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ROYAL ALBERT BRIDGE.

Biographical notice of
CHARLES LEGGE, Esq., C. E.

AS we purpose making it a special feature of this Magazine to give a short biographical notice of some of the most prominent men in the Dominion, noted for their scientific acquirements, in engineering, architectural, and mechanical skill; we have much pleasure, in the present instance, in giving a short sketch of the engineer whose design of the proposed Royal Albert Bridge across the St. Lawrence we now illustrate in the pages of this Magazine, and which is drawing considerable attention to its importance both here and abroad. Of the merits of this great design it would be presumptious in us to offer an opinion—but with respect to its commercial value to Montreal and to the country generally, there cannot possibly be a doubt. It is one of those great national projects in which no local interests should receive the slightest consideration—and one in which the government of the country should have a large interest and control—Without venturing to discuss the material points, that have been raised, pro and con, regarding this gigantic structure, we may venture to say that we have a full belief in its practicability, and express regret that the money which has been almost thrown away in the construction of the Intercolonial Railway and other schemes which can never be practically worked to any profitable advantage in a climate like Canada, had not been applied to the enlargement of our canals, and the development of other sources of national wealth and industry.

CHARLES LEGGE, Esq., Civil Engineer, was born at "Silver Springs," near the village of Gananoque, on the 29th September, 1829, and appears at an early age to have exhibited a taste for hydraulic engineering. In 1846, he entered Queen's University, Kingston, where he studied for the profession of a civil engineer. In the same year he was engaged on a trigonometrical survey of the north shore of Lake Huron, returning in the autumn to the continuation of his studies at the University. On leaving the University he was articled as pupil to Samuel Keefer, Esq., C. E., then Engineer on the Welland Canal, and on the appointment of that Gentleman to be Chief Engineer of Government Public Works, Mr. Legge followed his professional teacher from the Welland Canal to Montreal; applying himself during this period with great zeal and industry to the practical study of his profession. So high did the ability of Mr. Legge rate in the estimation of the Chief Commissioner of Public Works, the Hon. John Young, that he, with a keen perception of his youthful talent, appointed him Superintending Engineer of the St. Lawrence Canals. In the succeeding year he was appointed to the construction of the Junction Canal.

After the completion of this important work Charles Legge resigned his position on the Government Canals —at the urgent request of his late instructor, Mr. Keefer—to take the superintendence, laying out, and construction of a very difficult section of the Grand Trunk Railway between Brockville and Kingston. His services were retained on this railway until its completion, and the staff were being gradually reduced, then, when he was daily expecting a discontinuance of his own services, a high compliment was paid to his abilities by receiving the appointment of Superintending Engineer of the south-half of the Victoria Bridge across the St. Lawrence then about to be commenced. During between five or six years that the bridge was being constructed Mr. Legge enjoyed the full confidence of his chiefs, the two world renowned engineers, Stephenson and Ross, and here it was that he acquired that superior knowledge of bridge construction, on a gigantic scale, which he was shown so advantageously to the public in his present design of the Royal Albert.

Since then Mr. Legge has been connected with the construction of most of the railways in this country, and is at present Engineer in Chief of several, including the "Montreal, Ottawa and Western," also, of the "Montreal and City of Ottawa Junction Railways." He is also Engineer in Chief of a second bridge over the St. Lawrence from Coteau du Lac to Valleyfield, 30 miles west of Montreal, to unite the "Montreal and City of

Ottawa Junction Railway," with the United States railways on the south of the St. Lawrence. The bridge proper will be one mile in length.

As an hydraulic Engineer his name stands among the first in the Dominion, and he is consulting Engineer for many of its public works.

THE ROYAL ALBERT BRIDGE.

(See pages 100, 104 and 121.)

I.

We publish, to-day, views showing various parts of this contemplated bridge destined, when completed, to greatly excel in magnitude any similar structure which has yet been built.

The impetus which for several years past has been given to the construction of railways on the north of the St. Lawrence and Ottawa rivers; with a continuation through to the waters of Lake Huron, to tap the lake traffic of north-western States; a more immediate connection by rail of the great lumber districts of the St. Maurice and Ottawa rivers, including their numerous tributaries, with the leading markets in the United States; the geographical position of Montreal, almost on the air line; as well as other important considerations to be glanced at, demand a second bridge over the St. Lawrence at this city, in order to effect a union of those Eastern, Northern and Western roads with the great American system on the South, and secure an easy and cheap interchange of traffic.

The Victoria Bridge, while performing the most important function in this interchange of traffic, more strictly speaking accommodates but that of the St. Lawrence Valley with such through freight as it can get. It is a close corporation, in other words under the entire control of one railway company. It is not too much to say that, in a decade or two, its capacity will be tested to the utmost to accommodate the traffic of the Grand Trunk Railway alone. Even were its carrying capacity much greater, and in a position to be made use of by all railways on the same terms, the difficulty of access to it by the Quebec, Montreal, Ottawa, and Occidental Railway, coming in at the eastern end of the city would be almost insuperable.

It may be of interest to state that the point of crossing now determined on is nearly identical with the one pointed out many years ago for the Victoria Bridge, when it was proposed to pass the river by a span of then unheard of dimensions, from St. Helen's Island to a point east of the Market Place, and thence by arches north-ward to Côte à Barron.

The idea of that day is now being realized in the proposed Royal Albert Bridge, a fit mate for its Royal consort, a couple of miles farther up the river.

In combination with its railway traffic, it has also been thought desirable to accomodate that of ordinary character, such as city passenger cars with dummy engines, the various descriptions of vehicles, and also afford ample space for pedestrians.

As is well known, for about two months or more each year, this city is cut off entirely from the south shore, whence it derives its principal amount of market supplies, hay, &c.

During this period, prices go up and the additional money so paid would be no inconsiderable part of the amount required to meet the interest on the cost of the bridge. Ready access would be offered to the south shore night or day, the year round, at a very trifling cost, and at a most expeditious rate of speed, resulting in a few years in the growth of a large city, or "Southern Montreal."

The bridge will also give every required facility for reaching the St. Helen's Island Park., destined to be one of the most pleasant and beautiful of drives or resorts.

The great length of the bridge (about three miles) permits us to give views of but some of its most salient points.

Fig. 1. Represents general elevation.
Fig. 2. " bird's eye view of that portion over the navigable channel.
Fig. 3. Represents elevation of 500 ft. span.
Fig. 4. " " 300 "
Fig. 5. " end elevation of 500 ft. span.
Fig. 6. " part end elevation and part section of 300 ft. span.
Fig. 7. Represents General Plan, showing connection with the railways on the North and South shores.

II.

In connection with these views, the following brief description of the structure is given.

Leaving the level of the ground on the line of Sherbrooke St., it is carried as a viaduct, east of and parallel with Colborne Avenue, at a level of ninety feet above the surface of the ground, in spans varying from 150 to 200 feet each. Striking the navigable channel of the River St. Lawrence near Molson's Brewery, it passes over to St. Helen's Island with six spans.

Owing to the angle made by the axis or the bridge with the current, the piers are placed on the skew, so as to be lengthwise in line with the current, and in this manner offer the *minimum* of obstruction; while doing this service, however, it lengthens considerably the superstructure, as for instance in the case of the large span of five hundred feet between the masonry, measured at right angles, the length of superstructure span is increased to five hundred and fifty feet; and so proportionately with the four remaining spans of 300 feet each.

The bottom of the superstructure will be carried level from Sherbrooke St., to the centre of St. Helen's Island there meeting the natural surface of the ground. This will give a clear headway of 130 feet above summer water level in the harbour, or say 120 feet above winter level. (The latter figure is the height of the Brittannia Bridge above mean tide level, determined by the British Admiralty as a suitable elevation for navigation purposes).

Reaching St. Helen's Island, four spans of 240 feet each will carry the bridge to the height of land, where this first section of the structure will terminate.

From the south side of the Island the second section of the bridge will be carried over the unnavigable channel of the St. Lawrence, to the south shore by twenty-one spans of two hundred feet each, grading down with an inclination of one foot in one hundred feet. Reaching the south shore the bridge becomes again a viaduct of five additional spans of two hundred feet each, or until the superstructure has approached within such a distance of the natural surface of the ground, as to make embankment more economical; and thence proceeds with ordinary grading to a junction with the Montreal, Portland and Boston Railway, as also the Grand Trunk.

The total length of the bridge and viaduct will be fifteen thousand five hundred feet, or within a fraction of three miles; and the extreme distance covered from the point of departure from the Quebec, Montreal, Ottawa and Occidental Railway on the Mile End heights, to the junction with the line on the south side, will be five and a half miles.

A sufficient length on the natural surface of the ground on St. Helen's Island exists between the two bridges for siding purposes. Trains from opposite directions can thereby cross each other nere, and so double the capacity of the bridge.

The piers to be placed in the two channels of the river will be designed on the general principle of those of the Victoria Bridge, for the purpose of allowing the ice to cut freely past.

Those in the navigable channel will be sunk in *caissons*, thereby obviating the use of cofferdams and other obstructions in the river, and rendering pumping unnecessary. In the south channel the water is very shallow, with a rock bottom, and very little expense will be incurred in putting in the foundations of the piers.

The abutments and piers on the land portion will be of simple design, the first probably partaking of the Egyptian style.

The iron superstructure from end to end will be composed of four independent longitudinal ribs, or open lattice girders, placed certain distances apart, and strongly connected laterally.

These ribs will be provided with the usual friction rollers on each alternate pier, to provide for expansion and contraction. Between the two inner girders, on the lower floor, will be a space of eighteen feet to accommodate two tracks for trains of city cars, to be drawn by dummy engines. Between the two inner girders and outside girders, on either side of the bridge, will be spaces of fourteen feet respectively, for ordinary cart and waggon traffic, passing in one direction on the western, and in the opposite direction on the eastern side of the bridge. Exterior to these two outside girders will be footwalks, firmly supported on brackets of iron, strongly attached to the side girders and floor beams; they will each possess a width of 8 feet and be provided with ornamental railing for the protection of pedestrians.

At a distance of fifteen feet above the lower floor will be placed a second one, strongly connected and braced with iron kelsons and gussets to the longitudinal girders; on the floor, between the two inner girders, will be placed a railway track with crossing arrangements for trains, as before stated, at St. Helen's Island. The spaces existing between the inner and outer girders will each possess the width corresponding to the carriage-ways below, and are intended for carriages and other vehicles requiring a higher rate of speed than carts or waggons. Should a second track ever be required for railway purposes, across the entire length of the river, a fifth girder can be erected on the up stream side of the bridge, and be supported by iron columns from the saddles of the ice-breakers, at a comparatively small cost.

The entire height of the bridge from the surface of the water will be two hundred and ten feet for the centre span, or two hundred and fifty feet from foundation.

Carriages and carts will have access to, or departure from the bridge on the level of Sherbrooke St., and possibly at some suitable points between that street and the river, by means of incline approaches.

Pedestrians or those wishing to take the city cars, will also obtain access to the bridge in this manner.

A pretty close estimate of the work may be stated under the following heads :—

Masonry....... :..............	$2,250,000
Iron superstructure..............	2,250,000
Land purchase and contingencies..	500,000
Total cost of bridge..............	$5,000,000

III.

Fears have been entertained that the introduction of the piers into the water would materially increase the current in the channel ; that such fears are groundless will be seen from the following figures. Two lines of soundings were accurately taken, and the velocities of the current ascertained, one crossing Isle Ronde, below St. Helen's Island, the narrowest point in the channel ; the second sixteen hundred feet further up the river, and crossing St. Helen's Island. The sectional area of discharge at Isle Ronde was found to be 36,670 square feet, moving with a central surface velocity of 9.2 miles per hour.

Number two, or adopted line, gives a sectionol area of 51,448 feet with a central surface velocity of 6.9 English miles per hour. If from this sectional area be deducted that required for the piers, 4,248 square feet, there will yet remain 47,200 square feet, or 10,530 square feet in excess of the entire channel at Isle Ronde. The increased velocity arising from the obstructing piers, will be 0.8 of a mile in 150 feet, or the length of the pier ; making a total current for this distance of 7.7 miles per hour, or 1.5 miles less than at Isle Ronde in its present condition. The declivity generated by this obstruction will be but 5½ inches in the length of the pier. From the foregoing it will be seen that the channel opposite Isle Ronde will be in reality the sticking point, and not the site selected for the Royal Albert Bridge.

But apart from all this, the slight addition to the current for so short a distance would have no appreciable effect upon the speed of an ocean or river steamer ; while in the case of ships the present admirable arrangement of a steam chain-tug made use of by the Harbour Commission, will easily overcome the difficulty. The piers presenting a sharp angular sloping surface, on the up stream side, to the approaching current, will permit the water to glide past with the least possible disturbance.

The superstructure has been designed for carrying the following live load under a coefficient or factor of safety 6 ; in other words, the weight of live load to be presently mentioned, including the weight of the bridge itself is but one-sixth of the ultimate strength, or actual breaking weight of the structure.

1st.	A train made up of locomotive engines, running 30 miles per hour, equal per lineal foot to....	2,500 lbs.
2nd.	Two trains of city cars with dummy engines loaded with passengers, going six miles an hour, say..............................	2,500 "
3rd.	Carriage ways and foot-walks, loaded at 100 lbs. per square foot........................	7,500 "

Making a total of 12,500 lbs. per running foot, or divided into the four girders will make each one carry, in addition to its own weight, about 4,100 lbs. per running foot. Many bridges have already been built carrying even greater live loads.

The following comparision is made between the two rival bridges.

ROYAL ALBERT.	VICTORIA.
1 Span 550 feet skew.	24 Spans 242 feet each.
4 " 330 " "	1 " 330 "
4 " 240 " square	
51 " 200 " "	
4 Approaches, 400 feet each.	
With abutments, piers, &c., making about 15,500 lineal feet of iron superstructure.	With piers, &c., making a little over 7,00 lineal feet of iron superstructure.
Greatest clear heigth above water 130 ft.	Greatest clear height above water, 60 ft.
Height of centre span above water, 210 ft.	Height of centre span above water, 82 ft.
Greatest depth of water, 40 feet.	Greatest depth of water, 22 feet.
Strength of current, 6.9 miles.	Strength of current, 7 miles.
Estimated cost, $5,000,000.	Actual cost, $6,000,000.

The Victoria Bridge required six years in its erection. It is thought the Royal Albert can be built in three.

IV.

It is proposed that the bridge be under the control of no one railway company, but be free and open to all on equal terms : that the schedule of tolls for crossing shall be determined by Directors to be appointed by the different governments and corporations interested in the work, subjected to the supervision, if required, of the Governor in Council.

That as the Dominion Government and that of the Province of Quebec, are interested in obtaining a winter outlet for the roads they are now building, to the seaboard and into the neighbouring country, for the interchange of traffic, and that as many of the American lines both East and South, are also deeply interested passing over this new air line from Montreal to Lake Huron, and eventually to Sault Ste. Marie, to join lines in the West, the government and representatives of those railways be invited to assist, by giving guarantees on Bonds to be issued.

To the city of Montreal the work will be of almost incalculable value. Some years ago, the city contributed $1,000,000 to the M. N. C. R. In return or this she will get the railway, and the $1,000,000, or more, returned in the Barrack property, which the city now owns. Montreal might under these circumstances give liberal aid to the bridge, which will add so largely to her prosperity and growth.

The bill for obtaining a charter for the undertaking, is now before the House and is an advanced stage.

SOCIETY OF ENGINEERS.

SCREW PROPELLERS SHAFTS AND FITTINGS.

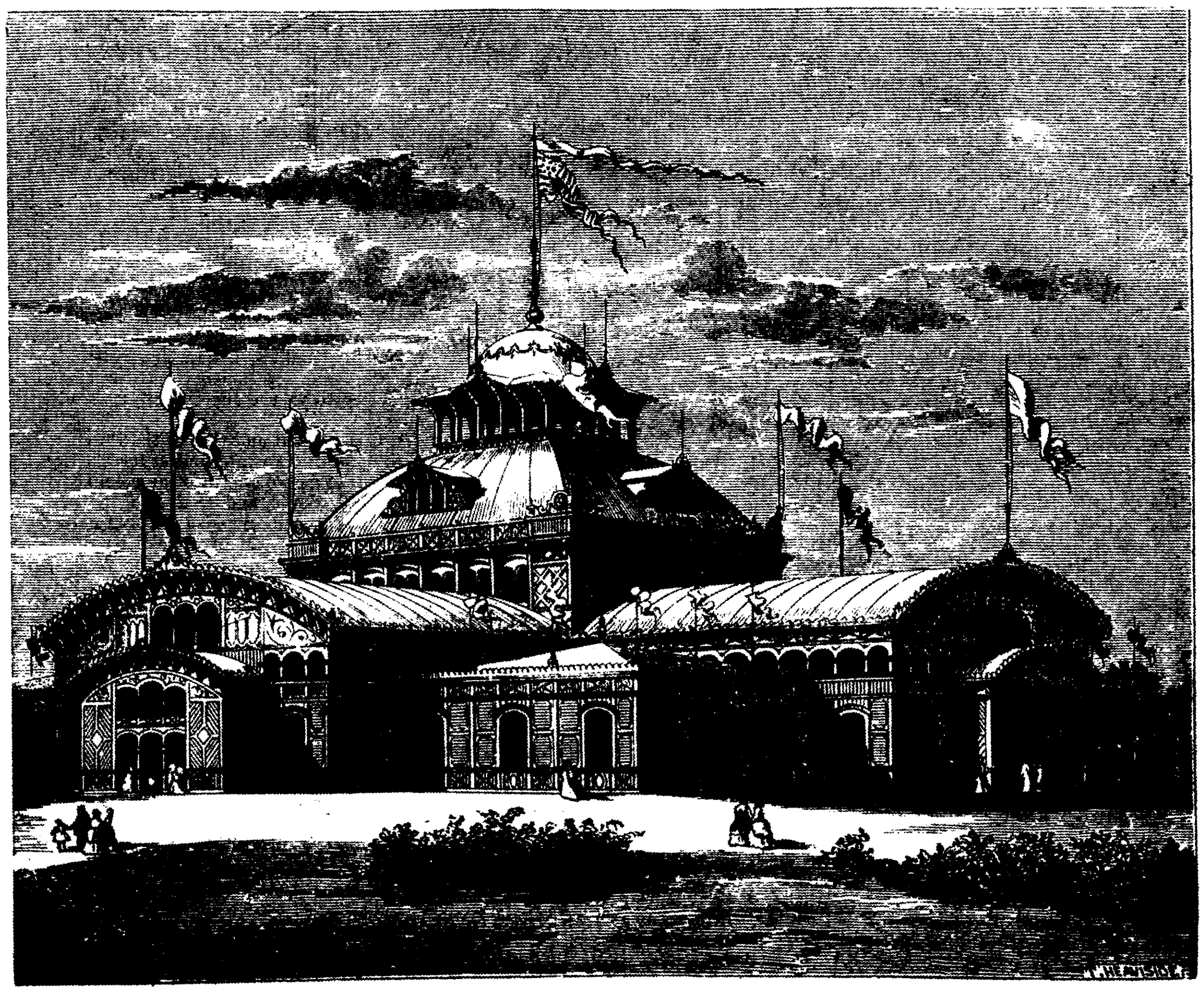
(See page 108.)

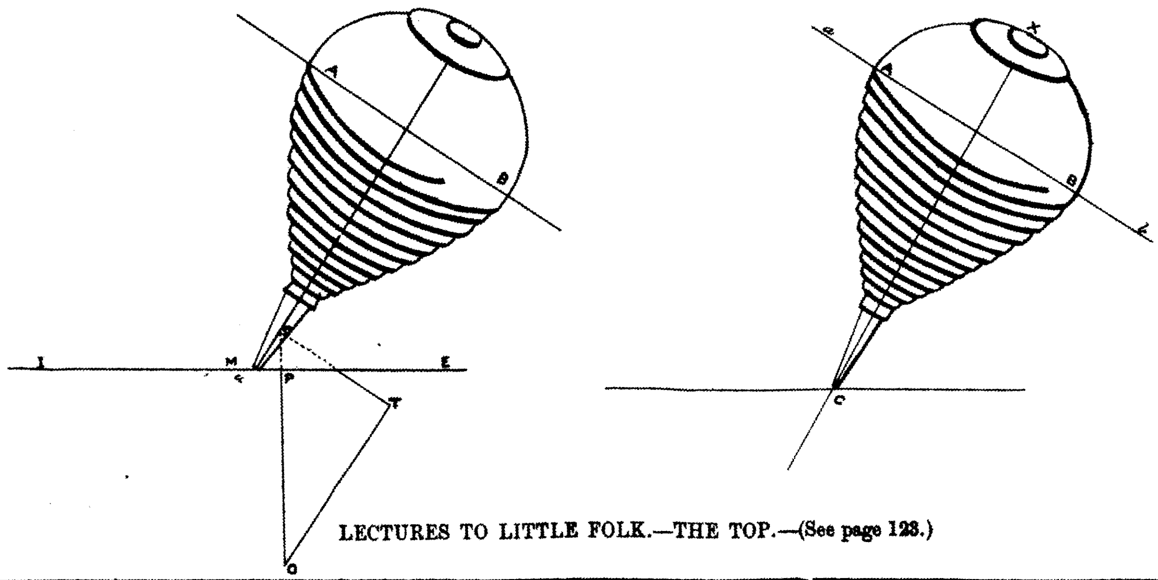
(Continued from page 70, March number.)

The author now invites the attention of members to diagram No. 15A, which illustrates one of the most recent arrangements for feathering the blades of a screw. It is the invention of Mr. R. R. Bevis, of Messrs. Laird Bros., Birkenhead. The leading feature in the contrivance is that a portion of the shaft is hollow, and within is a rod riveted in the screw boss with cranks upon the blade shanks, and united at the other with a screw collar on the shaft, and by this arrangement Mr. Bevis is enabled to feather the screw from the engine room — a matter of advantage in war ships, by placing all below the water line. The thing has been successfully tried in Mr. Brassey's yatch, the Kathleen, and after twelve month's service, was found in good order.

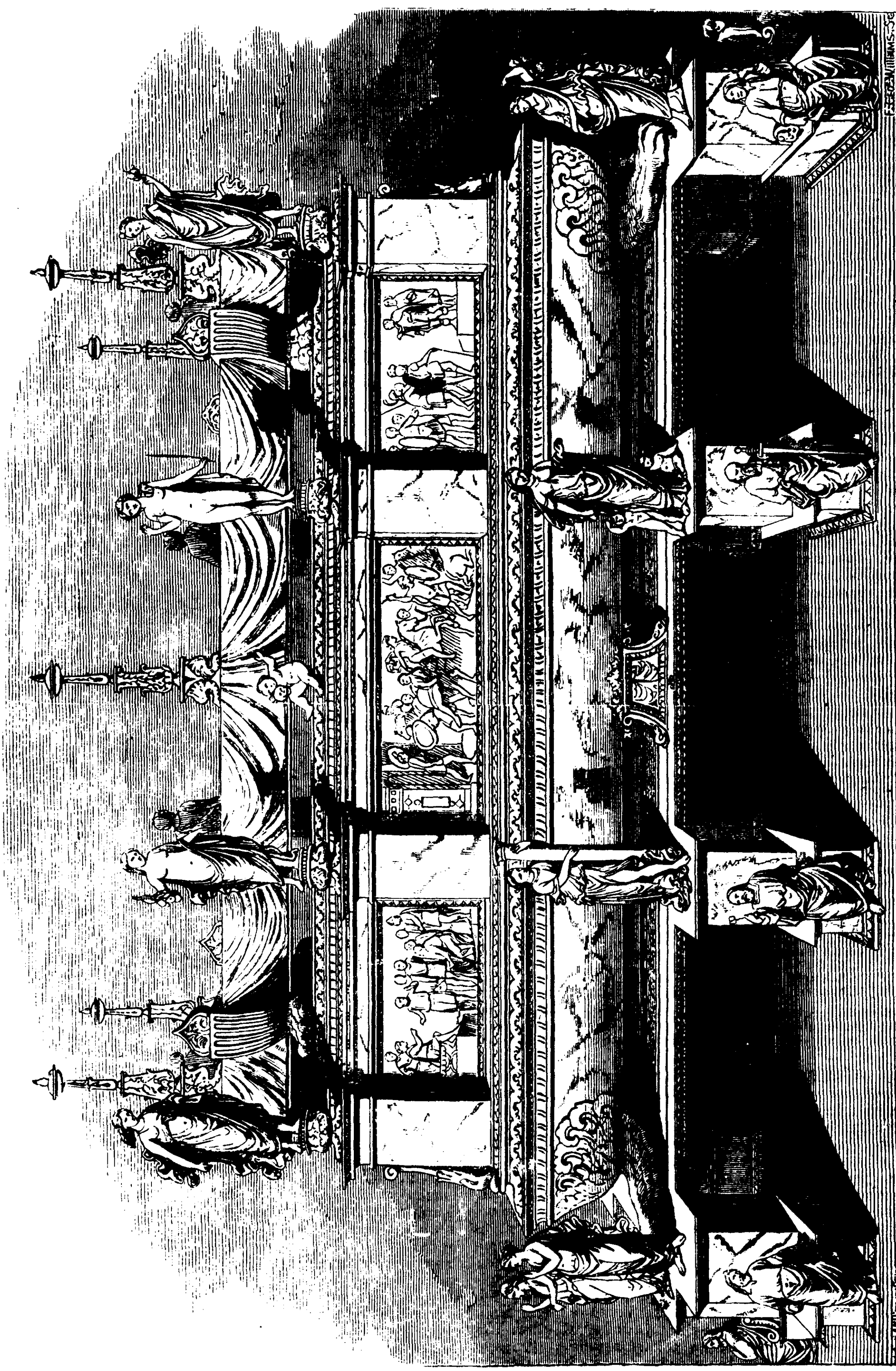
Turning now from the forms and performances of screws in actual practice, the author invites the attenion of the members of the Society to a different and more theoretical or experimental branch of screw propeller action, and he gives the following abstract of certain experiments instituted by Professor Osborne Reynolds, to investigate the causes of the phenomena of racing observable with the screw when at work. In a paper read by Professor Reynolds on this topic before the Institution of Naval Architects, in April, 1873, he remarks that the tendency which the screws of steamships have under some circumstances to lose their hold of the water, appears to have its causes enveloped in mystery, for although the circumstances under which this racing occurs are such as appear, *prima facie*, to afford an explanation of it as being due for instance to the pitching of the vessel, exposing the screw at certain intervals, yet a closer examination by lowering the screw to an angle with the ship's keel when in deep water, the connection with the engine shaft being made with a somewhat peculiar universal joint. When in shallow water the screw is raised so that the tip of the lower

WOMAN'S PAVILLION.—INTERNATIONAL EXHIBITION, PHILADELPHIA.





LECTURES TO LITTLE FOLK.—THE TOP.—(See page 123.)



THE MONUMENT OF GASTON DE FOIX.—By Agostino Busti, *Circa*, 1517.

blade is above the keel, but at sea the screw is dropped. The results obtained with this arrangement are said to be excellent.

The author now proceeds to the consideration of the second portion of his subject, namely, the shafts and fittings of screw propellers; about these he ventures to think there is still a good deal to be learned. The best form, as well as the best mode of fitting a shaft, which has to transmit on occasion the strain of engines exerting, it may be, 8000-horse power, deserves attentive consideration, more especially when it is remembered that the safety of much valuable property depends frequently on the trustworthiness of a screw shaft. The whole arrangement of these shafts involves some of the nicest questions of mechanical science. It is at all times a nice matter to centre truly a considerable length of shafting, even to a series of rigid supports, but the difficulty is greatly increased when, as on board a ship, the supports are not rigid, but yield with each strain and "working" of the vessel's hull. The author will refer to one out of numerous examples of the failure—first of a screw, and then of a shaft—illustrating the importance of this question. This was the case of the Atrato, which sailed from Plymouth for Australia, with some hundreds of emigrants on board, on the 17th September, 1872. On the 19th she returned with her screw broken. The damage was made good and she put to sea again, only to return again, however, about the 26th October with her shaft broken. Diagram No. 17 shows the general nature of the fracture. This second mishap gave rise to a lengthy correspondence between Messrs. James Watts & Co., who made her machinery, and the Board of Trade. By order of the House of Commons this correspondence was printed. Subsequently the Board of Trade sent a circular to all its marine machinery surveyors—thirty-two in number—requesting them to forward, in a tabulated form, the rules they adopted for calculating the diameters of screw shafts. This table, which can be seen in the printed report of the Board of trade, gives respectively the names of ships, the makers of engines, diameters of the cylinders, length of stroke, steam pressure, diameter of shafting abaft of the crank, and diameter of same as obtained by the rule the surveyor uses. Two columns of the table are bracketed together under the common head of differences between diameters of existing shafting in the vessels named and the sizes obtained by the surveyor's formulæ—the one column containing the amount less than existing shafting and the other giving the amount greater than the existing shafting in the respective vessels named. A list of thirty-eight ships was given. Some of the surveyors used respectively rules of their own, and of the remainder some used Rankine's, some Molesworth's and some Anderson's rules. The Table No. 11, gives a few of the more striking examples selected from these figures.

Atrato's Shaft.

Actual diameter of broken shaft	12 inches	
Proper diameter as computed by surveyors:—		
By Rankine's rule	13·7	"
" Anderson's rule	13·4	"
" Molesworth's rule	13·9	"
" Caird & Company's rule	13·4	"
" Mr. J. Rose, Hull Surveyor	14·0	"
" Mr. W. Wheatley, Cork	14·4	"
" Spencer's, used by Mr. Biped, Liverpool, Surv.	13·2	"
" Mr. G. Carlisle, Leith Surveyor	13·4	"
" Mr. R. Taplin, Liverpool Surveyor	13·2	"
" Mr. Snowden, London Surveyor	13·9	"

Particulars of the engines (compound): — Diameter of high pressure cylinder, 57 in.; diameter of low-pressure cylinder, 90 in.; stroke, 4 ft.; pressure of steam in boilers, 60 lb.; cut-off at about two-thirds stroke in small cylinder.

The sizes of shaft suitable for the Atrato's engines, deduced by the various surveyors, were from ½ in. to about 3 in. greater in diameter than the shaft which broke, and which was 12 in. in diameter; hardly any two surveyors however, found the same dimension. In the author's opinion, the probable causes of the fracture of total absence of any adequate torsional elasticity between the propeller and the engines. Hence, when the screw makes some revolutions out of the water, or it draws down air, then the engines race, and afterwards the screw may become suddenly and deeply submerged, throwing an abrupt strain on the cranks, causing the ship to tremble fore and aft, and some weak point in the shaft probably gives way, leaving the ship a helpless log upon the waves. In the author's opinion, two remedies present themselves for this evil; the one offering the prospect of greatly reducing the chances of fractures taking place and the other of repairing such fractures when they do come. The indicates that something more than this is requisite, the mere casual stripping of the screw being, in his opinion, not sufficient to account for the screw losing its hold of the water; citing as a proof of this the tendency that a screw displays to race in the smoothest water, if working against a great resistance, as when towing another vessel or even when starting its own. He states that his attention was attracted to this subject by the connection between the breakage or disturbance of the water surface, and the consequent admission of the air to the blades. He remarked that the screw never raced without getting air, and the admission of air was always followed by racing. With the view of satisfying himself on this subject he tried numerous experiments one of which was made with a model fitted first with a screw of a small diameter, and which had about 1 in. of water covering, and the other was with a larger one that had but ¼ in. of covering. When the boat was held still the small screw did not race whereas the large one did. In the opinion of the author, the tendency evinced by the thinly covered screw to race is due, not alone to the suction of the air, but also to the fact that any screw will race if it has not sufficient water to re-act upon, and as the resistance of the water must depend upon its solidity, so to speak, it follows that when a screw is near the surface of the water the column acting against the thrust of the screw becomes broken and the screw, losing resistance, races.

In the end of March, 1874, Professor Reynolds read a paper before the Institute of Naval Architects, on the effect of immersion on screw propellers, and he commented upon the results of two series of experiments — see Table No. 10 — made by him with a model screw 2 in. in diameter and caused to rotate by a spring.

Professor Reynolds' First Series of Experiments where same strength of Spring was used.

Number of experiment.	Depth of immersion.	Time taken to run down.	Remarks.
		Seconds.	
1	1	19	Did not race.
2	2	19	Do.
3	3	20	Do.
4	1	20	Do.
5	2	20	Do.
6	$\frac{5}{8}$	20	Do.
7	$\frac{1}{2}$	20	Race a little at starting.
8	$\frac{1}{4}$	12	Raced.
9	$\frac{3}{16}$	12	Do.
10	$\frac{1}{8}$	12	Do.
11	0	12	Do.
12	0	12	Do.
13	$-\frac{3}{8}$	10	Do.
14	$-\frac{1}{8}$	7	Do.

Professor Reynolds' Experiments. — Second set, where a stronger spring than in last series was used.

Number of experiment.	Depth of immersion.	Time taken to run down.	Remarks.
		Seconds.	
1	3	10	Did not race.
2	1	10	Do.
3	$\frac{5}{8}$	11	Raced at starting.
4	$\frac{5}{8}$	11	Do.
5	$\frac{7}{16}$	9	Raced intermittently.
6	$\frac{7}{16}$	9	Do.
7	$\frac{3}{8}$	6	Raced.
8	$\frac{1}{8}$	4	Do.
9	0	4	Do.

From the results of these experiments Professor Reynolds deduces that so long as the screw is not frothing but working in solid water, the resistance is independent of the depth of immersion, and he calls attention to the point that when a boat is stationary, there is a much greater chance of the screw drawing down air than when it is under way, illustrating his remarks by referring to observations made by him during a voyage on board the Palmyra, whose screw, although eight clear feet under water, frothed the water before there was "way" got on the ship, but did not do so once the vessel was in motion.

In reference to the question of the immersion of screws raised here, the author would call the attention of members to diagram No. 16, which shows Messrs. Harland and Wolfs' arrangement fitted to the Britannic, intended to furnish a deep immersion former method is to provide some elastic or flexible arrangement between the screw and the engines, so that each could have some movement independently of the other. Common sense dictates this, for the engine is subjected to one set of strains and the screw to another entirely different set, and these two are seldom or never in unison. Hence there are times when something between the two must give way, whereas, by allowing a little independent motion to the screw, the shocks and strains now so destructive would be avoided.

The introduction of torsional elasticity alone is not enough ; some longitudinal elasticity as well is wanted. The diagram Nos. 18, 19, 20 and 21 illustrate arrangements invented by the author some years ago, to provide torsional and longitudinal elasticity. The torsional is provided for by the cage of flexible blades between the two discs—See Fig. 18. The longitudinal elasticity is provided by arranging the thrust block in a pair of guides T, T, in which it can slide and bring the buffers P, P, to bear against the spring S ; while to provide against any violent recoil, the two air cylinders shown at B, are bolted at the stern or aft ends of the guides, and in these are pistons packed with cup leathers in such a way that no obstruction is interposed to the forward or thrust motion of the shaft. If a sudden stoppage or reversal of the engines takes place, then no violent recoil can occur, because the pistons encounter a cushion of air, and they can only recede as the air escapes through the two air cocks shown on the aft ends of the cylinders and these are so designed as to have a leakage space, so that the engineer can never perfectly close them, though he can regulate the degree of rapidity with which the air can escape. Diagram No. 19, shows a simpler plan of providing torsional elasticity than the foregoing, and is intended for steam launches and other small craft. It consists in forming an intermediate portion of the shaft of a single broad steel blade, which affords considerable torsional elasticity. The longitudinal elasticity is provided for by making a square box-end on the one part of the shaft, and a corresponding square end to fit it on the other part of the shaft; this latter bears against a buffer spring within the box ; a sectional view is shown on diagram No. 19. Diagram No. 22 illustrates a coupling invented by Mr. F. H. Varley and Mr. E. Furness to secure the same end. It consists of a box, into which is closely, but freely fitted, a species of piston or block, the one end of which is a simple plane, while the other, or outer end, is shaped as a spiral. The box A, in which it works is secured to one length of shafting, while to the corresponding length is fixed the boss B, which has a projection, the extremity of which has a spiral matching that on C. If undue strain comes on the shaft the spiral faces slip, and the block C, is forced up against a reservoir of oil, water, or air ; or else an elastic india-rubber cushion is interposed. The device is intended either for screw or for factory shafts.

That the principle of such arrangements as have just been described is sound has been demonstrated under severe test, and with great success. Mr. Jeremiah Head, of Middlesborough, has invented, and successfully applied, an arrangement for introducing torsional elasticity to prevent shock in reversing rolling mills. The arrangement consists in introducing cantilever springs, which are secured at their inner ends to a loose sleeve or box on the mill shaft, while their outer ends engage in projections on the wheels, so that when the clutch is shifted to reverse the movement, the motion is imparted, not through stiff and rigid studs, but through these, so to speak, flexible spokes.

As to the repair of shafts while at sea, the author is of opinion that if shafts were made of an oval section instead of a circular one, they could be more easily repaired. Some misapprehension seems to exist as to the author's meaning in advocating the use of over shafts, many persons supposing that he seeks to effect the rotation of an oval shafts in a bearing, which is an obvious absurdity. The author only proposes that shafts should be oval between the bearings, having proper journals at suitable points ; oval shafts when broken could be clamped without the need of cutting key-ways of drilling holes in the shaft, as an oval cannot rotate in the clamps, and because shafts break in the journal necks, he suggests that the entire shaft should be oval, and where a bearing is necessary, to put a steel sleeve—see diagram, Fig. 21—fitting the shaft, and having a circular outer face which may rotate in the bearing, when, if torsion break the shaft in the sleeve, the latter will transmit the strain. Several months ago a proportion for effecting the repair at sea of broken shafts was brought before the public by Mr. Cromwell Varley. The scheme consisted of a method of bolting and keying the pieces of a coupling box over the fracture, the weak point of the scheme being that key-ways, or flat places, must be cut on the shaft to prevent its rotating within the box without transmitting any torsional strain or power, which causes dangerous delay at sea in heavy weather. About December, 1872, the author proposed to place an ordinary coupling box on every length of shaft when first made, to run loosely on the shaft; and when a fracture took place this box was to be slid over the fracture, keyed and bolted up, making at least a good patch.

Diagram No. 23 illustrate a coupling invented by Mr. John G. Winton, of Edinburgh, for repairing broken shafts. He remarked in a paper read before the Royal Scottish Society of Arts, that as screw shafts are usually fitted just as they come from the steam hammer, the repairing coupling cannot be properly fitted. He allows an hour and a-half as the extreme limit of time for repairing a fracture on board a ship in a heavy sea-way. He proposed two different couplings, the one resembling Varley's, the other being represented in the diagram. The former was to be made in halves, and strongly bolted together, so tightly as to bind the shaft sufficiently to take a part of the torsional strain, while cupped set screws, biting into the shaft, took the rest. The coupling in the diagram, and which does not come at all in contact with the shaft, depending entirely on the set screws, is the second scheme.

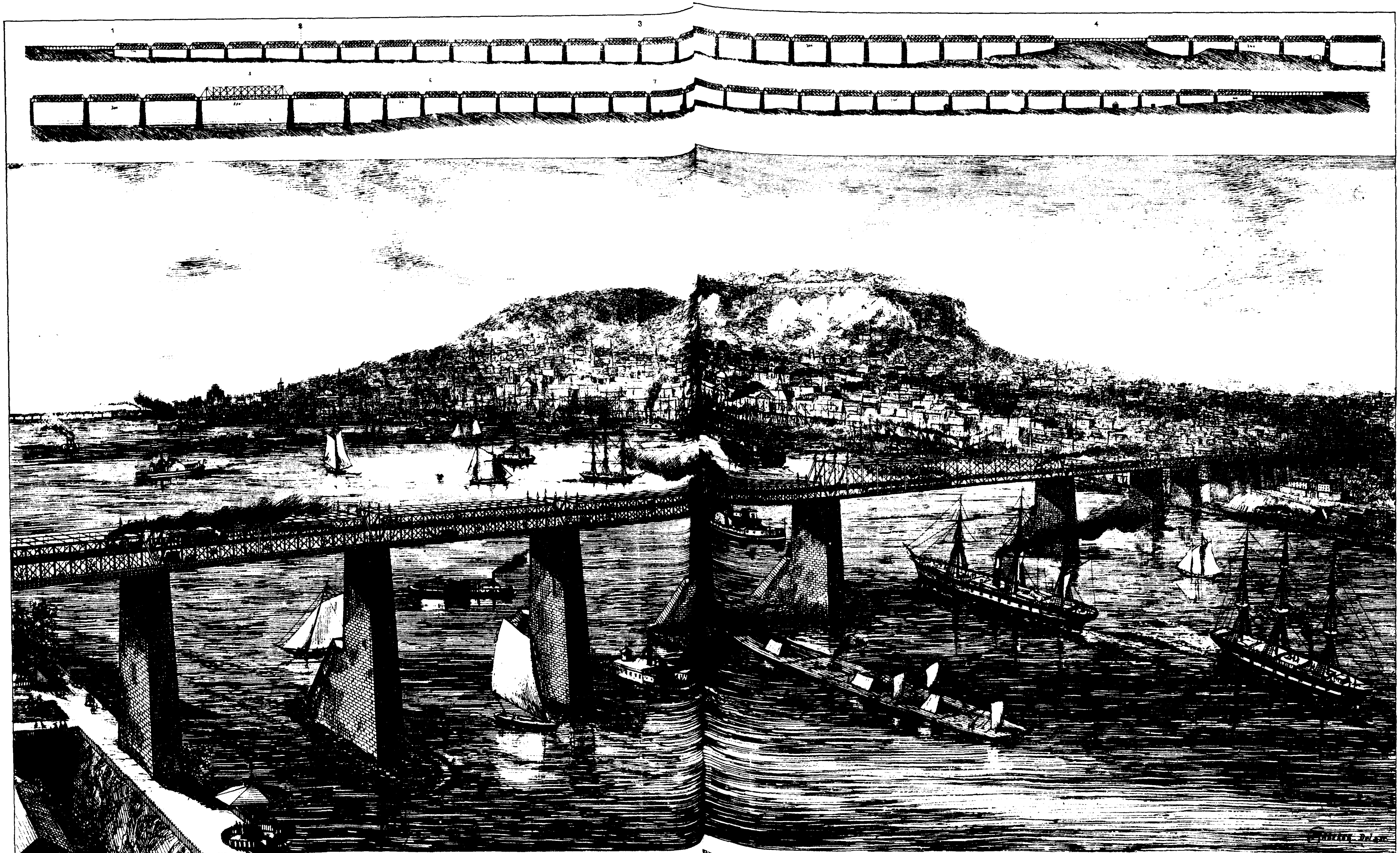
In reference to the strength of screw shafts, it may not be out of place to give the opinion of a gentleman of large experience. Colonel Clay, of the Birkenhead Forge Company, states that it is at present difficult to obtain first-class material for heavy shafting, a fact in a great measure due to modern methods of making and refining iron, the use of raw coal, combined with a hot blast, contributing to this. The Jeddo was, some years ago, very unlucky, breaking two shafts in quick succession. A Krupp steel one was then tried, but it only lasted a few weeks, and was found by subsequent test to be too "steely" and brittle. A puddled steel one, supplied by Colonel Clay, was next fitted, which lasted well.

An interesting example of what may be done by a skilful engineer under difficulties is supplied by the following case :— The Ethiopia, a first-class Atlantic steamer, quite recently broke her shaft on her voyage to New York, when about 1500 miles from port, and the fracture was repaired at sea in the manner shown in the diagram No. 26. The shaft is 15 in. in diameter, and the fracture was a simple diagonal one. The broken parts were raised by jack screws, the edges smoothed, and a 4 in. hole bored through the opposing portions, into which a bolt was tightly fitted. Four steel drivers 4 in. long, 1¼ in. broad, and ¾ in. thick, were sunk into the shaft, flush with its surface, just across the line of fracture. The whole was then tightly clamped by hoops bolted on the shaft. The vessel prosecuted her voyage safely to New York, and is to come home as she is for repairs, the shaft being considered reliable for the voyage. The repairs occupied eight and a-half days, working night and day. Of course this could not have been done in heavy weather.

The author's scheme for repairing broken shafts is shown on diagram No. 21, and diagram No. 21A, shows an oval shaft with a separate steel journal neck ; this latter receives no torsion till the shaft fail within it, when *it* at once transmits the power past the fracture. Diagrams Nos. 12 and 13, are tables of fractured and defective shafts. The one table No. 12 gives particulars of shaft actually broken at sea, and the ages, mileage and materials are all given, as well as the place and description of fracture. Table No. 13 gives similar particulars of shafts found on examination to be faulty, and therefore condemned.

The data were collected by Mr. Cameron, of the Wilson line of steamers, during his professional career.

In conclusion the author desires to summarise the foregoing paper by observing that the question of screw propulsion appears to him to depend, so far as the screw itself is concerned, not so much upon any particular form or number of blades fitted to any given propeller, as to the due adaptation of them to the lines of the particular vessels being fitted ; that it is a mistake, and causes much needless complication of a subject already difficult, to confound or mix up the economical performance of engines with that of screws ; that the performance of a screw cannot be measured truly without taking account of the form of hull, engines, and screw cannot be alone determined on the basis of the quantity of coal burnt per mile, but that the proportion of dead weight to paying load and also the maintenance cost must be taken account of. Propellers with more than two blades appear to cause the least vibration, and to some extent give a ship a greater margin of safety than the two-bladed screw, because each additional blade is an increased reserve. The author also—while admitting that great progress has heretofore been made in the development of the system of propelling vessels by means of the screw—is of opinion that there are still points of obscurity that need to be cleared up.



BIRDS EYE VIEW, AND ERAL ELEVATION OF THE

ROYAL ALB RT BRIDGE,

Proposed to be erected acros ver St. Lawrence at Montreal.

CHARLES LEGGE ESQ. E., CHIEF ENGINEER.

REFERENCES TO PLAN OF ELEVATION :—1. Terminus at St. Lambert ; 2. Longueuil and St. Lamb and 3. St. Lawrence River, South Channel ; 4. St. Helen's Island ; 5. St. Lawrence River, Main Channel ; 6. St. Mary Street ; 7. St. Catherine Street ; ario Street ; 9. Terminus at Sherbrooke Street.

DIMENSIONS : Total length between Termini : 15.500 feet.
Height of same-over summer level of St. Law 130 feet.
Length of Span over Main Channel : 550 feet.
Total number of Spans : 61.

TABLE 12.—*Crank Shafts Broken at Sea.*

	Dimensions of cylinders and stroke.	Pressure on boilers.	Diameter of journals and crank pins.	Strokes per minute.	Indicated horse-power	How long at work when it broke.	How long at work when removed.	When fractured.	Average annual mileage.	Total mileage.	Material.	
		lb.	in.			years.						
1	40x40 / 30	25	9	48	430	7	..	After crank fore-arm.	33,600	235,200	Iron	Steaming with one engine, and got into port.
2	45x45 / 36	25	9¾	54	540	8	..	After crank after-arm.	36,000	288,300	Iron	Towed forty miles into port: paid a salvage claim.
3	38x38 / 30	15	8¼	65	275	no date	..	After crank pin......	25,000	..	Iron	Able to work engines slowly, so got into port.
4	40x40 / 42	10	9¼	40	250			Close inside crank up journal...........	22,000	..	Iron	Straight shaft, cranks overhang driving wheel in centre; this ship very heavy on her shafts, breaking them generally close inside cranks. She broke her shaft and crank pins several times, but it is so many years since that I cannot give any particulars. The engines now broken up; always got on without assistance.
5	40x40 / 30	20	8½	57	520	7	..	After crank arm......	21,000	147,000	Iron	Towed 500 miles: paid salvage claim.
6	28x56 / 30	60	9½	66	420	6	..	Fore crank arm......	25,000	150,000	Bessemer steel	Broke in pilot water, so only engaged a tug.

TABLE 13.—*Crank Shafts which have shown Defects, but not Broken, having been Changed in Time.*

	Dimensions of cylinders and stroke.	Pressure on boilers.	Diameter of journals and crank pins.	Strokes per minute.	Indicated horse-power	How long at work when it broke.	How long at work when removed.	When fractured.	Average annual mileage.	Total mileage.	Material.	
1	36x36 / 30	20	8	54	300		5		22,000	110,000	Scrap iron	No information.
2	31x58 / 30	65	8⅞	57	528		5	After crank arm......	22,000	110,000	Bessemer steel	Still at work with strap on, cracked across round the fillet of crank pin.
3	38x76 / 36	60	12	57	888		4	Fore crank pin.......	22.000	88,000	Puddle steel	Cracked around fillet, put in 4 in. bolt through, and ran it some months, but eventually took it out, retaining it as spare.
4	32x60 /	70	10	57	590		4¼	Fore arm or after crank	32,000	136,000	Bessemer steel	Cracked about mid-way between the crank pin and the shaft.
5	32x60 / 33	70	10	57	599		4	Across fore crank pin.	34,000	136,000	Scrap iron	Cracket across fillet, but only about one-third the circumference of the pin between the jaws.
6	40x72 / 42	70	11¾	53	1020		1¾	Second fore bearing, oblique crack.......	52,000	90,000	Scrap iron	Turned the shaft round, so that the defective bearing had no work to do. Carried as spare.
7	24x48 / 30	70	8½	65	350		4	Both centre bearings, longitudinal........	25,000	102,400	Scrap iron	Heated the shaft, and cut into it, and found the defect to extend a very long way into shaft. Of course, condemned at once.
8	32x60 / 33	70	10	58	610		2	Second fore bearing, longitudinal	36,000	72,000	Scrap Iron	Not unserviceable, carried as spare.
9	32x60 / 33	70	10	57	590		2¾	Second fore bearing, longitudinal.........	35,000	96,250	Scrap iron	Not unserviceable, carried as spare.
10	33½x57 / 36	70	10¾	57	700		2¼	Second fore bearing, transverse crack	45,000	101,250	Scrap iron	Not unserviceable, carried as spare.
11	47x90 / 50	65	14½	47	1710		1	After main bearings, longitudinal	48,000	48,000	Scrap iron	Not unserviceable, carried as spare. This will reverse, so that the defect is at fore part.
12	35x68 / 42	65	11¼	48	900		3	After main bearing, longitudinal........	36,000	110,000	Scrap iron	Not unserviceable, carried as spare. This shaft is reversible, so that the defect goes forward.
13	44x78 / 42	75	14	54	1410		2	After crank fillet journal..................	—	84,280	Scrap iron	This is a faggot mark, running lengthwise of the bearing, and nearly straight through crank web, but the shaft is made to reverse, so it is still as good as a new shaft when turned round end for end.

Hull, 19th August, 1875.

JOHN GEO. CAMERON, Managing Engineer, Wilson Line.

BLASTING IN MINES.

At the monthly meeting of the North Staffordshire Mining Institute, at Stoke-upon-Trent, on Monday evening, Mr. James Ashworth, of Bursdem, read a paper on gunpowder, and after explaining the effects of various explosives now in use for blasting purposes in mines, remarked that it was impossible to work mines profitably without using some blasting compound. Blasting could not be entirely abandoned either in steep coal-seams or in ironstone mines, whether they gave off explosive gas or not, without increasing the risk to miners' lives in the first instance, and such a largely augmented cost in the second instance as to render their working so unremunerative that their abandonment would be a necessary consequence. The question then arose: What blasting agent should they use? If they use a nitro-glycerine compound they lessened their risk of fire in one way to increase it in another by the conclusion of the air stirring up the fine coal-dust and forcing the flame of a safety lamp through the gauze. On the other hand, in the much-abused gunpowder—carefully prepared, and composed of ingredients which on ignition produced carbonic and gas, and of such density and size of grain as would cause the least possible concussion of air—they had, after all, the surest, safest and best agent for their requirements. Where blasting was necessary in mines giving out fire-damp it ought to be done when the bulk of the men were out of the pits, and the holes should be charged by the fireman in order against the current of air—that is, commencing at the spot nearest the upcast, shaft, and, when practicable, using a detonator fired by electricity.

Mr. Glennie, of Birmingham, alluding to Curtis and Harvey's E. S. M. powder (which Mr. Ashworth had spoken of as the best and strongest that could possibly be manufactured), said he witnessed, about eighteen months ago, some experiments with it in Wales, and he believed 30,000 tons of rock were brought down by one charge. Mr. Ashworth said he advocated the E. S. M. powder for stone-getting, but for coal-getting he preferred a denser and better-prepared black powder, which would form carbonic acid gas on explosion.

STORED AIR AS A MEANS OF PROPULSION.

A paper bearing the above title was read before the Royal Scottish Society of Arts at Edinburgh, by Mr. W. D. Scott-Moncrieff, Glasgow, on Monday night.

The reader commenced with an elaborate outline of the history of pneumatics from the earliest times, leading up in our present knowledge of air as a means of motion, after which he proceeded to describe the particular method by which scientific apparatus could be made to take advantage of known facts in regard to air. This, he showed, could only be done by utilising the inherent elasticity of the air, which had its dynamical equivalent to heat, when connected with power. Any means employed had of course to be consistent with the conditions of a locomotive in which the available power was constantly changing. Passing on to describe in detail an arrangement of valve gear which he had invented, and which, he submitted, had taken advantage of these conditions, by means of a model he illustrated and explained the application of this arrangement as applied to his tramway car, with which recent experiments have been made in the streets of Glasgow. A marked feature of the invention was shown to be an arrangement by which the valve varies automatically with the varying pressure of the locomotive. Comparing air with steam as a motive power, Mr. Moncrieff remarked that there could be no objection, on sanitary grounds, to the use of the fluid, which we were breathing every day, and on which we were dependent for life. The air, when compressed by a mechanical contrivance, performed its work, and came out of the apparatus as pure as it went in. Considered from an economical point of view, he had no doubt it was much cheaper than steam. By erecting a pumping station, the machinery of which would probably cost £2000, the tramway cars could be charged at the rate of from 700 to 800 car miles per day, and the time occupied in filling the receivers with air would be between two and three minutes. His own car, he stated, had been running for the last eight months without the slightest trouble of any kind. On the whole, the vehicle exactly performed the journeys he expected of it in point of speed, and he hoped before long the poor horses, at present the subject of so much justifiable consideration, would be greatly relieved, if not quite dispensed with, for tramway traffic.

Various questions having been put by members of the society, Mr. Moncrieff, in reply, explained numerous points of detail in connection with his invention. He mentioned, for instance, that the speed attained by his car averaged seven miles per hour, but by the principle being adapted to a railway line a speed of twenty or twenty-five miles might be accomplished. He expressed the opinion that for the purpose of railway traffic his principle would be cheaper in its application than an ordinary locomotive, and would be well adapted for branch lines where there were few trains, though it would not be workable, he admitted, on lines where the traffic was heavy.

Mr. Cadell, of Grange, remarked that in mining the principle under consideration had been pretty extensively applied. A tube with compressed air carried down a shaft worked either machinery or pumps. In carrying air down a shaft, too, it contributed to its ventilation, whereas, if steam were employed they had to bring up the waste steam again or condense it.

Mr. Moncrieff, having answered various other questions, Mr. Lees expressed almost unqualified satisfaction with the invention, and expressed his belief that when a few possible improvements were carried out, the contrivance would be a perfect one. Mr. Sang, (secretary) also passed a favourable opinion upon it, after which the whole subject was remitted to a committee to consider and report upon it.

FLEXIBLE MANDREL FOR BENDING METAL PIPE.

We are always ready to call the attention of mechanics to any invention likely to prove of utility. In our advertising sheets in this Number we illustrate a Flexible Mandrel for bending Metal Pipe which has recently been patented in Canada—by the inventor Mr. Morris L. Orum, of Philadelphia.

The mandrel consists of a coiled or spiral spring, made of square steel wire, and of such size as to be inserted freely into the pipe to be bent.

Pressure may then be applied in any convenient way, but preferably it should be done with a block of wood shaped to the curve to which it is desired to bend the pipe, its edge being grooved to fit the outside of the pipe.

After the bend is made the mandrel is withdrawn by turning it from one end in the direction in which it wound, which slightly reduces its diameter, and it is *screwed* out very easily.

The old method of bending copper or brass pipes by first filling them with rosin, lead or sand, is tedious and uncertain, requiring much skill, especially for large pipes and the crimping of the inner side and stretching of the outer sides were very unequal. By this method the pipe was always considerably flattened and required hammering and filing into shape.

By using a flat plate above and below the mandrel, square pipes are bent with the same ease as those of circular section. The spiral mandral is taken out first, and then the plates are easily withdrawn. The rapidity and ease with which bends can be made with this mandrel is quite remarkable. A half turn has been made, in a 1¼ inch copper pipe, in five minutes, the radius of the circle being twice the diameter of the pipe. The quality of the work in this instance was all that could be desired, the pipe being smooth both inside and out, and not requiring any more finishing than a piece of straight pipe would. Bends of this kind can be made at any point in a pipe with the same case as at the end.

Mandrels are at present made for bending pipe up to 5 inches in diameter, and this size is in course of preparation. The operation of bending is a very simple one, the mandrel being inserted with a key into the pipe at the proper point, and the pipe bent around a grooved block by means of a press or by hand, according to the kind and size of pipe.

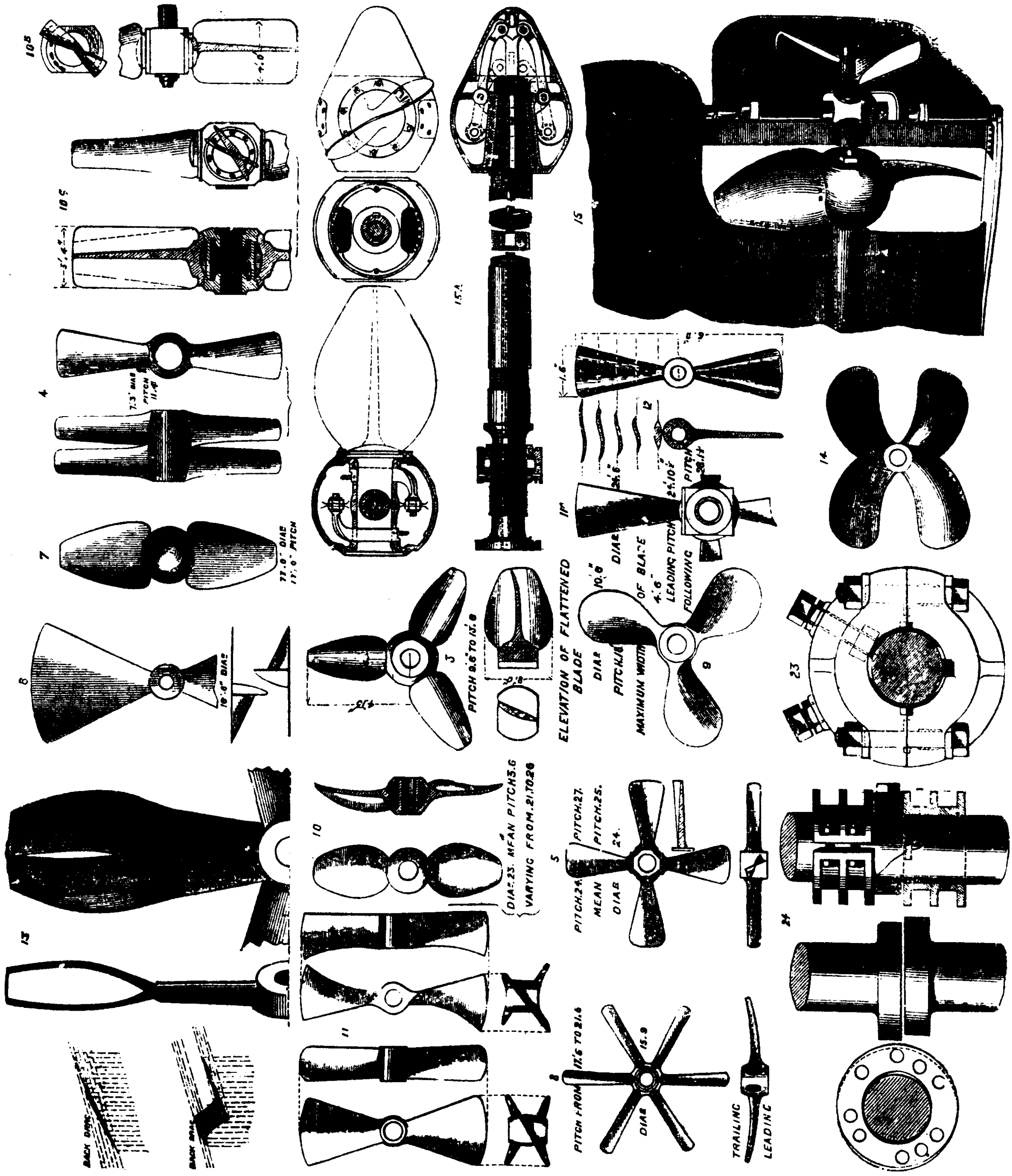
An objection has been raised to this method of bending pipes, viz.: that whilst the outer circle becomes stretched and made thinner the inside one is contracted, and, an extra thickness given where it is not required, but we look at this objection as more theoretical that true in practice; the thinness produced by the tension of the metal on the outer circle of bend is hardly appreciable. The surface is smooth and even, and the pipe is far less weakened, and the work is performed in one-twentieth part of the time than by the old process, and persons with much less skill can view the work.

Any one interested in plumbers' work can see a sample at our Office.—Editor C. M. M.

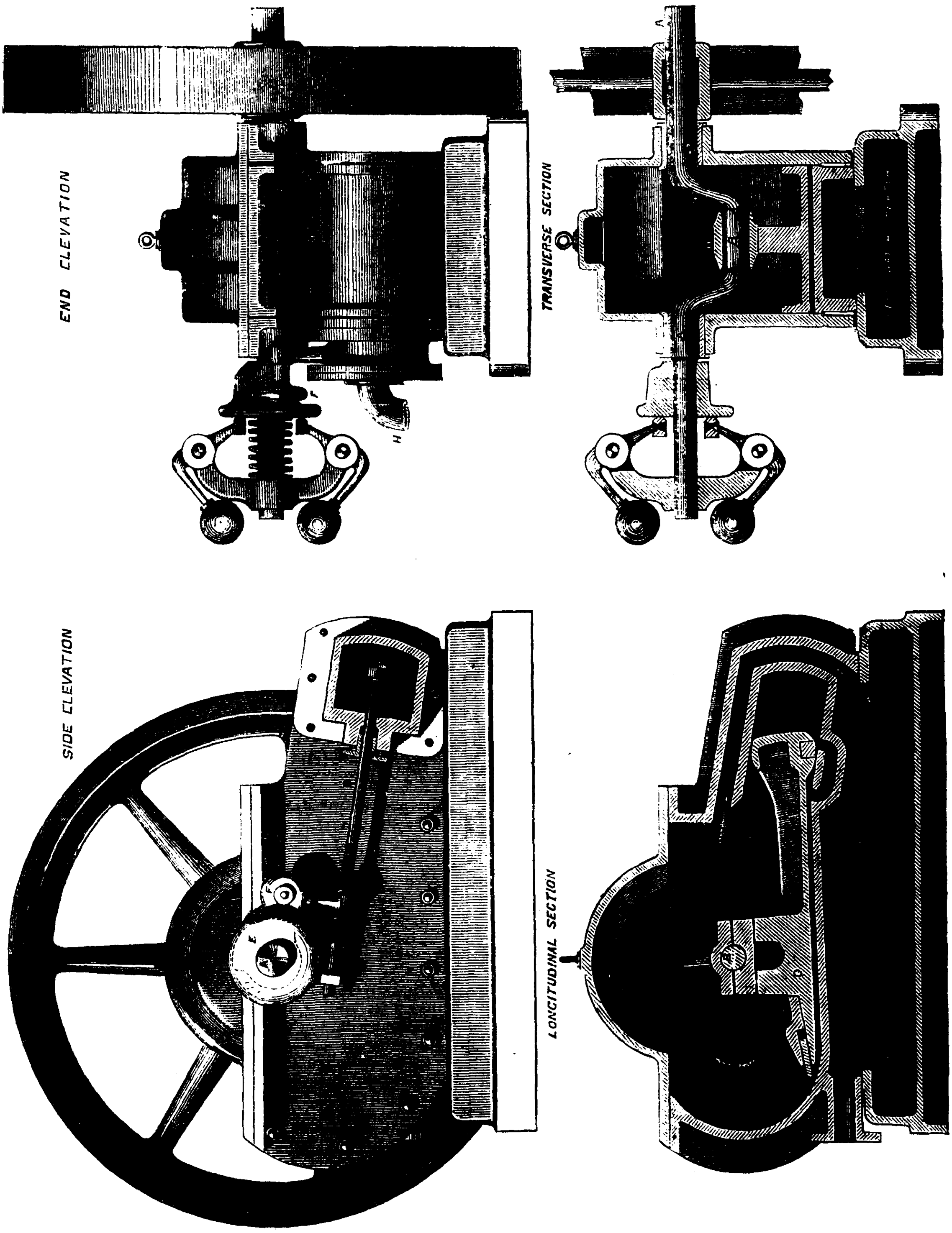
Still Another Mammoth Engineering Project. — The union of the Black and Caspian seas is in contemplation, and a project for the construction of a canal 750 miles in length for that purpose is said to be finding much favor in St. Petersburg and Moscow.

SCREW PROPELLERS SHAFTS AND FITTINGS.—(See page 99.)

Continued from page 80, March Number.



HIGGINSON'S SEMI-ROTARY ENGINE.



HIGGINSON'S SEMI-ROTARY ENGINE.

We illustrate in the previous engraving one of the most curious engines, perhaps, ever invented. Roughly speaking, Mr. Andrew Higginson, a Liverpool engineer, has converted a connecting rod into a piston. The engine is, however, very simple, and will be easily understood from the engraving. A is the crank shaft, B crank pin, C piston, D valve, E cam, F cam wheel, G valve spindle, H supply pipe. The steam is admitted on the face of the piston C at D by the small valve *d*, which is worked by the cam E, the governor working in such a way that the full boiler pressure is always admitted on the face of the piston. The piston moves in the direction of the arrows. The advantages claimed for this engine over the ordinary piston engine are—half first cost; occupies less than half the space; is governed expansively in an extremely efficient manner; and that there are fewer wearing parts.

BRONZE DOORS, BUENOS AYRES.

(See page 112.)

We copy from the *London Builder* some bronze metal doors which had been completed by Messrs. Bunnett & Co. (Limited), New Cross Works, for the Hypothecary Bank of Buenos Ayres. They are all double-leafed, the upper portion being fixed. The size of the largest is 18 ft. 8 in. by 8 ft. 7 in., and the weight of each five tons.

The design is rich and massive; the thickness of the meeting stile is 10¼ in. The method adopted was to cast each leaf in one plate, only $\frac{8}{61}$ in. thick, the ornamental panels being afterwards secured to it in such a manner that neither screw nor rivet head can be seen from the front, and having the appearance of one casting, enabling the various mouldings to be undercut, and giving to each a clear and sharp outline. The casting of these bronze-metal plates, each about 14 ft. 6 in. long, 4 ft. 6 in. wide, and $\frac{3}{16}$ in. thick, was accomplished in the new foundry each time successfully,—an operation, considering the large size and extreme thinness, necessitating great care and ability.

The doors are hung to the frames by six pairs of hinges to each leaf, with steel washers and pins; and, to prevent any deflection, a gun-metal roller, with steel axle, is fixed under the bottom of the meeting stile, working on a fixed quadrant, and, notwithstanding the immense weight, they can be opened and shut easily by a boy. There are six bolts to each door, which are secured thereto by means of a combination lock from the inside only; the end of each bolt is fitted internally with a steel roller, so that any attempt to cut the bolt would be defeated.

The whole of the enrichment is highly chased, relieved, and burnished, giving a rich appearance. The cost of patterns, models, and enrichment was, of course, considerable, the whole being made from brass patterns.

THE GERMAN LUTHERAN CHURCH, DALSTON.

On page 113, we give an illustration of the above new church. It is of brick, in the old Germanic Gothic style, and consists of a nave, chancel, and transepts, and has a tower and spire between the transept and nave on the south side. The principal entrance is from the Alma-road, and beneath a rose-window, which is the most prominent feature of the front. The seats are of oak, and provision is made for about 300 worshippers. The roof of the nave and transepts is of open timber, and that of the chancel is arched and boarded. The church is 79 ft. 6 in. long internally, the nave is 28 ft. 3 in. wide, the length of the transepts being 49 ft. across. The tower and spire are 136 ft. 3 in. high to the top of the metal cross.

NEW PROCESS OF COLOUR-PRINTING ON PAPER, LEATHER, &c.

M. J. P. Daguzan has invented a composition to replace the colouring matters usually employed in printing on paperhangings, leather, &c. The basis of the composition is caoutchouc in its natural state, which in certain cases may be replaced by gutta-percha or other natural gums. The base is reduced to a paste with benzine, and some organic colouring matter added in the requisite proportion. In practice feather-dust or fine clippings of wool, silk, &c., dyed to the desired tint, are used, but other colouring matters may be substituted if necessary.

STRENGTH OF RAIL JOINTS.

The plan of punching proposed, and the distance apart of joint sleepers, is shown on the drawing, being that ordinarily used for flange rails, on which it is seen that the deep stem of the fish-plates abuts against the sleepers, and prevents the road from travelling without notching the rail flange, but, of course, a greater distance between the joint sleepers might be used to compensate for the extra 10 per cent. of stiffness beyond that of the rail if necessary for stopping. As for strength, experiments No. 4 and No. 30, both on 2 ft. supports, show a load of 35 tons with more deflection on the rail than on the joint, proving a slight superiority of the joint, even in this respect best shown by the fact that the bolts were not the least hurt after such an extremely heavy test. The fish-plates might be made of either steel or iron, but in the former case they should be punched hot, or well annealed after punching cold.

The small extra cost of this improved fish-joint, judging from the results of these experiments, will be recovered over and over again by less cost of maintenance of permanent way, longer duration of the rails, particularly iron, and less wear of rolling stock, as well as greater comfort to travellers by obtaining one continuous line.

It would also involve another vital improvement, viz., the prevention of breakage of the rails through the bolt holes even when punched. No doubt this is caused by the weakness of the present fish joint, causing it to sink down under the engine, resulting in a blow from the bolts to the upper part of the holes in the rail. Such would not be the case with these stiff fish-plates, and the drilling of the bolt holes which is now so often insisted upon, particularly for steel rails, to a great cost and inconvenience to the maker, might then be done away with.

It is to be hoped that practical experience will bear out the result of these trials; at any rate, it will not be long before results on the road, whether good or bad, will be obtained, for same of these deep fish-plates are already made, and will have a fair trial on one of the best Government railways in Europe.

Meanwhile any information on the subject would be most thankfully received, and it should be distinctly understood that the author has no pecuniary interest whatever in the introduction of this deep fish-plate, but only wishes for the best pattern so as not to be blamed for the short duration of the rails through supposed faults in the manufacture or inspection, when the ordinary fish-joint is the real cause, and is also the weak point in the construction of the permanent way.

EXPERIMENTS ON STRENGTH OF RAIL JOINTS.

Description of Rail and Rail Joints.	Number of Experiment.	Distance of Supports.	Load in Tons. Dead Weight.	Deflection in Millimetres.	
				Temporary.	Permanent.
		ft.			
SOLID IRON RAIL.	1	3	16	2	0
67 lb. per yard flange. Section	2	3	18	3	0
4 ⅞ in. high by 4 ¼ in. broad,	3	3	20	4	1
15 deg. fishing angle. Fig. 1.	4	2	35	5	3
SAME RAIL SECTION.					
Ordinary fish joint. Fish-plates	5	2	9	2	0
18in. long, ⅞ in. thick. Fig. 2.	6	2	11	3	1
SAME RAIL SECTION.					
Fish-joint, French pattern.	7	2	12	2	0
Fish-plates 18 in. long, ¾ in.	8	2	15	3	1
thick, used with base plate	9	2	20	3	1
suspended joint. Fig. 3.					
SAME RAIL SECTION.	10	2	10	1	0
Fish-joint with ordinary fish-	11	2	11	2	0
plate on one side, deep fish-	12	2	12	2	0
plate on the other. Both	13	2	13	2	0
18 in. long. Deep fish-plate	14	2	14	2	0
¾ in. thick at the top, ½ in.	15	2	16	3	1
thick at the bottom. Deep	16	2	18	3	1
flange 3 in. below rail flange.	17	2	20	4	1
Fig. 4.	18	2	22	5	1

EXPERIMENTS ON STRENGTH OF RAIL JOINTS.

Description of Rail and Rail Joints.	Number of Experiment.	Distance of Supports.	Load in Tons. Dead Weight.	Deflection in Millimetres. Temporary.	Deflection in Millimetres. Permanent.
SAME RAIL SECTION. Fish-joint with two deep fish-plates 18 in. long, same as above. Figs. 5, 6, and 7.	19	2	12	2	0
	20	2	14	2	0
	21	2	15	2	0
	22	2	16	2	0
	23	2	17	2	0
	24	2	18	2	0
	25	2	20	3	0
	26	2	20	3	½
	27	2	22	3	1
	28	2	25	4	1
	29	2	30	4	1
	30	2	35	4	2
SOLID IRON RAIL. 66 lb. per yard. Flange section 4¾ in. high by 4 in. broad in flange, fishing angle 30 deg.	31	3	18	3	0
	32	3	20	5	1
SAME RAIL SECTION. Ordinary fish-joint 18 in. long, fish-plates 11/16 in. thick.	33	2	8	2	0
	34	2	9	3	1
SAME RAIL SECTION. Fish-joints, French pattern, fish-plates 18 in. long, ¾ in. thick.	35	2	11	2	0
	36	2	12	3	1
	37	2	12	3	1
	38	2	15	3	1
	39	2	20	4	2
SAME RAIL SECTION. Fish-joint with two deep fish-plates 18in. long, ¾ in. thick at the top, ½ in. thick at the bottom.*	40	2	18	2	0
	41	2	20	3	0
SOLID IRON RAIL. 56 lb. per yard. 4¼ in. high by 4 in. broad in the flange, fishing angle 15 deg.	42	3	14	2	0
	43	3	16	3	1
SAME RAIL SECTION. Ordinary fish-joint. Fish plates 18 in. long, ¾ in. thick.	44	2	6	2	0
	45	2	7	3	1
SAME RAIL SECTION. Single deep fish-joint.	46	2	11	2	0
	47	2	13	3	1
SAME RAIL SECTION. Double deep fish-joint.	48	2	16	2	0
	49	2	18	3	1
	50	2	02	4	2

RAIL TESTS.—When we consider that there are 125 tons of rails and 64 tons of chairs used in each mile of single-line railway the importance of rail tests will be apparent. The usual modes of testing rails are :— 1. Dead central weight, or static test ; 2. Dynamic, or test be impact ; 3. A combination of first and second —first by the central and afterwards by the falling load ; 4. Chemical or acid test ; 5. By rolling weight. To these might be added that of torsion, or twisting. It should be borne in mind that tests ought to be such as can at all times be easily applied, and not to cause unnecessary inconvenience to the contractor in carrying out his contract. Climate has great influence upon rails, for in tropical countries a comparatively hard rail might be employed, and a greater amount of duty might probably be obtained than from a softer rail. In practice, any sleeper may be badly packed, or decayed, so as to offer little resistance ; therefore it follows that a rail to be safe should not brake or take a permanent set under the weight of an engine. If every other sleeper were taken away, thie would always give a bearing at which to the test rails for different lines or gauges. A good steel rail, as used on the English railways, will deflect about 3-16th of an inch in a span of 6 ft., when a locomotive engine is passing over it. Taking the tests *seriatim*, it seems to me that the test by a falling weight is more to detect brittleness than a test of deflection, and being a destructive one only 1 or 2 per cent. of the quantities are tested, and the rest of the turn is supposed to be like them. For the test of brittleness, it has been suggested that a good method would be to drop rails from a given height on to a hard platform, which would certainly detect any *cold short* ones. To detect brittle rails is certainly most important ; yet it is difficult to imagine how the loads passing over rails come with the suddenness of a blow from a test monkey. Some engineers say the endeavour to ascertain whether a rail has sufficient toughness by submitting it to the action of a falling weight is most deceptive ; the test goes as far beyond the mark as that by a dead weight falls short of it, because it requires an amount cf toughness which is quite unnecessary, and inconsistent with a proper degree of hardness. Dead central weight tests determine the strength of a rail as a girder, and are adopted by some engineers, who consider nothing so good as the simple application of gradually-increasing bending stress to the centre, the deflection and set being noted after each successive increment of stress. These tests being usually made upon bearings varying from 2 ft. 8 in. up to 5 ft. and 6 ft., it is a question whether the amount of deflection shown by so short a length of rail without being damaged by a permanent set is not too small to be accurately measured ; and the difference of the deflection which would be exhibited by a short piece of very good iron and a similar piece of very bad iron would at any rate be too small to afford any certain gauge of its qualities. It would seem that a double test of dead weight and afterwards by impact, is a severe and, one would think, a satisfactory one, and, unlike a chemical test, is simple, quick, and inexpensive ; it severely tests the qualities of material and workmanship. Some engineers adopt this method, and though these tests are not designed to represent the wear the rail would have to undergo, yet they are, combined, the safest and simplest that we are at present able to apply. The acid test is made by cutting off a slice from the end of a rail, and, after polishing, immersing it in a dilute acid, which eats away all impurities, leaving a lot of cavities and furrows, thus showing up the fibre or grain of the metal very plainly. With most metals chemical analysis is in itself a complete and sufficient test of quality, but not in steel. The toughness of steel may be altered by sudden cooling, and although the effect of this operation, and generally the effects of tempering, are greater when the quantity of carbon is considerable, yet it acts more or less in the mild qualities of steel, so that we cannot rely entirely on the aid of the chemist, but must fall back on mechanical tests, which prove not only the material, but the workmanship. The rolling-weight test is made by heavy rollers fixed in a frame-work and radial bars connected to a central boss after the form of a turntable ; motion is imparted to a central vertical shaft by means of shafting and wheels underneath, which is driven by steam-power. It can be made with or without springs ; without springs the test is more severe, but by using springs the rollers may be lightened and greater weight thrown into the frame. The rails to be tested are formed into a circle or polygon, supported on sleepers packed with ballast in the usual manner. If the rails are bent into a circular form, Mr. Price, the patentee, says in his experience the texture of the iron is of no moment, provided the rails are bent at a dull red heat, but they may be arranged as a polygon, which plan possesses the collateral advantage that the rollers wear more evenly over their entire surface. Rails weighing 86 lb. per yard are tested by a dead weight produced by hydraulic pressure. A piece of the rail is placed upon 5 ft. bearings, and a slightly curved iron surface 3⅞ in. in width is made to press upon the centre of the rail. The test is that under these conditions a pressure of 40,000 lb. shall not deflect the centre of the rail more than 1 in. ; also that 60,000 lb. shall deflect it 9 in. without breaking it. The following are tests for iron rails 75 lb. per yard :—1. Each of these rails placed on two supports, 3 ft. 8 in. apart, muft catry for five minutes in the centre between points of support a hanging weight of 12 tons, deflection 0·15 in. as a maximum, and when the weight has been taken off the permanent set must not be more than 0·04 in., or 1 millimètre, and on condition that at the second placing of the same weight the deflection does not increase more than 1-150th of an inch or 1-5th of a millimètre. 2. Each rail in the same position must carry also for five minutes without breaking a weight of 30 tons ; then, having nicked the surface of the head, it shall be tested to breaking by the blows of a tup 648 lb. weight falling 18 ft., and the fracture must show a combination of iron conforming to the aforesaid condition. 3. Each of the two halves of broken rail placed on two supports, 3 ft. 8 in. apart, shall be tested by the blows from a tup 648 lb., falling 7 ft. on the centre between the point of support. Under this test

BRONZE DOORS, FOR THE HYPOTHECARY BANK OF BUENOS AYRES.—(See page 110.)

THE GERMAN LUTHERAN CHURCH, DALSTON, ENGLAND.

the rail may bend, but must not show any trace of destruction. The Vignoles section of rail would seem to have some advantage over the double-headed, as the bottom flange is placed at a greater distance from the neutral axis, besides resisting side strains and torsions, and, as a matter of practice, none but ductile tough iron can be rolled into a wide flange.

TEST FOR BESSEMER STEEL RAILS 80 LB. PER YARD. — Rails to be taken from each day's rolling, and placed upon bearings 3 ft. apart, when a ball weighing 10 cwt. is to be raised 10 ft., and dropped three times, when the deflection must not exceed 3 in.

TESTING OF FISH-PLATES FOR RAILS.— 1. Six fish-plates to be taken at random from one day's rolling, and bent to an angle of sixty degrees, without any sign of fracture. 2. Holes to be punched at a distance from the edge equal to the diameter of hole without bulging the metal at the sides.

WEAKENING RAILS BY DRILLING AND PUNCHING. — An experiment is also mentionod by Hackney, in his "Manufacture of Steel." 1. A piece of rail with no holes in it stood a blow of one ton, falling 20 ft. 2. A piece of the same rail, with a punched hole through the web, broke under the first blow at a 3 ft. fall. 3. A piece with a drilled hole the same size, while it stood the first blow at a 2 ft. fall, broke with the second blow at a 4 ft. fall.

(To be continued.)

M. MOUCHOT'S SOLAR ENGINE.

(See page 128.)

The principles on which the apparatus is based are well known, and we need only, therefore, describe the engine, which consists of three parts—viz., the metallic mirror, the blackened boiler, the axis of which coincides with that of the mirror, and of a glass envelope permitting the sun's rays to reach the boiler, but preventing their return. The ration of the heat utilised with the surface thus isolated, increased with the extent of this surface. The mirror has the form of a truncated cone, with parallel bases, and the generating line makes an angle of 45° with the axis of the cone. This is the best form that can be adopted, because the incident rays striking parallel to the axis, are reflected normally to this axis, and give a heat area of maximum intensity for a given opening of mirror. The reflectors are formed of 12 silvered sectors, carried by an iron frame, in the grooves of which they slide. The diameter of the mirror is 112:3in. at the top, and 39:3in. at the bottom, giving an effective reflecting area of about 45 square feet. The bottom of the mirror is formed of a cast-iron disc to add weight to the apparatus. In the centre of this disc is placed the boiler, the height of which is equal to that of the mirror. It is of copper, blackened on the outside, and is formed of two-eccentric bell-shaped envelopes connected at their base by a wrought-iron ring. The larger envelope is 31:5in. high, and the smaller 19:68in.; their respective diameters are 11:02in. and 8:66in. The water is introduced between these two envelopes, to that it forms a cylinder 1:18in. thick. The amount of water does not exceed 4:4 gallons, and about one-third of the annular space is left as a steam chamber. The inner envelope remains empty; it is furnished on one side with a copper pipe leading from the steam chamber and connected with the motor by a flexible tube. At the foot of the boiler is placed the feed-water tube. The glass envelope or bell is 15:75in. in diameter, and 33:46in. high, the thickness of the glass being 2in. thick. A space of nearly 2in. is thus left between the sides of the glass and the copper envelope.

Thus arranged, the apparatus is mounted on an inclined axis, the angle of which can be made to change to correspond with the motion of the sun, and a rotating movement of 15° per hour can also be given to it. To effect this double object the apparatus is carried on trunnions resting on a shaft perpendicular to their axis, and this shaft forms, from north to south with the horizon, an angle corresponding to the latitude of the place. Two movements result from this arrangement which permit the apparatus to follow the course of the sun, since by a half-revolution it turns from sunrise to sunset, whilst by an annual rotation of 46° at most on the trunnions it is brought opposite the sun in all positions. This double movement is effected by means of worm-gearing, the first being repeated at half-hour intervals; the second, every eight days.

Experiments made with this apparatus at Tours showed that in 40 minutes 44lb. of water were raised from a temperature of 68° to 252°, and thence to a pressure of 5 atmospheres. In less than 15 minutes 331lb. of water of 212° were raised to 307°. Finally, in favourable weather, 11lb. of water have been evaporated per hour. The steam generated was employed for driving a pump.

EXPLANATICN OF FIGURE:—A, glass bell; B, boiler with double envelope; D, steam-pipe; E, feed-pipe; F, conical silvered mirror built up in sections; GG, axis on which the apparatus moves east and west; H, gearing regulating the inclination; I, safety-valve; K, pressure-gauge: L, water-gauge.

EDUCATION FOR MECHANICS.

There is no branch of education of more importance to the progress of manufactures in the Dominion than the education of our mechanics; and yet there is no branch of education so totally neglected by the Government. We cannot expect that in our public schools teachers can be called upon to instruct a class in a certain branch of study, which to be done practically, requires, to a great extent, the use of tools and mechanical appliances; but we certainly consider that in every town there ought to be a school of instruction for the workman, partly supported by Government and partly by fees—with power to grant diplomas of efficiency. It is extraordinary the lethargy into which the Mechanics of Canada have fallen and what little interest they take in objects which would tend to their advancement. It is high time that the artizans in the various branches of the building trade and mechanical industries, begin to arouse themselves and seek to raise the standard of workingmen in this country; there is a most lamentable deficiency of technical education, and as a consequence, of mechanical skill. It must be acknowledged that a man who possesses a knowledge of the principles on which his craft is founded, must be a better workman than he who is ignorant of them. Let a man possess a good knowledge of geometry and drawing, and he will find that it greatly facilitates his work—for he will see the way of doing scientifically and correctly what he before did blindly by the rule of thumb.

We remember visiting schools in England in which the different branches of mechanics and building, were practically taught, and which, to a great extent, became self supporting from the sale of the different articles manufactured by the students aided by experienced foremen. Why cannot we adopt in our principal towns similar schools of instruction for the purpose of extending a technical education, we have no doubt but that they would be productive of the best results.

THE MONUMENT OF GASTON DE FOIX.

(See page 105.)

A curious history attaches to this work of art. Gaston de Foix was the nephew of Louis XIII. of France, and being killed at the battle of Ravenna, his body was carried to Milan, and at time in the hands of French, and it was determined to erect a sumptuous monument to his memory in the cathedral there. The work was confided to Agostino Busti, and not being completed in 1517, a number of other artists were also employed upon it. It was fated, however, never to be erected as intended. The precise reason is not known, but the bad fortune which attended the arms of France in Italy seems quite sufficient to account for this, but will not explain the circumstances that its various parts were dispersed throughout Europe, and no less than seventy-seven are ascertained to exist in Lombardy, Milan, Turin, Novi, and two statuettes and some panels in the South Kensington Museum, with the beautiful design for the whole executed at the beginning of the sixteenth century. Engraved representations of these we give in our present number.

In 1871, on the occasion of the National Exposition in Milan, a Commission was appointed and funds were voted for the purpose of bringing together the various parts of this remarkable work, but we believe nothing was done.—*Builder.*

SANITARY ARCHITECTURE AND ITS APPLIANCES.

(Continued from page 65, March number.)

Previous to giving our own views on this important subject, we furnish in this number illustrations of the methods proposed by Professor Godfrey, M.D., Aldermen McLaren, and J. K. Springle, Esq., Architect, for carrying off by ventilating shafts through the interior of dwellings the impure air of drains. All three of the above gentlemen have but one opinion with respect to the great necessity of ventilating drains, but somewhat differ in their views as to the simplest and most practical way of successfully carrying it out.

On page 116, Fig. 1, we give an illustration of the plan adopted by Professor Godfrey. Some years ago he erected on his property on Ontario street, a large flat roofed building for a Medical College; we have reason to suppose that he was the first person who practically applied the system, in this building, of carrying off the rain water from a flat roof by a conductor placed in the centre of the building, in place of conductors at the sides, and of making this central shaft, or conductor, the ventilator of the water closets and drains. His views have always been—and he speaks so far from practical results—that when there is a strong draft up from a drain by a ventilating shaft, no traps whatever should be used either in the house drain leading to the street, or to any of the water closets or sinks; that whilst the effluvia is rapidly carried upwards by the draft to its exit over the roof, all excreta is carried into the street drain uninterrupted in its course by any traps whatever, leaving nothing behind to create any unpleasant odour.

To this plan several objections have been made. Such as that the pipe would be apt to freeze up, especially in vacant houses; that a down draught would drive the ascending gas up through the untrapped water closets and wash basins; that any interruption in the pipe would cause an overflow of water into the rooms; that if the plan was adopted generally throughout the city the tendency to an up draft would cease, and that the gases would remain in the drain pipes in a state of rest. But these are simply theories which might occasionally occur, but, only under peculiar circumstances.

To these objections we would remark, 1st. That we never knew an instance of a shaft from a drain, no matter how short, but which had an upward draft; 2ndly that so long as that up draught continued, there could be no freezing up of the ventilating shaft, as the air in the drain is always sufficiently warm to thaw it in winter; 3rdly that supposing their was a down draught, of what would that down draught consist? why of pure air from without; there being no traps according to Dr. Godfrey's plan, there would consequently be no foul gas there accumulated to be forced up into the rooms; 4thly with respect to any overflow of the pipe, this is not likely often to occur, and could be prevented by providing an overflow pipe to the main shaft near the basement; 5thly that no amount of ventilating pipes would affect the circulation of air in the drain; air never remains in a state of quiescence where there are apertures; there are always disturbing influences from change of temperature and it must flow either up or down the ventilator; if up, and the ventilating shafts were universally used, such a vacuum would at times be formed in our drains, as to create a down draught of fresh air from the street grating to fill the void,—if down, the fresh air only would descend. In any case, ventilation by fresh air coming into the drain to fill the place of that forced out would be the result. We reserve, however, our opinion as to its general practicability in all cases, and merely observe that up to the present moment, it is the best suggestion yet made for the ventilation of sewers.

The next plan Fig. 2, is the one proposed by Alderman McLaren and brought before the City Council for discussion. This plan is very similar to that given by Professor Godfrey, with the exception that Mr. McLaren provides for traps to the water closets, sinks, and basins, to prevent gases entering rooms either in ascending or descending the ventilation shaft. At first sight such precautions may appear very necessary, but the matter requires to be carefully considered before adopting this system, unless in cases where it cannot possibly be avoided, that is where the small amount of gas, arising from excreta remaining in the trap, is less than a heavier body of gas forced up directly from the drain by atmospheric pressure. We have seen so much of these traps—the hidden sources of foul gas and imperfect workmanship—that if it were possible to avoid them we would strongly advocate so doing.

In illustration Fig. 2, we shew in dotted lines the plan proposed by Mr. Springle, at a meeting of the Public Health Committee in this city. Mr. Springle in an able paper read before the meeting, advocated the use of the D trap, and, also, of a bend in the house drain, shown on plan, to prevent gases ascending beyond that point; also a cowl at the top of the ventilating shaft carried by a branch pipe above the roof and independent of the opening for the rain water to descend.

The objections raised to this plan were: 1st. That the bend in the house drain would have the effect of stopping the ascending gases of the drain, and thereby prevent the main object of the ventilation shaft, and, also, that excreta to a certain amount would always remain in the bend, from which effluvia would arise at every flow of water through it, and for the same reason that the D trap would be also objectional. Professor Godfrey stated that so strong was the up draught in the ventilating shaft in his building that it drew in a strong current of air from all the connecting pipes.

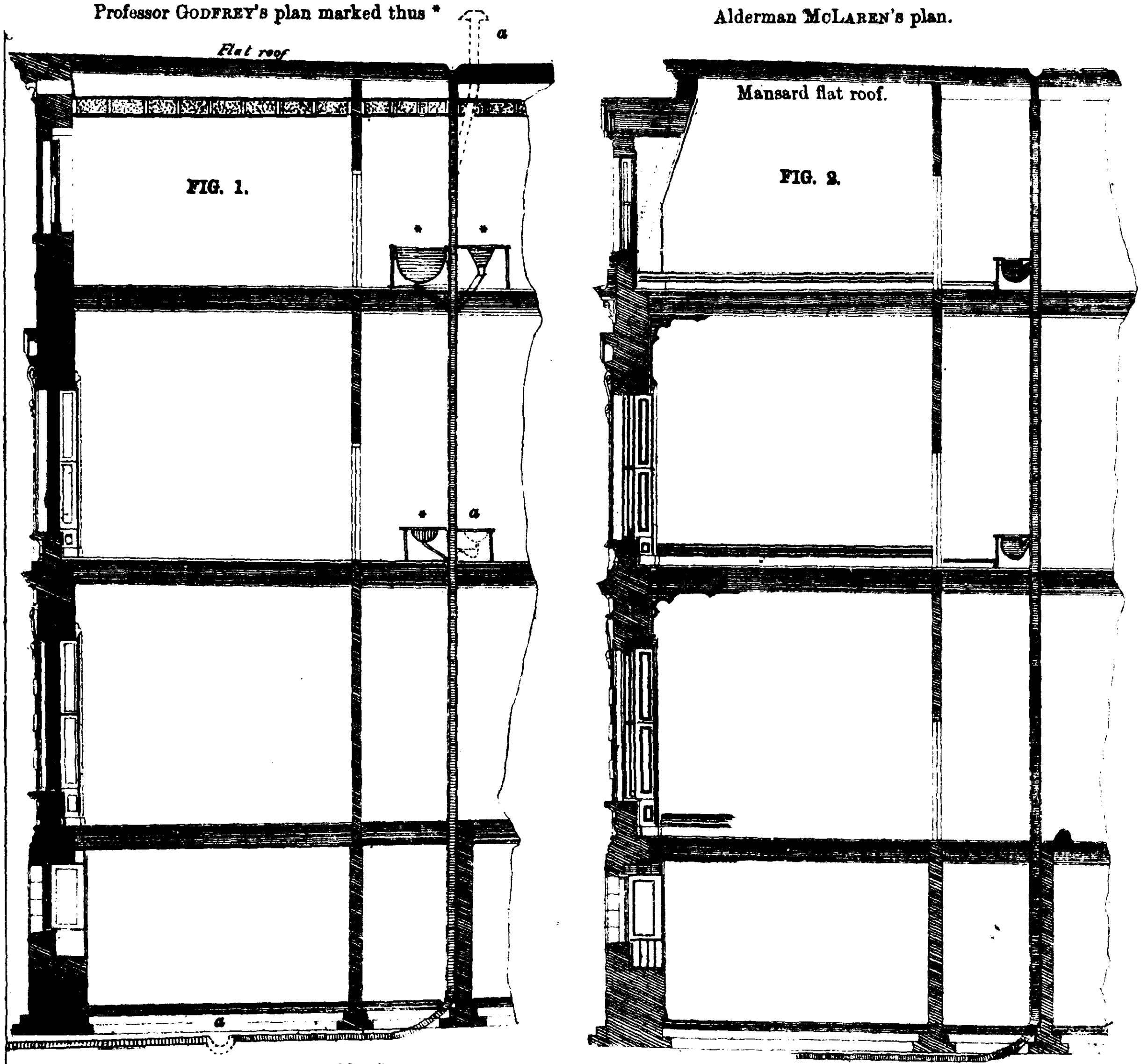
(To be continued.)

TRESTLE BRIDGE OVER OTTER CREEK, AT TILSONBERG, ONTARIO.

(See page 117.)

We give in this Number a view of the large Trestle Bridge over Otter Creek, at Tilsonberg, Ontario, constructed by Merrs. Stratford, Nicholson and Chisholm, civil Engineers, of Brantford. This structure is the second or third largest trestle bridge on this continent, and forms one of a line of 45 large and small trestle bridges on that portion of the Loop line of the Great Western Railway of Canada from Glencoe to Simcoe, a distance of 75 miles, constituting a Mileage of about 10 per cent of the Line. The following are its dimensions:

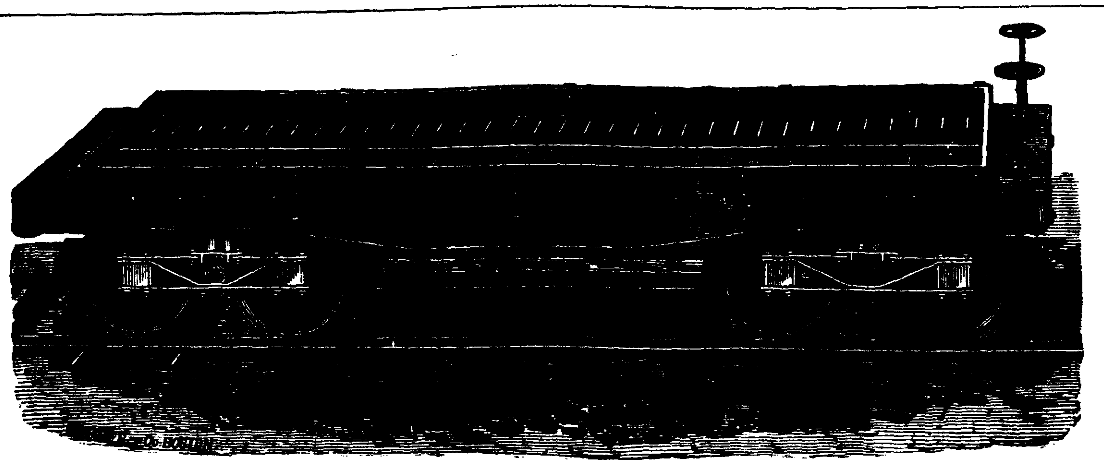
Trestle-work....................	200 feet
Howe Truss....................	1,108 "
Length..........................	1,308 "
Extreme height..................	110 "
Timber..........................	1¼ million ft. B. M.
Cost	$60,000 gold.



Changes proposed by Mr. SPRINGLE a

Connects with street sewer.

SANITARY ARCHITECTURE AND ITS APPLIANCES.



THE WISWELL CONSTRUCTION AND BALLAST CAR.—(See page 118.)

TRESTLE BRIDGE OVER OTTER CREEK, TILSONBERG, ONT.
Constructed by Messrs. STRATFORD, NICHOLSON & CHISHOLM, Civil Engineers, of Brantford.

THE WISWELL CONSTRUCTION AND BALLAST-CAR.

(See page 116.)

In the construction of road-bed or embankments for new railroads, it is, in this fast age, frequently important to get regular trains running as soon as possible. With this object the road-bed is made as narrow as possible, while allowing sufficient width to retain the sleepers in position. The road-bed having been made of such earth as is most convenient, the sleepers are laid upon the rough uneven surface and blocked or propped up here and there to cause the rails to bear so as not to bend them. This accomplished, ballast-trains are run over it loaded with coarse, porous gravel, and with men to shovel it off. From one to two feet deep upon the top of the road-bed this material is placed, affording a secure bed, for the sleepers, at the same time allowing the rains to percolate freely through, thus preventing the wood work from rot a much longer time than if it was constantly wet.

The shoveling of the ballast from the ordinary platform-car takes up much valuable time unless many hands are employed which makes it very expensive, as much of their time is spent in riding back and forth between the place of loading and the place of deposit. It is obvious that two trains cannot be alternately run by the one locomotive to give the men constant employment at each place owing to the impossibility of two trains passing on the main line.

On some roads the short "dumpy" or "rocker-car" is used in ballasting; but here again is a difficulty, viz., owing to the height of the wheels, and the necessity of the body of the car swinging over them to discharge, the point of deposit is five feet from the rail, precipitating most of the ballast down the inclined sides of the embankment, to be shoveled back by the "track raisers," necessitating the employment of more help. To "dump" one of these "dumpy-cars" requires from four to six men, who take each car in turn unloading them with rapidity compared to the slow process of discharging by shoveling from the platform-cars.

The engraving herewith illustrated represents a car intended to, and in its practical working does, obviate all the above named difficulties. It deposits a portion of the ballast between the rails, the balance outside—corresponding to length of sleeper between and outside the rails, none falling on the rails, however. The *modus operandi* by which this very desirable object is attained is as follows:—

The floor of the car is composed of two series of "trap doors" opening downwards. To the nether side of each door, a small casting is bolted and pivoted at its lower extremity to a long bar of sufficient length to connect the whole of that series. It is clear that when this bar is moved each connected door moves also, and by drawing this bar far enough to the right, by means of a chain and common brake-staff, every door will be simultaneously closed, forming an even floor, as shown in the cut, on the side nearest the observer. As both series are exactly alike, a description of one serves for both.

To prevent the earth from falling on the rails, and thus clogging the wheels, chutes or fenders are suspended immediately over them, upon the upper surface of which a portion of the earth falls, and, sliding on the inclined surface, is deposited on the ends of the sleepers. Wheel guards are placed as shown, over the wheels with the same object. Thus it will be seen that the ballast is left when needed, none going down the sides of the embankment to be shoveled back again.

To discharge this car is a very simple matter, and can be done by any one that can "wind up a brake," yet is not liable to occur in transit; therefore the brakesmen that are always required are all the men needed to unload a whole train. To do this, the workman grasps the hand-wheel, strains up on it as if to wind it still further; this loosens the catch, which he trips with his foot, then he lets go the wheel, and the load, pressing on the doors, open them and through the apertures thus made, the load disappears with a celerity that is an agreeable, as well as profitable contrast to the old fashioned shovel and "elbow-greese."

The many parts, being exactly alike, makes what at first appears complicated really very simple; so much so that the veriest tyro of a carpenter can readily make all needed repairs; while their extra cost is but little more than the ordinary platform-car.

It is easy to see the advantage they possess over any other car in use when employed for filling tesstle work, the side rack, so disastrous to light, high tesstles, and that is an inseparable attendant of the "rocker" cars, being entirely obviated. A trial of three years proves them to be as described, and we trust to see them in general use ere long on every railroad in the Dominion and United States.

For further information apply to the General Agent,

F. A. Wiswell,
Beebe Plain, Stanstead Co., Que.

FACTORY NOTES.

The Defence of London.—The Royal Engineers have for some time past been engaged in making surveys of the country around London with a view of some more definite steps being taken for the defence of the metropolis.

The Defence of Malta.—It is stated that the arrangements for the defence of Malta by means of torpedoes have now been rendered so complete by the War Office, that, should it be necessary to withdraw all Her Majesty's ships from that place at any time, the entire defensive system could be put into operation. The only requirements are a couple of steam-launches, by which the torpedoes could be placed in position.

In France, the average salary of workmen (without board or lodging) is sixty-eight cents; in Germany, Italy, and Switzerland, thirty-eight cents; in England, eighty-three cents, living being thirty per cent. dearer than in France.

Fire-Proof Joist.—An ingenious kind of fire-proof joist, recently introduced, consists of a slip of wood five inches wide, by five-eighths of an inch thick, belted between two flanged strips of quarter-inch iron, making a beam quite as strong as those of wood ordinarily employed. The iron sides, in addition to affording strength, it is claimed, render the joist substantially fire-proof, while the centre of woods affords the means of putting down floors and nailing on laths in the usual manner. The impediment to the manufacture of those joists heretofore has been the difficulty of rolling the flanged iron sides, but this has now been successfully overcome.

Preserving Wood by the Application of Lime.—The method of preserving wood by the application of lime, as pursued by M. Svostal, is published in the French journals. He piles the planks in a tank, and puts over all a layer of quicklime, which is gradually slaked with water. Timber for mines requires about a week to be throughly impregnated, and other wood more or less time according to its thickness. The material acquires remarkable consistence and hardness on being subjected to this simple process, and, it is alleged, will never rot. Beech-wood has been prepared in this way for hammers and other tools for iron works, and it is said to become as hard as oak without parting with any of its well-known elasticity or toughness, and to last much longer than when not thus prepared.

Imparting a Fine Orange-Yellow Tone to Oak Wood.—According to Niedling, a beautiful orange-yellow tone, much admired in a chest at the Vienna Exhibition, may be imparted to oak wood by rubbing it in a warm room with a certain mixture until it acquires a dull polish, and then coating it after an hour with the polish, and repeating the coating of polish to improve the depth and brilliancy of the tone. The ingredients for the rubbing mixture are about 3 ounces of tallow, ¾ of an ounce of wax, and 1 pint of oil of turpentine, mixed by heating together and stirring.

AN INVALID'S CHAIR.

(*See page 128.*)

The new chair invented by Dr. E. Cutter, and represented in the annexed illustration, involves some novel features which are not to be found in similar devices. The back of the chair, the seat, and the leg portion have each an independent motion in vertical corresponding to the motion of the great natural divisions of the human body. The arrangements allow of the variety of changes which are found existing in the human body in a state of perfect rest. Having made these adjustments the whole series of inclined planes can be made to revolve about a common centre, and the weight of the body can be thrown from one division on to another, or distributed equally over the entire body surface. At the same time the chair allows of the motion of the hip and knee joints. An endless screw gear secures an equable, firm, and certain movement, with no fear of detachment or breakage under ordinary usage. The feet may be easily raised higher than the head, thus allowing the return of the blood from the extremities by reversing the hydrostatic pressure of the column of blood in the veins—a very desirable arrangement in cases of cardiac disease.

A very simple but effective apparatus for extension in fractures may be connected with the leg portion, making a triple inclined plane, if possible an improvement upon the famous "double-inclined plane" of Charles Bell Three cases of fracture of the lower extremities have, says the Boston *Journal of Chemistry*, been successfully treated upon this device. This chair can be brought up to the same level as the bed on which a patient may be lying, who can then be transferred directly to the chair without lowering to the floor. The workmanship is durable and may last for generations. It is especially designed for invalidism in its varied forms where the decubitus is dorsal. The style and upholstery vary with the taste of the purchaser.—*English Mechanic.*

MULTIPLE DRILLING MACHINE.

The advantage of drilling the rivet holes in wrought iron structures, instead of punching them, has long been recognised by engineers, and although many arguments have been set up in favour of punching, and against drilling, yet the great hindrance to the adoption of the latter plan has hitherto been the tedious nature of the process, if carried out with single spindle drilling machines, and the delays and breakages, or other drawbacks, which have generally been found to accompany the use of multiple drilling machinery.

To overcome these difficulties the machine we illustrate at page 124 has been designed. The illustration shows a machine in the form especially adapted for travelling over the upper or lower flanges of straight or hog-backed girders, and drilling through the whole of the plates at once, in the position they will permanently occupy. It is driven by a steam engine, self-contained, which is supplied with steam from a portable boiler alongside, connected by a strong flexible pipe. Messrs. Buckton have also made various machines with feet and tables, some with 10 spindles for drilling keel bars, and some with 50 spindles and upwards for drilling girder plates and angle irons, &c., before they are placed in position. In these machines the driving and feeding arrangements are the same as in the travelling machine, but whenever there are more than 10 spindles to be driven, as the endways thrust of the driving screw would become very great by the accumulated resistance of so many spindles, a remarkably elegant device is introduced, viz., the quick-threaded driving screw is cut with a right-hand thread through half its length, and with a left-hand thread through the other half, so that the end pressures are balanced, and the screw runs in equilibrium between its end bearings, and any undue friction against thrust collars is avoided.

The arrangements of working parts in these machines is of such a nature that the combination may almost be regarded as bringing to bear six or more independent drilling machines upon one piece of work and under the eye and control of a single attendant. The importance of having each spindle as much as possible like an independent machine is, because, if the drills were all to act rigidly in conjunction, it would be requisite to maintain them all at an exactly uniform length, which is most troublesome to carry out in practice, and should one drill fail while going through its work it would be necessary to withdraw the whole in order to replace it.

In the present improved machine the whole of the spindles work normally in conjunction, being fed down together self-actingly, and also being run up quickly together out of their work by simply striking the feed bolt on the group of pulleys at the left-hand end of the machine; yet any one of them may be worked independently at pleasure, for, by giving the small handle of the feed clutch half a turn, the self-acting feed becomes disconnected, and the spindle may be wound either up or down by hand, with a removable hand wheel, as shown on one of the spindles. The drilling heads are also independent in their adjustment upon the cross-slide, to suit varying pitches of holes. They admit of being brought together within 3¾ in. Yet it will be observed that the driving wheels, by the arrangement of passing each other alternately at a higher and lower level, admit of being kept nearly 6 inches in diameter, and thus the stress upon their teeth is so light, that with well-formed teeth of gun-metal, driven by a steel screw, the wear is not appreciable.

The method of securing each drill in its socket, is designed to obtain the perfectly true running of the drills, so that the drill points find their centres without the aid of a centre punch pop, and afterwards run truly through the work, and it enables any drill to be released by merely tapping one end of the small cotter, and this may be done without stopping the revolution of the spindle, as would have to be done in the case of an ordinary cotter, or a set screw fixing. This part of the invention is applicable to all drilling machines, and forms a very efficient way of driving and securing a drill. The shank of the drill is truly parallel, fitting into a bored parallel hole in the drill socket. It has a flat formed on one side which serves to drive the drills, which is detained by a one-sided cotter going through the socket; and by the taper on the cotter tightening against the flat on the drill shank, the drill is secured from dropping out of the holder.

This improvement has been introduced, after long experience of the unsatisfactory nature of the ordinary methods in use for securing drills, viz., by having a taper shank, either square or round, driven up into a taper hole in the socket. In these cases the hold upon the drill is capricious, according to the precision with which the two taper surfaces fit each other. The friction on the taper shanks will sometimes hold the drills so firmly as to give considerable trouble in releasing them, and sometimes so lightly as to let the drill drop when it passes through its work. Moreover, when the taper shank is square, the difficulty of drifting the socket and shaping the drill shank, so as to be true with the axis of rotation, is so great, that drills so held can never be relied on to strike a centre without wandering.

Our engraving give a perspective view of the machine, Fig. 1; a front elevation, Fig. 2. Figs. 3 and 4 show the detail of the mode of fixing the drills. A is the girder upon which the machine is to operate; B are the drilling tools. These tools are secured in the sockets of the drill spindles *e* by a round parallel pin D, shown in Fig. 3, having an inclined flat formed upon it at *e*, which, when the pin is struck at the end *f*, tightens against a flat formed on the round parallel shank of the drill, as shown. When the pin is struck at the end *g* it loosens its hold upon the drill shank. On the end of the driving screw K the belt drum M is fixed, which drives the feed pulleys N, the middle one of which is a loose pulley, the inner one the feeding pulley, and the outer one for running up the drills quickly out of their work.

The feed and return motion are communicated to the spindles C by the screw O working into the worm wheels P; this screw when preferred may be made right or left hand for the same purpose as described for the driving screw K. The worm wheels P have an internal thread like a nut, which works upon the feed screw Q, whereby, when the screw is prevented from revolving, the spindles fall down; but if the screws are left free to revolve they will either revolve with the nut, or may be turned round by a handle, as shown at R, by which means the spindles C are raised or lowered at pleasure by the attendant, for although the nut may be turning slowly round it acts for all practical purposes lixe a fixed nut, because the movement of the screw by hand may be so much faster in either direction than that of the nut.

The means whereby the screws are set free or prevented from revolving is shown at *s*, Fig. 3, where there is a small bush it may be allowed to revolve or stopped at pleasure. The bush is fitted with a "feather key" taking into the feed screw; thus, when the brake *t* is on the bush, the feed screw cannot revolve, and the motion of the worm wheel operates upon it to wind it up or down. On the brake *t* being released from the bush the screw becomes free to turn round by hand, carrying round with it the bush, and it may then be made to wind the spindles *c* up or down independently of the movement of the worm wheel.

Treatment of Bee Stings.—A writer in the *American Journal of Microscopy* gives the following directions for the treatment of a bee sting, which are worth remembering: "Onions, ammonia, ashes, beef and a hundred other remedies have been prescribed, but we never found them of any special value. If the poisoning has not been emptied, remove it with a sharp knife, or still better, with a pair of tweezers, so formed as to grasp the sting itself without pressing on the bag. Common hair tweezers are just the thing. This must, however, be done very quickly, or it will be of no use. Grasping the bag and sting with the fingers only squeezes the poison out of the bag and into the wound. After the bag has been removed suck the wound strongly and apply a poultice of moist mud. We have never found anything better.

The Economic Gas Stove Cooking Apparatus.—At the Royal Aquarium and Winter Gardens, Westminster, Messrs. Leoni & Co. have erected one of their complete cooking apparatuses, which is sufficiently large to cook *recherché* dinners for about 500 persons. Messrs. Bertram & Roberts pronounce it to be a great success, as the ovens are so ingeniously contrived that they prove equal to the task of roasting the largest joint, and of baking the most delicate pastry satisfactorily. The kitchen at the Royal Aquarium is the only one where cooking on such an extensive scale and of such quality is done by the sole agency of gas.—*Iron.*

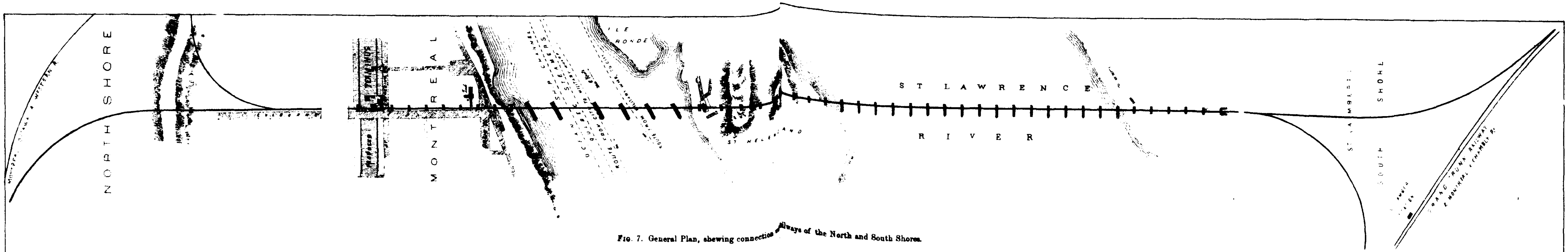


FIG. 7. General Plan, shewing connection ...ilways of the North and South Shores.

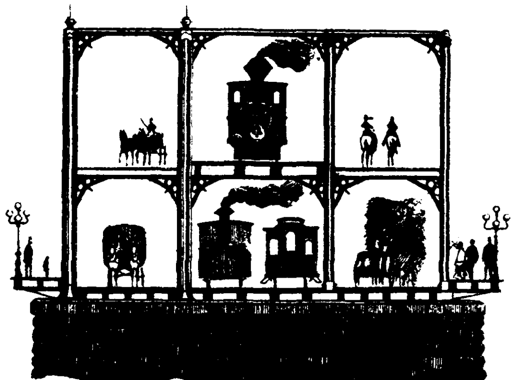


FIG. 6. End Elevation and Section of 300 ft. Span.

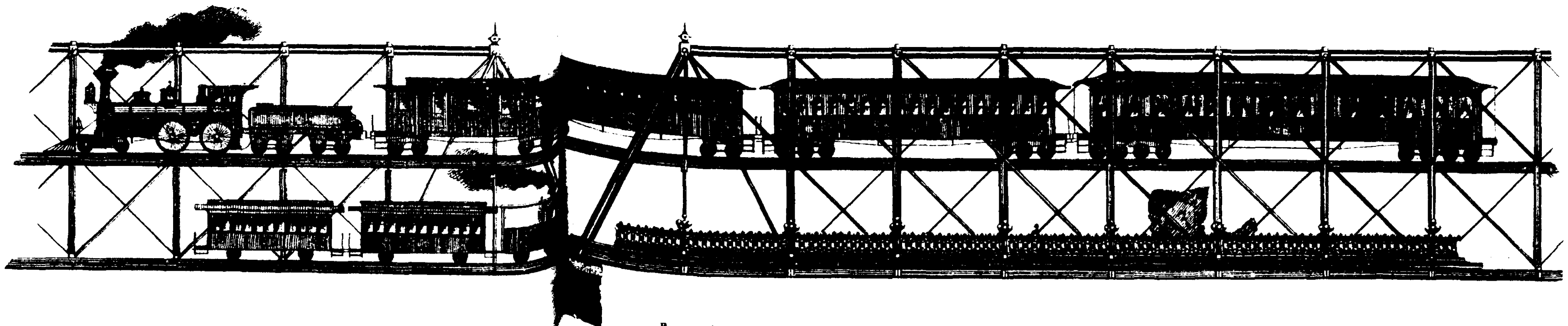


FIG. 4. Elevation of 300 ft. Span.

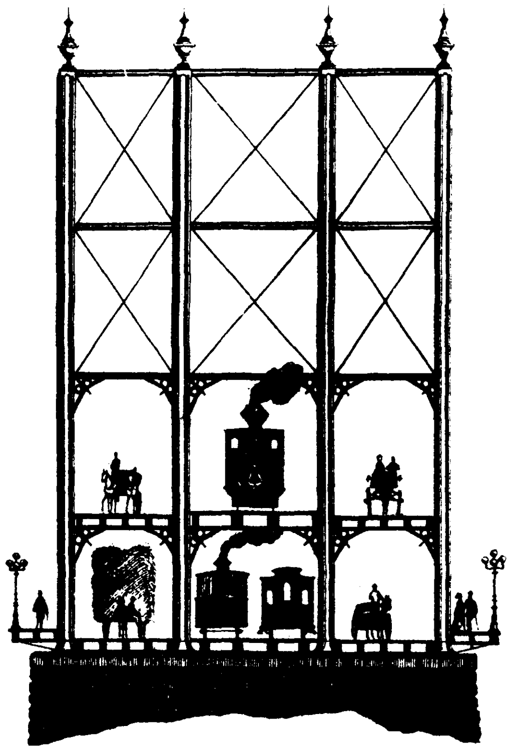


FIG. 5. End Elevation of 550 ft. Span.

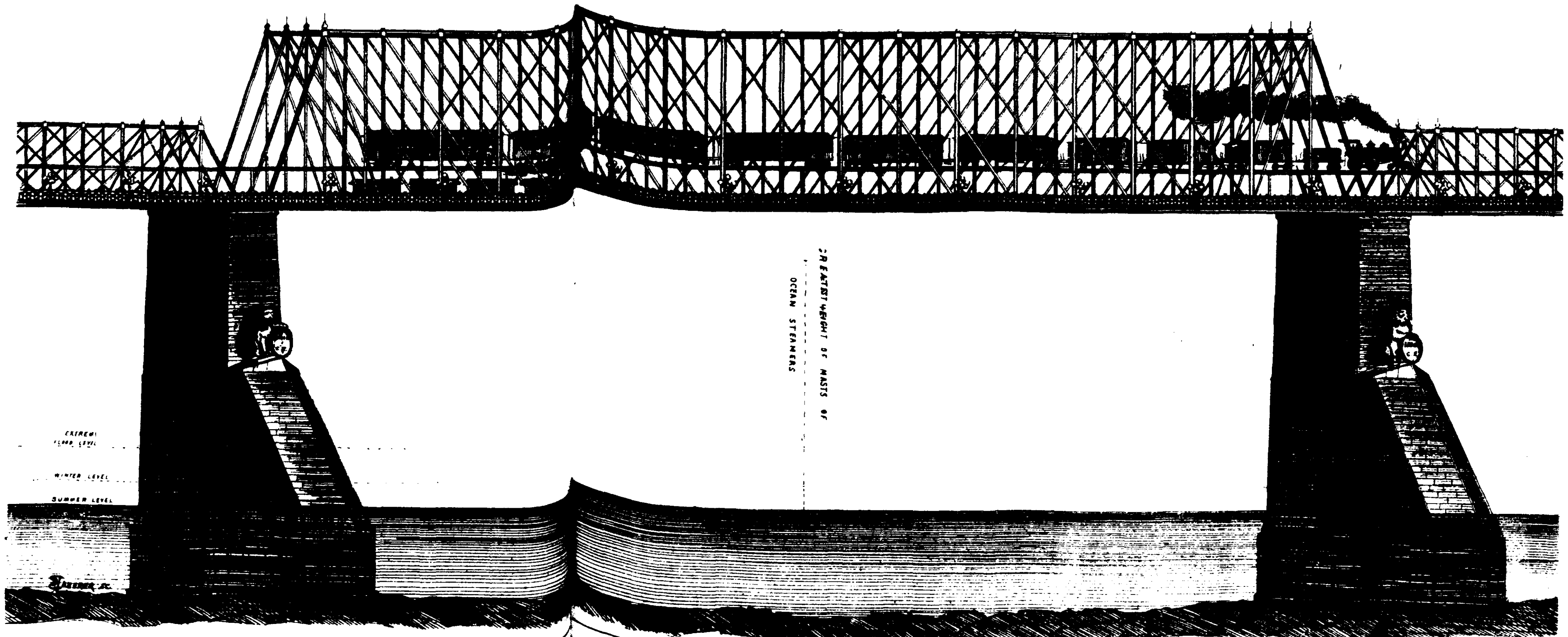


FIG. 3. Elevation of 550 ft. Span.

GENERAL PLAN, SEC ND ELEVATION OF THE

ROYAL AL RT BRIDGE

CHARLES LEGGE ES E., CHIEF ENGINEER.

E. BERRYMAN, C. E., DEL.

Extract from the Guide to Fret Work, Wood Carving, Marquetry, Buhlwork, and Mitreing Picture Frames.

(*By a "Practical Hand."*)

Published by C. H. Savory, Cirencester, England.

Although for the encouragement of the young, and the mechanical genius of riper years, as well as for unprofessional readers, we purpose giving from the pages of the above work, part of the instruction therein contained; yet we would strongly advise every young mechanic to obtain this useful little work as a volume for his library, as we cannot afford space to enter into all those minor details which are necessary to enable him to become a master of his craft. In England, arts herein described, are now much practised by amateurs, who have leisure hours to spare, and even many ladies there excel in fret work cutting, wood carving, and many other light artistic occupations.

A good and intelligent workman is always worth much more than one who bungles at his trade — the man who goes on continually in a mere mechanical way doing simply what he has been shown or told, will never make a first-rate workman; whereas a man who had studied theory, and possessed general knowledge, would prove himself not only a master of the theory, but also of the practice of his art. Often have we been in a workshop and inquired the reason of such and such a process, and why it produced the required results, but could not obtain the information from the artizan, who worked like the machine he directed, and never troubled himself to inquire further. Such men can never make a mark for themselves, or be a benefit to others.

WOODS AND ITS USES.

The wood mostly in use for ornamental purposes is sometimes selected because of its colour, figure, scent, grain, and other peculiarities.

For *figure* or handsome grain, use mahogany, birds-eye maple, Laburnum, Italian walnut, satin tulip wood, yew and oak.

For an *evengrain*, box, pine, lime or peartree is not to be equalled.

The most *elastic* is, lancewood, hickory, ash, hazel, yew, snake wood, and sweet chestnut.

The most *durable* is box, ebony, oak, cedar, poplar, sweet chesnut, and yellow deal.

The *toughest woods* are oak, walnut, beech, elm and lignum vitæ.

Wood emitting *an odour* is rosewood, cedar, camphor wood, sandal wood, sassafras, kauric pine and satin wood.

Wood used for making colouring matter are — for *Red*: logwood, red saunders wood, Brazil and cane wood. For *Yellow*: zante and fastic; and *Green* is obtained from green ebony.

TOOLS.

A *good workman* is generally proud and careful of his tools, and his books, also, are carefully seen to and valued, as they are recognized as a means to the end—on the contrary, an *inferior workman*, is generally the reverse to this—he is known at first by the general inferiority of his tools, chisels ground to a mere stump, with split or broken handles,—planes, with which it is impossible to make a true joint, and a tool-chest dirty with a medley of all sorts of old tools, long obsolete, nails, pieces of locks, bolts, &c., nothing of order about it, and he loses from five to ten minutes generally, in searching among the confused collection for some tool he may require—of books he seldom has any—but if he has the leaves are detached and many of them lost. The mechanic who keeps a chest of good tools is generally a good workman. "Show us the tools you "use and we will tell you the work you perform." One of the great advantages mechanics possess in the United States over ours is from the superiority of their tools, no workman will be allowed to work there with such apology for tools as are so frequently seen in the hands of Canadian mechanics. A good tool in a practised hand will always execute good work; and even those who are learning the use of tools will feel the benefit of using a proper instrument. The characteristic of a good tool, no matter of what description, is the temper of its steel, and that kept in good working order by grinding and sharpening. Good work cannot be produced with bad tools, but at the same time, we do not expect it to be supposed that an unskilled workman will make good work with good tools, if he want knowledge and handicraft.

We will now proceed to notice some of the principal tools required in the execution of the arts in which we purpose giving instructive. First, respecting planes—In these tools great improvements have been made of late by the Americans, and the iron plane which dispenses with the hammer in regulating the plane iron when at work, as shewn on page 128, Fig. 1, is a great convenience and improvement. It is made of three sizes, and although the price is higher than wooden planes, still the excellence and durability of the tool is such that no workman or amateur should be without a set. Fig. 2, shows a plane with an attachment, which enables those who have not had the practice necessary to make a good joint, with the help of this guide, to accomplish work, without which, would require considerable skill. This useful attachment, which by reference to the figure will be readily understood, may be attached to any planes, wood or iron. Its practical utility will at once be seen. The yoke A, is attached to the plane by means of a clamp screw, B, at one side, and a flanged extension at the other. C, is the guide-strip (made of wood) which is applied to a connecting piece D, which by its circular portion, is pivoted to the outward projecting end of the yoke A. The semi-circular part D, is bevelled along its circumference, so as to correspond with the bevelled edge of the curved-piece E, which is tightly secured by a wedge-screw between the piece D, and a small projection on the outer end of the yoke A. The piece E, extending from its semi-circular portion is slotted, and slides in a recess of the guide-strip C, so that the latter may be carried up to the base of the plane and firmly secured by the set screw and washer F. Between the arch D, and the projecting part of the yoke A, is a scale marked in degrees, for setting the guide at any desired angle without the use of any other rule, the upper part of the arc serving as an indicator.

The advantages of the plane-guide are such that an apprentice can do more work, and do it better by the aid of the "Guide" than an experienced workman can do without it—the guide-strap enables him to steady the plane, thereby always cutting at the proper point; also obviating the necessity of frequently testing the correctness of the angle by the aid of the try square or bevel. Perfect work can be done by the aid of this device where the light would be insufficient to correct work without it. This attachment enables the operator to square or bevel to the varying face of twisted material, which all mechanics know to be very difficult to do in the ordinary way. The great difficulty of balancing the plane in *squaring their stuff* is overcome by the use of the "Guide," as it is governed *by the face* and not by the edge.

(*To be continued.*)

Mucilage for Minerals, Etc.—Mr. F. C. Hill, of the geolo gical Museum, Princeton, N. J., writes to the *Journal of Pharmacy* as follows: "My friend, Professor R. P. Whitfield, of Albany, N. Y., was good enough to give me the following recipe for mucilage to mend fossils and minerals, and after several months of experience with it in the museum, I find it so valuable that, with his permission, I send it for the benefit of the readers of your journal:

Starch	2 dr.
White Sugar	1 oz.
Gum Arabic	2 dr.
Water	q. s.

"Dissolve the gum, add the sugar, and boil until the starch is cooked. Professor Whitfield is in the habit of drying it into sheets, on paper, and re-dissolving when wanted. He does not claim to have originated the recipe, but thinks it is one of the compositions offered to the United States government for gumming stamps. It is certainly a very adhesive mucilage, and, owing to the sugar, never becomes brittle; so that it never scales off, as most glues do, from stones or other hard substances. In a geological cabinet it is simply invaluable."

Defaulting Railways.—The American railway companies that first defaulted in 1875 did so to the amount of 140,448,-214 dols. Those that have defaulted since January 1, 1876, have done so to the amount of 4,494,400 dols.

LECTURES TO LITTLE FOLKS.

Where is the boy who is not familiar with a top? but does he ever think for a moment of the cause of that rotary motion which is the source to him of so much amusement. Tops have been familiar toys with boys, particularly English boys, for many hundred years. The top my boys is a subject that even the immortal Virgil, the great Mantean bard, did not consider beneath the patronage of his muse.

> The wooden Engine flies and whirls about
> Admired, with clamors, of the beardless rout;
> They lash aloud; Each other they provoke,
> And lend their little souls at every stroke.
> Dryden's translation of the Æneid.

But the top of antiquity was the whip-top;—the peg top is a barbarous innovation of modern times, an invention which cramps the activity of boys by superseding labor.

The Grecian boys also played at top. In a manuscript at the British Museum, there is to be seen a curious anecdote which refers to Prince Henry, the eldest son of James the First, it runs as follows:—

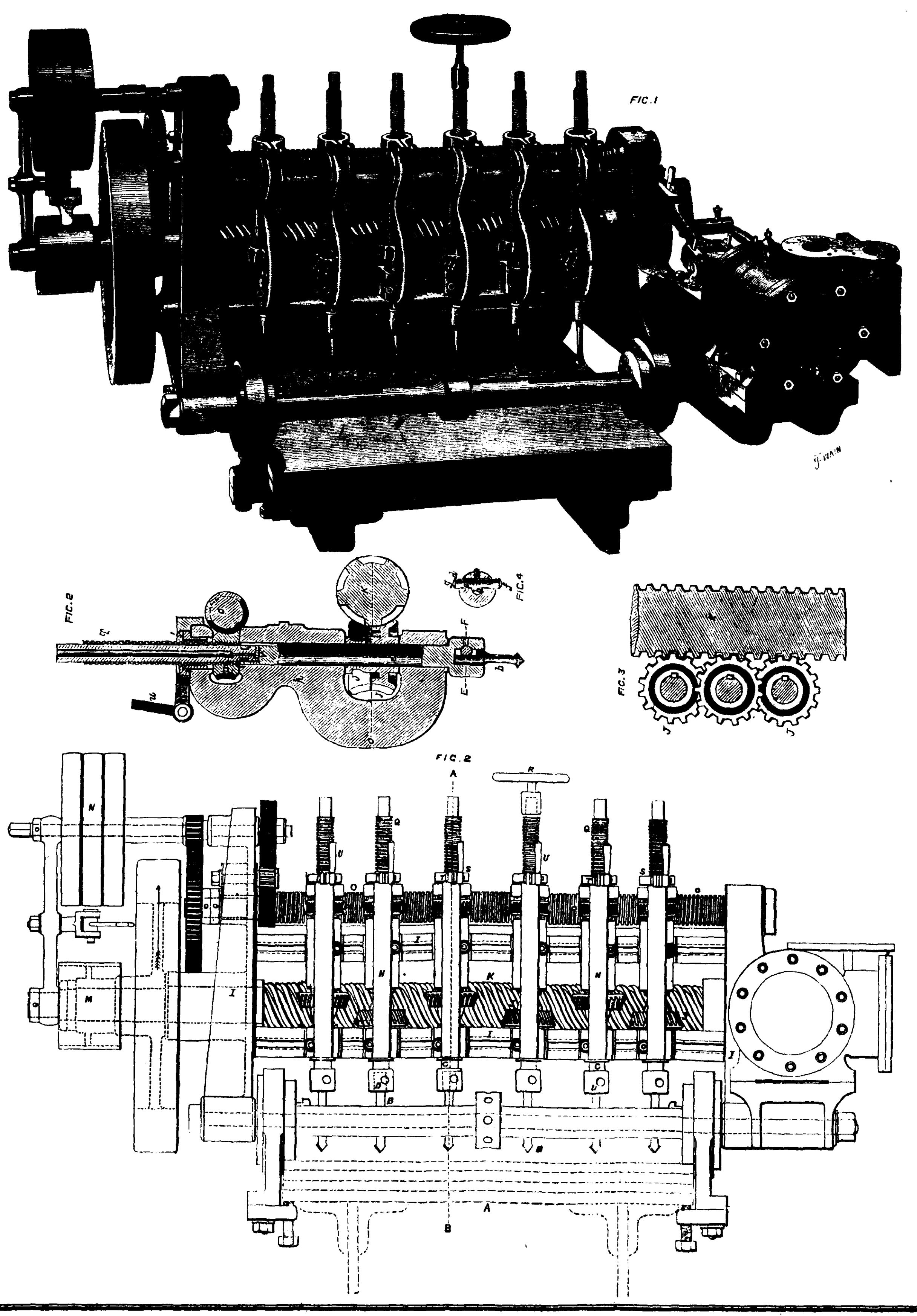
"The first time that he the Prince went to the towne of Sterling to meet the king, seeing a little without the gate of the towne a stack of corne, in proportion not unlike to a topp, wherewith he used to play, he said to some that were with him, "Loe there is a goodly topp;" whereupon one of them saying: "Why doe you not play with it then?" he answered "Set it up for me, and I will play with it." A clever retort which must have confounded the courtier who asked so silly a question. Did any of you ever try to set up a top so that it would stand on its point? If so, you have found how impossible it is, and yet when in rotary motion its erect position is maintained without difficulty. Now this is owing to what we know as centrifugal force, which is that tendency which a ball attached to a string, caused to move rapidly round a pivot or centre, has to fly off, which it would do if not held by the string to the pivot. This is perhaps more easily understood by the action of a sling; when whirled rapidly round it will fly off in a straight line as soon as let go. Now set the top a spinning, and observe that being in motion all its parts tend to recede from the axis, and with greater force the more rapidly it revolves; hence it follows that these parts are like so many powers acting in a direction perpendicular to the axis; but as they are all equal, and as they pass all round with rapidity by rotation, the result must be that the top is an equilibro on its point of support, or on the extremity of the axis on which it turns. But why does the top fall down? From two reasons; first from the resistance of the air, and secondly, owing to the friction of the ground. A top has been made to spin in vacuo that is in a box from which the air had been withdrawn as long as two hours and sixteen minutes. Now spin the top again, and observe at first how obliquely it is spinning, and then how gradually it rises from an oblique position, and at last how steadily it spins on a vertical axis until at last it seems scarcely to move. This is what boys call *sleeping*. Its centre of gravity is now situated perpendicularly over its point of support, which is the extremity of the axis of rotation. Now be attentive, for we are about to explain a phenomenon which has puzzled many older and wiser philosophers than yourselves. It is evident that the top, in rising from an oblique to a vertical position, must have its centre of gravity raised; now what can have been the force which effected this change? It certainly was not centrifugal force nor resistance to the air, for the same effect takes place in vacuo, then what could cause this phenomenon? It entirely depends upon the form of the extremity of the peg. We will first satisfy you that were the peg to terminate in a fine, that is to say a mathematical point, the top never could raise itself. Let *a b c* be a top spinning (see page 104 Fig. 1,) in an oblique position, having the end of the peg on which it spins, brought to a fine point. It will continue to spin in the direction in which it reaches the ground without the least tendency to rise into a more vertical position, and it is by its rotary, or centrifugal force, that it is kept in this original position, for if we conceive the top divided into two equal parts *a* and *b* by a plane passing through the line *x*, *c*, and suppose that any moment during its spinning the connection between these two parts were suddenly dissolved, then would any point in the part *a* fly off with the given force in the direction of the tangent and any corresponding point in the line part *b*, with an equal force in an opposite direction; while therefore, these parts remain connected together, during the spinning of the top, these two equal and opposite forces *a* and *b* will balance each other, and the top will continue to spin on its original axis.

Having thus shown that the rotary or centrifugal force can never make the top rise from an oblique to a vertical position, I shall proceed to explain the true cause of this change, and I trust you will be satisfied that it depends upon the bluntness of the point. Let A B C be a top spinning in an oblique position, terminating in a very short point with a hemispherical shoulder P *a* M. It is evident that, in this case, the top will not spin upon *a* the end of the true axis X *a*, but upon P, a point in the circle P M to which the floor I F is a tangent. Instead, therefore, of revolving upon a fixed and stationary point, the top will roll round upon the small circle P M on its blunt point, with very considerable friction, the force of which may be represented by a line O P at right angles to the floor I F, and to the spherical end of the peg of the top; now it is the action of this force, by its pressure on one side of the blunt point of the top, which causes it to rise in a vertical direction. Produce the line O P till it meets the axis C; from the point C draw the line C T perpendicular to the axis *a* X, and T O parallel to it; and then, by a resolution of forces, the line T C will represent that part of the friction which presses at right angles to the axis, so as gradually to raise it in a vertical position; in which operation the circle P M gradually diminishes by the approach of the point P to *a*, as the axis become more perpendicular, and vanishes when the point P coincides with the point *a*, that is to say, when the top has arrived at its vertical position, where it will continue to *sleep*, without much friction, or any other disturbing force, until its rotatory motion fails, and its side is brought to the earth by the force of gravity.

(*To be continued.*)

UTAH MINING.—During the six years since the first shipment of ores from Utah, the total products of ores and bullion are reported to amount to 26,000,000 dols., and the present cash value of mines worked—in connection with the thirty smelters now in running order, the twelve-stamp mills, four concentrating works, and one separating and refining establishment, nearly all within a radius of sixty miles from Salt Lake City—cannot be less than 60,000,000 dolls. The mining interests of Utah where never so promising or profitable as at present.

MULTIPLE DRILLING MACHINE.—(See page 119.)



THE PARAGON MOWER.

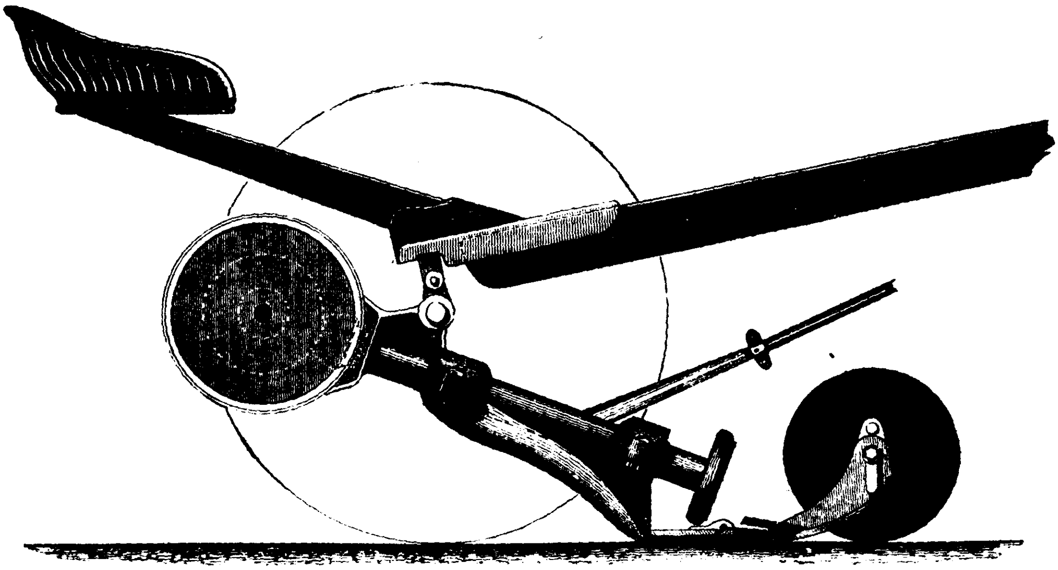


FIG. 3

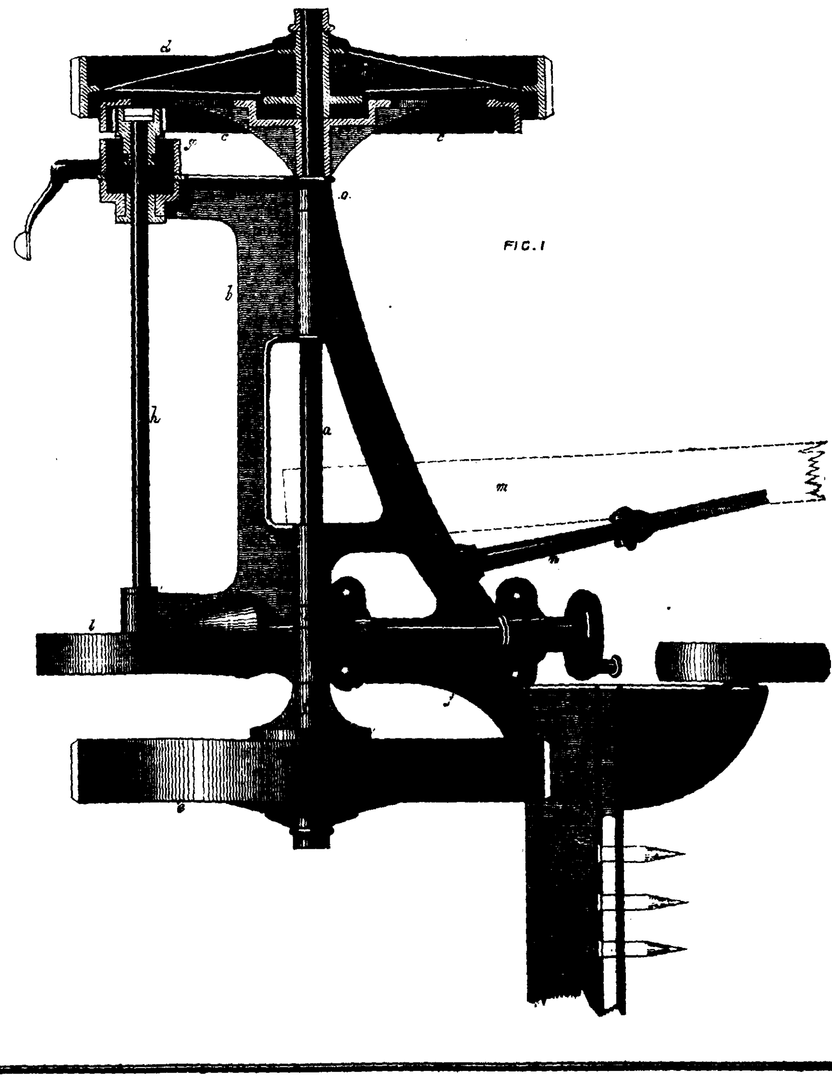


FIG. 1

THE PARAGON MOWER.

We give an illustration on page 125 of a mowing machine constructed by Messrs. Hornsby and Sons, of Gratham, England. This is a back-geared machine, and one of the most noteworthy features about it is, that the arrangement by which the pull of the horse is conveyed to the machine is such that there is no side draught, and the strains always tends to lift the cutter bar and fingers off the ground. There is a species of bridge across the 1-horse power machine, which can be so arranged that the horse always walks in a track clear of corn. There are a number of little details about this machine which tend to reduce friction and promote its longevity. Thus, for example, the crank pin is made hollow, and serves to hold the oil for lubrication. The crank is kept low without inconvenience, because it follows the horse in a track already cleared of corn. The driving wheels are 2ft. 4in. in diameter, and make one revolution to 26:5 revolutions of the crank shaft. None of the gearing save the first pinion is in motion when the machine is travelling on roads. The general construction of the Hornsby mower will be understood from our engravings, page 125. Fig. 1 is a plan and view and Fig. 2 a side elevation, showing Messrs. Hornsby and Sons' recent improvements. The first motion wheel *c* is placed on the driving wheel *d* on the opposite side of the machine to that of the cutter bar. This gives about an equal amount of weight on each of the driving wheels, *a* is the main axle, which is free to revolve in bearings form in the main frame *b*. Upon one end of this axle is keyed the first motion wheel *c*, with internal teeth, having ratchet teeth formed in its centre into which the boss of the road wheel *d*, by spring pawls, drives when the machine is drawn in a forward direction, but will slip when backing the horses, or turning at the corners. The opposite driving wheel *e* also drives in the same manner in the ratchet box *f*, which is also keyed upon the axle. The first motion wheel *c* gears the pinion *g*, which is formed with a clutch for the T-end of the cross-spindle *h* to bite against, and when drawn back by the turnover lever *i* it will be free to revolve upon the axis without driving it. The main slade *j* carrying the finger-bar, is connected to the tube of the main frame *b* by the bearings *k k*, upon which it is free to turn. This tube also forms the bearings for the spindle carrying the crank that drives the knife, which receives motion from the bevel wheel and pinion *l*, which is shielded in a box formed in the main frame *b*. The dotted lines *m* show about the position of the horses' pole, and it will be seen that the draught-bar *n* is placed to the side of the pole nearest the cutters, by which the whole of the "side draught" is taken away, and the downward weight of the finger-bar reduced to the greatest nicety, so that the machine may pass over inequalities of the land as well as over ordinary obstructions without damage or loss of power. The breadth of the horse-walk may also be adjusted by sliding the pole *m* upon the bridge piece, which is shown detached at Fig. 3. By this bridge-piece the pole and driver's seat is jointed to the main frame by bolts to the lugs *o o*, thereby perfect freedom of action is given to the machine independent of the horses' pole. The first prize one-horse mower is on the same principle as the two-horse, but is made lighter throughout, and has, of course, a much narrower cutting apparatus. It has a pair of shafts which move upon the bridge-piece. The firm also exhibited a somewhat novel arrangement of revolving rake delivery applied to a 2-horse mower. There are six rakes, two of which sweep the platform while the others only gather in the corn; but by a very simple arrangement any one or more of the rakes, according to the weight of the crop, may be converted almost in a moment into sheaf deliverers. This machine is constructed on the spring balance double governor system, and has hitherto given admirable results.

A SIMPLE and efficient book-holder has been introduced with notice, consisting of two pieces of hoop iron with longitudinal corrugation for strength, one of them being turned up at both ends to receive the spindle of the revolving wooden handle. A string passes from each end of the handle, through eyelet holes in both pieces of hoop, being united at the bottom of the under piece, or practically the string may be all in one. The pieces of hoop may be separated to the extent of the length of the string, and when the books are placed between them they are drawn together, clamping the books by turning the handle and thus winding up the string. When the requisite amount of tightness is obtained, a thumb-screw on one end of the handle securely locks it. This little piece of domestic engineering, which holds books securely without injuring them and costs but a trifle, is patented by Mr. C. Haymann, of Penge, Surrey.

FAMILY READING.

INTERESTING STATISTICS.

THERE is iron enough in the blood of 42 men to make a ploughshare weighing 24 lbs.

WILD ducks are estimated to fly 90 miles an hour; swallows fly rather faster; and the swift flies above 200 miles an hour.

THE cow eats 276 plants, and rejects 218; the goat, 449, and 126; the sheep, 387, and 341; the horse, 262, and 212; the hog, 72, and 171.

IN man, the temperature of the blood is 98 degrees; in sheep, 102; in ducks, 107; in ague it falls from 98 to 94; in fever it rises to 102 or 105.

THE beats in an hour of a common seconds clock, are 3,600, and 17,280 a common watch; seconds watches beat 18,000 times an hour, or 5 per second.

BUT two millions of species of land and water animals and plants are believed to exist. There are at least 100,000 species of plants, and 400,000 of insects only.

WHEN man and woman have attained their complete development, they weigh almost exactly 20 times as much as at their birth, while the stature is about 3¼ times greater.

THE human body consists of 240 bones, 9 articulations or joinings, 100 cartilages and ligaments, 400 muscles and tendons, and 100 nerves; besides blood, arteries, veins, glands, stomach, intestines, lungs, heart, liver, kidney, lymphatics, lacteals, fat, and skin, &c., &c.

THE species in the seas are believed to be still more numerous. The number of polypi exceeds that of other insects, and the infusoriæ are not numbered, nor are the parasitic tribes. The species of the whole may even be five millions. If an old species became extinct, and a new one were evolved once a week, the whole would last 100,000 years.

THE history of London records fifteen visits of contagious pestilences in England. In 762, 1025, 1247, 1347, 1367, 1379, 1477, 1499, 1548, 1594, 1604, 1625, 1631, 1632, and 1665, averaging 73 years between each. Some change in the proportions of the constituents of the atmosphere, affecting various artificial constituents, or its electrical condition, is the presumed cause.

About the age of 36, the lean man usually becomes fatter, and the fat man leaner. Between the years of 43 and 50, his appetite fails, his complexion fades, and his tongue is apt to be furred upon the least exertion of body or mind. At this period his muscles become flabby, his joints weak, his spirits droop, and his sleep is imperfect and unrefreshing. After suffering under these complaints a year, or perhaps two, he starts afresh with renewed vigour, and goes on to 61 or 62, when a similar change takes place, but with aggravated symptoms. When these periods have been successively passed, the gravity of incumbent years is more strongly marked, and he begins to boast of his age.

EATING-HOW TO KEEP OFF DYSPEPSIA.

It is an old German adage that "more people dig their own graves with their teeth than with spades," and verily it would seem so if we look at the immense number of dyspeptics, rheumatics and gouty individuals, creeping through life in pain and wretchedness. Yet it is next to impossible to induce even thinking people to control their appetites, and to eat such things and at such times as nature shows them is necessary and right. Dr. Hall declares, unhesitatingly, that it is wrong to eat without an appetite, for it shows there is no gastric juice in the stomach, and that nature does not need food; and not needing it, there being no fluid to receive and act upon it, it remains there only to putrefy, the very thought of which should be sufficient to deter any man from eating without an apetite the remainder of his life. If a tonic is taken to whet the appetite, it is a mistaken course, for its only result is to cause one to eat more when already an amount has been eaten beyond what the gastric juice is able to prepare. The object to be obtained is a larger supply of food; and whatever fails to accomplish that essential object, fails to have any efficacy towards the cure of dyspeptic diseases. The formation of gastric juice is directly proportioned to the wear and tear of the system, which it is to be the means of supplying, and this wear and tear can only take place as the result of exercise. The efficient remedy for dyspepsia is work—out-door work—beneficial and successful in direct proportion as it is agreable, interesting and profitable.—*National Granger*.

RECEIPTS.

GRAHAM FLOUR PUFFS.—One quart of sweet milk, two eggs, flour to make in a thin batter, fill the gem cups two-thirds full, bake in a quick oven.

WHEN TO TAKE A WARM BATH.—A warm bath should be taken at night just before retiring, and if the system is weak the bed and sleeping room should be warm to prevent taking cold. Very few persons can take a warm bath in the daytime and go out into the air and attend to ordinary business without much peril.

FRIED CAULIFLOWER.—Pick out all the green leaves from a cauliflower and cut off the stock close. Put it head downward into a saucepan full of boiling, salted water. Do not overboil it. Drain it on a sieve, pick it out into small sprigs, and place them into a deep dish with plenty of vinegar, whole pepper, salt and a few cloves. When they have laid about an hour in this, drain them, dip them in butter, and fry in hot lard to a golden color.

EGGS AND MINCED VEAL.—The New York *Times'* recipe for preparing eggs and veal is the following: Take some remnants of roast veal, trim off all browned parts, and mince it very finely; fry a shallot, chopped small, in plenty of butter; when it is a light straw color, add a large pinch of flour and a little stock; then the minced meat, with chopped parsley, pepper, salt, and nutmeg to taste; mix well; add more stock if necessary, and let the mince get gradually hot by the side of the fire; lastly add a few drops of lemon juice. Serve with sippets of bread fried in butter, round, and poached eggs on the top.

OATMEAL AND COCOANUT.—Oatmeal mixed with grated cocoanut produces a very attractive cake to both old andyoung. Take three heaping teaspoonfuls of grated cocoanut, or two of the prepared dessicated cocoanut; add to it half a pint of the finest oatmeal and two heaping teaspoonfuls of sugar; stir it into one gill of boiling water, and mix it thoroughly together; turn out on the rolling board, well floured, and roll it as thin and cut out as for common cracknels; put a bit of citron and a half dozen currants into each cake, sticking them into the dough. Bake in a slow oven and watch carefully lest they brown a shade too deep. To make them crispy let them stand a day in an uncovered dish.

TIPSY CAKE.—Take a stale sponge cake, cut the bottom of it so as to make it stand even on a glass dish. Make numerous incisions in it with a knife, and pour over it half a pint of sherry and a glass of brandy; let the cake soak these all up. Blanch, peel, and slice some sweet almonds, and stick the cake all over with them. Blanch, chop, and pound in a mortar one-quarter pound of sweet almonds, moistening with a little orange flower water to prevent their oiling; add one pint of milk and the yolks of six eggs; sweeten to taste with pounded loaf sugar. Stir over the fire till the custard thickens, but do not let it boil. Keep stirring now and then till it is quite cold, then pour it round the cake. Garnish the dish with crystallized fruit, and it is ready.

DEATH FROM TIGHT LACING.—There has just died at Pimilico, Mrs. Kezia Wheeler, an old lady at the age of 77, on whom an inquest has been held. Mrs. Wheeler was found dead in her bedroom on Sunday morning last, dressed for church, and with her Bible in her hand, having apparently expired suddenly. The surgeon said death had resulted from the bursting of an aneurism, and the post-mortem examination revealed terrible evidence of tight lacing on the part of the deceased, who had been a very beautiful woman. In fact, one end of the old lady's ribs had been pressed against the internal organs, and had kept them constantly at half action, as it were, until apparently an aneurism was produced by the sudden rupture of which she died. Mrs. Wheeler must have been an exceptionally healthy woman to have thus lived in spite of the corset which imprisoned part of her organs and interfered with their natural development; had she not laced she would doubtless have been a centenarian.

—*London Daily Telegraph.*

BESSEMER STEEL.—The success which is attending the attempts to substitute Bessemer for iron in many branches of manufacturing and construction, is full of promise for this industry. We have hardly done wondering at one achievement before we hear of another. Where the first rude and crude attempts to use it proved failures later experiments have proved successful. We have already informed our readers of the successful manufacture at Troy of horse shoes and nails from Bessemer. The shoes, it is claimed, are lighter and wear longer and more even than those of iron, while the cost is not much in excess of iron. The nails, it is asserted, can be driven through oak planks and clinched.

EGGS AND HONEY.

There are several branches of productive industry the value of which is not duly appreciated by those seeking employment, and who are so situated that they could easily embark in it. It is especially persons in the country and small towns who could successfully produce eggs and honey, and we have even seen instances of such profitable productions in large cities. A widow lady in the upper part of New York city, keeps a large number of chickens, producing eggs enough to supply a grocer in the neighborhood with the article, and as their freshness is reliable, she obtains a good price, and a not to be despised addition to her income as long as the season lasts; while another in the newly incorporated wards of Westchester county makes it the principal source of her income.

Another party in this city caused his bees to obtain their honey entirely from the waste of a sugar-house and such flowers as the public parks might afford. The honey was fully equal to the best, and as it is evident that the quantity of refuse which may yield honey is enormous in a city like New York, its utilization in this way might be profitable to many who will take the trouble of entering into this business, which, by the way, is one of the most profitable. Thus for instance, a lady who started five years ago with four beehives, which she bought for $10, declines now to take $1,500 for her stock, notwithstanding in the meantime she has sold 22 hives and 436 pounds of honey at 35 cents a pound. A man who five years ago started with six colonies, cleared 8,000 pounds of honey, and has now 54 colonies.

As such a business can as well be conducted on a housetop or in a back yard as on a farm, if only some honey yielding material is near at hand, we do not see why it could not be undertaken by many an intelligent housewife who is anxious to occupy herself with something profitable and amusing.

CARE OF THE HANDS.

Great care should be taken to keep the nails neat and well trimmed. They should be rounded at the top, and not too closely. Their polish and rosiness may be increased by brushing and rubbing.

To improve the skin of the hands and arms, take two ounces of Venice soap, and dissolve it in two ounces of lemon juice. Add one ounce of the oil of bitter almonds, and a like quantity of oil of tartar. Mix the whole, and stir it well until it has acquired the consistency of soap, and use it as such for the hands.

The paste of sweet almonds, which contains an oil fit for keeping the skin soft and elastic, and removing indurations, may be beneficially applied to the hands and arms.

For hands that are stained, there is an easy remedy. Dampen the hands first in water, then rub them with tartaric acid, or salt of lemons, as you would with soap; rinse them and rub them dry. Tartaric acid, or salt of lemons, will quickly remove stains from white muslin or linens. Put less than half a table-spoonful of salt or acid into a tablespoonful of water; wet the stain with it, and lay it in the sun for an hour; wet it once or twice with cold water during the time; if this does not remove it repeat the acid water, and lay it in the sun.

A most excellent ointment for hands that are scratched, burnt or sore, is thus prepared: Take three drachms of camphor gum, three of white beeswax, three of spermaceti, two ounces of olive oil—put them together in a cup upon the stove, where they will melt slowly and form a white ointment in a few minutes. If the hands be affected, anoint them on going to bed, and put on a pair of gloves. A day or two will suffice to heal them.

For chapped hands, instead of washing the hands with soap, employ oatmeal, and after each washing take a little dry oatmeal and rub over the hands, so as to absorb any moisture.—*Illustrated Weekly.*

THE first toll we read of in England for mending the highways was imposed in the reign of Edward the Third, and was for repairing the road between St. Giles's and Temple Bar.

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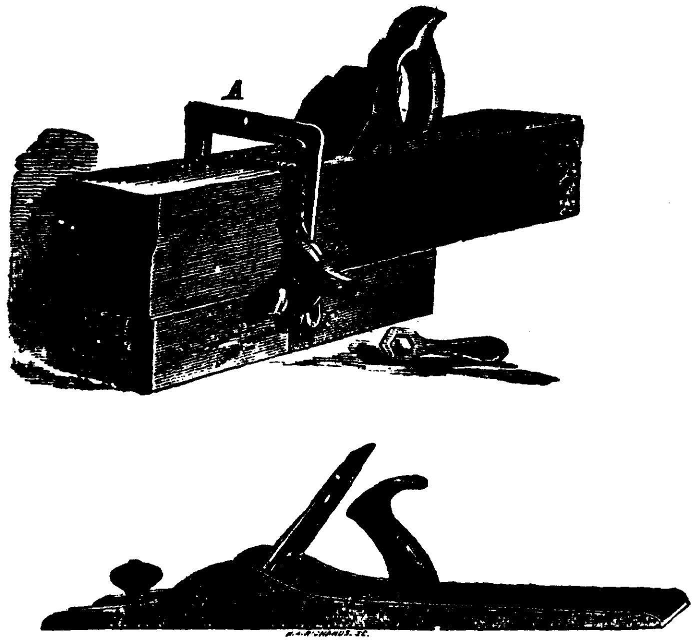
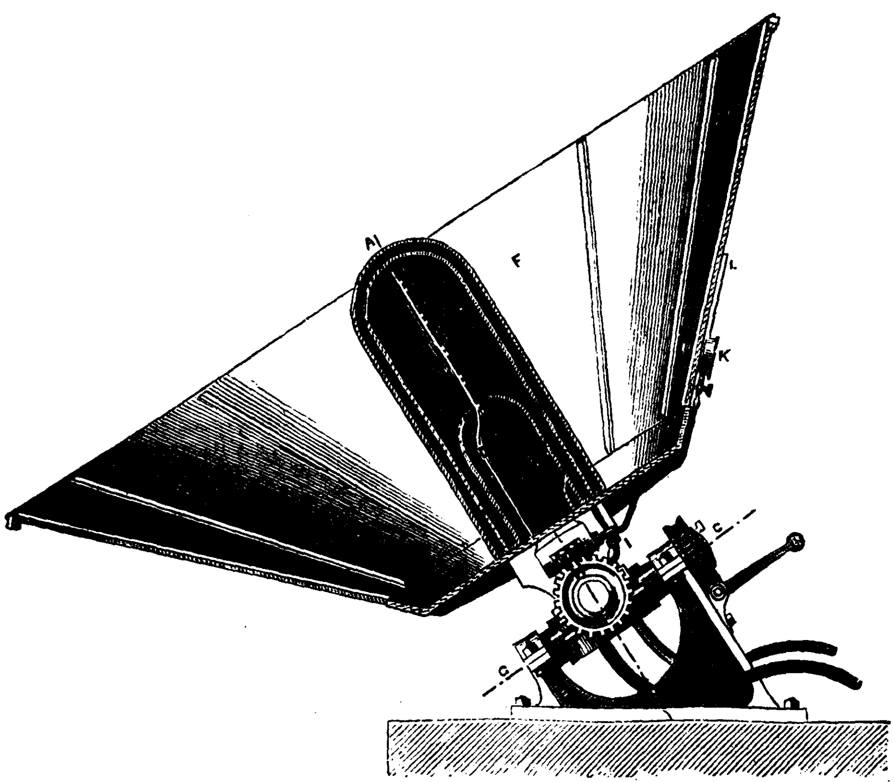


WOOD CARVING.—(See page 122.)

AN INVALID'S CHAIR.—(See page 118.)



THE MOUCHOT'S SOLAR ENGINE.