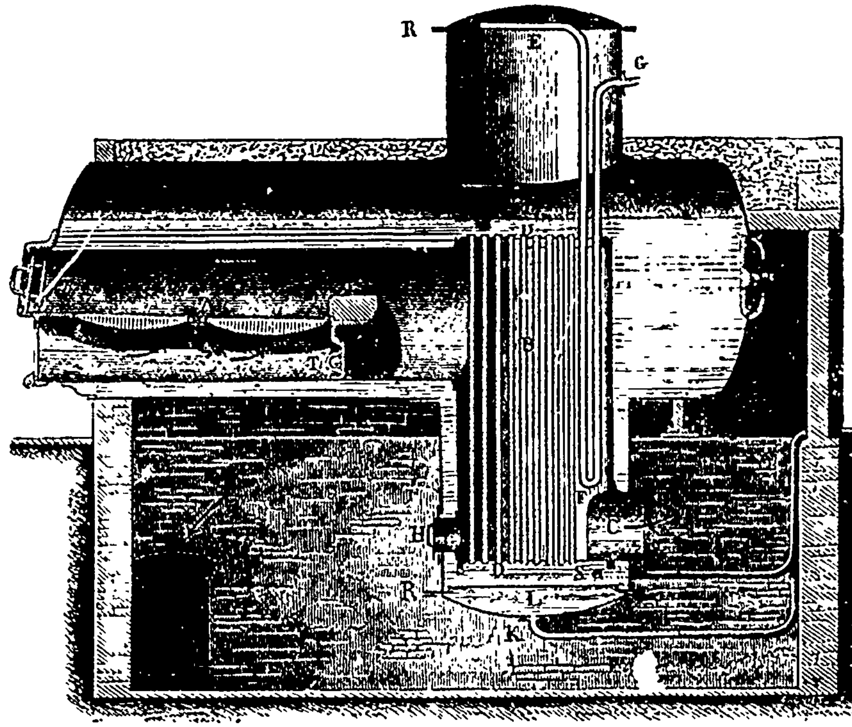


Fig. 2.

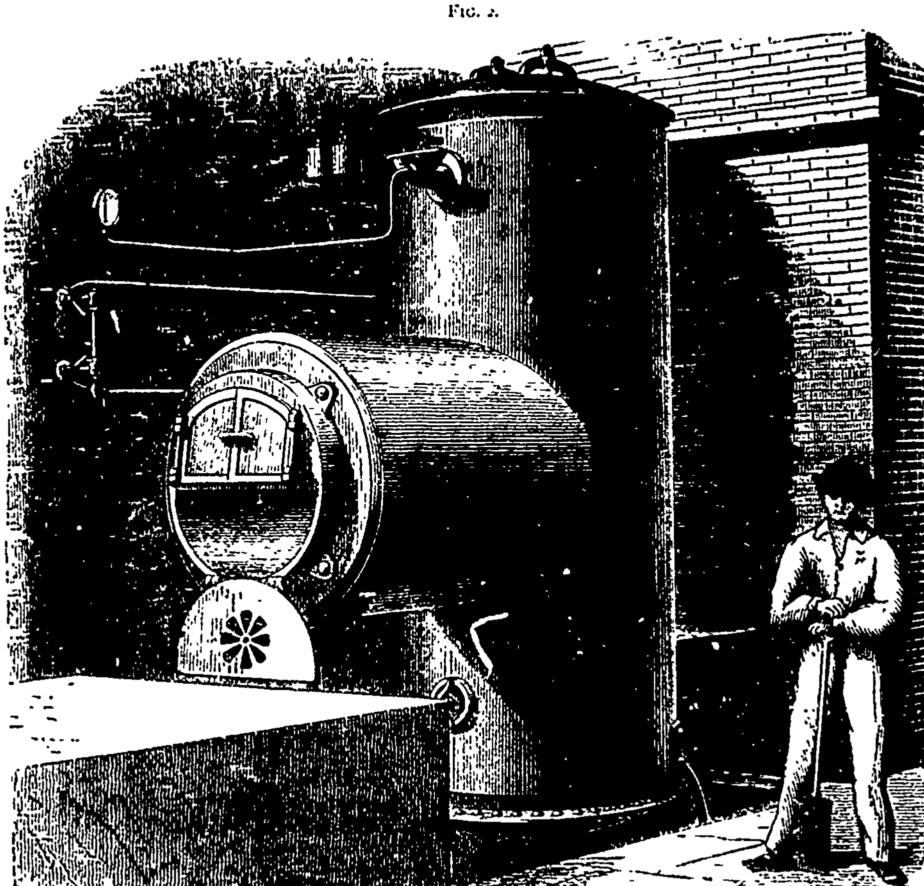

Fig 1.

NEW TUBULAR BOILER WITH INTERNAL FURNACE.