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CANADIAN MAGAZINE OF Science and the Industrial Arts.

Patent Office Record.

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Communications relating to the Editorial department should be addressed to the Editor, Henry T. Bovey, 31 *McTavish Street, Montreal.*

The Editor does not hold himself responsible for opinions expressed by his correspondents.

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NEW BOOKS.

The Materials of Engineering in three parts, by Robert H. Thurston. (New York, John Wiley and Sons.)

Part 1.—Non-metallic Materials. A correct knowledge as to the properties and strength of the materials of construction is absolutely necessary to the engineer and indeed to every one interested in the industrial arts. A work on the subject by a man of such eminence and authority as Prof. Thurston is everywhere recognized to be, cannot but be most heartily welcomed. Part 1 is now before us and is a compendium of valuable information. Chapter I. is devoted to the consideration of the various stones and cements, giving a summary of their most important characteristics.

Prof. Thurston then takes up the subject of timber, "that portion of the woody material of trees which is used in carpentry and joinery." After discussing the proper period for felling, both as regards the age of the tree and the season of the year, which is stated to be mid-summer or mid-winter, he passes on to describe five *seasoning* processes, viz., that of natural or air seasoning, of water seasoning, of steaming, of hot air seasoning, and of seasoning by boiling in oil. The characteristics of good timber are enumerated as follows:—"The heaviest is usually the strongest and most durable. That which has least sap or resin is the best. The freshly cut surfaces are firm and smooth, and the shavings are translucent, and should nowhere appear chalky or roughened, that being the first indication of decay. The annual rings should be closely packed, and the cellular tissue of the medullary rays should be hard and dense. The tissues should cohere firmly, and where sawn, there should be no wool-like fibre clogging the saw teeth. In general, the darker the colour, the stronger and more durable the wood." The *causes* of decay are then touched upon, and the remainder of the chapter is occupied by an illustrated description of the chief timbers (of which immense quantities are produced in our own forests) classified under the two heads of Leaf-woods and Pine-woods.

Chapter II is especially recommended to the careful consideration of the reader, as giving much and important information as to the *strength* of timber. Prof. Thurston carefully defines what is meant by limit of elasticity, coefficient of elasticity, etc., gives numerous tables shewing the resistance of timber to tensile, compressive, shearing, and transverse stresses, and explains their practical application by the aid of the standard formulæ. The tables are prepared from the results of the most recent and most reliable experiments, of which many were carried out by the author himself. On page 110 are Prof. Thurston's autographic strain-diagrams exhibiting all the mechanical properties of the more important woods. After an admirable summary of the conclusions relative to the application of timber to structural purposes and of the characteristics which specially distinguish the several woods, the chapter concludes with a concise account of the principal methods adopted for their preservation.

Chapter IV treats of the *fuels* used in Engineering and Metallurgy. They are considered with regard to their heating power, the quality of air required, the rate of combustion, their evaporative power, etc etc., and the requisites of an efficient furnace are carefully discussed.

Chapter V is an abridgment of Prof. Thurston's well known treatise on Friction and Lubrication, and the last chapter deals with miscellaneous materials, as leather, belting, etc.

An appendix contains tables comparing the metric system of weights, measures, etc., with that in use in Great Britain and the United States, and gives the First Report of the Committee (British) for the Selection and Nomenclature of Dynamical and Electrical Units.

The book is printed in clear type and is well got up.

The Railroad Spiral, by William H. Searles (New York; John Wiley and Sons, 1882).

The use of the cubical parabola in setting out railway curves with gradual changes of curvatures was first suggested by Mr. William Froude about 25 years ago, but a practical method of locating such curves on the ground has hitherto been wanting. The object of Mr. Searle's work is to supply this deficiency, and although it must be acknowledged that rail layers perform the easing of changes of curvature, with considerable accuracy by the eye, yet it cannot but be preferable to have fixed and reliable rules by which this operation may be effected. Mr. Searles starts by stating the objections to simple curves, then gives the theory of the spiral, exemplifying it by various elementary and special problems, and showing its application to field work. He concludes with a series of valuable tables. The book is of a convenient size for the pocket.

Saw Filing, by Robert Grimshaw (New York . John Wiley and Sons, 1883).

This handy little book is designed as the preface tells us, "as a practical aid to those who use saws for any purpose," and is evidently compiled by one who has had considerable experience in the subject with which he deals. The illustrations are carefully executed and the directions are always clear and to the point.

◆

OUR NORTH-WEST RAILWAYS.

BY ANDREW T DRUMMOND

The year 1882 has been notable for the extent to which railways have been constructed in Ontario and the North-West. In Ontario, the Canadian Pacific Railway has been continued to the north side of Lake Nipissing and thence westward towards Algoma Mills; the Canada Atlantic has been completed to Ottawa, forming a new route between that City and Montreal; and the Toronto and Otttawa and the Ontario and Quebec Railways—almost parallel lines for a considerable distance—are under rapid construction, the objective point of each presently being Perth, but the ultimate aim of the Ontario and Quebec Railway being to open between Toronto and Montreal, *via* Ottawa and in association with the Canadian Pacific Railway, a rival route to the Grand Trunk Railway. On the Canada Southern, Kingston and Pembroke, and other lines, some extensions have also been made, but, in each case, the additional mileage has been inconsiderable.

However marked railway construction may have been in Ontario, it has been far outstripped in the North-West Territory during the past summer. It was to be expected that with the natural facilities which the character of the country afforded, grading and track laying would, as on the the prairies of Minnesota, Dakota, and Iowa, be quickly accomplished, but few last spring would have been prepared for the announcement that the main line of the Canadian Pacific Railway, which at this time a year ago, was open to Brandon, about 150 miles west of Winnipeg, would have at the close of 1882 its terminus within sixty miles of the South Saskatchewan, or 586 miles west of Winnipeg. The rails are now laid to that point and the grading thence to Leopold, the new town at the crossing of the South Saskatchewan, is well under way. As many as four miles of track laying have been accomplished in a single day. This enormous amount of work has only been overtaken by conducting the operations under a most perfect system. A small army numbering over ten thousand men and horses had to be lodged, fed, and kept at work by the contractors, and that in a country where no supplies were to be had within 450 miles. During the months of August and September the graders had to be sufficiently far ahead of the track layers to permit of the latter laying an average of two to three miles per day. To accomplish this, a vast commissariat department had to be established, depôts formed, and supplies of provisions and forage sent regularly forward to the front, whilst to keep the track-layers at work, trains with all the requisite rails, ties and fastenings for the mileage of track to be laid each day, had to be systematically despatched beforehand from Winnipeg.

This, however, is but a part of the Canadian Pacific Railway work in the North-West during the past year. They have laid 115 miles of track on their South-Western branch, trains actually running now from Winnipeg to Manitoba City *via* Morris; 22 miles have been graded and are ready for the rails on the branch from Selkirk to Winnipeg on the west side of the Red River, while sixty miles of sidings on the main line, and three on the South-Western branch have been completed. These give a total of 635 miles of railway built by this Company during the year in the North-West alone. And yet this represents but a portion of the vast expense involved in the construction of the railways there. The whole line has been fully equipped with locomotives as well as passenger and freight cars, and extensive engine houses, repair shops, and freight sheds have also been built. Indeed, whatever opinion we may entertain of the contract obtained by the company and of the Government policy in entering into such an agreement, we cannot detract from the energy displayed in carrying it out.

Before the divide at the Kicking Horse Pass in the Rocky Mountains can be reached, 390 miles of further track have to be laid by way of Leopold, Calgary and the headwaters of the Bow River, and it is proposed to cover that distance next year. The belief is further entertained by the Company's engineers that from the summit at Kicking Horse Pass a feasible line has been obtained to the Columbia and thence down that river for some distance, when the Selkirk Range is crossed and Kamlooks reached by way of Shuswap Lake. From Kamloops the line is already under construction along the Fraser River past Lytton and Yale to Port Moody on Burrard Inlet.

Whilst numerous charters have been obtained both from the Dominion and Manitoba legislatures for railways in the North-West, the Canadian Pacific, Manitoba South-Western, and Portage, Westbourne and North-Western Railways have alone reached the point of active construction. Two other railways have had the promise of considerable Government land grants, namely, the South Saskatchewan Valley Railway, whose projected route is from Qu'appelle to Prince Albert, and the Souris and Rocky Mountain Railway, which, it was proposed to run from a point near Brandon on the Canadian Pacific Railway to Battleford but in neither case have steps been taken to commence construction. A mile or two of grading at West Lynne has been done by the Emerson and North Western Railway Company in the hope that the Grand Trunk would espouse the cause of that road, but the Government at Ottawa having disallowed the charter and the Grand Trunk not being as yet disposed to meddle actively with Manitoba Railways, the work has been entirely stopped, though it may be continued by the Canadian Pacific in forming a loop line from their South Western branch to Emerson.

The Manitoba South Western Railway has recently changed hands in so far that the interest of the Villard party in it has been sold to the Canadian Pacific Syndicate. This railway starting from Winnipeg runs due west to Headingly, where it crosses the Assiniboine River and takes a course south westerly to near Carman, a distance of fifty miles from its starting point. The rails are laid for the whole of this distance but all work on the line is in abeyance at present, pending rearrangements resulting from the recent partial change of ownership.

The Portage, Westbourne and North Western Railway has also quite recently changed hands and is now controlled by a syndicate at the head of which was the late Sir Hugh Allan, among other members being Andrew Allan, Robert G. Allan, of Liverpool, B. H. Buxton, of London, Eng., Lord George Campbell, W. L. Boyle, A. T. Drummond, Lieu't-Governor Dewdney, H. N. Ruttan and Duncan MacArthur. Fifteen miles of this road were graded late in the fall and when track-laying is completed on this section, there will be a total of fifty miles of finished road. Trains are now regularly running to Gladstone, and it is intended to reach Minnedosa by July and to cross the River Assiniboine by October next. Up to this point, the railway passes through a country already well settled; beyond it, its course lies as near as possible directly to Prince Albert on the North Saskatchewan,

The outlook in the North-West, notwithstanding the unhealthy real estate speculations is on the whole very favourable. Immense tracts of country are being opened to settlement through the construction of the railways, and even distant points on the North Saskatchewan are now readily reached during the summer months through the greatly improved class of steamers which ply on Lake Winnipeg and that river. A greater area, also, of desirable land has been found than was supposed to exist. It now only requires an effective immigration system to attract the surplus population of other parts of the world. The class of settlers who have taken up land during the past has been on the whole very superior and it is extremely desirable that more of their class should be found making their home in the Great North-West.

* * *

MONSTER STEAM WHISTLES.—People who in this country, complain of the noise made by railway whistles and factory "hooters" may congratulate themselves that they have not to listen to the enormous whistles now manufactured in the United States. A firm in Bridgeport, Connecticut, has recently completed one for a Canadian saw mill, the bell of which is 20 in. in diameter, a quarter of an inch thick and 27 in. long, and is placed five inches from the cup which delivers the steam. The valve is of the ordinary spring pattern, and is 4in. in diameter. The weight of whistle and valve is 406 lb., and the cost of the monster is 500 dollars. The mill, for the protection of which it has been made, has been several times burnt down, and the object, therefore, of the whistle is to arouse the surrounding country in case of a reoccurence of the catastrophe, and also to carry signals to the wood-choppers in the neighbouring forests. There is another big whistle at New Brunswick, in New Jersey State, with a deep bass hum which serves as the clock regulator for farmers and others within a radius of 30 miles of the town. There is also a whistle at Sandy Hook, 15 in. in diameter, while many of the ocean and Sound steamer have whistles from 8 in, to 10 in., which can be heard from 10 to 20 miles.

* * *

ON HYDRAULIC LIFTS FOR PASSENGERS AND GOODS.

BY EDWARD BAYZAND ELLINGTON.

(*Continued from Page* 11.)

DIRECT-ACTING LIFTS.

This safer construction is to be found in the case of those lifts which are not hoisted up from above, but pushed up from below, in such a manner that there is always a supporting column underneath the cage. Lifts have been constructed on this principle and worked by ordinary mechanical means, the supporting column being a rack, gearing into a pinion at the ground level; or, in another arrangement, the supporting column has a screw thread on its periphery, and is drawn up or down by means of a nut at the ground level. Looking to safety alone, it would not be possible to find fault with this latter arrangement; but the practicable speed of working must be extremely slow, and the power absorbed in friction very great. An hydraulic ram is clearly the right thing to use for the supporting column of the lift; and by adopting the direct-acting hydraulic ram, as shown on Page 36, it would appear as if the question of absolute safety in lifts were solved. But it is soon found that there is something still required.

An hydraulic lift, with a vertical direct-acting ram, presents some rather curious problems in construction, which increase in difficulty as the height of lift is increased, and the working pressure reduced. A low-pressure lift of this type has to be made subject to the following conditions:—

(*a*) A well or bore hole has to be sunk to a depth somewhat greater than the height of the lift, in which well is inserted the lift cylinder;

(*b*) The ram has to be of an area sufficient, when acted upon by the pressure of water at command, to overcome friction, and to raise both the load and the surplus weight required for lowering the cage when empty;

(*c*) The weight, and also the displacement, of the ram increases with its height and diameter;

(*d*) The bottom of the well being usually far below the drainage level, the water used in working has to be forced up to the drain by the descending ram;

(*e*) The pressure upon the ram at any time during its motion will vary proportionally to the difference between the head of water and the height of lift at that time.

Under these conditions it will be seen that, with a simple ram, equilibrium cannot be maintained. With a given pressure and load to be lifted, there is a limit to the height of lift; the pressure on the area of the ram diminishing as the ram ascends. In ascending with a given pressure of water, the ram would run out a certain distance, and then stop; and in descending with a given weight it would descend a certain distance, and then stop.

It is therefore necessary to balance the varying displacement, in all high lifts working with low pressures of water. It is also necessary, in order to avoid great waste of power, to balance the weight of the ram.

The usual practice has been to introduce counterweights, and chains travelling over head sheaves, as shown in Fig. 11, Page 14. The chains are of sufficient weight to balance the displacement of the ram. When the cage is at the bottom, the ram and cage are balanced by the weight of the counterweight *minus* the weight of the chain; and when the cage is at the top, the ram and cage are balanced by the weight of the counterweight *plus* the weight of the chain. The use of counterweights and chains unfortunately destroys the simplicity and absolute safety of the apparatus; for, though the risks attending the use of ordinary chain lifts are eliminated, and the chances of breakage are remote, there is still a reasonable possibility of accident.

In direct-acting hydraulic lifts the balance chain and weights entirely alter the character of the strains on the ram. For a considerable portion of its length from the top, the ram, instead of supporting the cage as a column, is thus really hanging from it: part of the ram is always in tension, and another part is always in compression, while the neutral plane varies in position according to the pressure on the ram. Should the ram break above the neutral plane, or the attachment between the ram and cage give way, the cage would be violently dragged by the counterweight to the top, the fall being as it were upwards instead of downwards.[*] A lift so constructed does not therefore fulfil the conditions of safety required in a first-class passenger lift; and means must be found for doing away with the chains and counterweights, leaving nothing but the hydraulic cylinder, the ram, and the cage.

This condition can be obtained by increasing the working pressure, and by reducing the area, and therefore the displacement, of the ram; leaving only sufficient section to prevent its bending under the load, as shown in Fig. 9, Page 36. The

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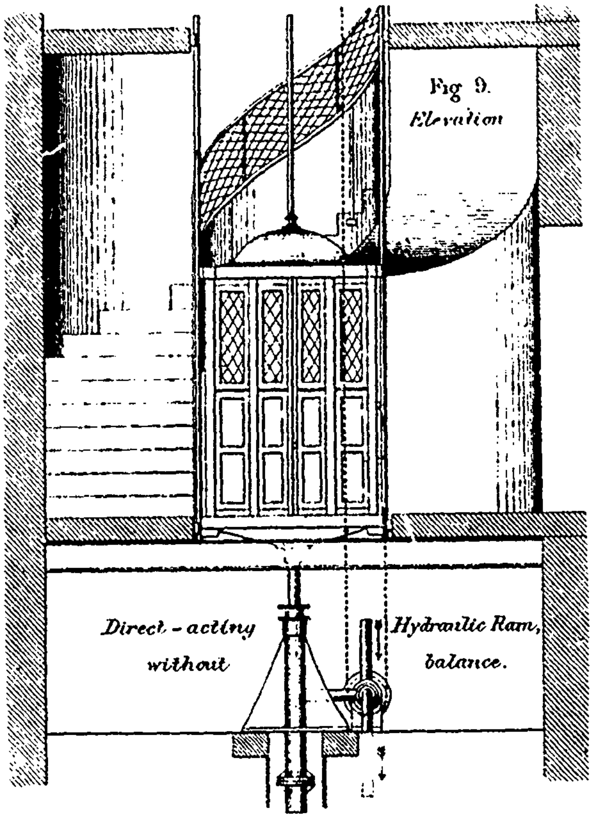
[*] This happened at the Grand Hotel in Paris, when several passengers were killed.



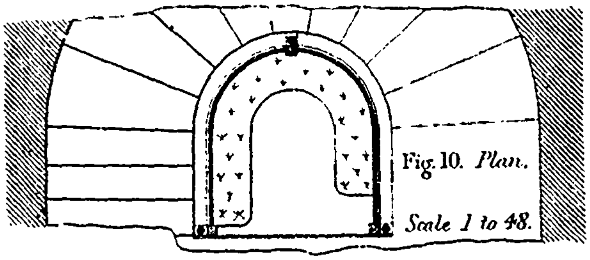


Fig. 10. Plan. Scale 1 to 48.

Direct-acting Hydraulic Ram with counterweight and balance chain.

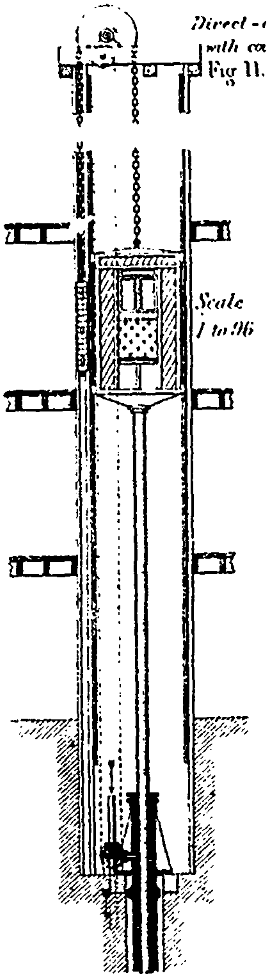
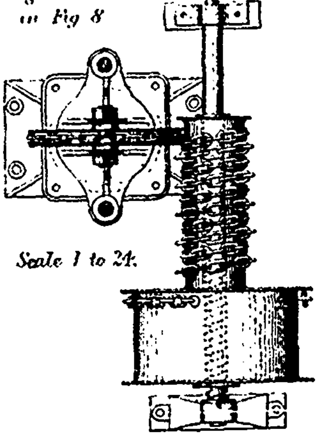


Fig 11.


Fig 12. Fig. 13.
Couplings of Hollow and Solid Steel Rams.

Fig 14. Plan of Winding Drum in Fig 8



ON HYDRAULIC LIFTS FOR PASSENGERS AND GOODS.

requisite safety is thus secured, but at a most extravagant expenditure of power, owing to the want of any balance; the expenditure due to weight of the ram and cage, and to the loss by displacement, being often five or six times that due to the net load. The author has erected several lifts on this plan, where it has not been necessary to provide special pumping plant to obtain the high pressure required. It would however be impracticable to adopt the arrangement as a general rule.

Messrs. Tommasi & Heurtvisé have designed a balancing arrangement separate from the lift cylinder, as shown in Fig. 15. The lifting cylinder A is in hydraulic connection with a second cylinder B of equal capacity, though of shorter stroke. In the second cylinder there is a loaded ram C, of sufficient weight to balance the minimum weight of the lift-ram and cage when at the bottom. This heavy ram works through the stuffing-box of a third cylinder D, of the same capacity as B; and the pressure of water in this third cylinder lifts the net load. Heavy chains E are attached to the ram C, between the two short cylinders, to balance the varying displacement of the ram A as it travels. This plan is satisfactory as regards safety, but the weight and size of the cylinders and moving parts are so great as to render its adoption on a large scale impracticable.

Hydraulic Balance Lifts.

The author has endeavoured to overcome the above-mentioned difficulties; and has devised an arrangement which appears to him to meet all the requirements of a perfectly safe, rapid and economical passenger lift. The conditions of the apparatus are as follows:—

(*a*) The motive power is water, either at high or low pressure;

(*b*) The ram is always in compression, and supporting the load directly;

(*c*) The dead weight of the ram and cage is balanced wholly or partly by hydraulic pressure;

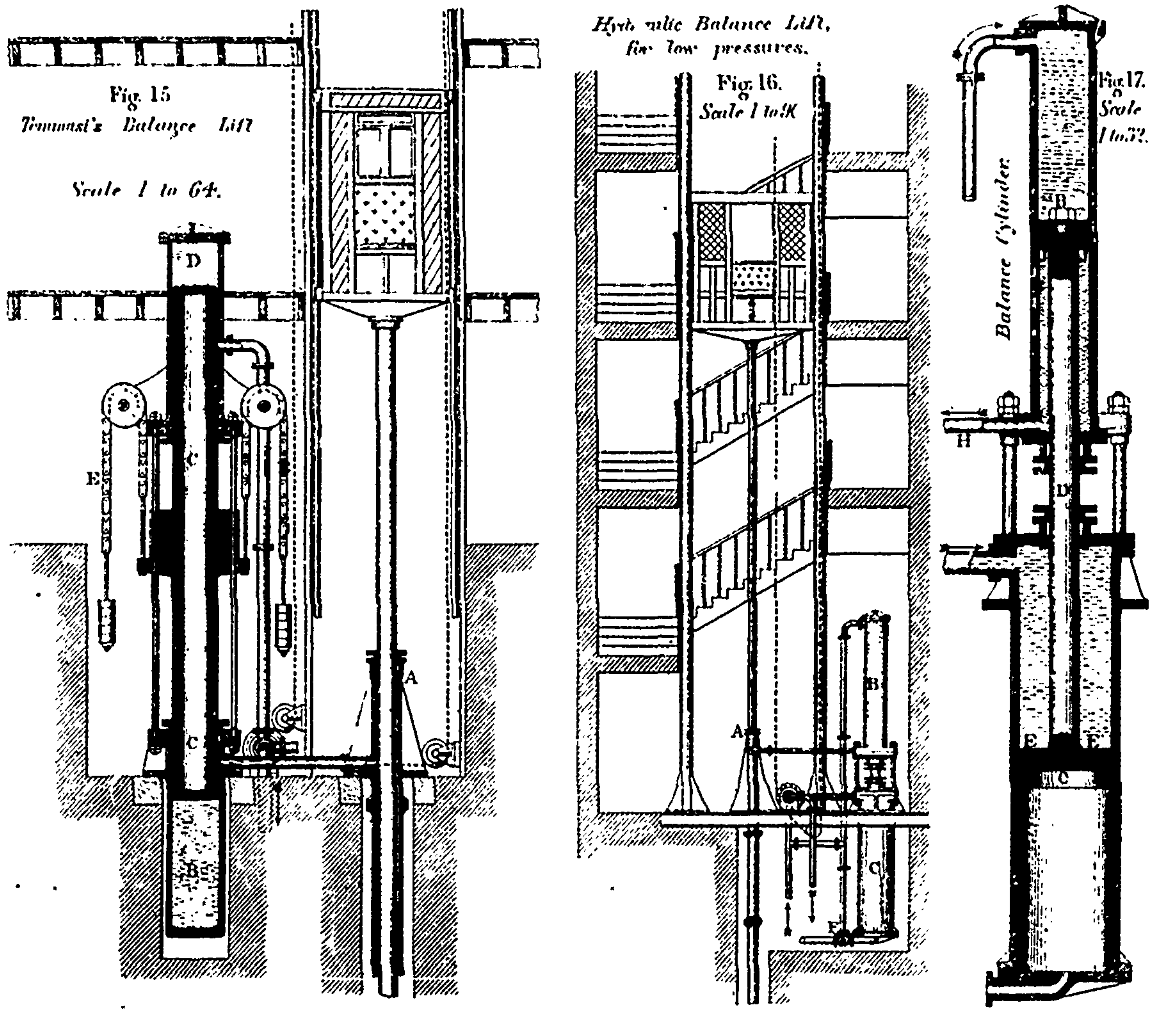
(*d*) The displacement of the ram is reduced to a minimum, and is balanced without any special mechanism;

(*e*) The weight of the moving parts of the lift is reduced to a minimum;

(*f*) No part of the machinery or supports is above the cage;

(*g*) There is no part of the machinery which, by giving way, could reasonably be expected to cause an accident to those ascending or descending in the lift.

This Hydraulic Balance Lift is shown in Page 87. The hydraulic lifting cylinder, ram, and cage are as usually made, except that the ram is smaller in diameter. Its size is deter-



HYDRAULIC LIFTS.

mined by the strength required to carry the load, and not by the working pressure of water available. As in Tommasi's lift, the lift cylinder A, Fig. 16, is in hydraulic connection with a second and shorter cylinder B, below which is a cylinder C of larger diameter. There is a piston in each, connected by the ram D, Fig. 17. The capacity of the annular space JJ below the upper piston is equal to the maximum displacement of the lift ram A. The annular area E of the lower piston C is sufficient, when subjected to the working pressure, to overcome friction and lift the net load; and the full area B of the upper piston is sufficient, when subjected to the same pressure, to balance within a small amount the weight of the ram and cage when at the bottom. When the parts of the apparatus are properly proportioned, the lift ram and the balance pistons are in equilibrium in every position; or, in other words, the displacement of the ram of the lift cylinder is automatically balanced.

The mode of action of the lift is as follows: Assuming the cage to be at the bottom of its stroke, the valve is opened from the cage by means of a rope or system of levers, and pressure is thereby admitted to the annular area of the lower piston at E. The top of the upper piston is always subjected to the same pressure. The pressures on the two pistons thus act in the same sense on water in the annular space J, below the upper piston; and the intensified pressure of this water is transmitted through the pipe H to the lifting ram A, which thereupon ascends. As it ascends, the ram increases in apparent weight, but at the same time the pistons B and C descend, and are thereby subjected to an increasing head of water, which increased head, acting upon the large area of the pistons, exactly balances the increase of weight of the ram, or—to state the case more accurately—compensates for the loss of effective head in the lift cylinder. When the ram reaches the top of its stroke, the valve is closed, and the lift stops. On opening the valve to the exhaust, the pressure is relieved from the space above the piston C, while the piston B remains subjected to the working pressure above it, as in ascending. The lift now descends: the weight of the ram and cage, pressing upon the water in the lift cylinder, transmits the pressure to the annular area a' the bottom of the piston B, and overbalances the weight of the pistons and the pressure on the top of the piston B. As the lift ram descends into its cylinder, it displaces the water and loses weight, or, in other words, encounters an increased resistance to its descent. At the same time the two balance pistons ascend, and the pressure above each of them decreases; the decrease in the pressure being in proportion to the increased pressure on the area of the lift ram. The lift ram and the pistons B and C are, as stated, in constant equilibrium. To make good any possible leakage, provision is made for admitting the working pressure through the cock F under the piston C, and so raising it, while the cage is at the bottom; this relieves the pressure in the annular intensifying chamber J, and allows water from above the upper piston B to flow down past the packing leather of that piston and replenish the space J. As a general rule, the part of the lower cylinder underneath the piston C is not filled with water in the regular working of the lift, but is open to the atmosphere. If however the cock F controlling the admission is closed, during the descent of the cage the rising of the piston C creates a vacuum beneath it, which becomes available as lifting power for the next ascent. In other words, the weight of the descending load is by this means utilised to augment the lifting power in the next ascent of the loaded lift; or, if the lift is being used for the purpose of lowering goods, the vacuum supplies power enough for raising the empty lift without the expenditure of any water at all.

The author's hydraulic balance lift permits of great variety of application; and the proportions of the balance cylinders may be adjusted to suit any working pressure available, without alteration to the size of the lift ram. This facilitates the employment of high working pressures; and the system is therefore particularly adapted for use in connection with public distribution of hydraulic power on the high-pressure or accumulator system, where economy in the use of the power is of vital importance. When working the lift with high pressure, the balance cylinders may be temporarily disconnected, and the pressure used direct from the accumulator.

The increase of the working pressure reduces the size of the lift cylinder, and also much increases the speed of the lift—a matter of great consequence in public offices, and other places where large numbers of passengers have to be accommodated. The author has for some time past adopted a working pressure of 200 lbs. per sq. in. and upwards for high direct-acting lifts; and by so doing has succeeded in working these lifts at a speed of 200 ft. per minute, and, with a single lift taking five or six people at a time to a height of about 40 feet, in accommodating as many as 3000 passengers in the course of nine hours.

When using high-pressure water from an accumulator for working the hydraulic balance, it is not necessary to use the high pressure for the balance piston. Water may be taken for this purpose from a supplementary tank, placed at any convenient height; or the fluid used may with advantage have a higher specific gravity than water. The water is taken from the tank and returned, at each ascent and descent of the lift cage. In many cases of high-pressure lifts the loss by displacement of the ram is not of sufficient consequence to be considered; then the arrangement adopted is as shown in Figs. 18 and 19, and the balance cylinders can, if desirable, be placed horizontally. Here the working pressure due to the area of the central pipe B acts constantly to balance the minimum weight of the ram and cage; and the lifting power is obtained by admitting the working pressure into the outer annular space EE, and so forcing water from J through the pipe H to the lift cylinder A.

Another incidental advantage of the Hydraulic Balance lift is that the space in the lift well, usually occupied by the counterweights and guides, is available for the cage. All head gear is avoided, and no special structural arrangement for carrying the weight from above is required.

Having thus described what the author regards as the standard form of lift for passengers and goods, it is necessary to remark that it is still possible for serious accidents to happen, unless attention is paid to the protection of the lift well, and to the method of working the lift. To work with safety and at a high speed, the lift well should be cased in, and closed by doors opened only from the inside of the lift. Doors should also be provided in the cage, though these may be dispensed with if care be taken to make the cage fit close to the framing of the lift well, the doors and boards being flush from top to bottom, so that they make a sliding joint with the cage. It is also desirable that the lifts should be worked by an attendant, especially in high-speed lifts, where it is necessary to be careful in handling the rope, to avoid jerks at starting and stopping. When lifts are not worked by an attendant, special arrangements of the controlling gear and doors are necessary, to prevent the doors from being opened while the lift is in motion, and to render the control of the lift as far as possible automatic.

ECONOMY OF HYDRAULIC LIFTS.

Having arrived at the conclusion that for practical purposes the only really secure lifts are those worked by hydraulic pressure applied on the direct-acting principle, without the aid of any balance chains or counterweights, it will be interesting to consider how far hydraulic power is to be preferred upon the ground of economy.

This question can be brought to a very simple test. Hydraulic apparatus, as used in hydraulic lifts, forms a system of mechanism for the transmission of power, and the relative economy of the prime movers need not for the present be considered.

On the one side we may place the direct-acting hydraulic lift, and on the other an ordinary geared lift. In both lifts the friction of the cage and its balance are the same, assuming the friction of the hydraulic balance to be equal to that of the balance-weight and chains which it supersedes. Which force then will give the greatest efficiency: power acting by fluid pressure, on a ram passing through a single stuffing-box or leather, or the same power acting through ordinary gearing, and finally winding the lifting chain upon a drum? The loss of useful effect from the latter cause alone may equal that due to the friction of the ram. Where the water pressure is available without pumping, the question of relative economy, as between hydraulic and ordinary gearing, does not require argument; that hydraulic gear is the most economical is sufficiently obvious.

But there are of course other considerations besides the friction of the machinery employed. If mechanical means have to be provided for obtaining the water pressure, it may be that the loss in first producing this pressure, and then applying it through an economical machine, may be greater than in applying the original power direct through an extravagant machine; or, owing to the peculiarity of hydraulic machinery, in involving, within narrow limits, an invariable expenditure of power, the loss of useful effect may more than compensate for diminished friction.

Now a steam engine working an accumulator gives an efficiency of 75 to 80 per cent. The loss between the work stored in the accumulator and the work done by a direct-acting ram may be taken at 5 to 10 per cent; which would give a final efficiency of say 70 per cent. No geared lifting machinery, driven direct by a steam engine, gives anything approaching so high an efficiency; and the efficiency would again be much lowered if, as in the generality of cases, the steam engine had to be kept constantly moving. The loss from this latter cause is much greater than the loss arising from the invariability of the hydraulic lifting power: moreover, though the power of hydraulic lifts is invariable, yet when lifting light loads there is a gain of speed.

The comparison between geared and hydraulic lifts is not in any way affected to the advantage of the former, by substituting a gas engine for the steam engine and boiler. The gas engine cannot drive direct, owing to its high speed; and it must be kept constantly going, since to start it takes time and labour. There can be no question that the efficiency of a gas engine is far less than that of a steam engine doing the same work; but this loss is in many cases compensated by the cheapness of the explosive power, and the convenience of having no boiler. These advantages of the gas engine are retained, by using it to obtain the hydraulic pressure; and the fact of its having to work constantly renders pumping against a constant head a peculiarly suitable occupation for it.

Until therefore it can be shown that the use of hydraulic pressure with a direct-acting ram entails more friction than a system of ordinary gearing to do the same work, hydraulic power will remain the most economical as well as the safest agent for direct lifts. The efficiency of the hydraulic jigger varies of course with the multiplying power; but the same argument holds good for the jigger as for the direct ram, though to a diminished extent.

There remains the question of first cost. On this point the author's view is:—

1st. Where safety is concerned, cost should be a secondary consideration;

2nd. The cost of hydraulic machinery, where the hydraulic pressure is already at hand, is no more than that of any other system;

3rd. The extra cost required, where the pressure is not at hand, is as a general rule amply compensated for by the greater safety, the greater general efficiency, the greater economy in working, and the diminished wear and tear of the machinery.

Lifts of Large Power

Thus far only lifts of small power, for hotels, warehouses, &c., have been dealt with, as to which there exists a great variety of practice On page 40 are illustrations of hydraulic lifts of greater power, and possessing some novel features.

Figs. 21 & 22 illustrate the direct-acting hydraulic lifts erected at Seacombe pier on the Mersey, to take the carts and wagons from the floating landing stage to the high level. The height of lift is 32 ft., and the net load 20 tons. The lifts were designed by Mr. Wm. Carson, M. Inst. C.E., to avoid the long approaches used at Woodside, and at the Liverpool landing stage, and they have most perfectly fulfilled their object. Owing to the weight of the ram and cage being unbalanced, the efficiency is low; but in this instance, as the rams are working in a tideway, Mr. Carson no doubt exercised a wise discretion in avoiding the complication of a balancing ram, or other balancing apparatus. There is however a connecting valve between the two lifts, so that a descending load in one lift may raise the other cage when required. The hoists are made to accommodate railway coal wagons, which can, if necessary, be taken across the river on the ferry boats The platform upon the cage is double; the upper portion B slides longitudinally upon the lower, and is guided to the radius of the bridge connecting the floating stage C with the upper pier. This bridge is hinged at both ends, and the guiding arcs A are struck with a radius of 160 ft., equal to the length between the hinges.

Fig 19 illustrates another arrangement of wagon hoists, constructed for the Midland Railway Company at Whitecross Street station on the Metropolitan Railway. The object of the arrangement was to get a direct-acting hoist without sinking a well, the condition being that the concrete floor of the station should not be touched. There are two lifting rams at each side, placed in hydraulic connection diagonally, so that either two or four can be used, the lifting force in both cases passing through the centre of gravity of the platform. When lowering loaded wagons, the water used to lift the platform alone, or with only an empty wagon on it, is returned to the reservoir by the descending load.

For such lifts as these, direct-acting hydraulic rams are now almost exclusively used. That direct acting hydraulic apparatus has not been more generally employed for small lifts is due, in the author's opinion, rather to the mechanical difficulties in the way, than to any doubt as to their superiority, whether used for heavy or light loads.

In conclusion the author would remark that he has left many varieties of hydraulic lifts untouched. He has dealt almost exclusively with a special class of lifts, which he considered to possess several points of interest; and he has confined himself, with one or two exceptions, to machinery constructed under his own supervision by the Hydraulic Engineering Company of Chester.

Abstract of Discussion on Hydraulic Lifts.

Mr. Benjamin Walker said that, with the author's general conclusion—that the hydraulic direct lift was the best and the safest he entirely agreed; but with his criticisms on some of the systems of hydraulic lifts he did not agree. For example, the author had stated, that the ordinary safety apparatus, designed in case of a chain breaking to prevent the hoist from falling to the bottom of the well, was not to be trusted. He had known many instances in which the life of a workman had been saved by the safety apparatus, and if that was done in one case, it was likely to be done in many others. He thought such apparatus was quite capable of being made safe; and if so, to give it up as being liable to lead to danger was, in his opinion, not a very wise step. The guides of the hoists used in grain and other warehouses were very firmly and substantially made, and were very different from the guides of the winding cages at a colliery. So far as a colliery was concerned he agreed with Mr. Ellington that an efficient safety apparatus was a very difficult matter to provide; but when there were reasonably firm and substantial guides, it was very easy so to construct the apparatus that any shock on the descent of the cage would be so far reduced as to do no damage.

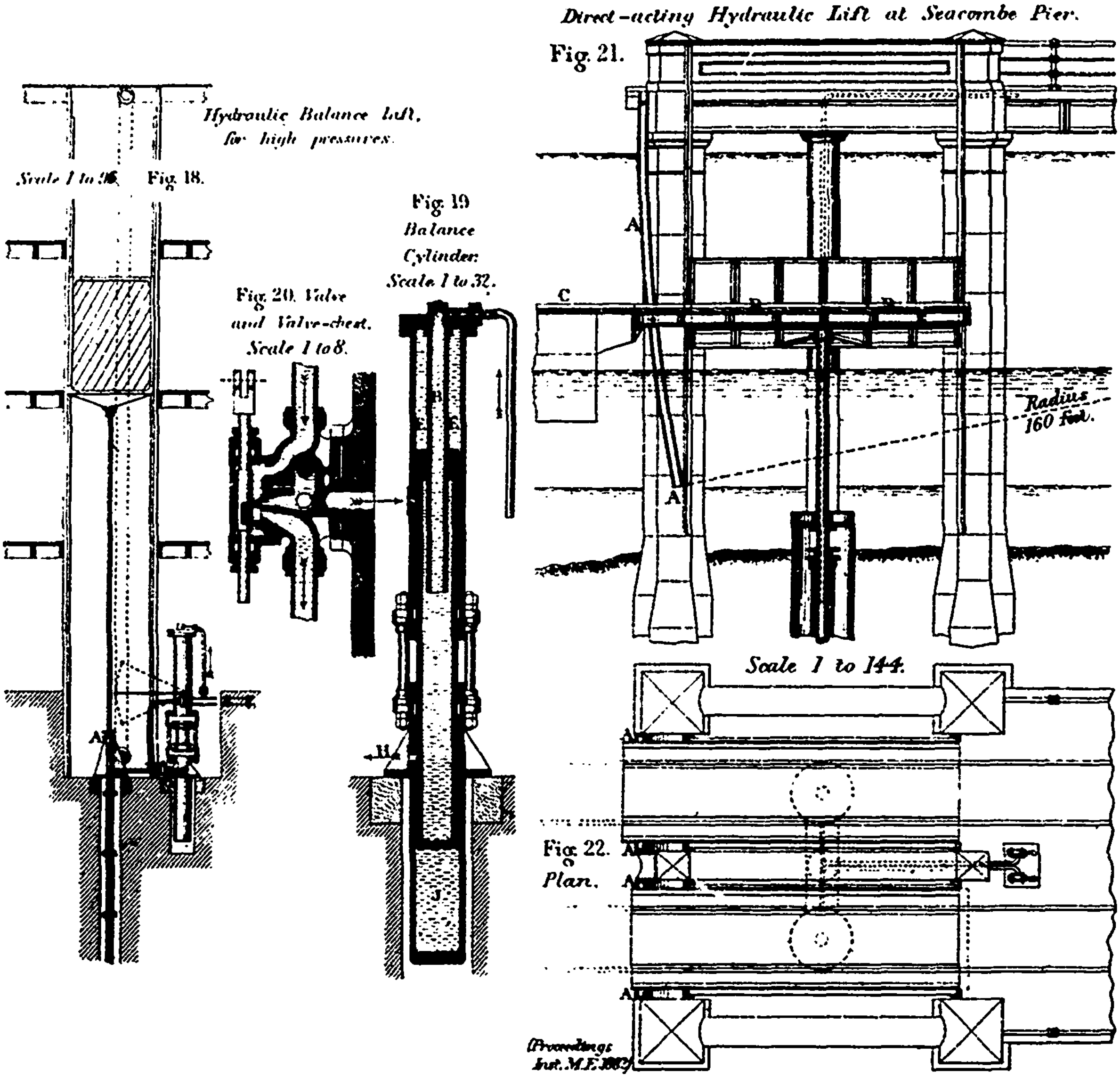
The author had spoken of worm gear, and had pointed out that although there might be complete safety fromthe use of worm gear, there was a considerable amount of friction and loss of power. But the worm, when properly applied, was a most valuable and useful mechanical contrivance. If indeed the worm had a large amount of friction—say the same as the friction on an ordinary toothed wheel—then the worm and worm-wheel were very wasteful of power; but if the worm was allowed to run at a considerable speed, and the friction was somewhat less than half the friction that would occur with an ordinary toothed wheel, other circumstances being the same, then it would be found that the loss of power was not considerable, while there was great safety arising from its use in many cases, such as in cranes or lifts

The author farther remarked, that if a hoist was driven by a belt, that was a great source of danger. He might mention that he had put up a hoist fifty years ago worked by a belt, and that it was working still, and he believed during all that time not a single accident had taken place. It was in a very high shaft in a tall flax mill, and there were hundreds of such hoists at work, driven by a straight and crossed belt. With regard to the use of the gas engine, he thought that, in connection with a single direct lift, a gas engine driving an hydraulic pump, or three or four pumps, was a very valuable means of getting a safe and useful passenger hoist.

The form of chain shown at EE in Fig. 15, though not mentioned in the paper, was a very valuable one—he meant a chain of plain links fastened with plain pins. The common chain was constructed of a large number of pieces of iron that were welded under great difficulties, and it was a most wasteful arrangement of material to carry load. But if you took plain thin plates of steel, cut from a long bar that had been tested, drilled or punched them, and fitted steel pins into them, you got a chain that was practically as safe as an hydraulic cylinder; for hydraulic cylinders did burst, and hydraulic joints did blow out. If that kind of chain were applied to a hoist, and the unbalanced weight of the cage &c. were just enough to make it descend slowly and not fall down, a very efficient hoist would be obtained, and one much less complicated than that shown in Fig. 15. The ordinary Armstrong jigger, if so arranged that it could be raised and lowered by a pitch-chain on a drum, formed a remarkably safe hoist; and he would just as soon travel in such a hoist as in the hydraulic balance hoist that had been brought before them. With regard to the instance mentioned, where the cage became disengaged from the ram, that was not an error in the principle, but a mere accident of construction. If engineers used pitch-chains carefully constructed, they would find that the accidents from breakage of the chain would be reduced a still greater proportion than the accidents on railways had been reduced by the change from the old welded iron tyre to the solid-drawn steel tyre.

Mr. F. Colyer agreed with part of Mr. Ellington's statements; but there were several things in which he could not agree with him. It was stated, that the safest and best form for passenger lifts should be also be adopted where practicable for goods, because workmen were often allowed to travel in those lifts. He would rather say that workmen should never be allowed to travel in an ordinary chain lift. Experience had taught him that, even with the best class of safety apparatus, it was very difficult to make such lifts absolutely safe. With regard to safety apparatus, as applied for the purpose of goods lifts alone, he had found a modification of the arrangement introduced first, he believed, by Sir Wm. Armstrong & Co.—a kind of cam and toothed rack, attached to the top of the cage and clipping the guide timbers—to answer perfectly well. Some years ago, through the courtesy of some of the largest Manchester firms, he had been allowed to see the safety apparatus they had in use, and he had found most of them very faulty. He had then examined many of those catches made by Sir Wm. Armstrong and Co., and from them he got the idea of an apparatus which he subsequently designed and used. In several instances the lifting rope had been wilfully cut by some one, in a fast-running lift, ascending at the rate of 200 to 250 feet per minute, and the total fall of the cage when the rope broke was only 3 inches. He thought that fact showed it was a good safety apparatus; and he knew a great number were in use at the present time. On one particular occasion when the rope broke in ascending, the fall being about the same, one of the gentlemen in the lift, who had been much frightened, said he had fallen 14 ft.; but the catches by measurement showed exactly the amount it had really fallen. Every one had been frightened, and as usual the lift was much overloaded. That occurred ten or twelve years ago; he had used the apparatus constantly in goods lifts ever since, and had never known it to fail.

It was remarked, that if wire ropes were used, two should be employed. If two were used, great care must be taken

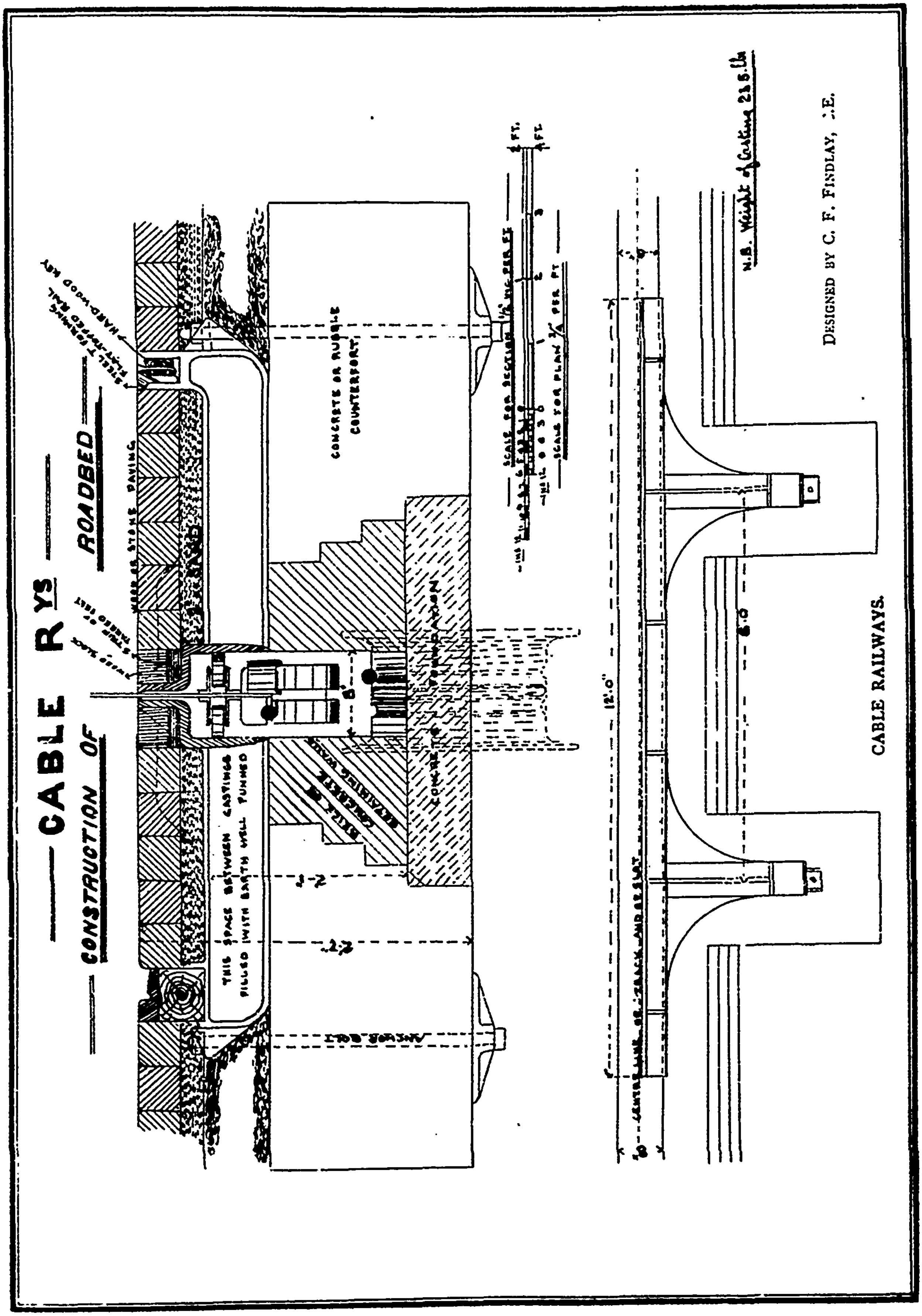


HYDRAULIC LIFTS.

to ensure that each rope should take the same amount of tension; otherwise, if one rope was tight and the other slack, when the tight rope broke, the shock thrown upon the other might be sufficient to break it. He agreed with what was said as to the attachments between the chains and the cage, because, in the numerous cases of accidents which he had been called to examine into, he had more often found that it was the attachment that was faulty than the chain. Therefore he always had attachments made expressly for the purpose, of the best kind, and made stronger in proportion than the chain.

It was stated, that there was a great loss in lowering by steam. when using steam lifts. With that he could not agree. The loss in lowering by steam was very small. The most efficient steam hoist that he knew of, where all the operations were done by steam—raising, lowering, and braking—was one having a special valve-box, which he had used for some years, and having only one lever to control the whole operation. The valve-box was placed between the cylinders, and the steam admitted at the top or bottom of the pistons as required. The advantage was that the man working the the hoist had the most perfect power over the apparatus, and could always easily control it. There were no clutches to throw in and out, and no brake to put on; consequently the wearing parts were reduced to a minimum. Mr. Ellington also said that with steam lifts there was a considerable danger of accident from overwinding. He did not propose to go into the question of colliery lifts, because that was a different matter; but overwinding in ordinary warehouse lifts, worked by steam, could be avoided. He was constantly using lifts for goods, running at 250 and 300 ft. a minute, and he used gear by which the lifting power would be thrown out of action at the top of the stroke. When the cage ran at that speed, its fall, with the safety-catch described, would not be more than 3 to 5 ins.

(To be continued.)



DESIGNED BY C. F. FINDLAY, C.E.

CABLE RAILWAYS.

HYDROLOGY.

BY F. FOSTER BATEMAN, M. INST. C. E.

PERHAPS in the history of the world, no science is more essential to the well-being of man, while none has been so little understood as that of hydrology

It means in its entirety almost everything to the welfare of human beings, in countries, cities or towns: and yet how little have we advanced in this intrinsically scientific subject A mere cursory glance at the history of the past, shows us that in our hydrological or sanitary arrangements we have little or nothing to be proud of, when they are compared with those of the ancients, or even the Indians of this continent. The Romans and Moors in Spain and Portugal, and the Incas of Peru are standing examples of this. An old Roman aqueduct is at the present moment being used for the supply of Lisbon with water, and a great portion of the northern part of Spain is being irrigated by old Moorish works. The remains of the very extensive works of the Incas for the irrigation of lands, and for the supply of water to their cities still exist, and it is natural for us to ask ourselves, how far have we advanced in our knowledge of the question? How is the city we are most intimately acquainted with supplied with water, and how is such supply carried away by drainage and other means from our houses? What do we know of the rivers of our country, of their supply, of the drainage area from which they take such supply, and of their effect upon the streams and country at large? All these are questions which touch in a primary sense upon the well being of man, and equally upon his financial and commercial success

It is therefore perhaps not out of place to ask ourservelves not only how far we have advanced, but also how much consideration we give to these matters; what rules and what means we should take to arrive at a just appreciation of the value of the above very important questions.

Perhaps in doing this it will not be amiss to take England as an example, and to draw our conclusions from that country. Nowhere in the world have scientific researches on these questions been more thoroughly gone into, while it also presents innumerable cases of the mis-appplication of their results. No country in the world has cities better supplied with water; knows more about what in its small area, the drainage system is,—the word drainage being used in its broadest sense that is, the flow of water off the land—how to utilize such drainage for the use of man, or how to guard against any results disastrous to the country which may arise from it. On the other hand we see a country with cities all excellently supplied with water, yet unable to cope, in the very matter of the drainage of those cities, with the water supply which they themselves have created. We see a country admirably drained in all respects as regards its farm lands, yet by such very drainage creating for itself floods, which its natural water ways are unable to pass off. It is true that England is freer from epidemics than any other country: that English engineers are looked upon as the greatest sanitary engineers in the world; that more money is expended on these questions than in any other country; and yet, it does and must occur to us, is this partially—and most emphatically only partially—due to money and skill alone, or to the climate?

In dealing with a matter of such magnitude as the above it is necessary to take each question by itself, and as all questions in connection with water are so closely allied, and bear such parental relations one to the other, it is well to prove the necessity of one portion before touching upon the other. In the present article therefore it is not proposed that we should embrace the whole subject of hydrology, but rather that we should prove the necessity of most careful observations with regard to drainage and rainfall; the manner of obtaining proper statistics in order to arrive at correct conclusions in regard to them; and the benefit that will accrue from them to the nation at large. Further, it is not proposed to discuss the drainage or the clearance of sewage from a city, which deserves an article for itself. Our purpose is to touch upon the good rather than the evil which water can do to man.

Perhaps water is without exception one of the most wonderful gifts of Providence. Without water man could not live, indeed nothing could live. Without water, communication could not be kept up, much commercial enterprise and many of our manufactures would be impossible, and yet, how far more versed the world is in matters connected with railways and mechanical appliances, than with water the ruling power of them all.

Allowing such to be the case, it seems that our government, our schools, and teachers, should in every way teach, not only theoretically but practically, all scientific engineering scholars, the primary rules of hydraulics; that the government should have all portions of the country properly contoured, observations of rainfall carefully taken in every district for a series of years, and the size and discharge of the rivers under different conditions determined in order that a correct idea be arrived at with regard to the power of the water, and the use to which it may be put.

Water it should be observed is an excellent servant to man, but at the same time a bad master.

In England, during the last twenty years, much alteration has been made in the preconceived conclusions on hydraulic questions, and the alteration is due to the admirable system of local statistics. A country that aspires to a name can never begin too soon to collect these data and statistics, as to those in great measure is due the preservation of the health of its people. These local statistics are however even at the present time little regarded by—no other name can be given them—the mushroom engineers of the old country; who when investigating any question listen far more to what they hear in the neighbourhood, than at the statistics from which they can deduce valuable information. This shows the danger of a theoretical education without a predominance of practical knowledge. On the other hand such men as Hawksley, Bramwell, Hawkshaw, Abernethy, and others, base their calculations upon these very statistics, caring little for what even the "oldest inhabitant" may say upon the matter; and yet these men are the most successful in England, and have found up to the present, no reason to alter their method. We are now in Canada much in the same position as England was twenty to forty years ago. English sons are more go ahead than their fathers; are they more correct? Americans claim that they are a go ahead nation; occasionally going ahead runs one on a reef; certainly, going ahead is not calculated, without discretion, to run one into deep water. Is it not better then that we Canadians, and the people of Montreal, should face the question in its correct light? Are the cities of Canada, and is Montreal properly supplied with water? What are the arrangements for supplying the cities in this country? Are they gravitation schemes, that is the supply of water from reservoirs to a city solely and totally by gravitation? or, are they pumping schemes? Returning to the question of local statistics, as exemplified in Great Britain, what do we find? In almost every case the original old pumping supply abandoned, and the gravitation system adopted. We find Manchester with its old pumping station near Gorton. We find Liverpool with its present gravitation extensions and its old pumping works. We find Glasgow, Halifax, Bradford, Ashton, Oldham and Dundee, all taking gravitation as againts pumping; and we have further the proof that the worst supplied town in the United Kingdom of any size or note is London, and that is effected in every case by pumping.

Now the conclusions to be arrived at from this are obvious. A pumping scheme may be from an unlimited supply, as far as is known, of water. A gravitation scheme must be, and is, from its drainage area, its position, and what is known about it, a certain supply, according to the rules and statistics. A pumping supply from a supposed unlimited demand is open to these objections: Pollution of the water; failing of the so called unlimited supply; cost of maintenance: breaking down of some portion of the machinery, and the costly question of filtration. The supply of a city with good water is of primary importance as regards the salubrity of that city. With a gravitation scheme large reservoirs are necessary, and it has been amply proved by past experience that atmospheric filtration is better than all other at present known.

But it is not only the question of gravitation versus pumping which we wish to discuss, but rather the question of what really is the position of our cities and towns, not only on this continent but throughout the world, what it really should be, and what it could be; what duties our governing bodies are imperatively, on this question, called upon to fulfil; and what benefit would accrue to us from their fulfilment of this duty. All this is more than one article can touch upon, but still something may be said; and it is proposed to take the question of water and its benefits to communities at large, as the subject of this paper.

But before touching upon these benefits, it should be borne in mind, that they themselves are sometimes by a misapplication, the very reasons of many of the most unfortunate occurrences in a community; and that the statistics already mentioned, are really our greatest guards against such misapplications. For instance, we will take a city fairly prosperous with a population of say 200,000 people. This city has to be supplied with water, for the following reasons: it is a thriving city; has sprung up quickly: has need of water for commercial enterprise, not to a large, but to a fair extent. Its sawmills, its bleaching mills, its paper mills, in fact every trade almost that can be mentioned requires water; whether the power to be created is steam or water power is a matter of small importance to our argument. Is this city during long droughts in a healthy condition? Is it capable of supplying during such droughts the inhabitants with sufficient water? During great fires is the pressure sufficiently great? Is there a sufficient supply of water for thoroughly flushing drains? And is the arterial drainage of the city sufficiently large to carry off the water supplied to the city for other sanitary reasons? And last but not least, are such supplies when required too costly?

Now reverting to the old question of statistics, how useful are they in a case of this sort, and how especially useful in the question of gravitation. If the contours of the drainage area or watershed in a gravitation scheme are accurately known; if the rainfall of the district has accurately been taken over a series of years; if the careful gauging of the streams of the district be accurately compared with the above, how correct and easy a thing it is, to arrive at what such district will supply to a town, either more nor less; for what length of time, at what cost, and how to provide for the future means of dealing with such a supply.

But further than this, how thoroughly does this question touch upon that of inland navigation. Canals require large supplies of water, and even a water supply itself to a town by pumping alone, is often dependent upon these very matters. Now it is generally admitted, sometimes most correctly, sometimes most incorrectly, that engineers are on this continent experts, on the old continent scientific men. Without the statistics and the information which we have above alluded to, how is an engineer, expert or scientist likely to arrive at any correct data for the calculation for which he is paid, and which are of extraordinary benefit to the communities for whom he may work, unless he chooses to collect them himself. But this is not a matter for an engineer to do, or to put one single community to the delay and expense of doing: nor is it right that cities, towns and villages, should be put to the expense for want of proper information by the mistaken conclusions arrived at by people acting without data.

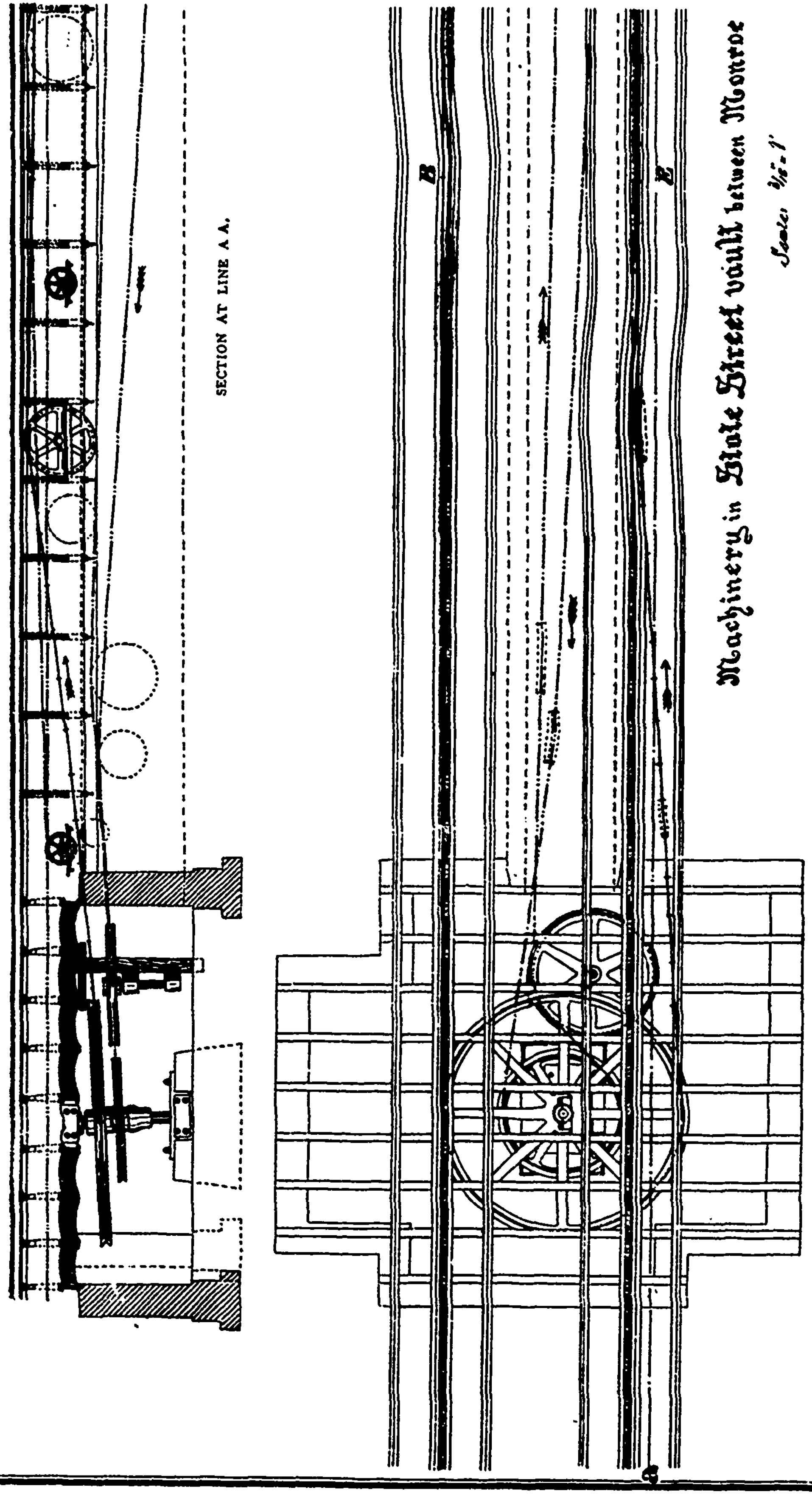
(To be continued.)

CABLE TRACTION FOR TRAMWAYS AND RAILWAYS.

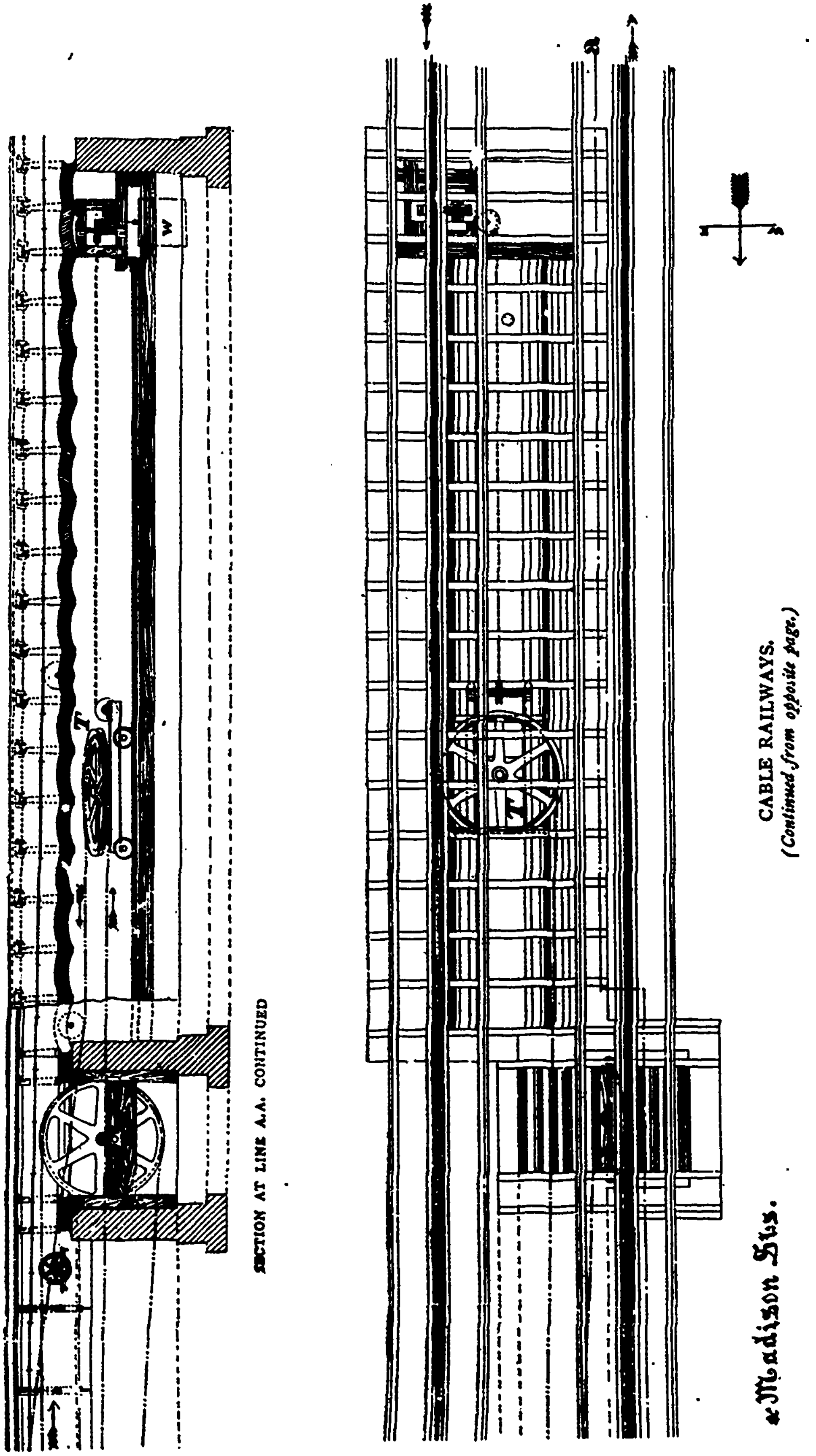
BY C. FARQUHAR FINDLAY, ASS. MEMB. INST. C.E.

(Continued from Page 7.)

A novel form of grip is to be used on the East River Bridge in New York where cars are to be drawn by cable between New York and Brooklyn at a speed of 10 miles per hour. The cable cars will have a separate right of way and therefore there will be no tunnel for the cable and the grip can be made of a much more substantial character than when it has to pass through a narrow slot into a tunnel. The grip is the invention of Col. Paine, one of the engineers of the bridge, and consists of pairs of rollers pressed horizontally against the cable and free to turn on their axles until brakes are applied to them. As the brakes are applied the friction between the rollers and the cable increases until, if the pressure on the cable is sufficient, a friction is developed which will start the car. The rollers will gradually cease to revolve as the car acquires the velocity of the cable and then they will be at rest. The objection made above to the use of rollers for this purpose will not apply so much here because the rollers can be of considerable size and can also be lined with a yielding substance which will allow their pressure to be distributed over an appreciable length of the cable.



CHICAGO CABLE RAILWAYS.



SECTION AT LINE A.A. CONTINUED

CABLE RAILWAYS.

(Continued from opposite page.)

Next in point of importance is the construction of the track and the tunnel for containing the cable. Since the slot in the crown of the tunnel cuts the road longitudinally into two separate halves and no connection between them can be introduced except below the line of the cable, it becomes a difficulty to support the sides of the tunnel so as to resist the pressure of passing loads from closing up the slot, and also to connect the rails to the tunnel so firmly that their position relatively to that of the cable will be invariable. The method usually adopted is to form the edges of the slot by wrought-iron bars and to connect these by cast or wrought-iron yokes enclosing the tunnel and rigidly attached to chains which form the rail supports. In the Clay Street hill construction the yokes were of cast iron Subsequently in San Francisco and in Chicago (as seen in our illustration) they have been framed out of wrought-iron bars. They are generally spaced 3 to 4 ft. apart. The walls and floor of the tunnel are generally made of concrete. The tunnel in the new road at Philadelphia is made of continuous castings without any concrete even as foundation and in using castings instead of wrought iron frames it seems to us they are right, because the chief requirement of the construction in question is that it shall be perfectly *rigid*, a condition which is difficult to attain with an elastic material and a large number of joints. This is less important in San Francisco than in severe climates where a hard frost in the ground would be apt to strain any structure in which there was any possible play. Of course the castings used must be of a good, tough quality and designed with proper strength to resist shocks, and it would be well for the edges of the slot to be planed. It would be far easier also with cast-iron than wrought, to secure accuracy in the building of the road, especially on curves. Some discredit has been cast on the cable system, undeservedly, by the number of accidents that have occurred with it in Chicago, but the causes of these accidents are sufficiently obvious and not in any way inherent in the system. In the first place the speed of eight miles an hour (at which the cars travelled until the outcry about the danger of it made the company reduce it) is too great for safety in such a very busy street as the northern end of State street. Then again trains of three or four cars are run which is a great source of danger in many ways and ought to be forbidden by a city ordnance. Also the driver is placed in the middle of a grip-car which also carries a number of passengers all round him, so that he cannot have a good view of the road and is also liable to be distracted at any time. The driver of a cable car has more demanding his attention than a locomotive engineer and ought just as much to be isolated from the passengers. The only proper plans are either to operate the grip from the platform of the car, as is to be done at Philadelphia, and could be done with any kind of grip, if the car were placed on trucks like a steam railroad car, or otherwise, to have a small grip car carrying no passengers. The speed of the cable is only limited by the danger to other traffic from high speeds. With an elevated track, probably a speed of 15 to 20 miles per hour would present no difficulty. Of course an, elevated road will not answer for the short distance passengers who form the most paying portion of a city's passenger traffic, but where the size and extent of a city is sufficient to warrant it, the elevated cable road possesses several advantages worth mentioning. It can ascend and descend almost any grades, the cable machinery is always in view and accessible, the speed may be rapid, it is not liable to obstruction from snow, and it can be very cheaply built, owing to the very light moving load, there being nothing to carry but passenger cars which when loaded need not weigh more than 600 lbs. per ft. The power required to work a cable road is very small, and in fact fuel is one of the minor expenses of operating such a road and it is to be observed that no more power is required for a day's work on a hilly road than a level one, for as much weight will be drawn down hill as up hill in the day, and the increased power required for the loads moving up is balanced by the diminished power for the loads going down. The most serious defect in cable roads as hitherto constructed is that the breakage of the cable involves the stoppage of the whole road, which, even for a few hours, is a danger some companies would not dare to face, for if horses had to be kept to meet such emergencies it would run away with much of the profits of the system, and, if not, the wrath of a disappointed public left to walk home on a wet night might be serious. We have shown how the breakages of the cable in the early months of the Chicago road were all from a remediable cause, and it may be safely said that a complete break of the cable is a thing that may be made almost impossible, but one strained will always be liable to break unless great expense is incurred in renewing the cable every few months, and the breakage of a strand means a delay of some hours to put in a splice. To attain perfect security it has been proposed to use two cables instead of one, the two running parallel to each other in the same tunnel, each about 1¼ or 1½ ins. from the centre, and so arranged that either may be used separately or both at once. The most of the grips now in use (including that at Chicago) are made so as to grasp a cable lying not immediately under the slot but a little to one side and could be made so as to connect equally well with either of two cables. The two might both be used each drawing part of the cars in the busier parts of the day, and one only at other times, and thus there would be ample time for inspection and repair of cables. They would be carried on separate sets of pulleys. Some arrangement of this sort will probably be adopted by most of the important companies who use the cable in future, for they can scarcely afford to trust to a single cable after the experience of Chicago, where the road has on the average been interrupted about once a week ever since it opened, for periods varying from one up to ten hours. Successful as have been the cable roads now at work, the system is yet in its infancy and we may look for great developments of it in this age so restlessly eager for profitable enterprises when its possibilities have become well understood.

[Ed. The diagram on page 41, shews the construction of a very strong and effective road-bed, designed by Mr. Findlay.]

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A New Method of Making Carriage-ways with Cold Asphalte. The best known process, and the one in most general use, is as follows: The rock in its natural state is broken up and reduced to powder by exposure to heat in revolving ovens. It is then placed in iron carts with close-fitting covers and double sides (to prevent loss of heat), is brought to the required site, taken out, and is laid over the surface with the aid of rakes, the thickness of the asphalte layer being about *one-third* greater than it is to be when ready for traffic. The asphalte, while hot, is compressed with heated irons into a homogeneous mass without joints. This calorific process presents the following objections:

(1.) The hot powder must be employed at a very high temperature, so that its use is confined to the warmest season of the year, and is also limited in point of production by the capacity of the apparatus and of the factories.

(2.) It renders partial repairs difficult and uncertain.

(3.) It necessitates a perfectly dry soil, as the least dampness gives rise to cracks which cause the rapid destruction of the road.

An attempt has been made to obviate these disadvantages by substituting for the calorific action a dissolvent which produces the same effect upon the bitumen, and a new process has thus been arrived at by which the asphalte may be applied *cold.* The material may be prepared *in advance* and in a quantity sufficient for the largest undertakings. It preserves its characteristics long enough to allow of its being sent to distant parts of the country, *provided only it is protected from* the influence of the air by being stored in tanks or in impermeable sacks and casks. This process which completely does away with the employment of heat, the sole cause of cracks, is *much more certain in its effect,* and may be conducted at any season of the year and even during severe frosts.

The powder is applied in two layers and is compressed like ordinary powder, *but with cold tools.*

Its manipulation is therefore much easier and does not require the help of skilled workmen. The volatilization of the dissolvent takes place more slowly than the loss of heat, so that there is a persistence of the compressive and cementing properties, favourable to the effective aggregation of the entire mass. The upper layer alone hardens pretty rapidly, but the lower layers preserve their malleability long enough to ensure that the compression under the carriage traffic is most complete, and until the whole thickness has become as dense as the most compact limestone. It follows that roads made with cold asphalte are much more compact than when hot asphalte is used, and therefore a much greater (about one-half) thickness of powder is required for them at the outset, in order to obtain a bed of definite thickness.

Attempts have been made to diminish the time necessary *for the compression of the material by* employing heavy and even steam rollers. But experience shews that, both for cold and hot asphalte, the best compression is that produced by the wheels of vehicles. It is, *consequently, considered* sufficient to subject it to the action of a roller weighing from 1,320 to 1,760 lbs. before handing it over for traffic.

Important applications have been made at Paris, where this process is employed concurrently with the ordinary process. For a certain length of road, the asphalte has been laid while rain fell. Under these conditions a surface was obtained as fine as that of the portions laid in dry weather. This characteristic gives cold asphalte an advantage over hot asphalte, which cannot be used in wet weather.

Hence, all the repairs of asphalte roads, may be made with asphalte, and it is no longer necessary, in winter, to have recourse to provisional and defective expedients consisting in the filling of the holes formed in the road, with the bitumen used for footpaths, which has to be replaced as soon as weather permits.—*Revue Industrielle.*

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THE USE AND ABUSE OF GAS.

Although gas as an illuminant is now so seriously threatened by its formidable rival electricity, it is surprising how little has been done by those most interested in fostering the continued consumption of gas to teach the public of what gas is capable, and *how to use it efficiently for lighting* purposes. It is true that many consumers of gas are now getting more light per thousand feet of gas than used to be got twenty years back; but *the great* bulk of users still burn the gas they pay for in a fashion so primitive that one might almost suppose that they forgot its cost. Our present object is to show the general principles which underlie the problem of gas lighting and heating, so as to *get the greatest* result in either case from the least gas.

In order to understand the problem before us it is necessary to bear in mind that the illuminating gas is a combination of hydrogen gas and carbon, with varying degrees of contamination from sulphur and other impurities. With these latter—which are not largely found in the gas of the present day—we have nothing to do as the heating and lighting properties of the gas depend upon the hydrogen and carbon. Hydrogen gas it is that gives to coal gas its light and ready inflammability, but from hydrogen alone scarce a perceptible light is given, the flame being of a dark red tint, and looking more like a spectre than a solid flame. The light of a coal gas flame is due to the heating of the carbon to a point of incandescence, and upon the *degree of incandescence* reached depends the light given and the economy attained. If the gas issues from the burner at too low a pressure the flame will be sluggish, thick and sooty giving little light and contaminating the atmosphere. This shows *that sufficient* heat is not generated to raise all the carbon to a point of incandescence. If, on the other hand, the gas issues at too great a pressure, there will be a roaring in the flame, with much blue light, and here too, much of the carbon will escape *unburnt. As showing* the difference in percentage of light given with the same gas consumed through different burners the following figures are very suggestive. The gas used in each case was 16·4 candle gas, *and the light given per cubic foot of gas burnt is given in* standard candles:—

Burner.	Light per cubic foot in standard candles.
London Argand	3·28
Bray's No. 5 fish tail	2·31
" " batswing	3·00
Silber's Argand	3·49
Sugg's K "	3·30
" 100-candle Argand	3·56
" 5 spray	3·00
" 3 "	3·17
Bray's 3 "	2·77
Siemens'	5·3
"	5·5
"	5·85
"	5·953
"	6·64
"	7.13

It will be noticed that the light given by the Siemens burners is on the average at least double that given by other burners. This result is due entirely to the fact that in the Siemens' burner the gas is consumed at a very high temperature, and the whole of the carbon raised to its point of perfect incandescence. It will, however, take a long time before Siemens' burners *become general,* as purchasers of burners look rather at the first cost of the burners they put on their fittings than at the saving of their gas. This is evident when we consider how small the percentage of improved burners in use is as compared with common ones. Not *only* so, but many of the so-called improved burners are scarcely so except in name and price. This is evident if we bear in mind that any ordinary fishtail or batswing burner would give as good results as some *of the above special burners.* Any *man of ordinary intelligence* could select good burners for himself if he were once made practically acquainted with a few simple facts. The difficulty is to indicate these without the aid of any practical illustration. We will, however, *do as much as we can in this direction.* First. Every burner should give a good, steady, solid-looking and clear flame, of symmetrical shape; and this flame should be silent, and the light white. So far the result depends on the shape of the burner tip. But, supposing that the burner fulfils these results at any given pressure of supply, an increase or diminution of pressure will at once create a difficulty. If the pressure of supply falls the light will go down; if the pressure rises, the flame will flare and roar. To guard against this it would be necessary to be constantly manipulating the tap for each rise and fall of pressure, a proceeding sufficiently annoying with *one* or two lights, and clearly out of the question with any large number. To obviate this inconvenience almost numberless contrivances have been brought forward, but one class only merits any attention, namely, that where each burner is fitted with its *own automatic means* of controlling the pressure beneath the burner tip, and keeping the supply equal under all pressures. This can be done to a perfection which would at first sight seem incredible, so much so *that the consumption of gas per hour under extremely varying* pressures can be measured by the burner almost as accurately as by a meter. In a future article we hope to describe the principles upon which these self-regulating burners are constructed, as a knowledge of the same cannot fail to be interesting and useful.—*Martineau's Circular.*

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Artificial ivory of a pure white colour, and very durable, has recently been manufactured by the inventor of celluloid; it is prepared by dissolving shellac in ammonia, mixing the solution with oxide of zinc, driving off ammonia by heating, powdering, and strongly compressing in moulds.

AUTOMATIC EXPANSION.

Assumed Indicator Diagrams.

Fig. 1. *Single Valve.*

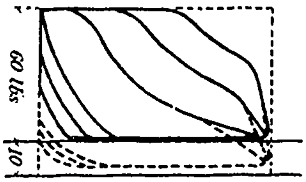


Fig. 2. *Double Valve.*

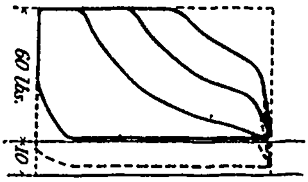


Fig. 3. *Throttling*

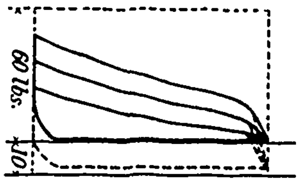


Fig. 4.

1 *Line for Diagram Fig 1 condensing.*
1a . . . *non-condensing.*
2 . . . *Fig 2 condensing.*
2a . . . *non-condensing.*

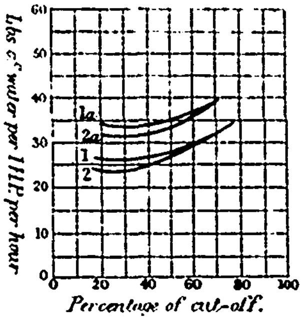
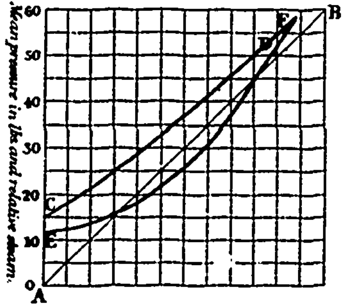


Fig. 5.

AB *Mean Pressure on piston in lbs.*
CD *Relative Steam used with throttling.*
EF . . . . *automatic expansion*



(Proceedings Inst. M.E. 1882.)

Fig. 6. *Curves of Relative Steam used, with expansion or throttling, for variable load.*

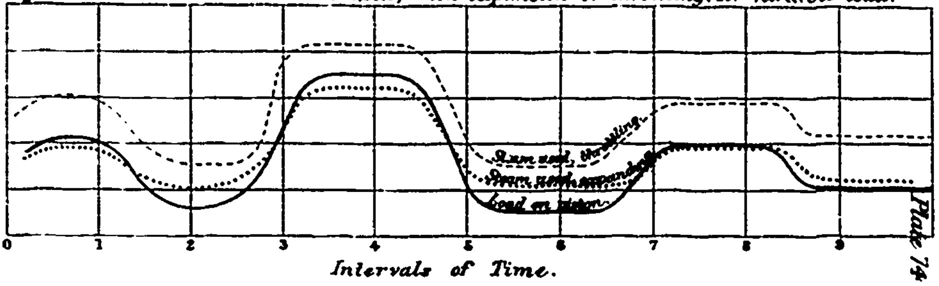
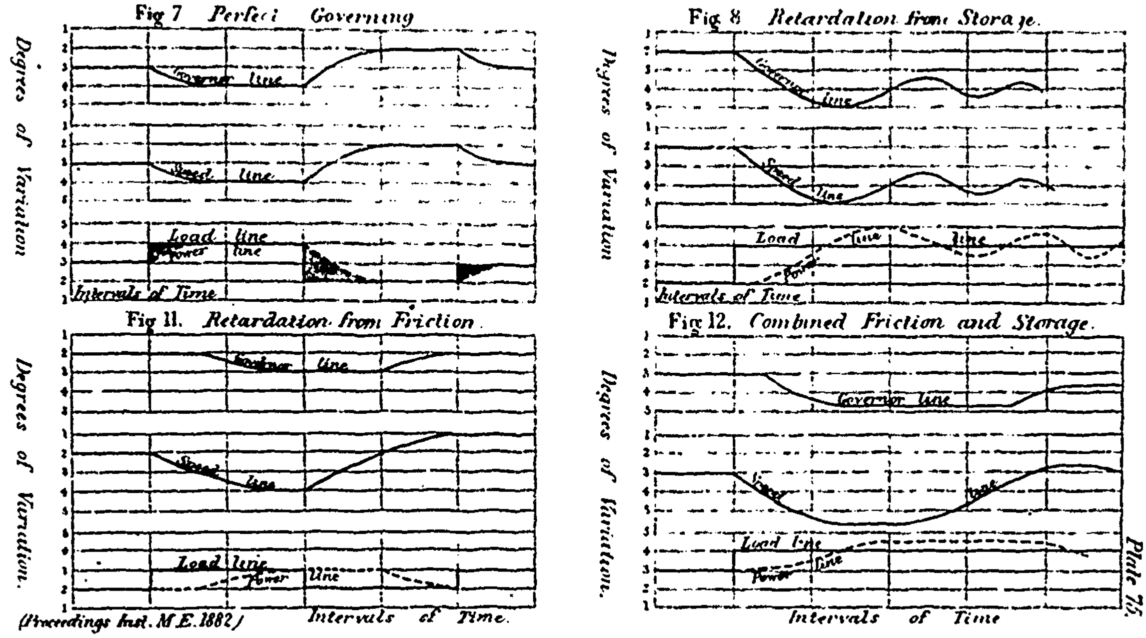


Plate 74



AUTOMATIC EXPANSION.

ON GOVERNING ENGINES BY REGULATING THE EXPANSION.

(A paper read before the Institution of Mechanical Engineers England.)

By Mr. Wilson Hartnell, of Leeds.

The object of the present paper is to illustrate the advantage of Automatic Expansion Gear: in other words, of controlling the expansion gear by means of the governor; and to describe two such methods which have been arranged by the writer, and which have been extensively used, chiefly for small steam-engines.

Advantages of Automatic Expansion Gear.

The chief advantages derived from automatic expansion gear are, firstly, the saving of fuel arising from the smaller consumption of steam, and secondly, the greater regularity of speed.

Economy of Steam.

Saving of fuel.—The extent of this saving depends upon the particular circumstances of the case. If the engine be for the most part fully loaded, expansion gear is of little benefit. If the steam pressure and the load be at all times nearly constant, expansion gear variable by hand may be equally advantageous.

Non-automatic expansion gear must be adjusted to cut off late enough for the maximum load with the lowest pressure, otherwise the engine is liable to be stopped instead of regulated. Hence for engines subject to very variable loads, such as ordinary agricultural engines, expansion-gear variable by hand is practically useless. It is well known that, when a non-expansive non-condensing engine is working with a light load, the fuel used is excessive in proportion to the net H.P. expended, the work of the steam being spent principally in overcoming the atmospheric resistance. The saving in fuel therefore, due to automatic expansion, will be greatest in non-condensing engines with very variable loads, for the most part lightly loaded. In portable engines with automatic expansion the saving of fuel and water has been frequently reported by the users to be as much as one-third, when compared with an ordinary engine under the same average conditions.

Estimate of the steam saved.—Since the economy effected by automatic expansion is a variable quantity, depending upon the range of variation in the load as well as upon the particular construction of the engine and boiler, it is better here to omit reference to the fuel. The measurement of the economy of steam, and the manner in which it arises, may be most readily shown by reasoning deductively from definite hypothetical conditions of load, and from assumed relations in regard to the point of cut-off; these relations agreeing with experiment in good average engines.

Throughout this paper the writer has illustrated the various relations discussed by means of geometrical diagrams, without giving the demonstrations; firstly as being the clearest and simplest means, and secondly because many of the investigations thus illustrated would occupy more space than the whole of this paper.

Form of indicator diagrams.—Figs. 1 and 2, Page 48, are hypothetical indicator diagrams, showing the cut-off at 20, 40, and 60 per cent. of the stroke, with single and double valves respectively, in condensing and non-condensing engines. Fig. 3 shows the effects of throttling. These diagrams are drawn in accordance with actual indicator diagrams, the initial pressure being assumed at 60 lbs. per sq. in.

Economy of steam with various periods of cut-off.—The vertical ordinates drawn to the curved lines in Fig. 4, show the water used per I.H.P. per hour for a cut-off at any part of the stroke, the lines being drawn in accordance with experimental data and with Figs. 1 and 2. The lines 1 and 2 are for condensing engines, and 1*a* and 2*a* for non-condensing engines.

Economy of steam under a variable load.—Fig. 5, shows the relation between the quantity of steam expended and the mean pressure on piston, using the throttle-valve and the expansion valve respectively, in non-condensing engines, corresponding with the diagrams in Figs. 3 and 2. The ordinates of the line A B represent the mean pressure on the piston, for the different points of cut-off, and the ordinates of the curved lines C D and E F the comparative steam used with the throttle-valve or the expansion-valve. The vertical distance between the curved lines shows the extra steam used with throttling as against expanding, at the corresponding mean presure. Fig. 5 may be constructed from real indicator diagrams, by drawing curves to represent the final cylinder pressures that correspond with the observed mean pressures, and making allowance for compression, condensation, &c.

Economy of steam with any given variable load.—This is illustrated by Fig. 6, The horizontal distances between the vertical lines represent intervals of time. The height of any ordinate to the full curve represents the mean pressure on the piston at the corresponding time The dotted curves are plotted from Fig. 5, at heights corresponding with the respective mean pressure. Hence the space enclosed between the full curve, the base line, and any two ordinates, represents the relative work done in that interval of time; and the spaces enclosed by the same ordinates and by one of the two dotted curves represent the relative quantities of steam used, when regulating with the expansion valve and with the throttle-valve respectively. The space between the dotted curves represents the steam saved by expanding instead of throttling.

REGULARITY OF SPEED.

Prompt governing.—The promptness with which automatic expansion gear controls the engine, as compared with a throttle-valve, is owing to its freedom from two evils, which may be termed "retardation from storage" and "retardation from friction."

The retardation from storage is the effect due to the steam that is stored between the throttle-valve and the steam-port. The retardation from friction is the effect due to the friction of the throttle-valve, or of the controlling gear.

With a cut-off valve there is no storage, if it be a main slide-valve or a valve on the back of the main valve. With a cut-off gear there is also little or no friction to be overcome by the governor; for the reciprocation itself tends to move the gear in opposite directions alternately, so that the governor has merely to hold it still, or else permit it to move itself.

Relation between position of governor, speed of engine, and pressure on piston.—These three quantities have a definite relation, if the boiler pressure be uniform. For the mean pressure depends upon the position of the cut-off gear or throttle-valve, which position depends upon the speed of the engine. This is illustrated in Figs. 7, 8, 11, and 12, by three series of lines, which may be called governor lines, speed lines, and power lines. Thus in Fig. 7 the speed line, when coinciding with line No. 3, is supposed to correspond with the position of the governor shown by the governor line corresponding with line No. 3, and also with the mean pressure or power shown by the dotted power line corresponding with line No. 3. If the speed falls to line 4, or rises to line 2, the corresponding positions of the governor line and of the dotted power line will be the line 4 or 2.

(To be continued.)

ENGINEERING AND ELECTRICAL NOTES.

THE SEVERN TUNNEL.—There appears to be some chance of this tunnel being at length completed, as there are now 2,300 men engaged on the work, and it is expected to be finished in 4 years' time. One hundred and twenty houses have been built and 50 others are being constructed for the use of the workmen. This tunnel, which will be the longest in England, is 4½ miles long and crosses underneath the river Severn about 16 miles from Bristol, 2½ miles being under water. The Great Western Railway Company, which is the promoter, will save 45 minutes in the journey from London to South Wales, and the ferry service at Bristol will also be dispensed with. The work was commenced 10 years ago by the Great Western Company itself and carried on until the works were flooded out, when, by the advice of Sir John Hawkshaw, it was handed over to the contractor, Mr. T. A. Walker. The tunnel will be 25 ft. wide, 25 ft. high, and will be brick lined from end to end, the thickness of the walls varying from 2 to 3 ft.

WE learn from the *Railway Age* that the Northern Pacific Railway is to run for some hundreds of miles under the shade of trees planted to protect it from storms and snowdrifts on the open prairies. The company has set a large force of men to work at planting them, and is offering every inducement to the settlers on its property along the line to cultivate forestry.

NOTE on a new optical apparatus for the study of flexure, by MM. Lœwy and Tresca. It consists of three parts (1) at the observer's end a reticule of horizontal wires viewed by a lens, before which is a total reflection prism throwing natural light along the optic axis; the eyepiece has also movable wires for measurement; (2) at the opposite end, an object holder, with stretched horizontal wires, illuminated; (3) in the middle, a lens with silvered surface, but transparent at the centre, and of such a focus that it reproduces in the plane of the reticule before the eye-piece, either the image of one set of wires by reflection, or that of the other by transparence. When it is desirable to observe by reflection, a movable wire is made to coincide with the image of one of the fixed wires and is brought back to the same position, after each definite deflection in the bar under experiment, by a suitable load. The distance thus measured is double the increase of the deflection; it would be exactly equal to it if the same method were pursued between the movable wire and its own image.

In order to observe by transparence, it suffices to see distinctly through the eye-piece, the displacements of the image of one of the wires of the object-holder, formed through the lens, in relation to one and the same fixed wire of this eye-piece. The distance measured in this manner is very nearly double the actual depression of the optical centre of the lens.

This mode of measurement presents three principal advantages, viz:—

(1.) The results obtained by the different methods check each other and lead to very exact conclusions.

(2.) The arrangements of the apparatus and the bar renders it possible to avoid every systematic error.

(3) The value obtained may be made equal to four times the required deflection. The sensitiveness of the apparatus is so great that the addition to the weight of the bar of a single gramme produces a very sensible effect.

THE SIZE OF CRANE CHAINS.

The kind of work the crane has to do, as well as the load, must be taken into account. In slow moving hand cranes, in which the maximum power is rarely used, a lighter chain may be used than is necessary for the same load on a quick-running steam crane, when there is a great deal of lowering with the brake or lowering into water (as in block setting). The limits are 6 tons and 4 tons per sq. in. working stress except in special cases.

As a general rule, the factor of safety is increased for small chains and an average practice is as follows:

Tons working load on single chain	2	3	5	8	10
Diameter	$\frac{9}{16}$"	$\frac{5}{8}$"	$\frac{3}{4}$"	1"	$1\frac{1}{16}$"

The theoretical formula should be $D = a + b.W^{\frac{1}{2}}$ tons and it will be found that $D_{16\text{-th}} = 2{\cdot}54 + 4{\cdot}58 \cdot W^{\frac{1}{2}}$ agrees fairly well with practice while the empirical formula $D_{16\text{-ths}} = W$ tons $+ 7$ is quite correct from 2 up to 10 tons.

Unless specified, we always procure best short link crane chain and require the proof-certificate of the admiralty proof, we always get ours at the same place and make this and the proof the standard of quality. The admiralty proof is not a continuous function of the diameter but is roughly 6 tons per *circular* inch or 7·63 tons per sq. in.

We carefully avoid the use of small barrels and pullies, having seen chains bent at every link and when it gets turned over and bent the opposite way it very soon breaks and the makers get the blame. For very heavy single lifts we are beginning to adopt the continental plan of flat link chain with steel pins, and sproket wheels. (*Messrs. Stothert & Pitt, Bath.*)

FRENCH AND ENGLISH RAILWAY SPEED.

The French claim to be quicker in railway traveling than we are. A comparison is made by a writer in *Annales Industrielles*, who takes for the case of England data recently furnished by M. Gerhardt for twelve of the principal English lines. M. Gerhardt distinguishes commercial speed and mean speed. The former is that appearing from a comparison of the whole distance run and the whole time including stoppages; the latter from a comparison of the same distance with the real time of travelling, deducting losses of time through diminished speed at departure or arrival, at junctions, &c. Taking express trains, it appears that the mean speed in England, with one exception, exceeds 60 kilometres (37.4 miles) an hour, and reaches or exceeds, in seven cases out of twelve, 63 kilometres

(39 miles); on the Great Northern particularly it is over 74 kilometres (46 miles). The commercial speed is under 55 kilometres (34 miles) only in one case exceeds 60 kilometres (37.4 miles) in five, and on the Great Northern it reaches 66·5 kilometres (41¼ miles). The mean speed of French express trains, on the other hand, is from 59·5 to 69·8 kilometres (37 to 43½ miles) an hour; the commercial speed, 52·4 to 63·4 kilometres (32½ to 39½ miles) an hour. A difference between the two countries of at least 10 per cent is recognized. Attention is called to the fact that in France junctions must not be passed at a speed higher then 20 kilometres (12.4 miles) for passenger trains, and 10 (6.2 miles) for goods trains; hence a loss of time in slowing before the junction (one minute), in passage (one minute), and in regaining normal speed (one minute); or three minutes lost at each junction. In England all latitude is allowed in this matter.

SELF CONTAINED ELECTRIC LOCOMOTIVE.—In a recent communication to the Paris Société d'Encouragement, M. E. Reynier described the electric locomotive, devised by M. C. Dupuy, for running along the bleaching grounds of M. Duchenne-Fournet, at *Breuil-en-Auge, in the department* of Calvados. The vehicle carries a Siemens's electro-motor, which not only propels it at a speed, if required, of over seven miles an hour, but also a series of rollers for unrolling along the grass, and again rolling up the pieces of cloth to be bleached, these actions being also *performed by the motor. The electricity* is supplied by 60 Faure accumulators, charged by the dynamo-electric machine that supplies the electric light, and these, as so much room is occupied by the cloth rollers, have to be carried by a tender. The engine will draw after it five trucks of seven tons weight, also *carrying cloth rolls. A larger* or smaller number of accumulators may be put into the circuit, as may be required by the exigencies of the road or work; and the engine will run either backwards or frontwards. It was stated at the meeting, that the locomotive is a thorough success, and can be constructed, *commercially, for 6,000 fr. (£240),* including the accumulators, being thus cheaper than steam, hot water, or compressed air.

STOPPING MACHINERY BY ELECTRICITY.—An ingenious method of instantly stopping machinery when in motion is said to be in operation at the *Dominion* bolt works, Toronto, Canada. A wire rope coiled around the stem of the throttle valve of the engine carries a weight, which is held in place by a rest, and the *whole arrangement is so placed* that the passing of an electric current along a wire releases this rest and causes the weight to fall. The tension thus thrown upon the wire rope acts upon the throttle valve, cuts off the supply of steam and consequently stops the machinery. Buttons with wire connections *are placed in different* parts of the works, and on pressing any one of these the passage of an electric current acts as above mentioned. In any *factory these* buttons can be placed in every room, or several of them in a large room, as may be required. Should anyone happen to get caught by the machinery, the *simple pressing* of a button in the most distant part of the factory will stop the whole as quickly as could be done were the engineer *standing ready to instantly* obey a given signal

WOODEN BOLTS IN HOUSE BUILDING. – Wooden bolts in house building, *and their superiority over nails,* is thus commented on by an English journal: "Why do you make such a lavish use of nails in the carpenter's work of our houses, to the exclusion of the honest old oaken pin? Pull down any building, if it be merely a barn, of more than 200 years old, and you will not *find a single* nail in the original work; rafters and joists were all bolted together so stoutly as almost to defy the tools af the destroyer. Many an old manor barn, when pulled down of late years—as unfortunately too many of them are—has shown itself to be better built than most palaces are now. *There are arguments* in the way of the economy of time, and so on, in favor of the use of nails in house building, but they are as nothing compared *with the* solid advantages of using wooden bolts. The iron nails in time canker and rot rafters and floors, but bolts hold them together 'like grim death,' and *render* a house practically indestructible."

THE WORLD'S PAPER PRODUCTION.—In the world there are 3,985 manufactories which annually produce 952,000,000 of kilogrammes (1 *kilogramme* equal to 2·2046 lbs.) of paper. About one-half of this, *i.e.*, 476,000,000 of kilogrammes is employed for printing properly so called.

Journals annually use 300 000,000 of kilogrammes, which is equivalent to a *daily* consumption of about 822,000 kilogrammes. The consumption in this department has increased nearly *one-third* in less than ten years.

Governments annually use for administrative purposes 100,000,000 of kilogrammes of paper; Schools, 90,000,000; trade, 120,000,000; the industries, 90,000,000; letters and private correspondence, 52,000,000. Finally the number of men, women and children employed in the industries now exceeds 192,000.

NEWCASTLE COAL.—Since 1873, Newcastle (England) has produced 30 million tons of coal per annum, and even 35 millions since 1880. The coal bed advances under the sea, but how far is a matter of speculation. Some English engineers are of the opinion that the bed extends outwards for seven miles, but M. de Soubeiran, mining engineer, does not think so and fixes the limit at two or three miles. Taking the latter as the basis of our calculations, and remembering that already 5,000 million tons of coal have been taken from *this bed, it* would appear that there still remains 7,000 million tons of coal which may be easily mined, and which according to the present rate of consumption may still form sufficient provision for about 200 years.

DEVELOPMENT OF THE TELEPHONE.—*L'Electricité* publishes a curious account of the development of the *telephonic industry* in various countries. Belgium and Switzerland are, portionately, the two most advanced nations in this respect, there being in the former one subscriber per 399 inhabitants and in the latter one per 277. In England there are 4,946 subscribers, in France 3,640, in Germany 2,142; but in these countries as elsewhere habits of centralization prevail. Of the total number of subscribers in France, 2,422 are in Paris.

In the United States there are 37,187 subscribers while the number in New York alone exceeds the total number in England.

THERE is an animated correspondence in the *Railroad Gazette* as to the comparative consumption of coal in American and English locomotives. The general result seems to be that the consumption in the former is much larger. One correspondent reckons it at double the amount, and accounts for it by three considerations:—1. That the loss by friction on curves is greater in America; 2, that inclines are more frequent; 3, that the entire heating surface of an American engine is of iron, the conductivity of which is greatly inferior to that of the copper or brass used in England.

THE DRAUGHT OF CHIMNEYS.—In the mechanical section of the British Association a paper was read by Lord Rayleigh relative to the draught of chimneys. He proved that a horizontal wind will nearly always produce a draught, that if the direction of the wind is inclined downwards at an angle of 30° or more with the chimney there will be a down-draught, while if the inclination of the wind is upwards, an angle of 30° will give a maximum up-draught. To prevent a down-draught a piece in the form of a T should be placed at the top of the flue.

THE FERRANTI DYNAMO MACHINE.—This machine, which is a combination of the invention of Sir W. Thomson and M. Ferranti, has for some weeks been causing a considerable commotion in the electrical and stock-broking worlds. It is at length made public, and bids fair to far outstrip anything yet produced for incandescent lighting. All the details are not yet available, but it is our purpose to supply them when the proprietors consider their patents secure, which they tell us will be about four or five weeks hence.

A HUGE FLAGSTONE.—What is said to be the largest flagstone in America, is soon to be laid in front of the stoop of R. L. Stuart's house at Fifth avenue and Sixty-eighth street. The stone measures 26 feet 6 inches by 15 feet 6 inches, is 9 inches thick, and weighs nearly 60,000 pounds. It was cut in Sullivan county, at the same quarry from which came Wm. H. Vanderbilt's great flagstone. It was drawn by eighteen horses to its destination.

AN automatic electrical appliance for giving notice of the approach of trains, invented by M. Mors, has, says the *Engineer*, been successfully tried on the Paris-Lyon Mediterranée line. It consists of a box filled with mercury placed under the rail at the required distance from a bell; the trepidation caused by a train passing over it agitates the mercury, and forms contact with the wire communicating with the bell, thus causing it to ring.

Plate 76.

Automatic Expansion Regulators.

Fig. 9.

8 H.P. Governor, Revs. 57 to 63.

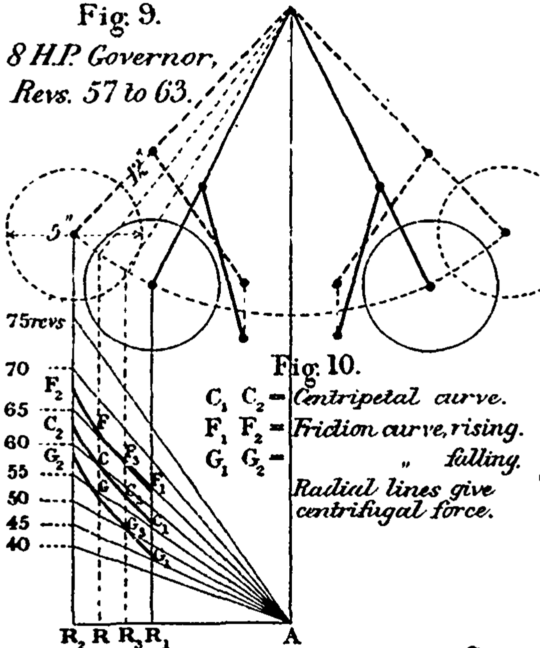


Fig. 10.

C_1 C_2 = Centripetal curve.
F_1 F_2 = Friction curve, rising.
G_1 G_2 = " falling.
Radial lines give centrifugal force.

Fig. 25.

For 8 H.P. engine.
Revs. 280 mean.

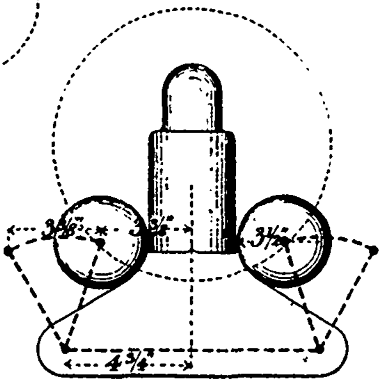
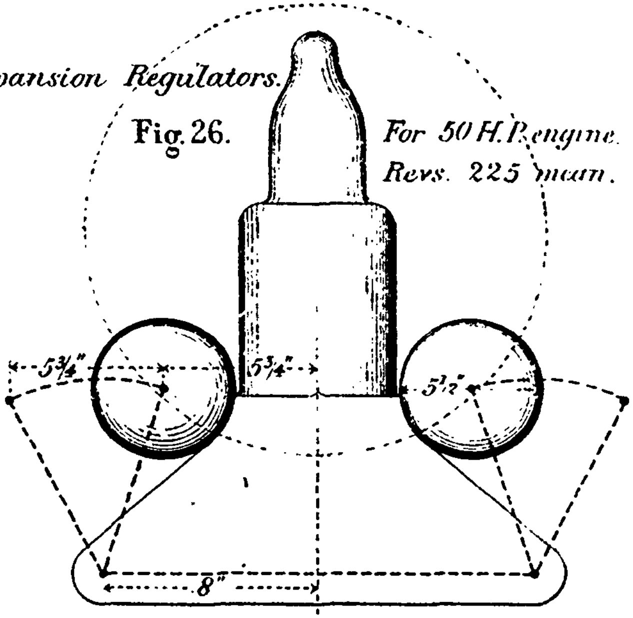


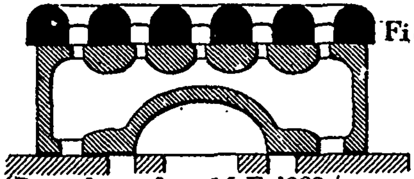
Fig. 26.

For 50 H.P. engine.
Revs. 225 mean.



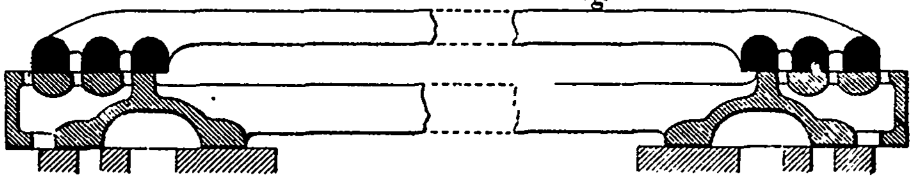
Sections . of Cut-off Valves.

Fig. 16.



(Proceedings Inst. M.E. 1882)

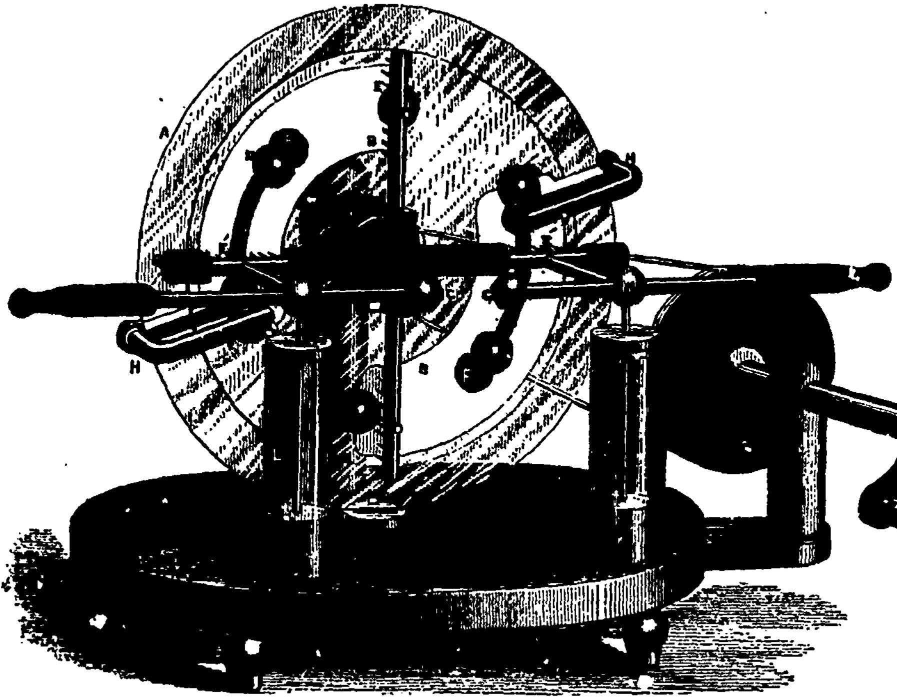
Fig. 17.



AUTOMATIC EXPANSION.

THE VOSS INDUCTION MACHINE. (*Knowledge.*)

The hold which telephony, electric lighting, and such-like applications of electricity have made upon the public mind during the past three or four years is so unduly great, that progress in other branches of the science has little prospect of receiving a fair share of attention. The Voss machine is in this unfavourable position, for, while it is one of the greatest improvements of the day, it has not until recently met with that attention to which it is so justly entitled. It is represented in the accompanying illustration, from which it will be seen that the apparatus consists, like the Holtz machine, of two glass discs, unequal in diameter, of which the larger, A, is held in a fixed position, while the other is mounted upon a horizontal axis, and can, by means of multiplying gear (seen to the right of the figure) be rotated at a high velocity in front of the fixed disc and in a plane parallel to it. To the back face of the larger plate are attached two pairs of tinfoil discs, F F, F F, each pair being connected together by a strip of tinfoil, and by a second strip to one of the two bent arms H and H, by which they are connected to a light metallic brush directed towards the front face of the rotating plate. Over the tinfoil are pasted two paper coatings, which correspond to what used to be called the paper "armatures" in the Holtz machines. To the face of the rotating plate are attached, at equal angular distances apart of 60 deg., and at a short distance from the circumference, six discs of tinfoil (one of which is marked D in the figure), about an inch in diameter, corresponding in position and size with the tinfoil discs upon the fixed plate—that is to say, if the discs (D) were numbered in rotation, 1, 2, 3, 4, 5, and 6, those numbered 1 and 2 would, in a certain position of the rotating plate, correspond and be opposite to one connected pair of discs on the fixed plate. Nos. 4 and 5 would similarly correspond to the other pair, and Nos. 3 and 6 would have no discs on the fixed plate opposite to them. To each of the little tinfoil discs on the rotating plate is attached a metallic button of the form of a plano-convex lens, and these buttons, in the revolution of the plate, pass under and are lightly touched by the metallic brushes (F F), which are held by the bent arms (H H), the brushes being so adjusted as only to touch the buttons, and not to come in contact with the glass of the rotating plate to which they are attached. E' and E' are two horizontal collecting combs, insulated from one another by being attached to a horizontal bar of ebonite, but connected respectively to the two discharge terminals (C and G) in the front of the instrument by the horizontal bars shown in the figure, and the distance between these terminals can be varied at pleasure by sliding them through the balls which are attached to the inner coatings of the two cylindrical Leyden jars by which the charge is accumulated and the discharge intensified. E is a vertical bar of brass, carrying at each end a comb, directed towards the rotating plate, as well as a pair of metallic brushes similar to F and F, and which also in their turn make momentary contact with the metallic buttons as they pass beneath them.



The machine is a step far in advance of anything previously produced, although it is somewhat similar in principle to Varley's electrostatic inductive multiplier.

A small initial charge is imparted to the machine in some as yet undetermined way. It may be due to the friction of the metallic brushes with the studs or buttons; or, on the other hand, it is possible that the various parts of the machine before starting are in slightly different electrical conditions. Whichever of these hypotheses is correct, a small charge of, we will say positive, electricity collects on one of the pairs of discs, on the fixed plate, and from this, as a nucleus, brilliant discharges may be obtained. To analyse the action of the machine, we will assume that we start with a stud, as being typical of the others, immediately after it has passed the bent arm, H, on the left, and that the corresponding side of the fixed plate has the small positive charge above referred to. As the stud passes before the charged disc, electricity is induced on it, the inner surface becoming negative, the outer receiving a positive charge, which is collected by the horizontal comb E', and passes thence along the brass rods to the discharge terminal C, and the inner coating of the Leyden jar, L. The stud, in revolving, undergoes further induction, and on arriving at the vertical comb, E (really not quite vertical, but opposite the end of the paper), a further withdrawal of positive electricity takes place; a considerable negative charge, therefore, remaining. This the stud carries round till it meets the brush of the bent arm on the right side of the machine. By this means, a negative charge is communicated to the pair of discs on the right half of the fixed plate, the stud at the same time becoming neutralised. It is then re-excited in an exactly opposite manner to that previously observed, negative being imparted to the horizontal comb, E, and Leyden Jar, L', and likewise to the lower of the two vertical combs. A positive charge is collected by the bent arm, H, on the left, thereby increasing the charge already collected on the corresponding pair of discs. This action continuing, a large charge accumulates on the fixed plate. It follows that if, by means of the electricity collected through the bent arms, we increase the inducing charges on the fixed discs, we shall obtained proportionately increased charges in the horizontal collecting-combs. Assuming that the discharging terminals (C G) are in contact, there will obviously be an almost constant flow of positive electricity in one direction and of negative in the other. If, a few seconds after the working commences, we separate the discharging terminals, a stream of sparks may be obtained. The function of the vertical combs is, as may be gathered from the above, an important one, their duty being to relieve the studs of the free electricity *induced in them as they pass from the horizontal* combs towards the vertical.

Very little labour is required to work the machine, owing mainly to the fact that practically none of the electricity is generated by friction, the small amount of work performed in turning the plate being almost entirely converted into induced electricity. The machine works well in any atmosphere, hot or cold, wet or dry—a very important point, considering the effect usually produced by the humidity of the air. Every lecturer or student of electrical science knows how difficult it is to generate static electricity by the ordinary frictional machine when a few persons are present in the room. As the result of considerable experience with the Voss, we can confidently say that such difficulties need never be apprehended, while a flow of sparks, 4 in. or more in length, can be relied upon from a machine weighing less than 7 lb., and with a rotating plate 10¼ in. in diameter. All the ordinary experiments of static electricity can, of course, be performed, and we are rarely able to so confidently recommend a commodity as we can the Voss machine to all who desire to perform electrical experiments with a minimum amount of trouble and at a moment's notice. The machine is comparatively a cheap one, and the English agents, Messrs. F. E. Becker & Co., of Maiden-lane, Covent-garden, are now manufacturing it in large numbers.

◆

Results of Experiments made at the Paris Exhibition of Electricity on Incandescent Lamps by M. M. Allard and others.

Comparison between the different series of experiments.

	Maxim Lamp.		Edison Lamp.		Lane-Fox Lamp.		Swan Lamp.	
	Results of M. Allard, &c.	Results of Special Com'te	Results of M. Allard, &c.	Results of Special Com'te	Results of M. Allard, &c.	Results of Special Com'te	Results of M. Allard, &c.	Results of Special Com'te
Ohms	43	41	130	137	28	27	31	33
Volts......	75	57	91	90	50	44	48	47
Ampères	1.74	1.38	0.70	0.65	1.77	1.50	1.55	1.47
Kilogrammètres...... ..	13.28	7.94	6.50	5.91	8.95	7.09	7.62	7.06
Spherical Mean Intensity	2.80	1.25	1.57	1.36	1.64	1.16	2.19	1.16
Carcels per H.P. of arc.	15.89	12.42	18.12	15.29	13.74	12.61	21.55	12.92

In general and for the spherical mean intensity of 1.20 carcel, only about 12 to 13 carcels per H.P. of arc, or 10 carcels per H.P. (horse power) of mechanical work can be counted on from incandescent lamps. Electric candles give 40 carcels per H.P. of arc, regulators nearly 100, so that, generally, the economic values of the three systems are nearly as 1, 3 and 7.

◆

Life of a Maxime Lamp. —At the New York Post-office it has been found that the average life of a Maxim incandescent lamp (the ordinary 50 candle-power type) is nearly 1,900 hours. About 25 per cent. of the lamps in this office have burned between 3,000 and 4,000 hours.

Storing Electricity. The new method proposed by the Faure Electric Storage and Light Company for illuminating steamships, railway cars, etc., is said by the projectors to be ready for active operations, and an exhibition of the plans and methods is to be given publicly at once. It is proposed to so store electricity that it can be carried exactly the same as gas is now done by ferry-boats, railway cars, etc.

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ELECTRIC POWER-HAMMER.

BY MARCEL DEPREZ.

(*La Lumière Electrique*, July, 1882, pp. 53-54.)

The Author exhibited on the 15th June, at the Conservatoire des Arts-et-Metiers, Paris, an electric power-hammer, consisting fundamentally of a solenoid in sections. Let there be a hundred flat coils, of 1 centimetre (.394 ins.) each in depth, placed one on another to form a single solenoid 1 metre in height, and let each of the entering and issuing ends of the coils be connected to each other and to the segments of a commutator, *as in a dynamo-machine, then if two brushes (fixed to an insu*lating piece movable by hand) are placed at such a distance that the number of plates of the collector or commutator-segments is ten, the current can always be made to pass through ten coils, whilst the same distance is preserved, whatever their position on the commutator; and the motion of the brushes is equivalent to the motion of a solenoid having ten coils. With this arrangement, and the brushes in a given position, let a current be caused to flow through the apparatus, and a cylinder of soft iron placed within it; the cylinder will remain suspended in the solenoid constituted by the ten coils, and its centre of figure will be at a greater distance from that of the solenoid as the current is weaker. It will fall completely if the current has not strength above a minimum value. If the current be strong enough to maintain the distance of the two centres of figure much less than the fall of the cylinder, the latter will be in equilibrium, and if it be moved will require, as if it were suspended by a spring, the force to increase with the distance moved through. So that if the brushes are displaced the space of a plate or segment of the collector, the active solenoid becomes displaced to an equivalent amount, and the cylinder reproduces the movements given to the brushes by the hands of the operator. The current is never interrupted, nor modified in volume or direction. In the power-hammer as constructed, eighty coils are built up to a height of 1 metre, and the wire-ends brought out to a circular commutator. The iron cylinder weighs 23 kilogrammes, (1 kilog. =2.204 lbs.) but when the current amounts to 43 ampères, and traverses fifteen sections, the lifting power developed is 70 kilogrammes, three times the weight of the hammer.

This power-hammer was placed, in derivation, on a circuit that fed also three Hefner-Alteneck machines [Siemens D,] and a Gramme dynamo [Breguet P. L]. Each of these machines made fifteen hundred revolutions a minute, and developed 25 kilogrammetres a second, (1 kilogrammetre=7 233 ft. lbs.) measured on a Carpentier brake. All the apparatus worked with absolute independence; the generator was the double-wound machine [Mr. Deprez' system] used at the recent Paris Exhibition. In a later trial 50 kilogrammetres per second were developed at each of the four machines, whatever the number at work, and then the addition of the power-hammer in shunt-circuit did not much affect the working. The efficiency with six machines working independently from one generator, and each machine giving two-thirds of a horse power, would be, with this system, $\frac{e}{E} = 0{\cdot}50$. —*Proceedings of Inst. of Civil Engineers*, Eng.

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At a meeting of the Berlin Physical Society, Helmholtz gave a report of this year's International Congress in Paris, from which he had just returned. The Congress having last year come to an understanding on the units occurring in electrical science and "technic," and their designations, the point now was to determine those units exactly, so that practical normal units might be prepared. Attention was first given to the determination of the unit of resistance,—the "ohm" (as most easily practicable); that is, the exact measurement in metres of the column of pure mercury of one square milimetre cross-section at 0° C, the resistance of which is the "ohm." There were already quite a number of measurements by methods which Herr Helmholtz specified in his lecture. The values obtained are: Herr Kohlrausch, 1·0593;

Lord Rayleigh, by the British Association method, 1·0624; Lord Rayleigh, by Lorenz's method, 1·0620; Mr. Glazebrook, in Cambridge, 1·0624; Herr H. Weber, in Brunswick, 1·0611; Herren W. Weber and Zöllner, 1·0552; Mr. Rowland, in America, 1·0572; Herr Dohrn, 1·0546. Against these pretty concordant values, however, stood the mean value obtained by Herr F. Weber, of Zurich, by reliable methods, and from experiments agreeing well together, viz. 1·047, which came so near the older ohm of the British Association, that the Congress, on the motion of Sir William Thomson, refrained meanwhile from forming a definite conclusion. It was rather agreed to recommend the experiments (1) to compare their resistances with the standard of resistance which the French Government will produce; (2) to compare the induction coils by the method adopted by Herr Kohlrausch with the wire-circuit; (3) in their measurements to avail themselves of the modified and still further to be improved method of Lorenz. The respective governments should finally be urged to support, as much as possible, the national experiments for determination of the "ohm."

Astronomy, &c.

THE TRANSIT OF VENUS.

BY ALEXANDER JOHNSON LL.D.

(Continued from Page 52.)

Questions of expense were set at rest to a great extent, though not wholly, by a money grant made in April, 1882, I think, by the Dominion Parliament at the instance, I believe, of the same Committee of the Royal Society. The distribution of the money thus granted to meet the expenses of the various observing stations in Canada was placed in the hands of Mr. Carpmael, Superintendent of Meteorological Observations for the Dominion, in concert with whom much work was afterwards carried on. By means of the grant it was possible to establish a station at Winnipeg, where Prof. McLeod, Superintendent of the Meteorological Observatory of McGill College, subsequently took observations, using the Ross telescope and other instruments described above. Another McGill College telescope (the Drummond) and a transit instrument, were sent to Ottawa for the use of the observers stationed there. But these instruments did not leave the College until October or November. Before that time a good deal of work had to be done, in the observers' training especially.

At all the Canadian stations attention was to be limited to the observations of contacts, as they had no double image micrometers with which to make measurements. Now these contact observations, which, theoretically, are simple enough, are practically difficult owing to a certain remarkable optical phenomenon, called the "black drop" "ligament" etc. When Venus at ingress has so far entered on the sun's disc that the moment of separation of the edges of the planet and of the sun appears to have arrived, and the observer is expecting the instantaneous appearance of a thin line of light between them, it is found that generally, though not always, a dark band or ligament connects the two for some time. A similar phenomenon occurs at egress; before the actual contact is expected to take place a ligament is formed. Figs. 4 and 5 show what was seen at Suez i 1874, by Mr. S. Hunter, when observing internal contact at egress. They are taken from the "British Observations" for 1874. The times are given as 13h. 26m. 34s., and 13h. 27m. 19s., respectively, giving an interval of 45 seconds.

Figs. 6, 7, 8, show the successive phenomena at Egress, as seen by Lieut. Hoggan, R.N., at Rodriguez, Fig. 9 shows the ligament as seen at Ingress in Rodriguez, by the same observer, who says: "I can speak with certainty of the decided and instantaneous appearance of the phenomenon." Fig. 10, represents what was seen at Ingress by Commander Wharton R.N. at Rodriguez also, who describes the ligament as a "blackish haze" joining the planet and the continuation of the sun's limb.

Phenomena such as these make it necessary that the observers should be carefully prepared to observe them by practice on similar phenomena. This practice is obtained by means of what is called the "model" which is represented in Fig. 11.

Its construction is thus described in the "British Observations" for 1874. "The shaded portions were cut out of sheet brass; the curved edges representing portions of the limb of the sun and the periphery of the planet, were bevelled to diminish parallax; the planet attached to a horizontal bar running on fixed wheels, was drawn towards the clockwork on the right by the action of the large weight, the motion being regulated by a pendulum." An instrument similar to this and of proportions suitable—when seen at a distance of 779 feet—for representing the actual circumstances of the transit as nearly as possible, was obtained from Greenwich and brought to Canada by Lieut. Gordon. R. N., of the Meteorological Observatory, Toronto. This was at first set up on the cupola of the centre building of McGill College, and practice on it was begun immediately after the meeting of the American Association.

A slight open shed was erected, at the proper distance from the model, as a protection to the observers against the sun's heat; it was near the College gate. There the telescopes were placed and the observers seated behind them, were aided in their practice by some one (frequently a student or graduate) who counted the seconds from the chronometer as contact approached in the model. The model itself was managed by another student, with whom a set of signals had been previously arranged. The reflector belonging to the model was used on all occasions, when possible, so that the small metal disc representing Venus should pass across the bright image of the sun, and thus reproduce as nearly as might be the phenomena of the transit.

The observers then watched for the times to be recorded according to the following definitions given in the "Instructions to Observers" for 1882:—

AT INGRESS.

"The time of the last appearance of any well-marked and persistent discontinuity in the illumination of the apparent limb of the sun near the point of contact."

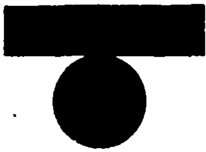
AT EGRESS.

"The time of the first appearance of any well-marked and persistent discontinuity in the illumination of the apparent limb of the sun near the point of comtact."

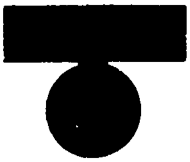
"It is a point of primary importance that *all* the observers shall as far as possible, observe the same kind of contact"—"The discontinuity of the illumination of the sun's limb near the point of contact will be recognized by the contrast between the illumination *at* and *on each side* of the point of contact." The observers (at that time,)—Dr. Jack, of New Brunswick, Mr. Carpmael, Prof. McLeod, and myself—first recorded in notebooks the times which appeared to them most to accord with the definitions; and subsequently compared the times thus noted. In this way the differences

Egress Fig 6.

Egress Fig 7.



Egress Fig 8.



Ingress Fig 9.

Ingress Fig 10.

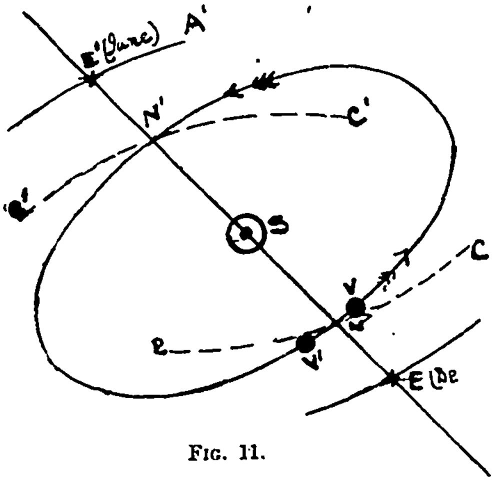


FIG. 11.

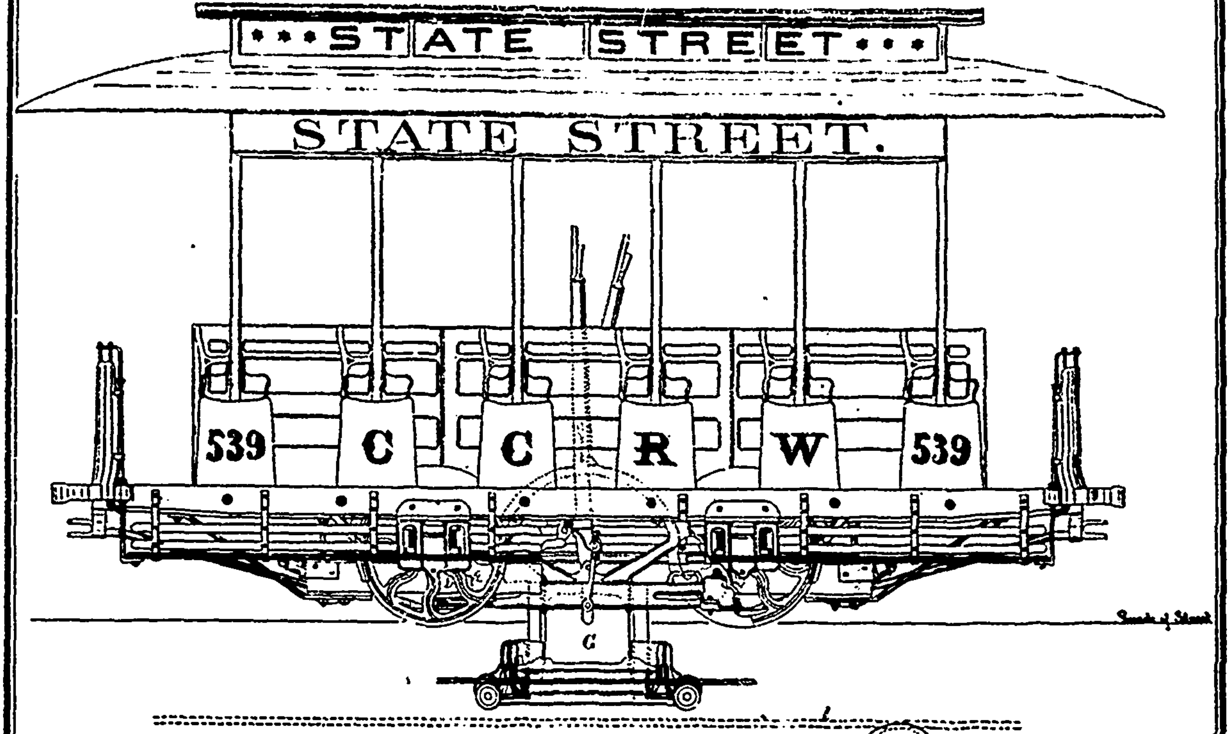
TRANSIT OF VENUS, 1882.

of judgment as to the exact phase for which the time was to be recorded, were reduced to a minimum.

When the model was subsequently removed to Toronto for use by other observers assembled there, another made in Montreal after the same pattern was substituted for it, and with this, practice was continued from time to time.

As it is of the utmost importance that the longitude of any place of observation should be known with the greatest possible exactitude and that it should be, therefore, determined many times in order to lessen the chances of error, Prof. McLeod connected the Observatory by triangulation with a post of the U. S. Coast Survey which was not very far off on the mountain, and by this means found the longitude to be 4h. 54m. 18s. 87 W., differing slightly from that previously adopted. Further determinations are yet to be made on this point by the telegraphic method. It would be tedious to go into details concerning all the matters that had to be attended to before the day of transit. The following brief statement will be sufficient. The distribution of the instruments to Winnipeg and Ottawa has already been mentioned. Prof. McLeod went to Winnipeg about the middle of November, and the time observations, which are taken regularly at the College throughout the year, and which were of special importance at the time of the transit, were thenceforward taken by Mr. Chandler, Lecturer in Mathematics in the Faculty of Applied Science, as his substitute. Mr. Chandler also undertook to observe the transit with the 2¾ inch telescope. Another telescope of the same size having subsequently been kindly lent by Mr. William Bell Dawson, M.A., M.E., a third observer for the Montreal stations, Mr. J. R. Murray, a fourth year student in Arts, was ready to take a share in the work. Mr. Chandler's station was near the reservoir, where a wooden shed had been erected for the purpose. Mr. Murray was to observe from the balcony in front of the centre building in the forenoon, and from an upper room on the west side in the afternoon. The 6½ inch equatorial was, of course, to be in the Observatory building, in which extensive alterations had been specially made. A considerable number of students had volunteered assistance in various capacities, so that the members of the three observing parties amounted to eighteen in all, including the observers.

The general distribution of work was as as follows:—While the observer's entire attention was given to his telescope, an assistant at the word "count" from the observer would begin counting seconds from the chronometer; another assistant, with paper and pencil in hand, sat at a table listening attentively. and at the word 'now" from the observer, instantly noted the



Side Elevation of Grip & Grip-Car. *Fig. 1.*

CHICAGO CABLE RAILWAYS.

minute and second and estimated fraction of a second, as heard from the student counting. A third assistant, who also noted the time, as a check, was ready to take notes of what the observer saw, as soon as the immediate crowding of phenomena had passed away and gave an interval for description. Other assistants had other duties, the neglect of any one of which might have been fatal to the observations.

There had been a complete rehearsal of all that was to be done for several days before Dec. 6th, so that every man was familiar with his special work. The chronometers, two of which had been kindly lent by Mr. P. W. Wood, of St. James's St., were regularly compared with the transit clock to ascertain their errors and rates. Time signals had been exchanged with Toronto and Quebec on Dec. 5th., and, as a check on the clock, time was also obtained from Washington Naval Observatory on Dec. 5th. and afterwards on the 6th.

The weather was very unfavourable for many days before the 6th., but we founded hopes even on this, hoping that all the bad weather would be exhausted by Wednesday. Wednesday morning presented itself with a densely clouded sky. Nevertheless the observing parties assembled at the appointed hour, at the Observatory, compared chronometers with the clock, and went to their several stations, hoping even still. Nine o'clock came and still the sun was hidden; minutes then passed all too rapidly, until it was certain that first contact had passed. As 9.30 approached, the intensity of expectation was greater, but the sky showed no signs of hopeful change. At length the time for the second contact too had passed, and our only hope was that the afternoon might be better. At $10^h\ 5^m$—too late to be of any service to us—the sun shone out, and Venus could be seen plainly on its disc. The observing parties consoled themselves as best they might by viewing her in various ways, through the telescopes, through coloured glasses, even with the naked eye when a mist passed across the face of the sun. The afternoon was equally unfavourable with the morning and no contacts were seen. The ill-success at Montreal was compensated to some extent by success at the other two stations, Winnipeg and Ottawa, to which the Montreal instruments had been sent; I say Montreal instruments, purposely, because it is worth noticing, that only one of the five telescopes used belonged originally to the College; the rest were either presents or loans from citizens of Montreal, to whom Canada is therefore indebted for a considerable part of such success as has fallen to its lot. Canada has certainly been unfortunate on the whole as to the weather; only two stations, Cobourg and Kingston besides those already mentioned having seen the contacts.

WHY TRANSITS OCCUR AT UNEQUAL INTERVALS.

The question has been frequently asked, why transits occur in pairs, two occurring at an interval of eight years, as in 1874 and 1882, and then a very long interval elapsing before the next transit.

The answer to this question will also answer another viz., How do we know that there will be a transit in 2004? Let us take an illustration. When we see Venus in the sun's disc, she is in a straight line between us and the sun. Venus is travelling in a circle round the sun; so are we on the earth travelling on another circle, outside that of Venus. Venus goes round more quickly than the earth. Let us imagine how the case of two men running a case in a field, the tracks being circular, and one man running in a smaller circle than the other and going round in a shorter time. Let there be a post at the centre of both circles. This post will represent the position of the sun. At the moment of starting, suppose both men to be in a line with the post, one a good deal nearer to it than the other; suppose further that the man in the innear circle can go round 13 times while the man on the outer goes round 8 times. It is evident that the latter looking towards the post will see the former pass him completely, immediately after starting (this corresponds to a transit), and that after his 8 rounds, they will both be again in the same positions as at first, that is, another transit is coming on. This represents pretty well what happened in 1874 and 1882. In December, 1874, Venus came between the earth and the sun, (there was a transit). In the intervening 8 years, the earth went completely round the sun 8 times while Venus went round 13 times. Thus in December, 1882, the earth was in the same part of its path as in December, 1874, and Venus came between it and the sun. Thus there was another transit. But, it will be asked, using the illustration given, it is clear that the inner runner has gained five rounds or "laps" on the outer, (just as the minute hand of a clock gains eleven rounds on the hour hand when they both start at twelve o'clock, and come again to twelve,) and has therefore passed five times between him and the post, that is, there ought to have been five transits since 1874, according to the illustration. Why were there not? The answer is that there certainly would have been five transits if the illustration fully represented the state of the case. But it does not. The tracks or paths of the two runners are in the same level, *i. e.*, in the same plane. Venus is generally either above or below the plane in which the earth is travelling (plane of the ecliptic) which passes through the centre of the sun also, using the terms "above" and "below" to indicate the northern and southern sides of the ecliptic respectively. The plane of her orbit at an angle of 3° 23½" to the plane of the ecliptic ascends from the south side to the north, crossing at a point (the ascending node) which is in a line with the sun, and another point where the earth is in December. If she cross at the particular time or near the time when the earth is in that part of her orbit, then as she comes between the earth and sun, we see a transit. On the other occasions where there would be a transit if all three bodies were on the same plane. She is either too much above, or too much below the line joining the centres of the earth and sun. Consequently does not come between us and the sun, and there is therefore no transit.

Next it may be asked why is there not a transit every eight years?

The reason is this. The number 8 and 13, are not exact. The earth makes a complete revolution in a year, *i. e.*, in about 365¼ days. Venus makes a revolution in 224·7 days. Now multiply these numbers by 8 and 13 respectively, we get 2,922 days and 2,921 days. Thus in 2,921 days Venus will have come back to her starting point, (the node supposed) but it will take the earth a day longer to reach it. Venus must therefore have passed the earth *i. e.*, inferior conjunction has occurred shortly before, and while still below the plane of the ecliptic; below—but only slightly below—and as the body of the sun also extends below this plane, she still may be seen between us and the sun. But after a second period of 8 years Venus passes the earth at a greater distance still from the node and therefore while too much below the plane of the ecliptic to be seen between us and the sun. She will pass below the sun. 235 years will elapse before there can be another transit at this node. For multiplying 365.256 days, a nearer value for the earth's revolution by 235 and 224·7 for Venus by 382 we get 85,835 days nearly, in both cases. Thus while the earth makes 235 revolutions, Venus will make 382, and the reasoning proceeds as before. In December, 1639, a transit occurred, (that observed by Horrocks), at the ascending node. The next at the same node took place 235 years afterwards, namely, in 1874. Then after an interval of 8 years came that of 1882. The next at this node will be in 2117. There was, however, a pair of transits in 1761 and 1769, respectively, but not at this node. As Venus ascends from the south to the north side of the plane of the ecliptic at the point in the line drawn from the centre of the sun to the earth's position on a day in December, so she descends from the north to the south side at point diametrically opposite on the ecliptic, and therefore on a line from the centre of the sun to the place where the earth will be on the same day in June. This is the descending node. It was at this node that the transit of 1769 took place. Adding 235 years to this, we get 2004, the year in which the next transits will take place. The month will be June, instead of December. The egress will be visible at Montreal and over a large part of North America. The subsequent transit will be in the same month in the year 2012.

In Fig. 11, V^1 V N^1 is intended to represent the orbit of Venus, N N_1 the line of node; E C and E_1 C_1 parts of the projection of the orbit on the plane of the ecliptic; V a position of Venus above the ecliptic; V_1 one below it. E A, E A^1, parts of the orbit of the earth; E, the region where the earth is in December, E_1 in June. The arrows indicate the direction of motion.

The two durations will plainly be different. The planet crosses nearer to the centre of the sun in one case than in the other. It will therefore have a longer path, a greater chord of the circle to travel, and therefore take longer to cross. Its rate of travelling from point to point in the heavens (*i. e.*, the number of hours, say it takes to pass over a given arc on the sky) is known. Hence, if the observers note carefully how long it takes in the transit, the lengths of the two parallel chords are known. But not in miles. They are only known thus far, that if we draw any circle on paper to represent the sun's disc we can lay down on it, on the same scale, the two chords, because, as we can measure the arc on the sky covered by the sun's diameter, we can readily calculate how long the planet would take to pass right across the centre of the sun's face. Now, when these chords are drawn correctly to scale on the circle on paper, suppose that we measure accurately in inches their shortest distance apart; then by measuring also in inches the diameter of the circle we have the ratio of the diameter to this distance, and this is the very number we wanted to find. We know now the number by which we must multiply the distance apart of the two chords in order to find the diameter; but this distance in miles can be found as already described, and thus the length in miles of the sun's diameter can be found. Hence the magnitude of the solar system can be determined. Thus our problem is solved. All that is required by theory is that the observers should notice the exact moment when Venus is first in contact with the sun's disc in going on, and last in contact on passing off. This method, suggested by the illustrious Halley is simple enough. There are, however, many practical difficulties. One may be noticed here. It demands that the sky should be clear both at the beginning and end of the transit, and as a transit may last about six hours the risk is much greater than if only a single observation were required. Considering this. De l Isle in 1753, pointed out that it was possible, adopting the fundamental principle of Halley's method, to solve the problem by a single observation of a contact either at the beginning or end, at places properly chosen whose longitudes could be obtained with great exactness. It is on this method, as regards observation of contacts, that reliance is placed in the transit of 1882.

THE NATURE OF THE VIBRATIONS ACCOMPANYING THE PROPAGATION OF FLAMES IN COMBUSTIBLE GASEOUS MIXTURES.

MM. Mallard and Chatelier draw attention to the fact that when a combustible gaseous mixture contained in a tube closed at one end and open at the other is lighted at the free end, the flame at first is propagated slowly, regularly, and without producing any sound, afterwards its flickers acquires a high and irregular velocity, and finally gives rise to a more or less intense sound. Indeed, the irregularities during this latter part are so sudden and numerous, that, in their opinion accurate results as to the velocity of propagation, can only be obtained by the aid of photography. In their experiments they employed gaseous mixtures giving flames of well-known photo-chemical properties, viz., bioxide of azote and sulphuret of carbon, but the results obtained seem to indicate that the photographic method may also be applied in the case of phosphuretted hydrogen, sulphuretted hydrogen and perhaps carbonic oxide.

The tube was 3 metres (1 metre=39·4 ins.) in length and .03-metres in diameter. The bioxide of azote was saturated with sulphuret of carbon vapour, at the temperature of melting ice. A photographic object glass projected the image of the tube upon a cylinder covered with a sensitive paper and revolving with a given velocity.

The photographs clearly explain the phenomenon and exhibit every movement of the flame.

The motion is *uniform* over *one-fourth* of the length of the tube from the free end, and the velocity of propagation is 1.10-metres per second. Beyond this the motion is *vibratory*, and the undulations are either sinusoids, which indicate a simple vibration, or are of more complex forms, indicating a superposition of several vibratory motions. The distance between the points at which the motion is a simple vibration, is generally one or two-fifteenths of the length of the tube.

The times of the different vibrations vary from .025 (sec.) to .034 (sec.), and are proportional to the numbers 1, 2, 3, 4, 6. No relation, however, has been found to exist between these numbers and the position of the flame in the tube. This is not to be wondered at as the gaseous vibrating mass is composed of two distinct columns, the one of burning gases, the other of cold gases, whose densities and lengths vary at every instant.

The *amplitude* appears to be greater for vibrations of longer periods, but especially increases near one of the centres of vibration, when the tube is giving out the first harmonic of the fundamental note. The amplitude of the vibrations may then become enormous, and in one of the experiments was 1.1-metre, or more than one-third of the total length.

It may be here remarked, that these experiments, for the first time, give an exact idea as to the amplitude of the vibrations of a gaseous mass emitting a note.

To these large vibrations must necessarily correspond very high *pressures*. The average pressure is found to be at least 5 atmospheres, and although it is only maintained for some ten-thousandth of a second, it has been found sufficient to forcibly eject the stopper which had been firmly inserted in the tube to a depth of .03-m. From this example we may conceive of the enormous pressures which might be developed in mixtures whose initial velocity of propagation is no longer 1-m., as in the present case, but 20-m. as in the mixture of H + O.

The *mean velocity* of propagation seems to increase with the amplitude and rapidity of the vibrations. The extreme limits of the velocities were, in one experiment, 1.10^{m} and 5.40^{m}, and in another $.97^{m}$ and 8.60^{m}. In a third experiment, Berthelot and Nelles' explosive wave was produced; it began in the period of the large vibrations, *i.e.*, at two thirds of the length; the last third of the tube in which the wave was propagated was completely pulverised.

The brightness of the flame varies during the successive phases of the same vibration. It is less intense during the recoil motion than during the advance. The difference of intensity increases with the amplitude of the vibration, and must certainly depend upon the changes of pressure. It is known, in fact, that the brightness of gaseous flames rapidly increases with the density of the gas.

These experiments have been repeated with a tube .01 metre in diameter, and it is found that the narrowing of the tube favours the development of the vibratory motion, and, therefore, of all the consequences of this motion, viz., irregularities in the velocity of propagation, the production of greater or less pressures. (*Comptes Rendus, October, 1882.*)

"OUR BODIES:"

BONES.

By Dr. Andrew Wilson, F.R.S.E.

If there is any one part of the human frame which more than another appears to be dead and lifeless in its character, that part is the skeleton. We are apt to translate our ideas of what a *living* bone should be, from that which a *dead* bone is —hard, firm, dense, unyielding, and, above *all*, lifeless, material. Now this is very far indeed from the true state of matters. The physiologist tells us that bone is not merely a thoroughly living tissue, but that it is literally living in all its parts. Furthermore, a little reflection will teach us that as bones have to grow, they must needs do so by processes similar to those through which other parts of the human frame increase. If we cut a bone it bleeds; and this fact alone shows us how plentifully bone is supplied with blood-vessels, carrying the nutrient fluid for its repair and growth. Again, there was a period in our individual history when bone was not. Bone must, therefore, have been formed as other tissues grow, and must have exhibited all that vitality which marks the production and development of the varied *belongings of our frames*.

Let us suppose that we cut across a long bone, such as the thigh bone, or any bone of the arm itself. In the hollow interior of the bone, we find *marrow* when the bone is examined in the fresh condition. The bone itself is very dense and thick towards the outside layer, but of more open structure as we approach the inner layers. Outside the bone, and adhering very closely to it, is a tough layer known as the *periosteum*. There is no doubt that this layer has much to do with the repair of bones when ehey are broken or injured, and, for one thing, it supports the bloodvessels which enter the bone and which nourish it.

To properly understand what bone is, we must appeal to the microscope. A thin cross-section of bone, ground down till it becomes so transparent that we can reflect the light through it, is placed under the object-glass of the microscope. Regarding this view of bone attentively, we see the following things: firstly, a number of round spaces. These are the ends of tubes or canals cut across. They are named *Haversian canals* (after Clopton Havers, their discoverer), and in the living state contain the larger blood-vessels of the bone. Secondly, around these *Haversian canals* we note a series of irregularly-shaped spaces

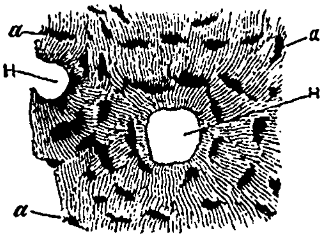


Fig. A.—A transverse section of bone in the neighbourhood of two Haversian canals, *H, H*; *a* lacunæ. Magnified about 250 diameters.

arranged in concentric circles. These spaces are called *lacunæ*. Thirdly, leading from one *lacuna* to another, and also connecting the *lacunæ* with the Haversian canals, are a number of fine lines, which are, in reality, channels.

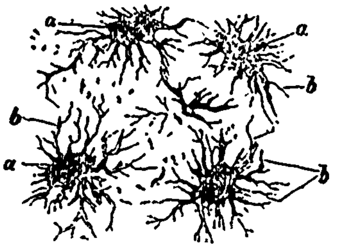


Fig. B.—Lacunæ, *a*, and canaliculi, *b*. Magnified about 600 diameters.

These are called *canaliculi*. The *lacunæ* measure about the eighteen-hundredth part of an inch in length, and the *canaliculi* a fifteen-thousandth of an inch in diameter. If we imagine the *lacunæ* to be a series of lakes, the *canaliculi* will represent small rivers which connect the lake-systems. Between the lakes and their rivulets is the mineral substance of the bone, chiefly consisting of *phosphate of lime*. Now, what, it may be asked, do the *lacunæ* and *canaliculi* contain in a living bone? The Haversian canals we have seen to protect the bloodvessels which nourish the bone. The *lacunæ* contain each a small mass of living *protoplasm* —the universal matter of life—forming the *bone-cell*. From each bone-cell, lodged in its *lacuna*, there passes along the *canaliculi* fine threads or processes of this jelly-like protoplasm. Thus the protoplasm of one *lacuna* is brought into connection with that of the other spaces; and the whole living substance of the bone forms a continuous meshwork of minute cells and fine fibres. Little wonder is it that, thus filled with living material, bone should demand a rich supply of nourishment in the shape of blood.

Bone, when analysed, is found to consist of an *animal* part and a mineral part. The animal part consists chiefly of *gelatine*. The mineral part is largely *phosphate of lime*, or "bone earth," with a little *chalk* (*carbonate of lime*) and other minerals. We learn from this fact how important for the young and growing body it must be to obtain in the food a due supply of bone-forming materials. From bread, porridge, water, and like foods we obtain the minerals necessary for bone-growth. Rickety children have bones in which the process of nourishment has not been duly carried out, and hence arises the deformities to which these children are so liable. In early life the bones contain a larger proportion of animal matter than in old age, when they become brittle and easily broken from excess of the mineral constituents. If we soak a bone in a weak acid, the acid removes the mineral part, and leaves the animal part untouched, the bone retaining its shape, but becoming lithe and flexible.

"*How and from what is bone developed?*" *is a question* of much interest. The *long* bones of our bodies are "laid down," so to speak, in *gristle* or *cartilage* as their foundation. The *flat* bones, such as those of the skull, are formed from *fibrous membrane*. Cartilage, which is the *matrix* or "mother-tissue" of long bones, consists essentially of minute cells, set in a structureless layer. Where bone is to be formed, these cells arrange themselves in long, parallel rows, and multiply rapidly in numbers. Then comes the process of *calcification*, or that by which the living matter, derived from the blood, is thrown in amongst the cells, and invades the cartilage. Thus lime is provided for the formation of the bone. The further changes which take place in the growth of the bone, consist in the formation of a thin layer of *spongy* bone, which consists of *bone-cells* containing living protoplasm, and which has been produced by the under surface of the *periosteum*, or layer covering the bone. These bone-cells in turn develop lime around themselves, so that naturally, a ring or circle of these bone-cells will form a layer of bone, embedded in which we find the living protoplasm in spaces which will become the *lacunæ* of the full-grown bone. The spaces in the centre of the circles of bone-cells will become in like manner the *Haversian canals* of the adult bone. Meanwhile, outside the bone, the *periosteum* continues its work of bone-formation, the thickness of the bone being thus ensured and increased; whilst later on, the *lacunæ* or spaces which are set widely apart in the young bone appear more closely set, owing to the growth which fills up the interspaces, and which adds to the solidity of the structure.

Bones begin to grow usually at several points in their substances. These points are the "ossifying centres." For instance, a long bone, like the thigh bone, begins existence as a mere rod of gristle, and ends it as a dense solid bone: its growth having taken place from three "centres"—one in the shaft or column of the bone, and one for each end thereof. When it grows in length, the increase takes place at each end of the shaft; for if two pins be placed a little way apart in a growing bone, the distance between them does not increase, whilst the bone itself extends in length. Removal of the end of a growing bone destroys its further increase.

Lastly, we should note how the whole process of bone-growth is *one dependent on the living protoplasm of which* the *bone-cells* are composed. Later on, we shall see how the entire life of man—and necessarily that of other animals—may be truly described as the cumulative result of the growth and work of these minute living structures. And no more wonderful thought can be impressed on the mind than that which shows us that, after all, human life, as we know it, represents merely the activity of those minute units which only the higher powers of the microscope reveal to our understanding.

If an eccentric slips on the road on a locomotive, pinch her on the dead centre, on the slipped side; disconnect the valve stem on the disabled side, and set the valve by the blow cock, so that steam just shows blowing through it, and then give her whatever lead she had originally. Then bring the eccentric round so that all parts will connect again. The lengths have not been disturbed; they are all right, and when the parts will connect, the engine will go ahead (if the valves were ever right) a great deal better than some whose eccentrics have never slipped, but ought to. Don't get excited and set the valve by the wrong end of the cylinder and then try to connect her up. *Mechanical Engineer.*

FIG. 5.

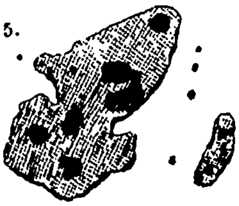


FIG. 1.—Sun-spots seen at Montreal, Nov. 18, 1882, at noon.

FIG. 6.

FIG. 2.—Same group seen, Nov. 20, 1882, at 11 a.m.

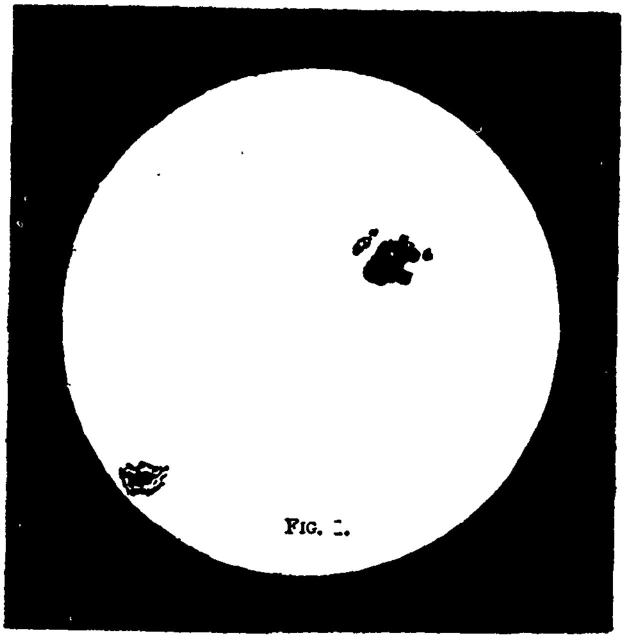


FIG. 1.

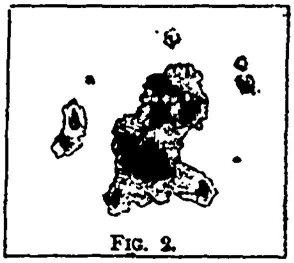


FIG. 2.

At 8 a.m., Nov. 19.

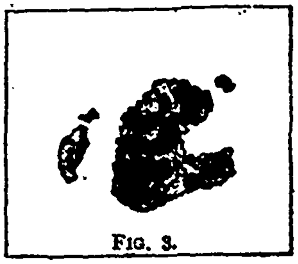


FIG. 3.

At 11 a.m., Nov. 20.

FIG. 4.

GREAT SUN-SPOT, Nov. 19, 12.

THE GREAT SUN-SPOT AS SEEN FROM MCGILL COLLEGE.

On Wednesday, November 15th, 1882, I was informed by Prof. McLeod, who had been testing the performance of his telescope preparatory to the observation of the Transit of Venus, that a very large spot was visible on the sun's surface On Thursday morning I exhibited this to my Astsonomy class with a telescope of 2¾ inch aperture. Mr. Murray, a member of the class, looking at it in the afternoon, observed that it had undergone a great change in the interval. Learning this, and news arriving from all quarters on Friday, the 17th November, of the extraordinary disturbance of telegraphic communications caused by a violent "magnetic storm," I sent a brief notification to the city papers (which appeared in their Saturday issues, November 18th) of the presence of this spot of unusal size and of the rapid changes it was undergoing, suggesting its possible connection with the "magnetic storm." A subsequent announcement from the Toronto magnetic observatory stated that indications of the "storm" had begun as early as 7 p m on Thursday evening. Figures 5 and 6, page 61 showing the spot as seen through the same telescope, with an inverting eye-piece, were sketched on Nevenber 18th and 20th respectively. ALEXANDER JOHNSON

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THE GREAT SUN-SPOT. (*Knowledge.*)

WE have endeavoured in Fig. 1, page 61, to give a telescopic view of the aspect of the sun with the great spot on it, which has been visible to the naked eye during the last week, whenever the sun's disc has been somewhat dimmed by fog or mist. The actual area of disturbance is almost as large as any single area ever recorded; though no actual umbra of any very extraordinary size is now visible on the sun's face. As will be seen from our picture, the spot—regarding as one the whole penumbral region—has four large umbræ and many smaller ones. We show the spot as it appeared on Monday, seen under very unfavourable atmospheric conditions, our rough sketch being only just finished before the sky clouded over, and the opportunity for further observation was lost. The evidence of disturbance around the spot region was marked But the faculæ around the triple spot which has recently come into view near the eastern edge are even more conspicuous than those around the great region of disturbance, though, within the large penumbral region of disturbance, facular streaks of great splendour can be seen.

We are inclined to believe that the great spot is a phenomenon by no means so independent of the great comet as some of the daily papers have confidently asserted it to be. Professor Kirkwood's theory of the association of a great solar disturbance with meteoric matter following in the train of the great comet of 1843 will here occur to many readers. We shall touch on this later.

Mr. Sydney Hodges has kindly forwarded to us a picture (Fig. 2) of the sun spot, as drawn by him on Nov. 19, at 8 a.m. We have inverted his picture to show the spot as it would have been seen with an erecting eye-piece, so that it may be more readily compared with our own drawing. We give both for comparison. It is singular that Mr. Hodges should have made his drawing, in our hands before last number appeared, to almost exactly the same scale as ours.

The spot at this time was decidedly of a *cyclonic* appearance, a huge forked tongue lying *spirally* over the umbra, and all round the larger spot there were shelving "tongues" distinctly seen projected into the blacker umbra.

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SOLAR ENERGY.—By M. Rey de Morande. (*Comptes rendus.*) The conservation of solar energy seems sufficiently explained by Laplace's theory of the gradual contraction of the sun; the recent investigations which have been made in fossil botany have strengthened this hypothesis still more.

At the time of the first geological explorations in the polar regions, the explorers discovered to their surprise that the coal of these regions was sensibly the same as that of other terrestrial parts; the quantity of heat and light given out by the sun near the poles must therefore have been very nearly equal to that given out near the equator. At that time, Dr. Blandet published in the Bulletin de la Société Géologique de France, his theory, which up to the present has alone accounted for the facts observed, and which is also a necessary consequence of Laplace's theory.

So long as the sun's diameter was sufficiently great to enable it to illuminate and heat at the same time the two terrestrial poles, there was great uniformity in the investigation of our planet; but this condition of things ceased pretty suddenly at the Cenomanian epoch. At that time first appeared vegetables with decaying leaves, natives of the most northern countries; very slowly, but very surely, the southorn regions, and confined the tree-ferns and other primitive plants within a more and more contracted equatorial zone.

The great uniformity of the terrestrial vegetation up to the Cenomanian epoch, and, afterwards, the gradual differentation of this vegetation, according to the latitude, the gradual encroachment of the meritional regions by trees with caducous leaves and the disappearance of all vegetation in the polar regions are phenomena which may be explained by the gradual cooling of the earth.

The solar energy sustains over the tropical zone the principal vegetable types which were formerly spread over the whole of the terrestrial surface; so that the sun, in consequence of its gradual contraction, still gives out to this zone a quantity of heat which has apparently undergone but little variation since the primary existence of terrestrial vegetables, but which, nevertheless, must subsequently diminish with extreme slowness.

TOTAL ECLIPSE OF THE SUN IN 1883.—M. Janssen in a report to the Bureau des longitudes respecting the eclipse which is to take place on the 6th of May, 1883, says that this total eclipse of the sun will have an altogether extraordinary duration due to the respective positions of the sun and moon, positions which are rarely assumed. We ought to take advantage of it in order to clear up certain pending questions, especially the constitution of the sun and of the unexplored spaces which border upon it, as well as the existence of those hypothetical planets which Le Verrier's analysis places on this side of Mercury.

M. Janssen reminds us that during the great Asiatic eclipse of 1868 was discovered the long sought secret of the character of those roseate protuberances which surround in such a singular manner the limb of the eclipsed sun. It was then discovered that those protuberances are only jets, expansions of a layer of gases and vapours from 8" to to 12" thick, in which hydrogen predominates and which is at a very high temperature in consequence of its close contact with the sun's surface.

The American eclipse of 1869 enabled us to make the important observation, confirmed on every subsequent occasion, of the inversion of the solar spectrum at the outside edge of the disc.

The eclipses of 1875, 1878 and 1882, have enabled us to unravel pretty rapidly the sun's constitution. But it remains to be determined whether the *immense appendices which the* corona has presented during some eclipses have an objective reality and are a dependant of that vast coronal atmosphere, or whether they are not rather streams of meteorites revolving round the sun. The relation of the zodiacal light to these appendices of the sun has also to be determined. It is necessary to know whether the regions which we inhabit enclose one or *more planets which the illumination of our atmosphere, so vivid* in the neighbourhood of the sun, has always concealed from us. Le Verrier had been led by his analytical investigations to suppose their existence, and *other* observers have seen round and dark bodies in front of the sun; but these observations are by no means to be relied upon.

There are two methods only by which these problems may be solved, viz., by a careful investigation of the solar surface or by an examination of the circum-solar regions, when an eclipse enables us to explore them; the last is the most effective method *if the occultation is sufficiently long to allow of* a minute examination of all the regions in which the small star may be observed. Now the total eclipse on the 6th of May next, will last for 5'. 59" at the point where the phase is a maximum, this is three times the duration of ordinary eclipses. The central line of the eclipse is wholly comprised within the South Pacific Ocean.

The most suitable islands for the observation of this eclipse are Flint and the Caroline islands. The duration of the eclipse will be 5'.33" in the former, and 5'. 20" in the latter.

Among the numerous observations made by M. P. Tacchini during the total eclipse of the sun on the 17th of May, 1882, one of the most remarkable was that on the western side of the corona where was seen a plume which was attributed to a comet whose supposed nucleus-at the middle of the total eclipse, *i.e.*, at 20h 31m 37s, was defined by the following coordinates: R A=3h 35m 16s. and D= +18°. 30'.17".—*Tr. from Comptes Rendus*

Notes.

M. DUMAS recommends water saturated with alum for extinguishing fires, its value being supposed to be due to the objects wet with it, which prevents contact with the oxygen of the air, and thus diminishes the rapidity of the combustion. The Minister of the Interior has recommended that the firemen of the French towns be supplied with facilities to use such solutions of alum.

FOR CONVERTING A PHOTOGRAPHIC NEGATIVE INTO A POSITIVE, Capt. Bing coats the back of the negative with soluble bitumen or asphaltum, and exposes it to light through the negative. The parts through which the light penetrates become insoluble, and the remainder of the asphaltum is dissolved off with any of the usual solvents, leaving a positive. The silver negative is thereupon dissolved off with chloride of copper and a fixing agent, such as cyanide or hypo.

THE COLOUR OF WATER.—Experiments made by J. Aitken confirm the usual notion that pure water has a blue tint; but he finds that the theory of selective reflection is insufficient to account for all the variations as to tint met with in the case of natural accumulations of water. Whitish particles are suspended in the water of the Mediterranean, and the tint varies from deep blue to chalky blue-green, according to the proportion in which these particles may be present.

ELECTRICAL PHENOMENA IN PLANTS.—M. Kumkelo has found that the veins of the leaf are generally electrified positively with respect to the remainder. When a plant is broken or bent, the electrode, if placed in the neighbourhood of the break or bent is negative. Dr. Sanderson has pointed out analogous phenomena in the leaf of the Dionée fly-trap; the lower surface of the sensitive lobe of the leaf is electro-negative with respect to the upper surface, at the instant the leaf is irritated; at the end of half a second, the upper surface becomes in turn electro-negative and remains so for some time.

LIQUEFACTION OF OZONE.—A few years ago, Pictet, of Geneva, succeeded in liquefying several gases which thus far had been considered to be beyond the possibility of being liquefied; it was principally oxygen and hydrogen to which his attention was directed; now the report comes that Hauteville has succeeded in liquefying that peculiar alotropic form of oxygen called *ozone*, to a liquid of a beautiful blue color. The agent of course, is also pressure and cold. The pressure being some 125 atmospheres or 1800 lbs. to the square inch in connection with an artificial cold of many degrees below zero, Fahrenheit.

AURORA BOREALIS (Northern Lights).—According to Nordenskjold the aurora borealis is a permanent natural phenomenon in the polar regions. It appears every night and always in the same parts of the sky. The centre of the aurora is a little to the north of the magnetic pole in a plane perpendicular to the polar axis. This would be something like one of Saturn's rings, but of a very different composition and with frequent changes of brilliancy and form.

The Abbé Moigno, however, considers the above hypothesis to be improbable.

At the meeting of the Paris Academy on Monday, M. Dumas stated that at the very beginning of its work, the Academical Commission for the destruction of the Phylloxera proposed to arrange for the immediate destruction by fire of each plant proved to be infested. Objections were made to this scheme grounded on the state of French legislation on rural property, and the Academical Commission desisted. M. Dumas states that he has in hand an official report from Switzerland establishing the soundness of the views taken by the Academy on this important question. The cantons of Geneva, Vaud, and Lucerne having resorted to the destroying process, all the vines, of which the value exceeds £40,000,000, had been saved at the expense of a few thousand pounds. A special tax had been imposed on the proprietors of vines for compensation to the owners of the destroyed plants.

THE RANGE OF SOUNDS IN AIR.—M. Allard in his investigations as to the range of sounds in air observes that in seeking to establish for sonorous ranges, a formula analogous to that which gives the ranges of light, it is necessary to assume that the intensity of the sound is proportional to the work expended in producing it. From a large number of experiments M. Allard deduces that the intensity of the sound in the air decreases more rapidly than as the square of the distance. He considers that a second cause of enfeeblement of the sound lies in the action of the air itself which, when it is non-homogeneous, reflects and disperses a part of the vibratory movements of the wave.

Besides, these experiments have demonstrated that a given sound, apart from the influence of the wind, may have very different ranges, varying, *e.g.*, from 2 to 20 nautical miles; differences which may be explained by supposing the coefficient of acoustic transparency to be variable within certain limits. Finally, the work required rapidly increases for small augmentations of range, and the differences of range for different pitches within the octave, are very slightly sensible.

NEW ANTISEPTICS.—At the last Annual meeting of the *British Medical Association*, M. Mayo Robson described a series of experiments made by him to verify the efficacy of atmospheres charged with volatile antiseptics to prevent the development of life in putrescible liquids. The results are very favourable. Bottles containing an infusion of dead grass, suspended in open large-necked jars, *in which a little of the oil of the Eucalyptus* had been poured, remained perfectly limpid, while phials of the same infusion exposed in the open air and even protected by cotton cloth become thick and covered with mould in a few hours. These vapours in fact are fatal to the germs of bacteria, and probably also to the *germs of fevers and infectious diseases*. As these vapours are not hurtful to respiration, it is to be hoped that hospital experience will confirm the anticipations of M. Robson. Eucalyptus oil is abundant and cheap. Many surgeons have employed it in their operations, the method of application being as *follows*:

Air is first received in a vessel filled with cotton, then in others filled with pumice-stone saturated with Eucalyptus oil. The air is thus deprived of all germs, and is blown upon the wound.

DR. KING, the Superintendent of the Royal Botanic Gardens, Calcutta, has recently issued his report for the year 1881-82. The Calcutta Garden may be said to be the centre of botanical work in India, and none can probably claim a greater antiquity, as the report before us is stated to be the ninety-fifth annual report of these Gardens. Like its predecessors the report opens with a description of the changes and improvements in the Garden itself, points which are, of course, only of local interest. On the subject of india-rubber yielding plants —a subject of very great importance—Dr. King says: "Ciara rubber (*Manihot Glaziovii*) continues to grow well here; our trees are beginning to seed, and from their produce I was able to distribute during the year a good many seedlings to tea-planters in Assam, Chittagong, and elsewhere. A species of *Landolphia*, which is one of the sources of the rubber collected in Eastern Africa, has (thanks to the exertions of Sir John Kirk, Her Majesty's Consul-General at Zanzibar) been introduced in the Garden. From the seeds sent by Sir John Kirk a number of young plants have been raised, and these at present look very healthy. The cultivation of the plant yielding Para rubber (*Hevea Brasiliensis*) has been abandoned, as the Bengal climate proves quite unsuitable for it. Of *Castilloa*, another South American rubber-yielder, we have as yet only eight plants, but it is being propagated as fast as possible." Another important subject is that of the production of materials for paper-making, and of these plantain fibre seems to have occupied some attention. It seems that during the dry months, simple exposure of the sliced stems to the sun is a sufficient preparation for the paper-maker, provided the paper-mill be on the spot. What is still wanted is some cheap mode of removing the useless cellular tissue, so that the fibre may be shipped to England without the risk of fermentation during the voyage. The cultivation of the plantain for its fruit is so universal over the warmer and damper parts of India, and its growth is so rapid, that the conversion into a marketable commodity of the stems at present thrown away as useless would be an appreciable addition to the wealth of the country. The paper mulberry of China and Japan (*Broussonetia papyrifera*) is being tried in the Garden, as well as in the Cinchona plantations in Sikkim, as it is well known that the bark yields a splendid paper material. A plant which appears to be at present unknown, but which Dr. King thinks will prove a species of *Eriophorum*, is also favourably reported upon. Under the head of "Other Economic Plants," mahogany, the rain-tree, and the Divi Divi, are said to be in considerable demand. A large interchange of seeds and plants has been affected during the year, with other parts of India, as well as with England and the Colonies.

AT a recent meeting of the London Physical Society a paper by Mr. W. Ackroyd was read on rainbows produced by light reflected before entering the rain drops. The author investigated mathematically the rare phenomena of three bows, and inferred that it would generally take place about sunrise or sunset. Mr. Lecky thought that the effect might be said to be due to two suns, one (reflected) appearing to be below the horizon.

A NEW EXPLOSIVE.—The Neva *Militarische Blätter* gives an account of a new explosive called dynamogen recently invented by a Viennese, M. Petri. It compares favourably with ordinary powder and neither contains sulphuric acid, nitric acid, nor nitro-glycerine. It may be formed into cylinders under pressure; no danger is incurred either in its manufacture or use. Its properties are not affected either by heat or cold; it costs 40 p. c. less than gunpowder.

ELECTRO-CHEMICAL DEPOSITS OF VARIOUS COLOURS PRODUCED ON PRECIOUS METALS, FOR JEWELLERY, BY M. WEIL. —M. Weil exhibited at the Paris Academy of Sciences, pieces *of gold and silver jewellery, polychromised industrially, by his* processes, with oxide of copper.

The colours, undeniably artistic, resist friction, the action of dry and moist air, air vitiated by sulphuretted hydrogen and coal gas, and light.

CHEMICAL STUDY ON MAIZE AT DIFFERENT EPOCHS OF ITS VEGETATION, BY M. LEPLAY.—Sugar is found in the leaves, and accumulates in the stem till the moment of formation of starch in the grains. It then migrates into the spike, first into the support of the grains, then into the grains themselves, where it is replaced by starch. The migration continues to be fed by the leaves till they disappear, then in great part by the stem diminishing, however, as the starch is developed. The function of the sugar, then, is to furnish to the grain the elements of starch.

THE AGE OF TREES.—It is everywhere stated that the age of trees may be determined by the number of concentric ligneous layers corresponding to one year's growth. This principle is not applicable to tropical and equatorial trees, as the following fact proves. After an interval of twenty-two years, M. Charency visited the ruins of Palenque, in Mexico; he cut off a branch of a shrub, on which he found 18 concentric layers, while from its size, he considered it to be only 18-months old. Better still, in his first visit, in 1859, M. Charency caused a certain number of trees to be cut down. Since that time these trees have grown again, and are naturally all of the same age, viz., twenty-two years. Upon one of them, M. Charency counted 230 concentric layers. If, as he thinks, warm and wet years count double, even in Europe, the trees must have certainly gained considerably in 1882.

PROCEEDINGS OF SOCIETIES.

MEDICO-CHIRURGICAL SOCIETY.—At the Meeting on the 12th a paper by Dr. Osler and Mr. A. W. Clement was read on "Parasites in the pork supply of Montreal." One thousand animals were investigated, and of these four were trichinous. Seventy-six contained "measles" or the larvæ of tape worm, and thirty-one contained Echinococci. The following conclusions were arrived at:—

1. The investigation shows that the hogs slaughtered for our markets present parasites in number sufficient to necessitate a more thorough inspection than is at present carried out.

3. As regards *trichina spiralis*, which was found in proportion of 1 to 250, we are of opinion that, considering the extreme rarity of cases of trichinosis, and the difficulties attendant upon a systematic inspection, *a compulsory microscopic examination of the flesh of every hog* killed is not at present called for.

3. In the case of "measles," the liver should be carefully examined, and if present in it, the flesh of the animal should receive the special attention of the inspector; if only in the liver, the entire carcase need not be confiscated.

4. Echinococcus cysts in the liver renders that organ unfit for food, but in other parts, unless very numerous and disorganizing, they may be cut out, and the carcase remain marketable.

5. The public should be made aware of the possible dangers of eating, in any form, raw or partially cooked meats. The best safeguard against parasitic affections is not so much inspection of the flesh unless, indeed, this is minutely carried out, as careful attention to culinary details.

6. To reduce the number of infested hogs greater attention should be paid to their hygienic surroundings, particularly in the matter of feeding. The danger is not during the period when the animals are penned and fed on grain, &c., but when they are allowed to roam at large and feed indiscriminately.

MONTREAL MICROSCOPICAL SOCIETY.—The regular Monthly Meeting was held on Monday the 8th. D. J. Baker Edwards read a short paper on "Aquarium Studies," and exhibited a number of beautiful ciliated Infusoria. Dr. Wilkins showed a series of injections and specimens illustrating treble staining.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—Mr. W. H. Paine in the chair. Mr. W. P. Shinn read a paper on the increased efficiency of railway for the transportation of freight.

The first portion of this paper gave, from carefully gathered statistics, a valuable amount of information in regard to the actual increase of traffic upon American railways. In 1860 the tonnage mileage of the New York Central and Hudson River Railroad, the Erie Railway, and the Pennsylvania Railroad was about equal, and amounted in the aggregate to a little over ¾ of that of the New York State Canals, and in 1870 each of these railroads averaged about the tonnage of the Canals, and in 1880 they averaged each nearly double that of the Canals.

The aggregate tonnage mileage of the other railroads was in 1881, 1,217 per cent. more than 1860. Statistics were also given showing the increase of population, of railroad mileage, of the production and export of grain and other leading exports. The means by which this rapid increase of freight transportation had been developed was considered under two general heads, namely, improvements in the administration. The improvements in the physical condition were treated on under these heads:—

1. Improved track or "permanent way," including bridge structure.
2. Additional sidings, and second, third, and fourth tracks.
3. Increased capacity and strict clasification of locomotives.
4. Increased capacity of freight cars.
5. Additions to terminal facilities.

The improvements in the administration were referred to under the following heads:—

6. Improved methods of signalling.
7. Running locomotives "first in, first out," and running freight trains at higher rates of speed.
8. Consolidation of connecting lines under one management by purchase, lease, amalgamation or otherwise.
9. Running freight cars through one point of production to tidewater without trans-shipment.
10. Issuing through bills of lading (or freight contracts) from western points of shipment to Atlantic and European ports.

The general introduction of steel rails was stated to be the very corner-stone of increased efficiency. The improvements in all the directions referred to were treated of, and described at considerable length.

The second portion of the paper presented the views of the writer as to the means whereby still greater efficiency could be most economically obtained. The constant demand is for more transportation facilities, for more cars. In the opinion of the writer, what is needed is not so much more cars as more movement of cars. Freight blockades will be prevented, not by having more tracks to stand cars upon, but by having fewer standing cars. It was shown that upon one railway there had been a decrease in the miles run by the cars of 21 per cent. between 1868 and 1881, and that the Union Line Cars between 1879 and 1882 were increased 49 per cent. in number, while the mileage run by them decreased 16 per cent. in the same period. The remedies suggested by Mr. Shinn were more main tracks, more locomotives, more trains, the improvement of the making up of trains at the points where loaded. The detention of cars at stations and private sidings and the absence of cars on foreign railroads were considered as among the greatest causes of loss, and the writer suggests that the remedy will be to charge a per diem charge for cars when on foreign roads, and that this charge would be based upon the average economic value of the cars in use to their owners.

The paper was discussed by Messrs. T. C. Clarke, G. S. Greene, jr., W. C. Andrews, C. Macdonald, C. E. Emery and by the author.

ENGINEERS' CLUB OF PHILADELPHIA.—The regular meeting of this club was held December 16th, 1882. Mr. Henry G. Morris in the chair. Mr. E. F. Loiseau, read a paper on the subject of his Artificial Fuel, which he exhibited, in process of consumption, in the club room grate. After giving a short historical sketch of the manufacture of Artificial Fuel in Europe, where "briquettes" have been made for years past, Mr. Loiseau said that the aim of inventors has been to manufacture small lumps in paying quantities and, so far, the attempts have been failures. Sixty-eight fuel factories have been successfully operated in Europe, but they all make brick-shaped lumps, too large for family use. Mr. Loiseau claims to have solved the problem, and states that the Loiseau Fuel Co. at Port Richmond cannot supply the rapidly increasing demand for the small egg-shaped lumps (weighing about 2 oz.), which they manufacture at present. Mr. Loiseau described at length his process, and the machinery used for mixing and pressing into lumps the coal dust and the pitch, of which the fuel is made.

Prof. J. E. Denton's tests shew:—1st. That the Loiseau Fuel evaporates more water to the pound of coal than ordinary anthracite; 2d, that the quantity of ashes is smaller; and 3rd, that these ashes contain no clinkers. Mr. Loiseau demonstrated its insolubility by the *exhibition of specimens which had been placed in jars of water.* The specimen of Mr. Loiseau's fuel was found intact and the water clear. In the consumption of the fuel in the grate no offensive odour could be detected, and it was noticed that the lumps retain their shape while burning and threw off a great amount of heat.

Mr. Ashburner presented a memo relating to the maps and sections of the Anthracite Survey.

Prof. L. M. Haupt presented a short description by John C. Trautwine, and W. E. Babbit, of the floating drawbridge at Rouses Point, and also a drawing, with notes, of a wooden arch bridge across the Genesee River below Rochester, of 352 feet span, 54 feet rise, which failed by descending at the haunches and rising at the crown.

DR. R. ANGUS SMITH, F.R.S., read before the Manchester Literary and Philosophical Society "A Note on the Development of Living Germs in Water." The process employed cannot be too generally known. About 2½ per cent. of gelatin well heated in a little water is mixed with the water to be tested, and the mixture forms a transparent mass. If any organisms are developed they do not fall to the bottom, but become visible as spheres of activity, which remain long and can be closely observed. It is suggested that photographs of these globules may be taken and become a visible report made by nature when the water has active organisms in it.