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During the absence in England of the Editor, Professor Henry T. Bovey, communications, &c., relating to the Editorial Department should be addressed to R. W. Boodle, *21 McGill College Avenue, Montreal.*

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DESCRIPTION OF A DREDGE.

BY F. F. MILLER, C. E.

The dredge, designed by Mr. John Kennedy, Engineer of St Lawrence Ship Channel Improvements, Montreal, is of the elevator or ladder type, and is shown by engravings at pages 260-1. It has a single set of buckets which act through a well along the centre of the hull and will dredge to a depth of 22 feet below the water level. The dredge was designed for working on a river in the Western States, where timber is abundant and economy of construction is of some consequence, and timber has therefore been used in several places where under other circumstances iron would have been used. This form of dredge is eminently suited for dredging in ship channels, open spaces in harbours, &c. The hull is designed for working in water not subject to any great storms, and is scow-shaped to give a roomy deck especially at the ends where the winches are placed. It is 135 ft. in length, 28 ft. breadth and 12 ft. deep. Figs. 1, 2 and 3 shew the position of the machinery. Figs. 4 to 8 show the details of the buckets.

The upper tumbler shaft and the head of the bucket frame are supported by a main framing which is strongly built into the hull. The framing is composed of white oak timbers strengthened and secured with bolts, cast-iron knees and rails. The sides of the frame are closed in with $1\frac{1}{2}$ inch pine planking, tongued and grooved, and placed in line with the insides of posts. A breast of five inch pine planking extends across from post to post, and from the deck to the heads of the posts. The breast is iron-plated on the face next the buckets from the chute to 2 feet above the tumbler. The planking is lapped and secured with bolts so as to exclude water and mud, as well as to protect the plank. In front of the frame one inch sheeting extends along the sides of the well and is finished with rails at the same rake as the main braces of the frame and 5 feet above them.

The forward or lower end of the bucket frame is supported by white oak A frames. The heads of the frames have cast iron knees and are connected by an oak cross bridge 18 by 22 ins. The bucket frame has sides of best sound white oak dressed to 8 inches by 24 inches. The ends of the frame are mounted with wrought iron straps $3\frac{1}{2}$ by 7 inches. The frame is trussed vertically as shown in *Fig. 1*, and horizontally, by a system of cast iron transoms and $1\frac{1}{2}$ inch round truss rods, not shown. The rollers supporting the chain of buckets on the frame are made of cast iron and are 15 inches in diameter and $1\frac{1}{4}$ inch thick in the body. The bodies of the spindles are square and are made fast in the rollers by oak and iron wedges. The journals are made of steel. The bushes of the pillow blocks are made of iron.

In the bucket chain there are twenty-seven buckets, twenty-seven pairs of links and fifty-four link pins. The buckets are of 3 ft. pitch, 21 cubic ft. capacity and are in this instance designed to work in materials of moderate hardness. The bucket bottoms are made after a patent of Mr. Kennedy's and are of annealed crucible cast steel, having eyes for the links cast on solid. The backs of the buckets are of $\frac{1}{2}$ inch steel plate. The lips are of $\frac{7}{8}$ inch steel plates tempered on their cutting edges.

The buckets are riveted with rivets $\frac{7}{8}$ inch in diameter in drilled holes. The eyes for the links are bushed with steel tempered hard and shrunk into the eyes. The pins and links are made of steel.

The dead eyes carrying the head of the bucket frame are made of cast iron and they are of unusual strength. The pillow blocks of the tumbler shafts are made in the most accurate manner with planed joints throughout and the brasses are made reversible

The tumbler shafts are made of forged steel. The spur wheels (one on each end of the shaft) are 16 ft. 2ins. in diameter, 9 inches face and $3\frac{1}{2}$ inches pitch.

The upper tumbler is cast in one piece, without flanges and fitted to the shaft and secured by two keys. The faces of the body of the tumbler are steel plated all round. The plates are planed to fit truly and are put on with countersunk rivets of the best tough iron. The sides of the hexagon are $\frac{1}{4}$ inch smaller than those enclosed by the links of the bucket chain when folded round it. The lower tumbler has a cast iron body, flanges, and gudgeons, and is protected on the sides with $\frac{3}{4}$ inch steel plates bedded on dried oak packing $\frac{3}{4}$ inch thick and rivetted to the body. The bearnig surfaces of the gudgeons are chilled.

The lower end of the bucket frame is supported with two sets of wire rope tackle. The rope is made of steel wire and $\frac{7}{8}$ inch in diameter. The sheaves of the blocks are 20 inches in diameter. The upper blocks are secured to the cross bridge of the A frame by four $1\frac{3}{4}$ inch bolts to each block. The standing part of the rope is attached to the bridge with a screw so as to have an adjustment of 6 inches in length. The chain for connecting the lower blocks to the buckets is made of $1\frac{3}{4}$ inch iron.

A steam winch with two cylinders 8 inches in diameter by 10 inches stroke is secured to the deck for lifting the bucket frame and working the bow chain of the dredge. The gearing is so arranged that the wire rope barrel for the bucket frame, or the bow chain sheave may be worked, either separately or together, by means of loose pinions and suitable clutches on the second counter shaft.

Steam winches with double cylinders 7 inches in diameter by 8 inches stroke, are placed, one at the bow and the other at the stern on deck for breasting or working the dredge athwartwise. A small steam winch with two cylinders of 5 inches diameter by 7 inches stroke is placed near the chute for handling the scows and for general use.

Wrought iron steam pipes are brought from the main boilers to all the winches.

Three of the breasting chains lead over the gunwale on cast iron sheaves 14 inch s diameter to bottom of grooves and hung with wide cheeked blocks on ball and socket joints so as to freely accommodate themselves to the lead of the chain. Each block is provided with a spring pawl set between the cheeks and so arranged as to prevent the chain running out in case of its breaking inboard, and also to let go easily when required. The after chain on the same side as the chute is led out through a small well opening just inside the bilge fitted with a hawse pipe, the mouth being chilled and formed so as to offer little resistance to the chain and also so as to be easily renewable by a diver.

The chute for carrying off the dredgings is 4 ft. 8 inches in width and 2 feet deep inside, with a moveable cover over part of it. The shell or body is of $\frac{3}{8}$ inch boiler plate strengthened with 3 by 3 inch angle iron trasverse ribs, inside the main framing, and of $\frac{1}{4}$ inch plate with similar ribs in the remaining portion to the gunwale. The bottom, outside the frame, is lined with extra plating $\frac{3}{8}$ inch thick and well riveted to the outer shell. Within the frame and under the buckets the whole inside is lined with longitudinal bars $1\frac{1}{2}$ inch thick, laid close together and rivetted to the shell. The head end is of $\frac{3}{8}$ inch plate and it has a cast iron flange with a four inch opening rivetted into it near the bottom, for the admission of a water jet nozzle.

The cover is made of $\frac{1}{4}$ inch plate strengthened with 3 by 3 inches angle iron ribs at its ends, and it is bolted to the under part of the shoot by angle iron flanges on both.

The outer section of the chute beyond the gunwale is made of $\frac{1}{4}$ inch plate strengthened by 3 inches by $\frac{5}{8}$ inch bars at the edges and outer end and with a 3 by 3 inch angle iron at the upper end and the bottom is lined with $\frac{1}{4}$ plate.

The outer end of the lower section is carried by a suitable bale, $\frac{5}{16}$ chain, davit and counter weight, and the whole so arranged that it may be set and held at any inclination below the level when at work or may be folded in board over the other part.

The chute within the main frame is bedded its full on a blocking of pine timber built up nearly solid from the deck to the chute so as to afford weight of mass as well as strength.

A neat wrought iron derrick crane is provided for lifting the buckets off and on the frame, for lifting parts about the lower tumbler and other uses. The crane is adjustable from fifteen feet to four feet radius, and is supported from its own mast through the deck. It can wind up 25 feet of chain on its own barrel without riding, it is adapted to carry 2 tons and is provided with friction brakes capable of lowering the same.

GENERAL SPECIFICATIONS FOR ORDINARY IRON HIGHWAY BRIDGES.

By J. A. L. Waddell, C. E., B. A. Sc., Ma. E.,

Prof. of Civil Engineering in the University of Tokio, Japan.

(*Concluded from page 231.*)

Sizes of Stay Plates.—The dimensions of stay plates in struts where latticing or double rivetted lacing is employed, are not to be less than those given in the following table of the distances between the inner faces if the channels be more than the depth of the latter and less than one and a quarter times the same, either the thickness of the stay plates must be increased one sixteenth of an inch above that given in the table, or the width must be increased sufficiently to allow space for one more rivet at each side; or if the distance between the faces be between one and a quarter and one and a half times the depth of the channels, both of these changes in the thickness and width must be made;

Depth of channels.	*Thickness of* Stay Plates.	*Width of Stay* Plate.	*No. of Rivets* on a side.
4 inch.	$\frac{1}{4}$ inch.	4 inch.	2
5 "	$\frac{1}{4}$ "	4 "	2
6 "	$\frac{1}{4}$ "	4 "	2
7 "	$\frac{1}{4}$ "	4 "	2
8 "	$\frac{5}{16}$ "	4 "	2
9 "	$\frac{5}{16}$ "	$6\frac{1}{2}$ "	3
10 "	$\frac{5}{16}$ "	$6\frac{1}{2}$ "	3
12 "	$\frac{3}{8}$ "	$6\frac{1}{2}$ "	3

while if the distance between the faces be more than one and a half times the depth of the channels, either the thickness must be increased by one sixteenth of an inch and the width sufficiently for two more rivets on a side, or the thickness must be increased one eighth of an inch and the width sufficiently for one more rivet on a side.

But if single rivetted lacing be used the dimensions of the stay plates are to be taken from the next table, the same allowance as before being made for the increased distances between channels:

Depth of channels.	Thickness of Stay Plates.	Width of Stay Plates.	No. of Rivets on a side.
4 inch.	$\frac{1}{4}$ inch.	4 inch.	2
5 "	$\frac{1}{4}$ "	4 "	2
6 "	$\frac{1}{4}$ "	$6\frac{1}{2}$ "	3
7 "	$\frac{1}{4}$ "	$6\frac{1}{2}$ "	3
8 "	$\frac{5}{16}$ "	$6\frac{1}{2}$ "	3
9 "	$\frac{5}{16}$ "	$8\frac{1}{2}$ "	4
10 "	$\frac{3}{8}$ "	$8\frac{1}{2}$ "	4
12 "	$\frac{3}{8}$ "	$8\frac{1}{2}$ "	4

Inclinations of Latticing and Lacing Bars.—Lattice bars shall make with each other, as nearly as circumstances will permit, angles of ninety degrees, and lacing bars angles of sixty degrees.

Diameters of Rivets for different Channels.—For attaching plates and lattice bars to channels the least diameters of the rivets to be used are to be taken from the following table; and the greatest diameters must not exceed those given in the table, in any case, by more than one eighth of an inch:

Depth of Channels.	4in.	5"	6"	7"	8"	9"	10"	12"
Diam. of Rivets.	$\frac{1}{2}$in.	$\frac{1}{2}$"	$\frac{5}{8}$"	$\frac{5}{8}$"	$\frac{5}{8}$"	$\frac{3}{4}$"	$\frac{3}{4}$"	$\frac{3}{4}$"

Sizes of Lattice Bars.—The minimum sizes of the lattice bars for the different depths of channels, when the distance between the inner faces of the latter does not exceed their depths, are to be taken from the following table: but if this distance exceed the depth and be less than one and a quarter times the same, either the thickness of the bars must be increased by one sixteenth of an inch or their width by one half of an inch; if the distance between the faces be greater than one and a quarter times the same, both of these changes in thickness and width must be made; while if the distance between faces exceed one and a half times the depth, the thickness must be increased by one eighth of an inch and the width by one half of an inch. This table can be made to apply to single rivet lacing by increasing the width of the bars by three eighths of an inch, and making the same allowance for increased distance between the faces of channels.

Depth of channels.	Thickness of Lattice Bars.	Width of Lattice Bars.
4 inch.	$\frac{1}{4}$ inch,	$1\frac{1}{4}$ inch.
5 "	$\frac{1}{4}$ "	$1\frac{3}{8}$ "
6 "	$\frac{1}{4}$ "	$1\frac{1}{2}$ "
7 "	$\frac{1}{4}$ "	$1\frac{5}{8}$ "
8 "	$\frac{5}{16}$ "	$1\frac{3}{4}$ "
9 "	$\frac{5}{16}$ "	$1\frac{7}{8}$ "
10 "	$\frac{5}{16}$ "	2 "
12 "	$\frac{3}{8}$ "	$2\frac{1}{8}$ "

Splice plates.—The length of a splice plate is to be determined by the number of rivets necessary to transfer the stress from one main member to the other: the sum of the working resistances to shearing of all the rivets on either side of the joint must not be less than the stress in the main member upon that side, nor must the latter stress be greater than the sum of the working resistance at the bearing surfaces of the rivets on that side of the joint.

When practicable, a splice plate must be placed on each side of every member where a splice occurs.

The transmission of compressive stresses shall be considered as entirely through the medium of the rivets and connection plates, and these must be proportioned accordingly.

Reinforcing plates. — Simple reinforcing plates or plates rivetted to webs at pin holes in order to compensate for strength lost there, or to provide additional bearing for the pins, must have as many rivets to attach them to the webs as will give shearing and bearing resistance for same, at least equal to the greatest allowable stresses upon the reinforcing plates.

Cover plates.—Cover plates for top chords or batter braces are to have the same section as the chord or batter brace plate, the joints of which they cover, and enough rivet on each side of the joint to take up the greatest allowable stress that could ever come upon the cover plates.

Extension or connecting plates. — All extension or connecting plates on the ends of struts, for the purpose of attachment by pins or rivets, must be designed of such a strength that they will bear without buckling the ultimate resistance to compression of the struts, and to provide sufficient bearing for pins and rivets. There must be a sufficient number of the latter to transfer all the stress in the post to the extension or connecting plates.

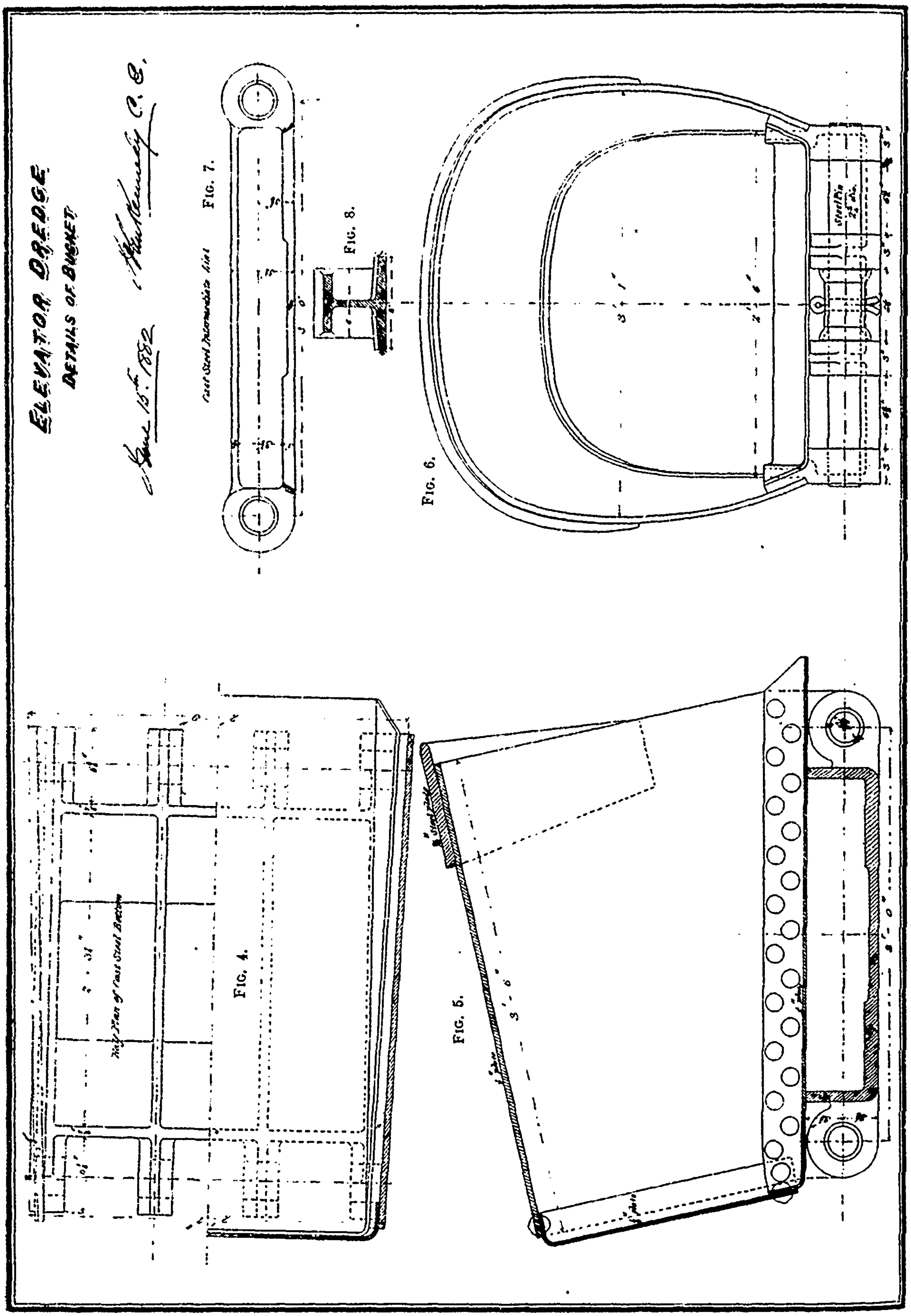
Shoe plates and roller plates. — No shoe plate or roller plate is to have a less thickness than three quarters of an inch.

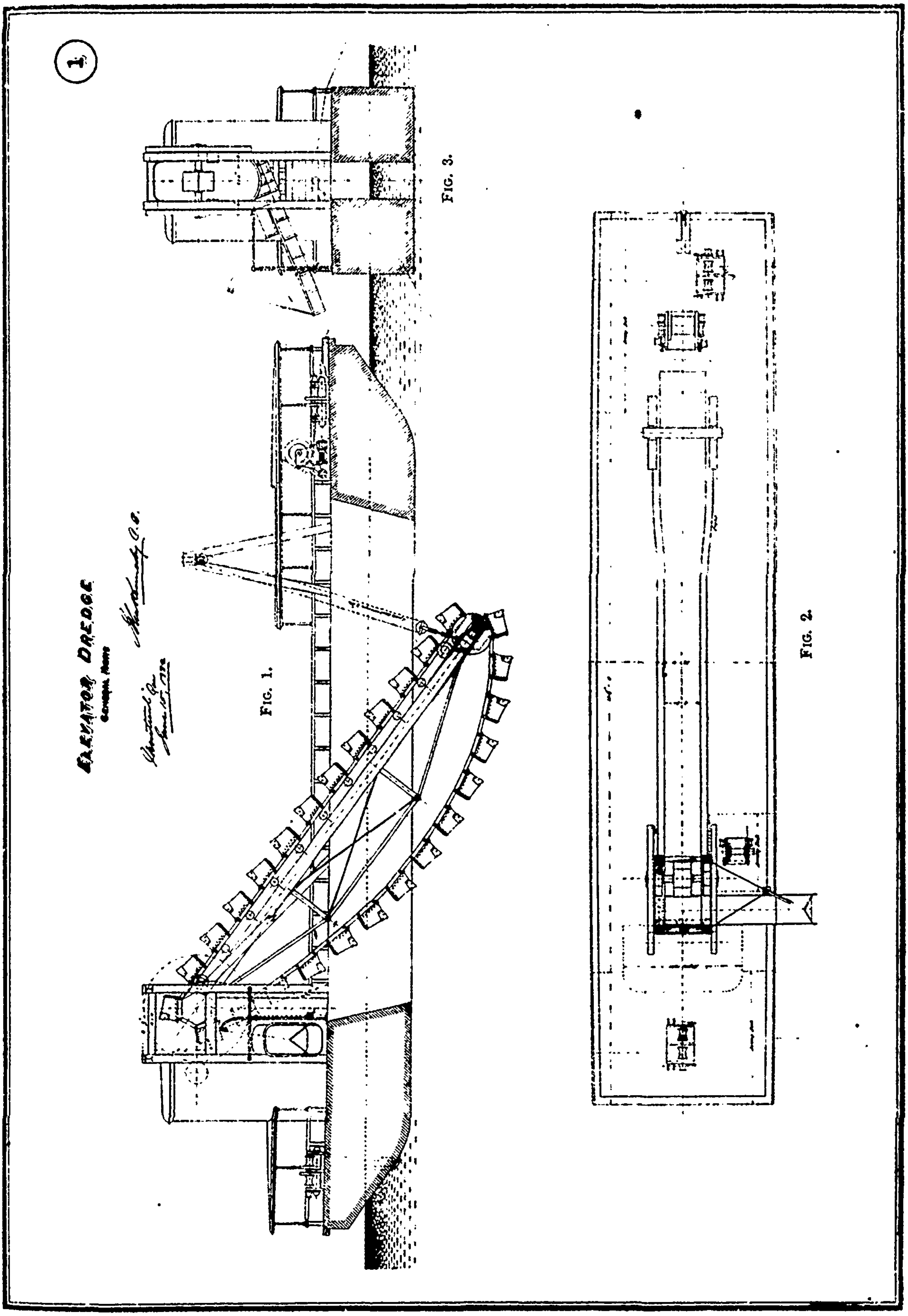
Beam hanger plates.—Beam hanger plates are never to be made less than three quarters of an inch thick, and their areas are to be such that the hanger nuts will always have a full bearing thereon.

The necessary thickness for a beam hanger plate is to be found by considering it as a beam uniformly loaded by the whole weight that comes on the hangers, the length of said beam being the distance between the centre of holes, through which pass the ends of one hanger and its width being the extreme dimension of the plate measured parallel to the floor beam: the working stress for bending on the plate is to be taken equal to that used in proportioning the floor beam.

Rivetting.—In rivetted work all joints are to be squarely and truly dressed, and the rivet holes must be accurately spaced.

No rivets with crooked heads or heads not formed accurately on the shank, or rivets which are loose either in the rivet holes or under the shoulders will be allowed in a bridge.


ELEVATOR DREDGE
DETAILS OF BUCKET
June 15th 1882
FIG. 7.
Cast Steel Intermediate Link
FIG. 8.
FIG. 6.
FIG. 4.
Half Plan of Cast Steel Bottom
FIG. 5.


ELEVATOR DREDGE
FIG. 1.
FIG. 2.
FIG. 3.

Rivet holes in chords shall be spaced as nearly as practicable three inches centre to centre near the panel points, and four inches centre to centre elsewhere.

No rivet holes shall be less than one and a half diameters from the edge of a plate, and the diameter of a hole shall never exceed that of the rivet by more than one sixteenth of an inch.

When two or more thicknesses of plate are rivetted together in compression members, the outer row of rivets shall not be more than three diameters from the side edge of the plate.

Rivet holes must never be spaced less than two and a half diameters from centre to centre.

All the rivet holes of the respective parts of any structure must be made to exactly coincide, either by drilling the holes full size through the connecting portions after being put together, or by sub-punching the pieces separately and afterwards reaming the combined rivet holes to proper size. In all cases the burrs must be removed by slightly countersinking the edges of the holes.

All rivets in splice or tension joints are to be systematically arranged, so that each half of a tension member or splice plate will have the same uncut area on each side of its centre line. No rivet is to have a less diameter than the thickness of the thickest plate through which it passes, nor, in any case, less than half an inch.

Use of bolts.—The use of bolts instead of rivets is to be avoided whenever possible.

Floor beam stiffeners.—Built floor beams must be well stiffened at the points of support, and at several intermediate points, the distance apart of the stiffeners being made no greater than twice the depth of the beam when the ratio of thickness of web to depth of beam is not less than one eightieth, and no greater than one and a half times the depth when this ratio is one hundred and twentieth; distances for intermediate ratios being interpolated.

Angle irons rather than tee irons are to be used as stiffeners, and are to be placed opposite to each other instead of being staggered.

They must extend from the upper leg of the upper flange to the lower leg of the lower flange of the floor beam, being made flush with the other legs of the flanges by means of filling plates.

Rivets in flanges of floor beams. — In spacing the rivets in the flanges of floor beams, the latter are to be divided into equal portions of about two feet in length, the stresses in the flanges are to be found at the points of division, and there must be enough rivets between any consecutive points of division to take up the difference of the stresses at the points, providing that the rivets are not spaced more closely than two and a half diameters, nor more than six inches apart.

Limiting depths of floor beams. — The greatest allowable depths for floor beams with webs of different thickness are to be taken from the following table :

Thickness of web...........	¼in.	$\frac{5}{16}$in.	⅜in.
Depth of beam	30in.	38in.	45in.

Eyes.—In welded heads the length of metal behind the pin must be at least equal to the diameter of the pin: while, in hammered heads, the amount is to be the same as that above or below the pin.

The least amount of metal in the heads across the pins is given in the following table :

Width of Bar.	Diam. of Pin.	Metal in head across pin.	
		Welded.	Hammered.
1	0·80	1·40	1·50
1	1·01	1·50	1·50
1	1·12	1·50	1·53
1	1·20	1·50	1·56
1	1·28	1·50	1·60
1	1·36	1·55	1·72
1	1·43	1·60	1·76
1	1·50	1·67	1·85
1	1·61	1·67	1·95
1	1·77	1·70	2·05
1	1.90	1·70	2·21

In loop eyes the distances of the inner point of the loop from the centre of the pin must be not less than three times the diameter of the pin, where the section at the eye is reduced to a minimum, but if the bar be simply turned around the pin and welded, this distance may be decreased. Pin holes in eye bars shall be bored to an exact size and distance, and to a true perpendicular to the lines of stress; no error in the length of bar or diameter of pin hole exceeding one *sixty fourth of an inch will be allowed, nor any variation* of more than one sixteenth of an inch between the centre of the eye and the centre line of the bar.

Pins.—Pins are to be proportioned to resist the bending produced in them by the bars or struts which they connect. No pin is to have a diameter less than eight tenths of the depth of the deepest bar coupled thereon, nor shall it vary from that of the eyes of the bars coupled thereto by more than one fiftieth of an inch.

Pin bearings.—Where a pin bears against a reinforced channel bar, the web of the latter is not to be assumed to take up any bearing stress, unless the reinforcing plate or plates were rivetted to it before the pin hole was bored.

Expansion rollers.—Expansion rollers are to be proportioned by the formula p sq. rt. $0.135d$, where p is the working load in tons per lineal inch of roller, and d is the diameter of roller in inches. The least allowable diameter for rollers is one and three quarter inches for bridges of class A, or one and a half inches for bridges of classes B and C. The spaces between rollers must never exceed three quarters at their diameter.

Turn buckles and sleeve-nuts.—All turn buckles and sleeve-nuts must be made so strong that they will be able to withstand without rupture the ultimate pull of the rods, which they connect. U nuts are not to be used in any part of a bridge.

Sizes of nuts. — The dimensions of all square and hexagonal nuts for the various diameters of rods are to be taken from "Carnegie's Pocket Companion," pages 130 and 131, excepting those nuts on the *ends* of pins, which are subject to but a slight tendency to shear the thread; in this case these dimensions may be diminished in direct proportion to this tendency until the thickness reaches the limit of one half of an inch.

Washers and nuts.—Washers and nuts must have a uniform bearing.

Jaws.—Great care must be taken in designing jaws for the ends of any strut that they be *so strong in* every respect that when the strut is subjected to its ultimate load, it will fail in the middle rather than at the ends.

Brackets. — Except when intermediate struts are employed, brackets or knees must be used to connect each upper lateral or portal brace strut to the posts or batter braces. They are to be of the angle or channel iron, and are to be made straight instead of curved.

Cutting off the flanges of channels. — The flanges at the ends of channel bars must never be cut away, if it be possible to avoid doing so; if not, there must be sufficient reinforcing used to make the strut as strong as it would have been with the flanges uncut.

Iron hand railing.—If the hand rail employed be of iron, it must be made strong and rigid, and must be firmly attached to the floor beams.

Sizes of flooring and joists.—Pine flooring is to be made at least three inches thick and oak flooring at least two and a half inches thick.

It is to be laid with close joists and well spiked to each joist with seven inch cut spikes.

Joists are to be proportioned by the formula

$$W = \frac{bd^3}{cl^2}$$

where W is the safe uniformly distributed load in tons, b the breadth of the joist in inches, d the depth of same in inches, l the length in feet and c—16 for pine and 11.5 for oak.

Where the load is concentrated on wheels, it is to be considered as supported equally between the joists directly under the wheels and those contiguous to the same; i.e., the wheels on one side of a wagon are supposed to be placed directly over a joist, which joist is assumed to take half their loads, the remaining half being equally divided between the two adjoining joists. All concentrated loads must be properly reduced to equivalent uniformly distributed loads, in respect to deflection, before applying the formula. The minimum live load to be used for proportioning joists for bridges of classes A and B is one hundred pounds per square foot, and for bridges of class C, eighty pounds per square foot, regardless of the length of span of the bridge.

Wooden hand rails, etc. — Wooden hand-railing is to be made of pine, the posts being 4″ × 6′ × 4′, with two runs of 2 in. × 6 in. timbers, one on its flat and the other below on edge to support the first, for a hand rail, and one run of 2″ × 12″ hub-plank. The latter and the lower run of 2″ × 6″ are to be let into the posts to their full depth, and spiked to same with five inch cut spikes, and the posts are to be halved on to the outer joists, to which each one is to be bolted by two five-eighths inch bolts.

Guard rails are to be of 6′ × 6′ pine, bolted to the floor once in at most every five feet by five eighth inch bolts.

Details not previously mentioned. — Finally as regards the proportioning of any structure, if cases should occur, which are not covered by the preceding specifications, the following rule must in all such cases be adhered to: "details must always be proportioned so as to resist every direct and indirect stress, that may ever come upon them under any probable circumstances, without subjecting any portion of their material to a stress greater than the legitimate corresponding working stress."

Cast iron. — No cast iron is to be used any where, unless it be for washers for hand rail post bolts.

Field rivetting.—Field rivetting must be done with the button sett; the heads of the rivets must be hemispherical, and no rough edges must be left.

Painting.—All iron work is to be thoroughly cleaned (by acid or otherwise), and all scale or oxide formed in rolling or working is to be removed from the surface before painting. All iron work is to have one coat of metallic paint before leaving the shop, and before corrosion commenses.

All turned and faced parts are to receive a coat of tallow mixed with white lead before shipment.

After erection all iron work is to receive two coats of metallic paint, mixed in equal parts of parafine and linseed oil, dissolved and applied while hot.

There must be no part of the iron work inaccessible to the paint brush.

Timber.—All timber is to be of the best quality, free from wind shakes, large knots, decayed wood, sap or any defect that would impair its strength or durability.

Quality of workmanship. — All workmanship is to be first class; abutting joints are to be truly planed or dressed, so as to secure a perfect bearing; the pin holes in chords and posts are to be bored as truly as is specified for the large bars; and there are no rough corners or edges to be left on the iron work.

Tests of materials.—All wrought iron is to have an elastic limit of not less than twenty-six thousand pounds per square inch.

Full sized bars of flat, round, or square iron, not over four and a half square inches in sectional area are to have an ultimate strength of fifty thousand pounds per square inch and are to stretch twelve and a half per cent of the whole length.

Bars of a larger sectional area than four and a half square inches are to be allowed a reduction of one thousand pounds per square inch for each additional square inch of section, down to a minimum of forty-six thousand pounds per square inch.

Specimens of a uniform section of at least one square inch taken from bars of four and a half square inch section and under are to have an ultimate tensile strength of fifty-two thousand pounds per square inch, and are to stretch eighteen per cent in eight inches. Similar specimens from bars of a larger section than four and a half square inches are to be allowed a reduction of five hundred pounds per square inch for each additional square inch of section, down to a minimum of fifty thousand pounds per square inch.

Similar sections from angle and other shaped iron are to have an ultimate strength of fifty thousand pounds per square inch, and are to stretch fifteen per cent in eight inches.

Similar specimens from plate iron are to have an ultimate strength of forty eight thousand pounds per square inch, and are to stretch fifteen per cent in eight inches.

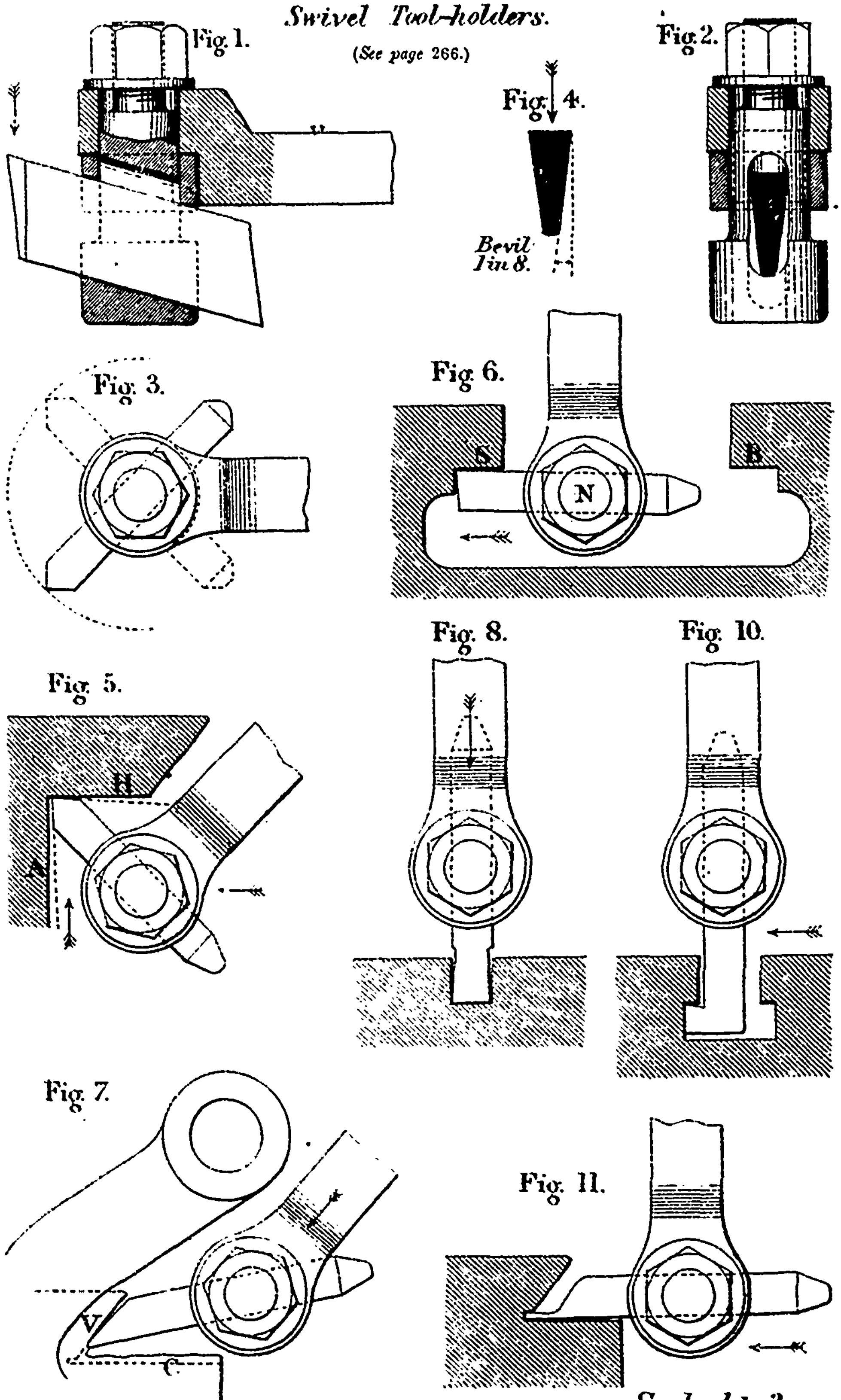
All iron for tension members is to bend cold, without cracking, through an angle of ninety degrees to a curve, of which the diameter is not more than *twice* the thickness of the piece, and at least one sample in three is to bend one hundred and eighty degrees to this curve without cracking.

Specimens from plate, angle, and other shaped iron are to bend cold, without cracking, through an angle of ninety degrees to a curve, of which the diameter is

CUTTING OF METALS.

Swivel Tool-holders.

(*See page* 266.)



Scale 1 to 3.

CUTTING OF METALS.

Tool-holder for Planing Machines.

Fig. 9A.
Scale 1 to 8.

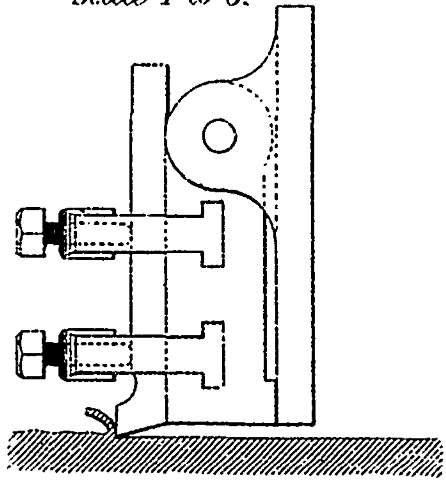


Fig. 9.

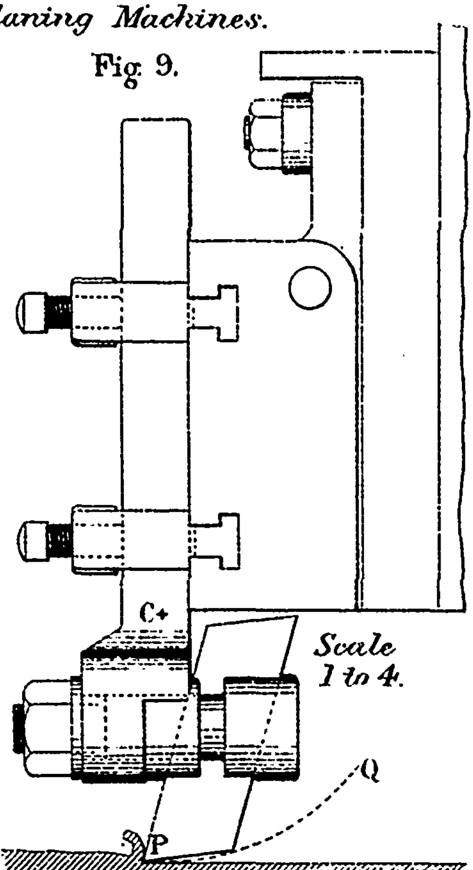


Fig. 9B.
Scale 1 to 8.

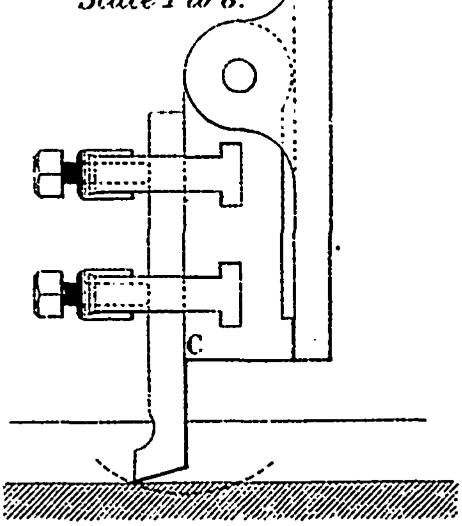
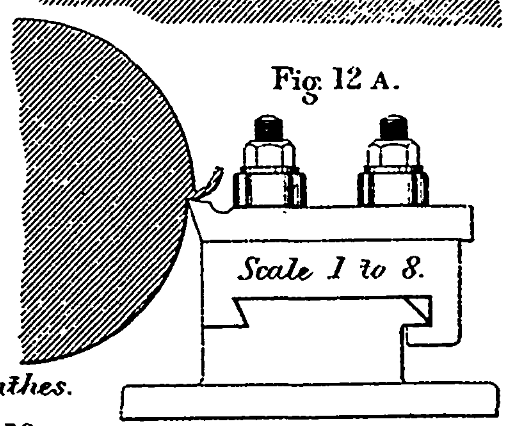


Fig. 12 A.



Tool-holder for Screw-cutting Lathes.

Fig. 12.

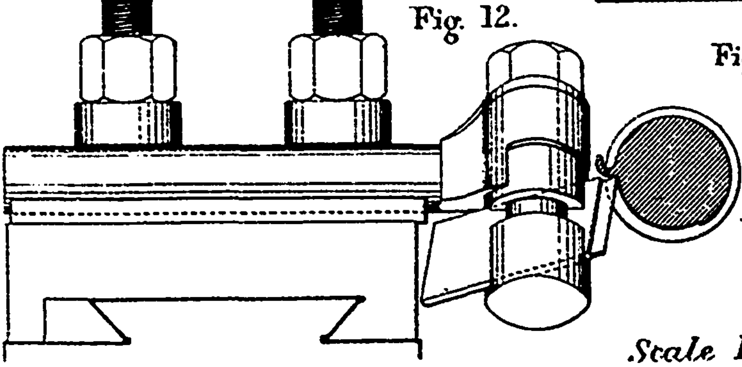
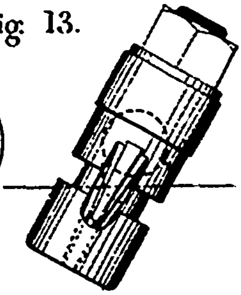


Fig. 13.



Scale 1 to 4.

not more than *three* times the thickness of the specimen.

Rivets are to be of the best quality of iron, and so ductile that a bar of the diameter of the largest rivet used will bend close through one hundred and eighty degrees without sign of fracture.

Test of structure.—On the completion of the entire structure, any bridge, after being in constant use for one day, may be tested by a load equal to that for which it was designed, remaining upon it for at least one hour, without showing any permanent set.

ON SOME MODERN SYSTEMS OF CUTTING METALS.*

By Mr. W. Ford Smith, of Manchester.

In this paper it is proposed to treat of some of the processes of Cutting Metals which the writer has adopted since he read a paper on Tool-holders before the Institution (Proceedings, 1866, p. 288). The success of the round tool-holders then described has led to the further adoption of mechanical means of making and maintaining the tools used in various machines for cutting and finishing metals in their cold state. Such machines are commonly known by the term "machine tools;" and comprise lathes, planing, shaping, and slotting machines, milling machines, drilling and boring machines, screwing and chasing machines, etc.

Tool-Holders and Cutters.

The former paper mainly described what have since become known as right and left-hand round tool-holders. They are used in different machine tools principally for "roughing out," or, in other words, for rapidly reducing castings, forgings, etc., from their rough state to nearly their finished forms and dimensions. The tool-holders are called round from their cutters being made of round steel cut from the bar. Notwithstanding that they are very widely applicable, take heavy cuts, and do the bulk of all machine-work in lathes, and in planing, shaping, and slotting machines, it was soon found that they could not compass the whole of the work required in the shops; and it was therefore necessary still to allow the use of some of the common forged tools in conjunction with the round tool-holders. This however was objectionable, as no positive rule could then be laid down to define what number of forged tools should be allowed to each workman; and it became apparent that the tool-holder system, in order to reach the highest degree of efficiency, must be made complete and independent in itself. This led to the designing of another tool-holder of the most general kind the writer could devise, in the hope thereby to complete the system.

With this object in view, all the remaining forged tools then in use were collected together, and the swivel tool-holder was schemed, Figs. 1 to 3, page 264; with cutters so adjustable that they could not only be swivelled round and then fixed to any desired angle, but could also be made to project at pleasure to any required distance in order to reach and cut into all sorts of difficult and awkward corners; in fact to machine any work which the round tool-holder could not finish. Two of the principal objects aimed at were to devise a system of cutters which should not require any forging or smithing, and should yet be capable of being adapted by the simplest possible means, and by grinding the ends only, to all forms which the round cutters would not meet. The special section of steel decided upon was a sort of deep V section the lower part of which is slightly rounded, as shown in Fig. 4. The angles of the sides give the same amount of clearance (1 to 8) as that given in the round tool-holders, and this same angle of clearance is given to the ground parts. The section of the swivel cutter is made very deep, in order to obtain ample strength in the direction of the pressure it has to support when cutting, as shown by the arrows, Figs. 1 and 4. The angle of the cutter, as in Fig 21, page 268 is 68°, and is common to every swivel tool-holder. In the cutter for the round tool-holder two angles had been fixed upon as standards, one to cut all kinds of wrought metals, the others all cast metals. To avoid complication however, in the swivel toolholders one cutting angle was fixed upon for all metals, and applied to all cutters. The angle selected, or 68°, is one differing slightly from that of the round cutters, but is that which worked out the best in practice. The cutters of the round tool-holders are found very advantageous in producing and finishing standard-size round corners in journals of shafts, etc., and in other cases, where the engineer of the present day is anxious to preserve all the strength possible in the parts; but there are still cases where square, angular, or undercut surfaces must be produced, as illustrated in Figs. 5-11, page 264. These are front views showing the tool-holders at work planing or shaping. They are supposed to be travelling forward, or the work to be moving in the opposite direction; and the arrows in each view indicate the direction in which the tool-holder is being fed at each stroke of the machine, to take the next cut.

Fig. 5, page 264, shows the mode of planing the under horizontal surface of a lathe bed. The cutter shown in use is ground to an angle of 86°, or 4° less than a right angle, and thus has a clearance of 2° at each side when cutting either horizontally or vertically. This cutter is very general in its applicability, and is devised so as to finish with one setting both the vertical surface A, and the horizontal surface H, without the necessity for disturbing the cutter in any way. The ordinary system is to use at least two tools for roughing out, and two for finishing, on two surfaces at right angles with each other.

Fig. 6, page 264, shows the method of planing in a very limited space the under horizontal surface S; the corresponding surface B is planed afterwards, without disturbing the tool-holder in the tool-box, by simply slacking the nut, swivelling the bolt N halfway round, replacing the cutter with one of the opposite hand, and again securing it by the nut.

Fig. 7, page 264, shows a swivel tool-holder clearing without difficulty a boss which projects and would be very much in the way of any ordinary tool. The cutter in this case planes not only the horizontal surface C, but the inclined surface V also, with one setting and without being being disturbed in the tool-box.

Fig. 8, page 264, shows the method of cutting a vertical slot in a horizontal surface of metal. The cutter in this case is called a parting tool. Fig. 9, page 265, is a side elevation of this same cutter, showing the cutting angle, which is 68°.

Fig. 10 and 11, page 264, are tool-holders with cutters of rather special forms. The former is shown planing out or under-cutting a T-shaped slot; and the latter is planing out a small rectangular clearance corner.

Figs. 12 and 13, page 265, show a swivel tool-holder with a round shank, such as is used on the slide-rest of a screw-cutting lathe, for cutting square threads. It is carried on a wrought-iron or steel block, provided with a groove, semicircular in section, in which the round shank of the tool-holder lies, and is clamped down in the usual way. The cutters for cutting out the spaces between the square threads are of very simple form, and by aid of this tool-holder any tool made to the correct width of the space will cut either right-hand or left-hand screws, no matter whether they are single threads, double threads, or any other. To cover the same ground with forged tools, no less than six expensive cutters would be required, each one forged from square steel, and carefully filed up and hardened. With the tool-holder only one cutter is required, and it costs probably not more than 10 per cent. of one of the six forged tools, while it maintains its size much better, and consequently lasts much longer. It also takes off about twice the weight of cuttings per hour as compared with an ordinary forged tool. This system is useful where many screws of odd forms and pitches are required; but where there are sufficient numbers to be cut, special chasing lathes are far preferable to ordinary screw-cutting lathes, as they will do about six times as much casing of V threads, or cutting of square threads, as can be accomplished in the ordinary lathe in the same time. Instead of carrying one chaser, the chasing lathes carry, in a chasing apparatus, three or four chasers; and these have their threads, whether square, V, rounded, or any other form, cut in their places by aid of a master tap. They are then tapered at the mouths, backed off, and hardened ready for work. The number of shavings cut simultaneously from a screw by this process varies from twelve to twenty-four, according to the size, strength, and pitch of the thread. Screws up to 6 in. diameter, can be very rapidly cut by this system, on which very much more might be said if time permitted. A few screws cut by this process are exhibited.

When the two systems—the round and the swivel tool-holder—are worked in conjunction with each other, their universality of application is so thorough that almost every difficulty is met; and it was only in the case of paring and shaping articles

* Reprinted from Proceedings of the Institution of Mechanical Engineers, London.

in the slotting machine that two modifications had to be made in holders, the same cutters being applicable.

The Capstan-rest Chasing Lathes designed by the writer's firm have now become much used, and as a large amount of their work is produced from black bars of iron, steel, or other metals, each of which has to be finished at its extremities and cut or parted off, it was found advisable to make one special tool-holder, Figs. 14 to 17, page 268, for carrying tools of the correct sections to produce the desired shapes for the ends. The tedious and unreliable process of turning the end with hand-turning tools is thus avoided. Each cutter is of absolutely the same section throughout its entire length, and the re-sharpening is done by grinding the end of the cutter only, so that it can only produce the same standard form as long as it lasts, that is to say till it is ground too short to be used any longer. The parting off might have been accomplished by the swivel tool-holder, but a special form, Figs. 18 to 20, is found to be more convenient in parting off close up to the chuck or lathe spindle.

To produce a maximum amount of cutting in a minimum space of time, there are two main points which must be carefully attended to. These seem to be applicable to all cutters for cutting metals, whether they happen to be those fixed rigidly in tool-boxes, as in turning lathes, planers, shapers, slotters, etc., or those which cut while they revolve, as milling-cutters, twist-drills, boring-bits, etc.

These two important points are;—

First, the cutting angle, or angle of the cutting surface, Fig. 21, page 268, i. e. that surface which removes the shavings of metal, and upon which the pressure of the cut comes, as shown by the arrow.

Secondly, the clearance angle, or angle of the clearance surface, i. e. that surface which passes over the surface of the metal that has been cut, and does not come in contact with the metal at all.

To produce the best results, and to ensure the utmost simplicity, it is important that these two angles be correctly constructed in the first instance. The best measure for both angles has been arrived at from actual practice and a series of experiments. When once obtained and started with, they should not alter by use, but should always remain constant, if the greatest amount of cutting efficiency is to be attained. When aided by a mechanical system of re-grinding, and the use of standard angle-gauges, Figs. 22 and 23, page 268, there is no difficulty in maintaining the exact angles. The only changes which take place are that the cutters in tool-holders become gradually shorter by grinding, and that milling cutters during a long period of time become very gradually smaller in diameter, by the process of re-sharpening them on a fine emery-wheel. In the case of the tool-holders, as already explained, the cutting angle is maintained by the system of re-grinding, and the tool-holder itself always maintains the clearance angle. The system is thus simplified, as will be clearly understood when it is remembered that each one of the tool-holder cutters, no matter of what description, is ground on its end only. Thus the section is never altered, no smithing or alteration in form is necessitated, and consequently no repairing has to be done in the smith's shops.

The objects aimed at have been :—

1st. To produce the highest class of workmanship, by providing the best known form of cutters, carefully made, and capable of having their cutting edges accurately re-ground, so that the surfaces of the machined work may be produced direct from the cutters so highly finished that no hand-work could possibly improve them. Most of the turning of wrought iron, for instance, may be so perfectly finished that there is no necessity to polish it by means of emery or emery-cloth.

2nd. To make all the cutters so free from complication, and simple to keep in order, that no difficulty or error may occur in re-grinding them.

3rd. Since finely-polished surfaces cannot be obtained without the most perfect cutting edges, to make all cutters not only of the best steel, but with their cutting edges most accurately and carefully ground up, in almost all cases by mechanical means. The durability of the cutters, from their construction and high class of material, is very great, and they are thus capable of removing a great weight of metal in a given time.

The grinding or re-sharpening of all cutting edges is reduced to the greatest simplicity; and only three descriptions of machines are requisite for this purpose. They are all arranged to grind mechanically; that is to say, the cutters while being ground are carried and pressed on the grindstone or emery-wheel by mechanism. The requisite forms and angles are also obtained by mechanism, it being found in practice that sufficient accuracy cannot be secured by hand-grinding.

The machines are as follows :—

1st. A grindstone with slide-rest, for grinding all the cutters used in tool holders.

2nd. A twist-drill grinder; this also is by preference a grindstone, with mechanism for holding and guiding the twist-drills. A machine with an emery-wheel in place of the stone is also used for the grinding of twist-drills, with much the same mechanism for carrying the drills. In practice however the stone grinds about double the number of drills per hour, and with less risk of drawing the temper. Both stone and emery-wheel are run at a high speed, and used with water.

3rd. A small but very complete machine, one of which is exhibited, for re-grinding milling-cutters. In this case gritstone does not answer, and the grinding wheels are obliged to be of emery or corundum. They are very small in diameter, and many of them are exceedingly thin, and so delicate in form that if made of gritstone they would rapidly lose their shapes. They are run at a high speed, 3000 ft. per min., and are turned into form while revolving by means of a diamond.

A milling-cutter will work for a day, and in many cases for two days, before showing signs of distress. Before the cutting edges are visibly blunted, but as soon as the sense of touch indicates that their keenness is diminished,* the cutter should be put into this machine; and the probability is that not more than one 1000th in. need be ground off each tooth, before it is restored again to a cutting edge almost as fine as that of a wood chisel. Each cutting edge, or in other words each tooth of the milling-cutting, is only passed rapidly once or twice under the revolving wheel, which is itself of very fine emery. It can therefore be readily understood how delicate an operation this is, and why emery alone will answer for it.

In order to maintain the correct forms and angles of all cutters for tool-holders, sheet-steel angle-gauges, Fig. 22, page 268, are provided, and the process of grinding is thus reduced to a complete and exceedingly simple system. In well-regulated shops, a young man is selected to work each machine for cutter grinding, and in practice each man so engaged can keep a works employing 150 men (exclusive of moulders or boiler makers) well supplied with all the necessary cutting tools from day to day. A very great saving is thus effected, as no machine need ever stand idle for want of cutters, and no repairing of tools in the smithy is needed.

Take for instance an engineering works employing 250 men. The requisite number of improved grinding machines, with special mechanical appliances, is as follows :—

Two patent grindstones for re-sharpening cutters mechanically.

One patent twist-drill grinder for re-sharpening twist-drills mechanically.

One improved cutter-grinder with small emery-wheel, for re-sharpening the cutters used in milling machines.

To follow the system out satisfactorily, the man working the grindstone goes round to each machine every morning, collects together those cutters which have been blunted by use the previous day, carries them to his grindstone, re-sharpens them, and distributes them out again to each machine;—which is thus kept well stocked with an ample number of cutters, always ready for immediate use.

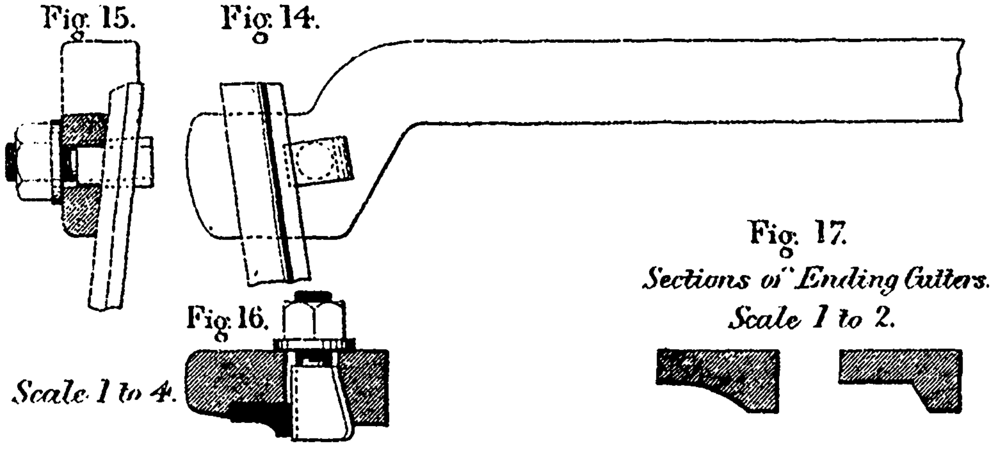
The cutters for tool-holders do not require any repairing in the smithy; consequently that operation, which is costly in so many ways, is avoided, and jobbing or tool smiths with their strikers are almost entirely dispensed with.

For re-hardening the cutters, a rule is made that when the grinder meets with cutters which are not as hard at their cutting points as they ought to be, he puts them on one side, and periodically, say once every fortnight, he sends the lot into the smithy for the end of each to be re-tempered. This is a very inexpensive operation, the time occupied being about two hours per fortnight. They are placed in a small oven by dozens and very slowly heated up to a dull red; the end of each cutter is then plunged into a perforated iron box immersed in water till the bottom is covered to the required depth for hardening the cutter up to the proper distance from its point. The cutters are left standing in a nearly vertical position in the box of water, until they have gradually cooled down sufficiently to be removed. They are then sent to the grindstone, re-ground, and given out with the other cutters to be used again in the

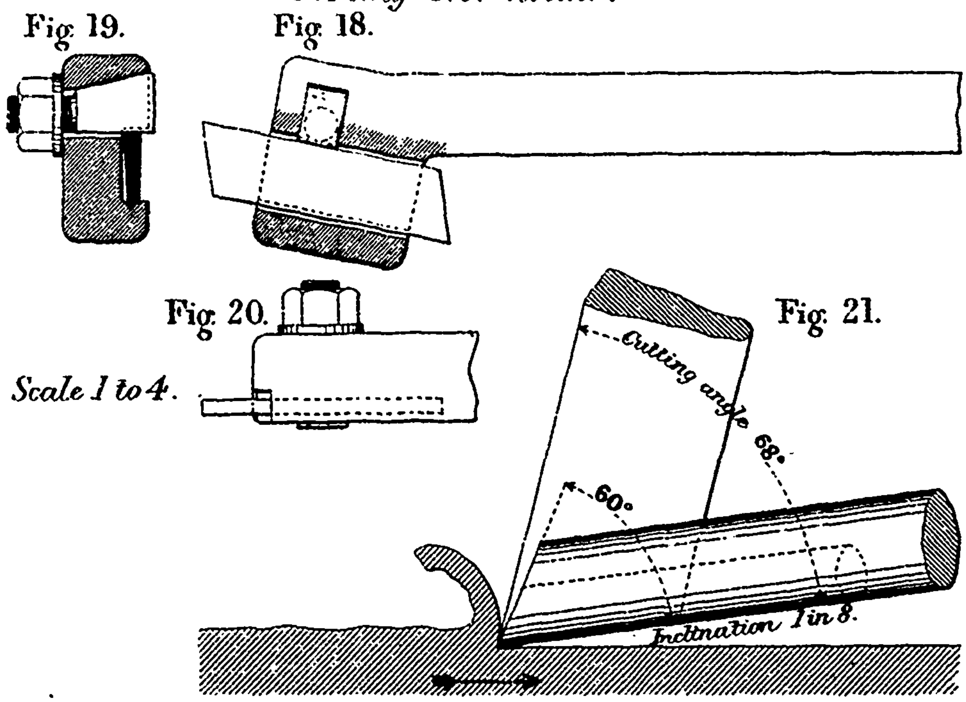
* The sense of touch, in passing the finger over the cutting edges, conveys the idea of slight bluntness better than it can be detected by the eye.

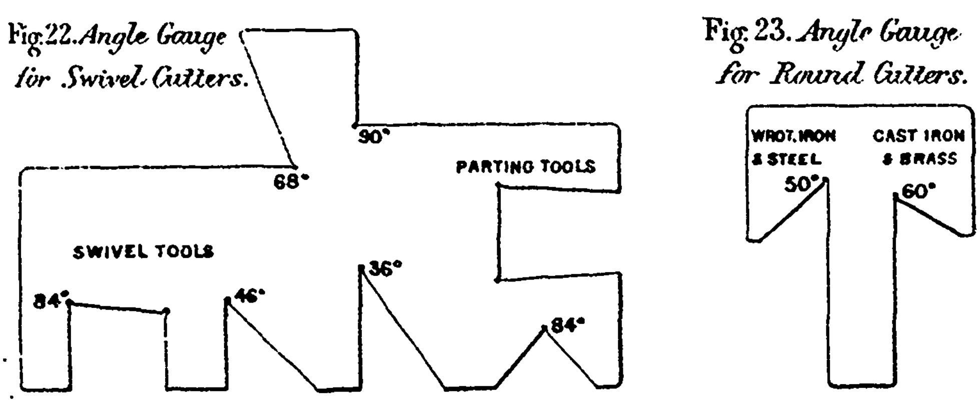
CUTTING OF METALS.

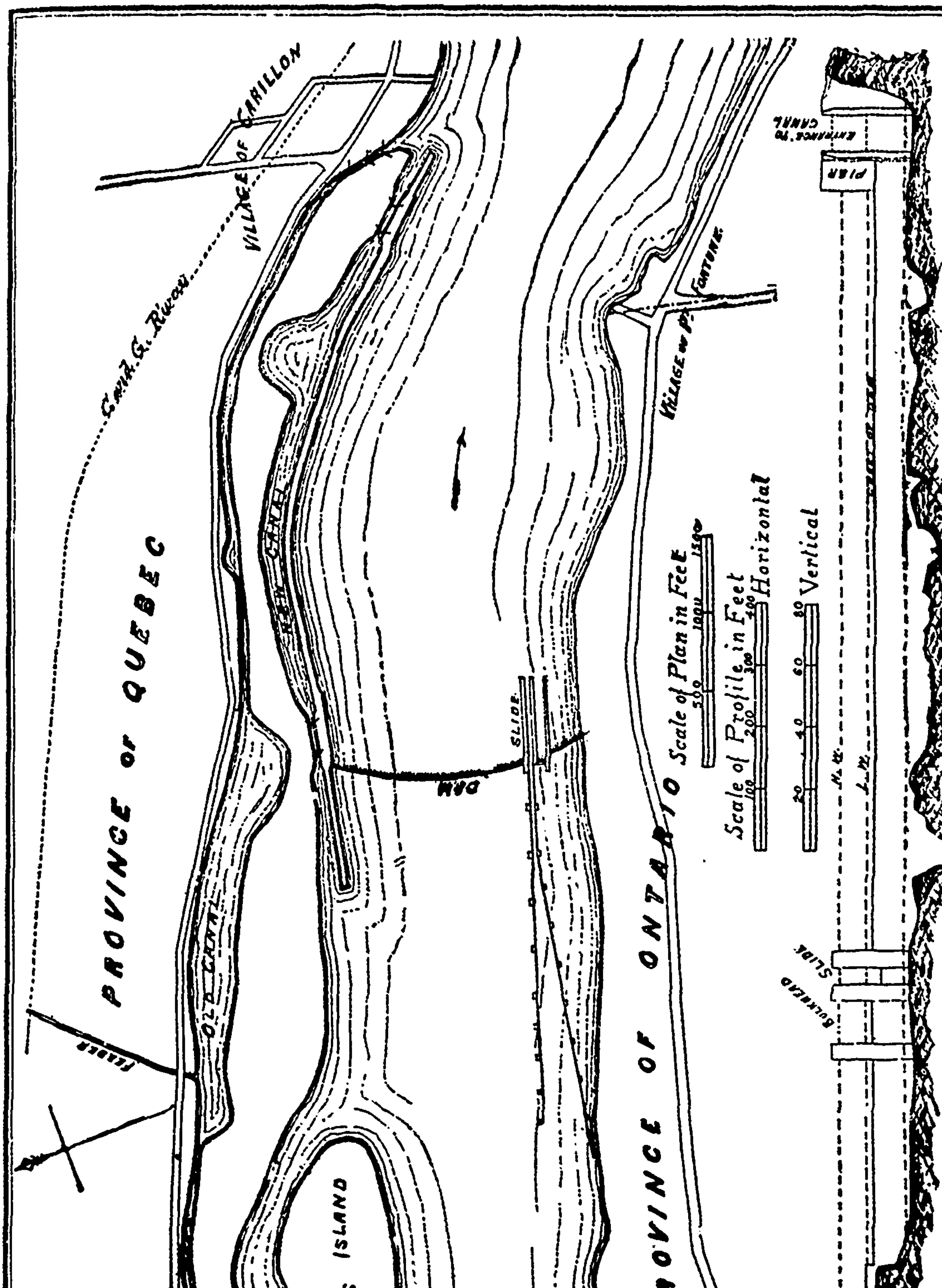
Ending Tool-holder.



Parting Tool-holder.







SECTION OF RIVER AT DAM. NOTE.—THE LOWEST DOTTED LINE IS LOW WATER BEFORE THE DAM WAS BUILT. THEN THE LINE OF HIGH WATER WAS ABOUT A FOOT ABOVE WHAT IS CREST OF DAM NOW.

MAP OF OTTAWA RIVER AT CARILLON RAPIDS.

different machines. With steel of the highest quality for cutters, it is most important to keep it out of the smith's fire entirely, if possible. That object is here attained, the cutters never going to the fire except for re-hardening. During the life of a cutter it only see the fire probably six times.

As the weight of each cutter is small, usually not more than from 1-15th to 1-20th that of a forged tool used for the same purpose, the outlay for best tool steel is not heavy; and the engineer is not tempted to purchase any but that of the highest quality. With such steel, especially when used in the best manner, each machine is capable of cutting at a high speed, and the cuts may be coarser than those ordinarily taken. When the swivel tool-holders were first used on planing machines, cutting slots 1 in. broad into solid castings, it was found that two teeth of the feed could be used at each stroke. Previously a forged tool of the same breadth, ground to form by the planer to the best of his ability, had been used in the same machines; but he found, on trial from time to time, that it was impossible to use more than one tooth of the feed; or, in other words, the tool-holder cut a given depth into the metal in half the time of the forged tool.

Again, when the swivel tool-holders were first used in cutting square-threaded screws, the utmost the lathe could no with ordinary forged tools, ground only by the judgment of each man and not to the best selected and standard angles, was to take four degrees of feed at each cut, as indicated by the micrometer feed-wheel. The tool-holder on the other hand took seven degrees of feed in the same lathe, doing the same work, and producing quite as good or a better finish with the same expenditure of steam power.

The cutters for the swivel tool-holders can not only be made at the outset, but also constantly maintained, at the best and most efficient angles which practice can teach, it therefore follows that a very much better class of machine-work can be produced. The finished surfaces obtained from the tool-holders show a striking superiority over those from forged tools, especially when in the latter the angles are ground by hand, by each man or boy working a machine, who of course has not made a study of the best angles. The tendency then is to grind the cutters to all sorts of incorrect forms, which more or less tear the surfaces of the machined work, and leave bad finishes, such as require a considerable amount of hand-labour bestowed upon them afterwards, in filing, polishing, etc.

Again, the tool-holders have led up to a considerable extension of what is called Broad-finishing, in planing, turning, shaping, slotting, etc.

Broad-cutting feeds, varying from ½ in. to 1½ in. in width, are very commonly taken by the swivel tool-holders, and more accurate surfaces produced than with finer feeds. The advantages in point of time saved are very great; the time occupied in finishing by broad-cutting being from one-twelfth to one-twentieth of that consumed by finishing with ordinary feeds and in the usual manner.

The width of broad-cutting can be increased to any desired limit, and there have been special cases where it has been advantageous to take thin shavings 3 in. to 6 in. in width.

The principal limits to broad-cutting are as follows:—

1st. The power of grinding the cutting tool to a sufficiently straight or true cutting edge. the best plan of course is to do this by mechanical means.

2nd. The securing of sufficient stability in the machine tool to hold the broad-cutter so rigidly up to its work that neither the cutter itself nor the work may spring away, and that no jarring or injurious vibration may be produced, and impart its evil effect to the finished surface.

3rd. The securing of sufficiently accurate work to answer the purpose for which it may be required. For instance, the piece of work planed or turned by this process may be a portion of a large railway bridge, where absolute accuracy is not requisite; or on the other hand it may be some portion of a machine tool, where the utmost accuracy is needed; or again, some part of an engine, where the builder is anxious to obtain all the accuracy which can possibly be produced direct from the machine tool.

(To be continued.)

Etching Liquid for Steel.—Mix 1 oz. sulphate of copper, one-half oz. of alum, and one-half a teaspoonful of salt reduced to powder with 1 gill of vinegar and 20 drops of nitric acid. This liquid may be used for either eating deeply into the metal or for imparting a beautiful frosted appearance to the surface, according to the time it is allowed to act. Cover the parts you wish to protect from its influence with beeswax, tallow, or some similar substance.

THE ECLIPSE OF 1882.

At the present time, when interest is chiefly drawn toward the successes of the astronomers who observed the eclipse of the sun the month before last from the small islands in the Pacific Ocean, the results of May 17, 1882, obtained in Egypt, have especial significance. These were briefly stated by Dr. Schuster at a late meeting of the Royal astronomical society. During the progress of the eclipse three photographic instruments were at work: one took photograps of the corona itself; a second was a photograpic camera with a prism placed in front of it, that is, a spectroscope without a collimator; and the third was a complete spectroscope. Photographs were obtained in all three instruments. The direct photographs of the corona indicate its variations from eclipse to eclipse, — a matter of much importance in solar physics. If the photographs taken during eclipses in the past twenty years are compared with each other, it will be seen that the corona varies in a regular way with the state of the sun's surface, although there are irregular minor changes. At the sun-spot minimum the corona is much more regular than at the maximum. At the minimum there is a large equatorial extension, and near the solar poles a series of curved rays. At the maximum there is practically no regularity at all. the long streamers go up sometimes in one direction, and sometimes in another; and this last year, near the sun spot maximum, there was absolutely no symmetry in the appearance of the corona. The transparency of the streamers was most striking. One streamer can sometimes be traced through another, showing that the matter, whatever it is, must be very thin. The rifts start from the solar surface in an entirely irregular way, with a tendency very often toward the tangential direction at the lower parts of the rifts. The photographs extend about a diameter and a half from the sun's limb, and a comet appears on the plates about a solar diameter and a half from the sun's centre. It must have been very bright, as it appears clearly in the photographs. Measurements seem to indicate a small shift in its position during the interval between the first photograph and the last.

Turning now to the photographs taken with the camera and prism in front, —an instrument which gives an image of the prominences as oft repeated as there are rays in the prominence,—the plates employed were sensible to the infra-red as well as violet rays. One prominence gave a great number of lines in the ultra-violet. The fact was brought out in this eclipse, that the brightest lines in the prominences are due, not to hydrogen, but to calcium. Besides these and the hydrogen lines, there is the line *D3* in the yellow, and the *C* line of hydrogen in the red, and also a photograph of two prominence-lines in the ultra red. In addition to the prominences, there are visible in the photographs certain short rings round the moon, which mean that at these places the light sent out by the gaseous part surrounding the moon is not confined to the prominences. It is, as would be expected, the green coronal line which chiefly corresponds to one of those rings. This green line, *K* 1474, is a true coronal line, and is only very fairly traceable in one of the prominences.

In considering the results obtained with the complete spectroscope, it is a striking fact that some of the lines cross the moon's disk, and especially the two lines *H* and *K*. This proves that the calcium-lines, *H* and *K*, were so strong in the prominences that the light was scattered in our atmosphere, and reflected right in front of the moon.

The prominence-lines are very numerous: thirty such lines appear in the photograph. The hydrogen-lines are there, including those in the ultra-violet photographed by Dr. Huggins; also *H* and *K*, and other calcium-lines; and still others, chiefly unknown.

Close to the sun's limb we can only trace a continuous spectrum, a very strong one, going up to about a quarter of a solar diameter. The photographs bear out the distinction between the inner and the outer corona, the former being much stronger in light. The boundary at which this continuous spectrum ends corresponds to the extension of the inner corona. The continuous spectrum is stronger on the side where the prominences are weaker. In the corona we first of all see a very faint continuous spectrum, and in that continuous spectrum one can trace at *G* the reversal of the dark Fraunhofer lines. In addition, a series of faint true coronal lines can be traced in the outer regions of the corona. We have not traced any known substances in the solar corona. The greater number of the prominence-lines in the ultra-violet are also unknown, but they seem to be present in Dr. Huggins's photograph of the spectrum of *α* Aquilae.—*Science.*

MINING INSTITUTE OF CORNWALL.

The members of the Mining Institute of Cornwall recently inspected the jigging machinery working on that sett. The modus operandi was detailed to the members and their friends by Captain Argall, the manager, who lately read an interesting paper on the subject at a meeting of the Institute. For a long time the applicability of jigging machinery to tin mining has been a debatable point, and those who have favoured the idea have been the exception rather than the rule. The process has been tried at Wheal Jane tin mine, and Captain Southey claims that it has answered well. Its chief merit is that it effects the desired speedy classification of the ore. The other day blende was under treatment, and so far as that material is concerned it was fully acknowledged the jigging left little or nothing to be desired. The machinery is so laid out that the ore from both shafts of the mine passes by a tramway direct to the crusher, where it is placed between the rolls, and is not again touched until completely dressed. The stuff classified passes to the machines, and the concentrated ore deposited in compartments underneath the waste in wagons conducted over the waste heap. The cost of the process is about 6d. per ton, and the quantity treated is about four tons an hour. The machinery cost about £700, and has been in active operation for about two years. There can be no denying, however, that many of the members, while fully recognising the efficiency of the apparatus for the treatment of lead and blende, strongly adhered to their conviction that it was not adapted to tin dressing. Possibly some may be somewhat prejudiced on this point, but others argued with much reason that with the tin stamps for reducing the ore to a fine grain, the subsequent "buddling" operation was the more preferable process, as it both separated and classified. But it is still a question which method secure the largest percentage of mineral, and where the waste is largest in the slimes. Perhaps it would be well to make a practical test, and in this matter it would be possible for the Mining Institute to afford much valuable assistance, so that the views of those interested might be regulated on a more accurate basis than is now available. In justice to Capt. Argall, it should be added that at Duchy Peru they are dealing with stuff as fine as the average tin stamped in Cornwall, and at a cost of 70 per cent. less than the methods usually observed.

DAM ACROSS THE OTTAWA RIVER AND NEW CANAL AT CARILLON, QUE.

By Andrew Bell, Resident Engineer.

(*See Page* 269.)

The natural navigation of the Ottawa River from the head of the Island of Montreal to Ottawa City—a distance of nearly a hundred miles—is interrupted between the villages of Carillon and Grenville, which are thirteen miles apart, by three rapids, known as the Carillon, Chûte à Blondeau, and Longue Sault Rapids, which are in that order from east to west. The Carillon Rapid is two miles long, and has, or had, a fall of 10 feet; the Chûte à Blondeau, a quarter of a mile, with a fall of 4 feet, and the Longue Sault six miles, and a fall of 46 feet. Between the Carillon and Chûte à Blondeau there is or was a slack water reach of three and a half miles, and between the latter and the foot of the Longue Sault a similar reach of one and a quarter miles.

Small canals, limited in capacity to the smaller locks on them, which were only 109 feet long, 19 feet wide, and 5 to 6 feet of water on the sills, were built by the Imperial Government as a military work around each of the rapids. They were begun in 1819 and completed about 1832. They were transferred to the Canadian Government in 1856. They are built on the north shore of the river, and each canal is about the length of the rapid it surmounts.

The Grenville canal (around the Longue Sault) with seven locks, and the Chûte à Blondeau with one lock, are fed directly from Ottawa. But with the Carillon that method was not followed, as the nature of the banks there would have, in doing so, entailed an immense amount of rock excation—a serious matter in those days. The difficulty was overcome by locking up at the upper or western end 13 feet and down 23 at lower end, supplying the summit by a "feeder" from a small stream called the North River, which empties into the Ottawa three or four miles below Carillon, but is close to the main river, opposite the canal.

In 1870-71, the Government of Canada determined to enlarge these canals to admit of the passage of boats requiring locks 200 feet long, 45 feet wide, and not less than 9 feet of water on the sills at the lowest water. In the case of the Grenville Canal this was, and is being, done by widening and deepening the old channel and building new locks alongside of the old ones. But to do that with the Carillon was found to be inexpedient. The rapidly increasing traffic required more water than the North River could supply in any case, and the clearing up of the country to the north had materially reduced its waters in summer and fall, when most needed. To deepen the old canal so as to enable it to take its supply from the Ottawa would have caused the excavation of at least 1,250,000 cubic yards of rock, besides necessitating the enlargement of the Chûte à Blondeau also.

It was therefore decided to adopt a modification of the plan proposed by Mr. T. C. Clarke, of the present firm of Clarke, Reeves & Co.; several years before when he made the preliminary surveys for the then proposed "Ottawa Ship Canal," namely, to build a dam across the river in the Carillon Rapid, but of a sufficient height to drown out the Chûte à Blondeau, and also to give the required depth of water there.

During the summer and fall of 1872 the writer made the necessary surveys of the river with that end in view. By gauging the river carefully in high and low water, and making use of the records which had been kept by the lock masters for twenty years back, it was found that the flow of the river was, in extreme low water, 26,000 cubic feet per second, and in highest water 190,000 cubic feet per second; in average years about 30,000 and 150,000 cubic feet respectively. The average flow in each year would be nearly a mean between those quantities, namely, about 90,000 cubic feet per second. It was decided to locate the dam where it is now built, namely, about the centre of Carillon Rapid, and a mile above the village of that name, and to make it of a height sufficient to raise the reach between the head of Carillon and Chûte à Blondeau about six feet, and that above the latter two feet in ordinary water. At the site chosen the river is 1,800 feet wide; the bed is solid limestone, and more level and flat than is generally found in such places—the banks high enough and also composed of limestone. It was also determined to build a slide for the passage of timber near the south shore (see map), and to locate the new canal on the north side.

Contracts for the whole works were given out in the spring of 1873, but as the water remained high all the summer of that year very little could be done in it at the dam. In 1874 a large portion of the foundation, especially in the shallow water, was put in. 1875 and 1876 proved unfavorable and not much could be done, when the works were stopped. They were resumed in 1879, and the dam, as also the slide, successfully completed, with the exception of gravelling of the dam, in the fall of 1881. The water was lower that summer than it had been for thirty-five years before. The canal was completed and opened for navigation the following spring.

THE DAM.

In building such a dam as this, the difficulties to be contended against were unusually great. It was required to make it as near perfectly tight as possible, and to be, of course, always submerged. Allowing for water used by canal and slide and the leakage, there should be a depth on the crest of the dam in low water of 2·50 feet, and in high about in 10 feet. These depths turned out ultimately to be correct. The river reaches its highest about the middle of May, and its lowest in September. Nothing could be done except during the short low water season, and some years nothing at all. Even at the most favorable time the amount of water to be controlled was large. Then, the depth at the site varied in depth from 2 to 14 feet. The current was at the rate of from 10 to 12 miles an hour. Therefore, failures, losses, etc., could not be avoided, and a great deal had to be learned as the work progressed. I am not aware that a dam of the kind was ever built, or attempted to be built, across a river having such a large flow as the Ottawa.

The method of construction was as follows: Temporary structures of various kinds, suited to position, time, etc., were first placed immediately above the site of the dam to break the current. This was done in sections, and the permanent dam proceeded with under that protection.

In shallow water, timber sills, 36 feet long and 12 inches by 12 inches, were bolted to the rock up and down stream, having their tops a uniform height, namely, 9·30 feet below the top of dam when finished. These sills were, where the rock was high enough, scribed immediately to it, but if not, they were "made up" by other timbers scribed to the rock,

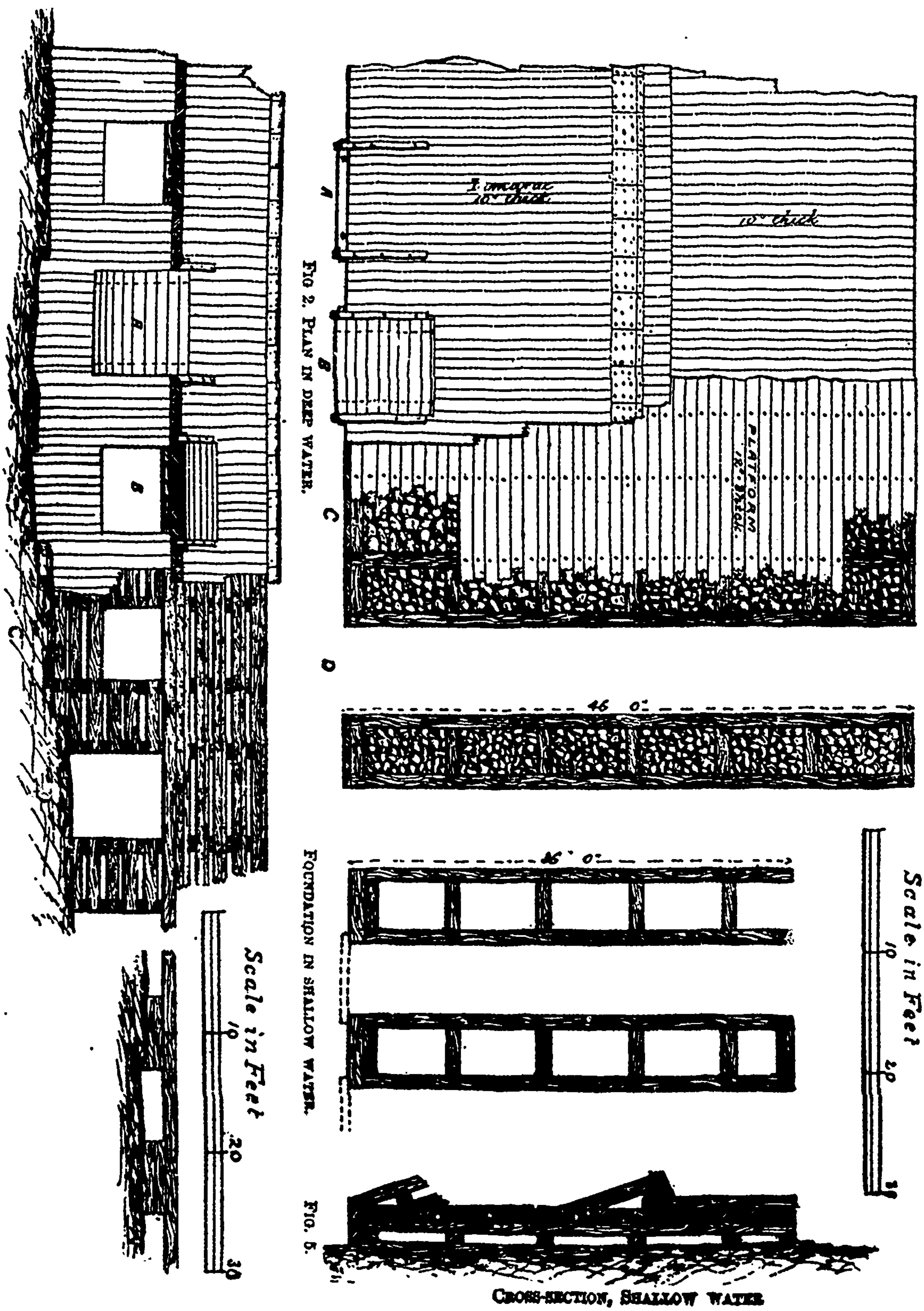


FIG. 2. PLAN IN DEEP WATER.

FIG. 3. ELEVATION IN DEEP WATER.

FIG. 4. ELEVATION OF FOUNDATION SHALLOW WATER.

FOUNDATION IN SHALLOW WATER.

FIG. 5.

CROSS-SECTION, SHALLOW WATER.

as shown by Figs. 4 and 5. They were generally placed in pairs about 6 feet apart, and each alternate space left open for the passage of water, to be closed by gates as hereafter described. Each sill was fastened by five 1½ in bolts driven into pine plugs forced into holes drilled from 18 inches to 24 inches into the rock. The temporary rock was then removed as far as possible, to allow a free flow of the water.

thick and the crest covered with ½ in. boiler plate 3 ft. wide. The whole structure was carefully filled with stone—field stone, or "hard head" generally being used for this purpose.

At this stage of the works, namely, in the fall of 1881, the structure presented somewhat the appearance of a bridge with short spans. The whole river—fortunately low—flowed through the sluices, of which there were 113, and also through a bulk-

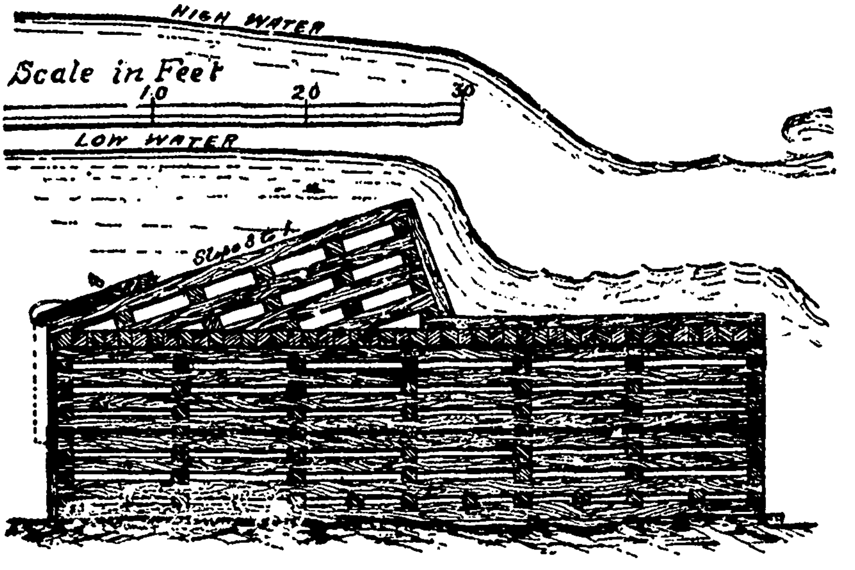


FIG. 1. CROSS SECTION IN DEEP WATER.

In the channels of which there are three, having an aggregate width of about 650 feet, cribs 46 feet wide up and down stream were sunk. In the deepest water, where the rock was uneven, they covered the whole bottom up to about five feet of the level of the sills, and on top of that isolated cribs, 46 in. × 6 in. and of the necessary height were placed seven feet apart, as shown at C, Figs. 2 and 3. At other places similar narrow cribs were placed on the rock, as shown at D, Figs. 2 and 3. The tops of all were brought to about the same level as the before mentioned sills. The rock bottom was cleaned by divers of all bowlders, gravel, etc The cribs were built in the usual manner, of 12 in. × 12 in. timber, generally hemlock, and

head which had been left alongside of the slide with a water width of 60 feet. These openings had a total sectional area of 4,400 sq. ft., and barely allowed the river to pass, although, of course, somewhat assisted by leakage.

It now only remained to complete the dam, to close the openings. This was done in a manner that can be readily understood by reference to the cuts. Gates had been constructed with timber 10 in. thick, bolted together. They were hung on strong wooden hinges and, before being closed, laid back on the face of dam as shown at B, Figs. 1, 2 and 3. They were all closed in a short time on the afternoon of 9th November, 1881 To do this it was simply necessary to turn them over,

FIG. 6. SECTION THROUGH CANAL EMBANKMENT.

DETAILS OF THE OTTAWA RIVER DAM, AT CARILLON.

carefully fitted to the rock on which they stand. They were fastened to the rock by 1½ in bolts, five on each side of a crib, driven into pine plugs as mentioned for the sills. The drilling was done by long runners from their tops. The up-stream sides of the cribs were sheeted with 4 in. tamarack plank

On top of these sills and cribs there was then placed all across the river a platform from 36 to 46 feet wide, made up of sawed pine timber 12 in. × 12 in. each piece being securely bolted to its neighbor and to the sills and cribs below. It was also at intervals bolted through to the rock.

On top of the "platform" there was next built, a "flat dam of the sectional form shown by Fig. 1.. It was built of 12 in. × 12 in. sawed pine timbers, securely bolted at the crossings and to the platform, and sheeted all over with tamarack 10 in.

when the strong current through the sluices carried them into their places, as shown at A, Figs. 2 and 3, and by the dotted lines at Fig. 1. The closing was a delicate as well as dangerous operation, but was as successfully done as could be expected. No accident happened further than the displacement of two or three of the gates. The opening thus left were afterward filled up with timber and brushwood. The large opening alongside of the slide was filled up by a crib built above and floated into place.

The design contemplates the filling up with stone and gravel on up-stream side of the dam about the triangular space that would be formed by the production of the line of face of flat dam till it struck the rock. Part of that was done from the ice last winter; the balance is being put in his winter.

Observations last summer showed that the calculations as to the raising of the surface of the river were correct. When the depth on the crest was 2·50 feet, the water at the foot of the Longue Sault was found to be 25 in. higher than if no dam existed. The intention was to raise it 24 in.

The timber slide was formed by binding parallel piers about 600 feet long up and down stream, as shown on the map, and 28 ft. apart, with a timber bottom, the top of which at upper end is 3 ft. below the crest of dam. It has the necessary stop logs, with machinery to move them to control the water. The approach is formed by detached piers, connected by guide booms, extending about half a mile up stream. See map.

Alongside of the south side of the slide a large bulkhead was built, 69 ft. wide, with a clear waterway of 60 ft. It was furnished with stop logs and machinery to handle them. When not further required, it was filled up by a crib as before mentioned.

The following table shows the materials used in the dam and slide, and the cost :

	Timber, cu. ft.	Iron, lb.	Stone filling, cu. yds.	Excavation, cu. yds.	Cost.
Temporary works	134,500	92,400	11,400	....	$ 79,000
Permanent dam..	265,000	439,600	21,000	6,500	151,000
Slide, including apparatus.....	296,500	156,400	32,800	....	102,000
Total......	696,000	687,000	68,200	6,500	$332,000

The above does not include cost of surveys, engineering, or superintendence, which amounted to about ten per cent. of the above sum.

The construction of the dam and slide was ably superintended by Horace Merrill, Esq., late superintendent of the "Ottawa River Improvements," who has built nearly all the slides and other works on the Ottawa to facilitate the passage of its immense timber productions.

The contractors were the well known firm of F. B. McNamee & Co., of Montreal, and the successful completion of the work was in a large degree due to the energy displayed by the working member of that firm—Mr. A. G. Nish, formerly engineer of the Montreal harbor.

THE CANAL.

The canal was formed by "fencing in" a portion of the river-bed by an embankment built about a hundred feet out from the north shore and deepening the intervening space where necessary. There are two locks—one placed a little above the foot of the rapid (see map), and the other at the end of the dam. Wooden piers are built at the upper and lower ends—the former being 800 ft long, and the latter 300 ft. ; both are about 29 ft. high and 35 ft. wide.

The embankment is built, as shown by the cross section, Fig. 6. On the canal side of it there is a wall of rubble masonry, F, laid in hydraulic cement, connecting the two locks, and backed by a puddle-wall, E, three feet thick ; next the river there is crib work, G, from ten to twenty feet wide and the space between brick-work and puddle filled with earth. The outer slope is protected with riprap, composed of large bowlders. This had to be made very strong to prevent the destruction of the bank by the immense masses of moving ice in spring.

The distance between the locks is 3,300 feet.

In building the embankment the crib-work was first put in and followed by a part (in width) of the earth-bank. From that to the shore temporary cross-dams were built at convenient distances apart and the space pumped out by sections, when the necessary excavation was done, and the walls and embankments completed. The earth was put down in layers of not more than a foot deep at a time, so that the bank, when completed, was solid. The water at site of it varied in depth from 15 feet at lower end to 2 feet at upper.

The locks are 200 ft. long in the clear between the gates, and 45 ft. wide in the chamber at the bottom. The walls of the lower one are 29 ft high, and of the upper one 31 ft. They are from 10 to 12 ft. thick at the bottom.

The locks are built similar to those on the new Lachine and Welland canals, of the very best cut stone masonry, laid in hydraulic cement. The gates are 24 in. thick, made of solid timber, somewhat similar to those in use on the St. Lawrence canals. They are suspended from anchors at the hollow quoins, and work very easily. The miter sills are made of 26 in. square oak. The bottom of the lower lock is timbered throughout, but the upper one only at the recesses, the rock there being good.

The rise to be overcome by the two locks is 16 ft., but except in medium water, is not equally distributed. In high water nearly the whole lift is on the upper lock, and in low water the lower one. In the very lowest known stage of the river there will never be less than 9 ft. on the miter sills.

As mentioned at the beginning of this article, four locks were required on the old military canal to accomplish what is now done by two.

The canal was opened in May, 1882, and has been a great success, the only drawback—although slight—being that in high water the current for about three-quarters of a mile above the upper pier, and at what was formerly the Chûte à Blondeau, is rather strong. These difficulties can be easily overcome—the former by building an embankment from the pier to Brophy's Island, the latter by removing some of the natural dam of rock which once formed the "Chûte."

The following are, in round numbers, the quantities of the principal materials used .

Earth and puddle in embankment..cub. yds.		148,500
Rock excavation,	"	38,000
Riprap,	"	6,600
Lock masonry,	"	14,200
Rubble masonry,	"	16,600
Timber in cribs, lock-bottoms and gates	"	368,000
Wrought and cast iron, lb		173,000
Stone filling cu. yds.....................		45,300
Concrete "		830

The total cost to date has been about $570,000, not including surveys, engineering, etc.

The contractors for the canal, locks, etc., were Messrs. R. P. Cooke & Co , of Brockville, Ont., who have built some large works in the States, and who are now engaged building other extensive works for the Canadian Government. The work here reflects great credit on their skill.

On the enlarged Grenville Canal, now approaching completion, there are five locks, taking the place of the seven small ones built by the Imperial Government. It will be open for navigation all through in the spring of 1884, when steamers somewhat larger than the largest now navigating the St. Lawrence between Montreal and Hamilton can pass up to Ottawa City.—*Engineering News.*

PROPOSED NEW BRIDGE, LONDON.

(*See pages* 276-7.)

It is recorded that when James I. thretened to punish the citizens of London by the removal of himself and his court to some other city, the Lord Mayor calmly informed the King of the hope of the citizens that His Majesty would leave them the Thames. So long as the river remained, the people of London believed that they might endure the loss of even the Solomon of the West. Since that time much has been done by means of railways and improved roads to facilitate the intercourse of nations and to promote commerce ; but the Thames is still what it was in the days of King James, the link by which London is united with the rest of the world. If, as Sir John Herschel says, "London is the centre of the terrene globle," that position is due to the possession of a navigable channel. What other city can show such a proof of international trade as may be witnessed every day in the year between London Bridge and Blackwall ?

The supremacy of London in commerce is in a great measure attributed to the navigability of the river, and in dealing with the Thames this fact should never be overlooked While every one admits the advantage of unimpeded communication between the parts of the metropolis on both sides of the river, it should also be remembered that an advantage of the kind would be dearly purchased, if, to secure it, impediments were raised to interrupt the traffic on the water. The local requirements of Whitechapel and Bermondsey should never be allowed to override the general interest of the city (which is also the interest of England), and although it would be well for carts from Shoreditch to reach the Old Kent Road expeditiously, the gain in time would hardly compensate for the loss that is inevitable if commercial arrangements which have taken centuries to mature should be disturbed or destroyed.

When, for example, it is proposed to erect a bridge with a massive pier in the very middle of the waterway, or a bridge of a height that will prevent many of the vessels that trade with London from passing under it, or a bridge on so ingenious a principle that there is risk of the intricate machinery becoming disarranged in the opening or closing, it is evident that in every one of those cases there is a certainty of interference with the traffic of the Thames, and the trade of the port will in consequence be sacrificed to local interests. On the other hand, a fixed bridge at a high elevation above the river would involve local inconvenience, for it must be costly, and unless the approaches are carried for a great distance inward, the gradients will be steep and involve a loss of tractive power.

If the foregoing assumptions are correct, it is evident that the question of constructing a bridge over the Thames below London Bridge is one in which compromise is demanded if there is to be a satisfactory solution. Something must be abated by all parties, by the representatives of land traffic as well as by the riverside proprietors. It is physically impossible to have a bridge with easy gradients for land traffic, and which will be also clear above the highest masts, or one on a low level which shall still be equally convenient for ships and wagons; and the most prudent course will be to construct a bridge on a principle that will give a minimum of inconvenience, while allowing of easy gradients and a capacious waterway. In the opinion of the special committee of the London Corporation, who were appointed to investigate this question, the design which is illustrated by us this month complied with those conditions. The committee reported that the design commended itself to them "as one providing a bridge which would interfere but very slightly with the river traffic, and would bring about that relief to the commerce and trade of this city contemplated by the references to your committee."

It will be seen from the illustrations that the City Architect has adopted the bascule principle for his bridge, as being simple in arrangement, economical, and convenient, besides admitting of that architectural effect in the towers which is necessary for a structure placed is so important a position. In one view the bridge is open, and in the other closed.

The proposed bridge, having in its centre the same height of waterway as London Bridge, viz., 20 feet, would consist of two side spans of 190 feet each, and a centre span or opening of 300 feet. The roadway of side spans would be carried by two wrought iron lattice girders, of ordinary type, or by shallow lattice girders carried by suspension chains from the towers, with girders spaced 35 feet apart, and cross girders between, carrying buckled plates on which the railway would be bedded.

The center span of 300 feet would be bridged by two hinged platforms, forming the "bascule." The longitudinal and cross girders and buckled plates of the platforms are all proposed to be steel, to reduce the weight as much as possible. Each platform would be suspended by eight pitched chains, passing over polygonal barrels fixed in the semicircular arches between the towers, and from thence to the hoisting machinery in the towers, where they would terminate in a plain chain or iron rod carrying the balance weights.

The hoisting machinery could be worked by steam power, or by hydraulic apparatus, supplied by tanks fixed in the roof of the towers.

The arches between the towers carrying the polygonal chain barrels would be formed of four wrought-iron braced semicircular arched ribs, connected transversely by four wrought-iron lattice frames. The rise of each arch in centre would be 130 feet above Thames high-water mark, or of 100 feet headway for a width of at least 150 feet.

The principal advantages of the design proposed are:

First. Lowness of level and, consequently, *easy gradients for the land traffic.*

Second. *Economy of construction* in the approaches on both banks of the river, the lowness of the level allowing of direct access, and necessitating very slight alterations of the adjoining streets and properties.

Third. *Occupation of less river space* than a swing bridge, which, when swung open, requires a clear space equal to the half span of the bridge.

Fourth. *Less interference with the tide-way* or navigation of the river, there being only two towers or piers, instead of three or four, as in the swing bridge schemes.

Fifth. *Beauty of form.* The chief features of the bridge being capable of architectural treatment, it might be rendered the most picturesque bridge on the river.

Sixth. *Facility and rapidity of working* by the special arrangements of machinery proposed. For instance, a ship signaled at a quarter of a mile distant, and sailing or steaming at the rate of, say, six or seven miles an hour, could pass through the bridge and the land traffic be resumed in three minutes; or if half a dozen vessels were within half a mile of the bridge, all could pass in five and a half minutes.

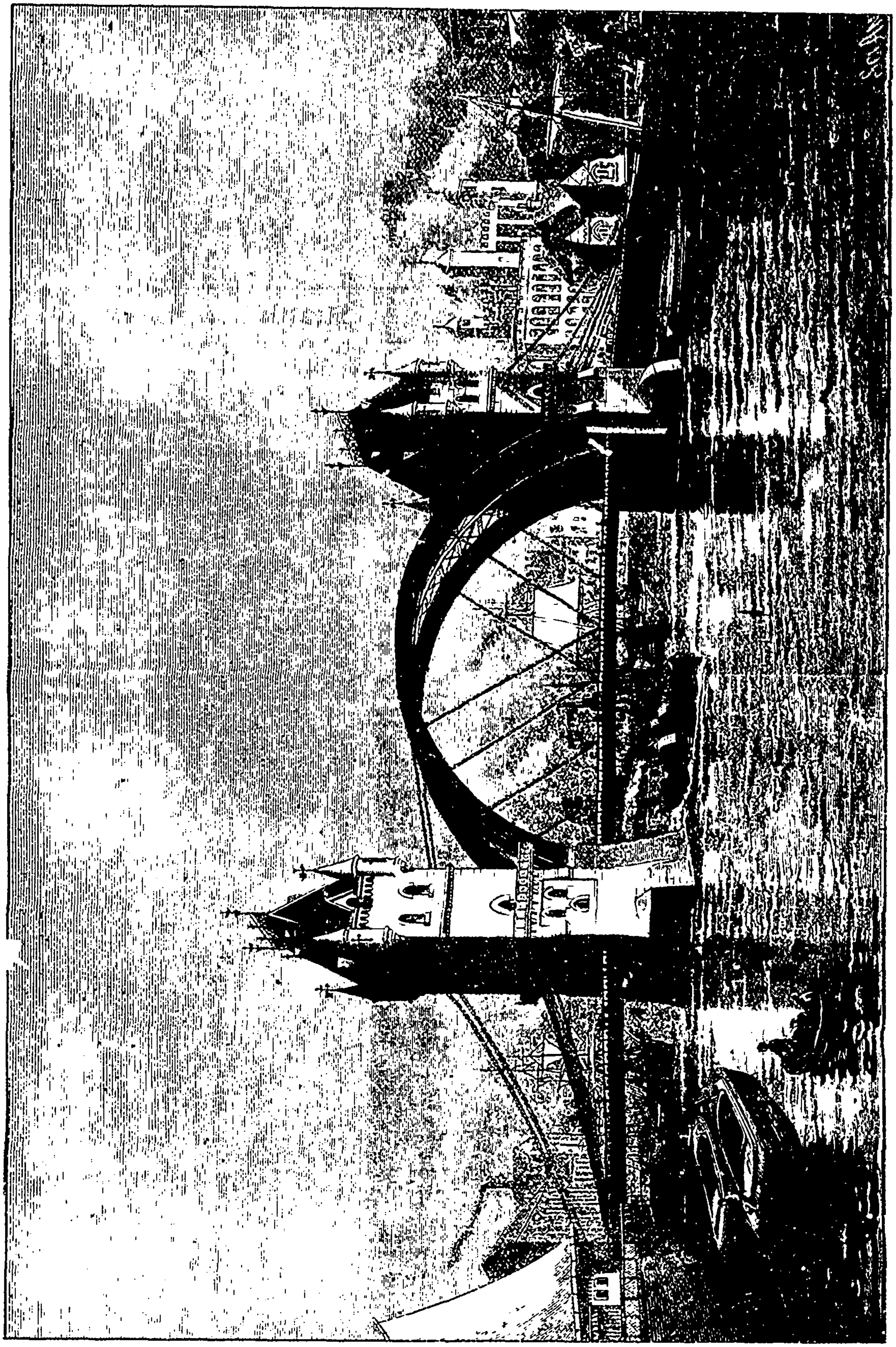
It has been estimated that the cost of the bascule bridge, including approaches, machinery, maintenance, etc., would not exceed 750,000*l.*, which is about one-half the sum that would be necessary for the construction of a high level bridge allowing of equal facilities for the river traffic.—*Scientific American.*

Health and Home.

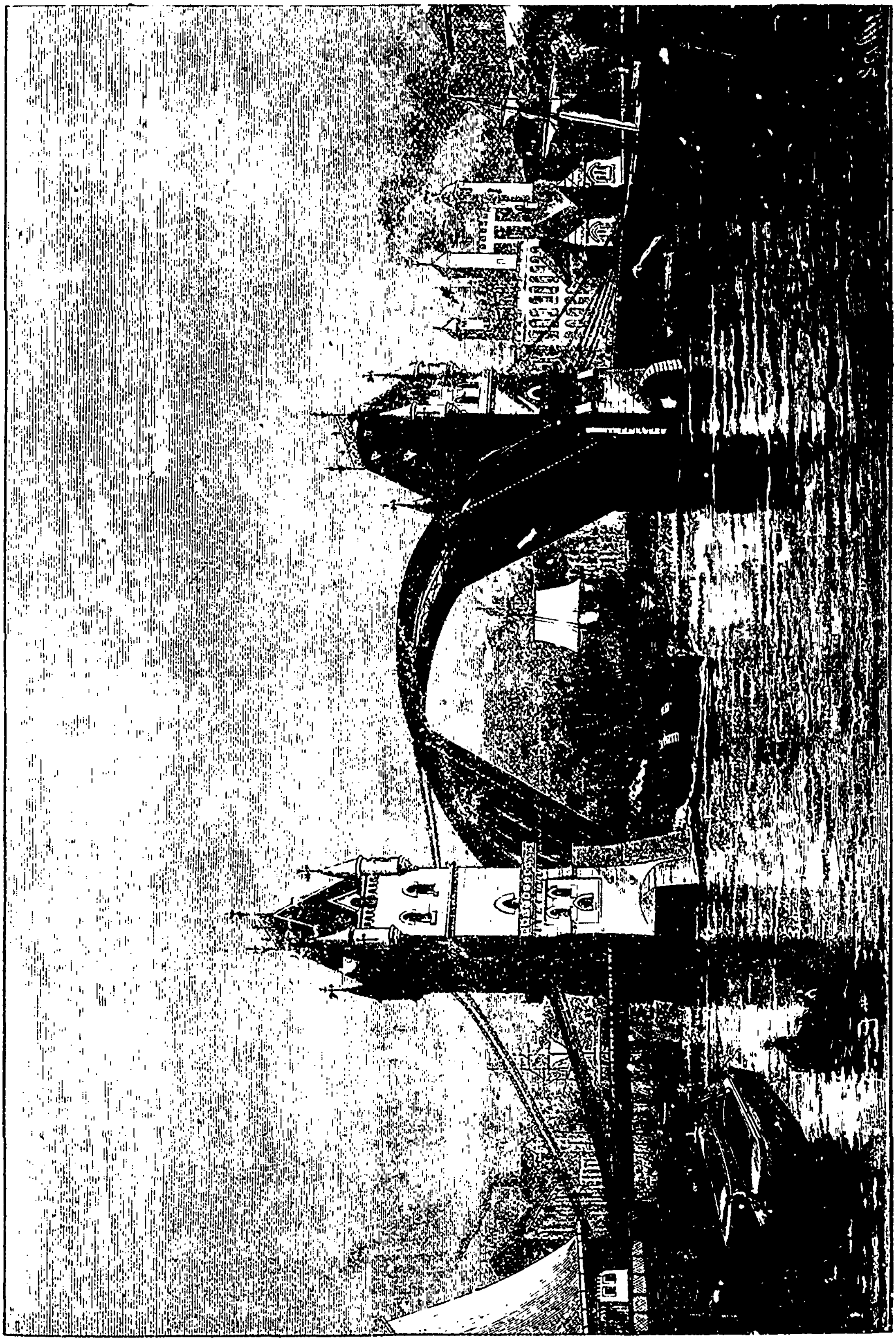
Hygiene of Mountain Climbing.—Dr. Brenner advocates exercise in the high, fine air of mountains as the best protection against the diseases contracted in city life. The characteristics of the mountain climate are the low temperature and air-pressure, the low relative humidity, the high per cent of ozone, the strong light and insolation, the freedom from dust and bacteria. All these act well on the bodily health. The lungs work with greater strength, the heat beats faster, the blood circulates more quickly, appetite is increased, perspiration becomes freer, the muscles become more energetic, and the whole body gains in strength and endurance.

London Water.—Mr. Crookes and Professors Odling and Tidy have lately given in their Report, on the composition and quality of London water during 1882, to the Local Government Board. In that year they examined 2110 samples of water drawn in nearly equal proportions from the mains of all the seven London Companies; testing generally even samples daily by their colour according to the register of the colour meter, by the quantity of free oxygen and ammonia contained in them, by the amount of oxygen required for oxidation of the organic matter present in them, by their proportions of organic carbon and nitrogen, of nitrates and chlorine, and by their initial hardness in degrees of Clark's scale. The results exhaustively set forth in numerical tables are further illustrated by seven diagrams, in each of which three wave lines represent the fluctuations throughout the year of discoloration, of the proportion of organic carbon, and of the amount of oxygen required to oxidise the organic matter of the water of the London Company in question. These diagrams show to the eye what the statistics confirm, the remarkable parallelism existing between the degree of discoloration, the amount of organic carbon present in the water as determined by combustion, and the amount of oxygen requisite for oxidation of the organic matter as determined by permanganate. The Report altogether would seem to reflect most favourably on the quality of London water. Throughout the whole year the water of the New River Company as determined by the samples was, without exception, "clear, bright, and well filtered," a character supported by analyses of other kinds, and in only a few cases, in the samples of the other Companies, was the water describable as "turbid," "slightly turbid," or "very slightly turbid." For the nine months from February to October 1882 the organic matter in the water of all the London Companies is estimated at ·137 per 100,000, and the highest monthly mean for the same period at ·181 per 100,000. There is, however, one important factor in the question with which chemical analysis cannot directly cope, the comparative innocuousness, namely, of the organic matter present in the water according as it is of vegetable origin, or its comparative virulence according as it is of animal origin. As Prof. Huxley, in a lecture in 1880 to the Chemical Society, said, water as regards chemical analysis may be perfectly unobjectionable, and yet as regards its operation on the human body deadly as prussic acid.

Potato Disease.—We learn from *Naturen* that a hitherto unknown form of the potato disease, which had been making slow but steady progress near Stavanger during the last ten or twelve years, has recently begun to show increased energy. The stalk of the plant is the part affected, and here Herr Anda has discovered small white fungoid growths, which after a



DESIGN FOR BASCULE BRIDGE OVER RIVER THAMES BELOW LONDON BRIDGE. [See page 274



NEW BRIDGE OVER THE THAMES.

time assume a greenish, and finally a black colour, after attaining the size of a small bean. While the fungus is rapidly increasing at the expense of the plant, the interior of the stem is first reduced to a pulpy condition, and next shrivelled and hollowed out, until nothing remains but a mere outer shell, which breaks down on being touched. When the ripe black germs of the fungus have remained in the earth through the winter, they are found after the return of the next year's warmth to have developed small stalked fruits filled with minute spores, which penetrate into the young plants before they appear above the ground. The end of July or beginning of August is the time when the ravages of the fungus are most conspicuous, and at those periods whole fields of potato plants are often rapidly reduced to the condition of withered straw.

CANADIAN SANITARY ASSOCIATION.

In December last the first steps were taken at Ottawa towards forming the above association. Its objects as stated a Prospectus issued are as followed :—

FIRST.—For the promotion of sanitary education and diffusion of sanitary information throughout the whole of the Provinces—also, for endeavouring to obtain education in our public schools in the simple laws of hygiene, and the means of suppressing, and avoiding, those causes which tend to propagate and spread infectious and contagious diseases.

SECOND.—For using the influence of its members to obtain joint legislation between the Federal and Provincial Governments, so as to enable more effectual steps to be taken, when necessary, to check the spread of infectious diseases.

THIRD.—For mutual co-operation with Provincial and Municipal Boards of health, in order to assist them, by its influence and the personal exertions of its members, in all matters relating to the public health.

FOURTH.—To publish, in its Sanitary Journal, for the use of schools, lectures on the laws of Physics, Hydrostatics, Chemistry of Sewage ; Disinfectants and Deodorizers ; Water Pollution and Analysis ; proper methods of laying drains and plumbing ; ventilation of dwellings and public buildings, etc., illustrated by object lessons ; designs of plumbing appliances and apparatus, etc.

The annual subscription to the association is to be $2.00, with $1.00 entrance fee, and in order to create a continued interest in the association an Illustrated Monthly Sanitary Journal will be published and sent free to members. We can only add that the association has our entire sympathy. Societies of the same sort exist in England, the United States and France, and it is very desirable that Canada should follow their lead. The Association was to be legally formed on the 1st September and those desiring to be members should send their names to the Secretary. Address :—

F. N. BOXER, *Provisional Secretary.*
243 St. Denis St., Montreal.

LABOR AND FOOD.

The human body never ceases to work. Even in the most profound slumber some of the functions of life are going on, as, for instance, breathing, the circulation of the blood, digestion, when there is food in the stomach ; and it follows that some part of the nervous system is therefore awake and attending to business all the day and night long. In the act of living, some of the substance of the body is being constantly consumed. The amount of work done by the heart in one day in propelling the blood is now estimated as equal to the work of a steam engine in raising 125 tons one foot high or one ton 125 feet high. We lose in weight by working. Weigh a man after several hours' hard labor, and he will be found two or three, and, in extreme cases, several pounds lighter. If we do not wish to become bankrupt, we must replace by food the amount we have lost by labor. Hunger and thirst are the instincts which prompt us to do this. They are like automatic alarm clocks, which stop the engine at various points to take on fuel and water. In a healthy man as much is taken in as is required to maintain the weight of the body against loss. Nature keeps the account. On one side is so much food spent in work, on the other, so much received into the stomach for digestion. They should balance like the accounts of an honest book-keeper. In an unhealthy person the instinct of hunger becomes disordered and does not sound the alarm, and so the person goes on working without eating until he becomes pauperized ; or the instinct works too frequently, and he eats too much and clogs the vital machinery. A calculation of the business done in the body reveals the fact that for a hard working person about 8½ pounds of food and drink are used up daily ; some bodies use more and some less, but this is the average. The profit which the body gets on this transaction has been calculated, and may interest our readers. The energy stored up in the 8½ pounds of food ought to raise 3,400 tons one foot high. Most of this energy, however, is expended in keeping the body warm and its functions active. About one-tenth can be spent in our bodily movements or in work. The profit, then, on the process is about ten per cent. This is enough to raise 340 tons one foot high each day. A profit which is quite enough for earning a good living if rightly expended, and it is probably more than most make ; but all ought to strive to reach this point if possible.

SMOKE ABATEMENT.

An important meeting was held in the Egyptian Hall of the Mansion House during July, to take further steps towards the abolition, or at all events the reduction,, as far as possible, of the smoke nuisance. The Lord Mayor presided.

The proceedings were opened by the reading of a Report, which has been carefully prepared by the Council, detailing the steps which have already been taken, and giving particulars of the exhibitions of last year in London and Manchester. The Report also deals with the work which has been done regarding the chemical composition of smoke by Prof. Chandler Roberts, and the many tests of coal made by Mr. Clark. In this important investigation, attention was called to the fact that a very great discrepancy exists between the heating efficiency of various types of grates, stoves, furnaces, and the like. In some forms of grate, for instance, only 22 per cent. of the total heat is utilised, whilst others require nearly three tons of coal to do the same work which other stoves manage to get out of one ton.

The Council desired to report that, so far as they had been able to ascertain, the most marked benefit resulting from the movement had been in the increased use of gas and coke for heating purposes. The improvement in gas-heating apparatus had been considerable, and the use of coke had been greatly facilitated by its being supplied to the public in more convenient sizes than formerly, and by the introduction of firebrick or other slow-conducting substances used in the fireplaces for burning it. The use of smokeless coal had also been extended in the metropolis ; but the Council found that the description of such coal supplied was in a large number of instances unsuitable or inferior, and from that cause, coupled with the fact that smokeless coals were not generally supplied by coal merchants, there had not been, so far, any very marked increase in its consumption. Marked improvement had, however, been made in open grates and stoves for burning that description of coal, and one firm of manufacturers, who brought out a cheap stove at the South Kensington Exhibition, had sold upwards of 14,000 during the past two years ; and they remarked that the public seemed ready to burn non-smoky coal if proper stoves for using it were offered at a reasonable price. Appliances for improving the draught of chimneys had also been introduced lately, and that tended to facilitate the use of smokeless coal. The Council had examined the present state of the administration of the law for the suppression of smoke, and they considered that in view of the enormous extension of buildings and factories in London and large towns, and in view also of the evidence that smoke could be to a great extent, if not entirely, avoided, the scope of legislative enactments for abating smoke should be extended and their provisions duly enforced.

One part of the Report deals with a matter to which we attach the greatest importance. It is suggested that there should be some place which the public can visit and where they may examine any apparatus that is approved of, or which they may wish to purchase ; but above this it is pointed out that a place is requisite where scientific, chemical, and other tests may be made for the information of the public generally, but especially for the help of inventors and manufacturers who may wish to try new suggestions. The Report also suggests that in connection with this there should be some place for discussion and public lectures, for the general advancement and diffusion of knowledge touching smoke abatement. The third proposal is certainly the most doubtful one, but the first and second are so important that the less time that is lost in starting such an institution the better ; and we are glad to learn that towards its foundation the Duke of Westminster has promised 500*l.*, Mr. C. Waring 100*l.*, and Mr. Cubitt 100*l.*

The most important speech, perhaps, was that made by the Duke of Westminster, in moving the adoption of the Report. He pointed out that we are face to face with a very gigantic evil—an evil not only gigantic in itself, but, considering the enormous yearly increase of 40,000 in the population, one of a very alarming character. Therefore it was necessary that some steps should be taken to abate, if not to entirely do away with that monstrous evil, which affected the health and vitality of the inhabitants of the metropolis. They were all aware of the evil effects of smoke, and how far worse it became when mixed with fog, but they believed that it was an evil which might be considerably modified if not entirely prevented. They had indisputable authority for saying that smoke was very wasteful and destructive. The waste in London alone amounted to one million yearly, and the waste in the country must be taken in proportion to that in the metropolis. They had also the highest authority for informing the public that the evil affected the health of those who lived under the canopy of smoke. Its effect on public buildings was also most destructive, and Mr. Shaw-Lefevre had said that to repair the damage done by its agency to the Houses of Parliament alone involved an expenditure of 2500*l.* per annum, and there could be no greater curse and bane to the metropolis than that smoke nuisance. The object of the meeting was to impress upon the public the importance of the subject. The Smoke Nuisance Act had been useful in the past, and could be made more efficacious in the future if its provisions were more strenuously enforced. Quoting from the correspondence which had taken place between the Home Office and the Association upon the subject, the speaker said that the Home Secretary had stated that in the majority of cases the fines inflicted was far less in amount than had been contemplated by the Act. That was not a right state of things, and efforts should be made to remedy it as soon as possible; and it was not unreasonable to suppose that with a proper enforcement of the law a check to a certain extent might be put to the nuisance. After some other observations, his Grace concluded by moving the adoption of the Report.

Sir Spencer Wells and Sir Frederick Abel spoke in favour of the Duke of Westminster's proposal, which was carried unanimously.

The next resolution was moved by the Duke of Northumberland, and was to the following effect:—"That the period has now arrived at which systematic inquiry is desirable into the application of the resources of technical science for the abatement of smoke now largely produced in industrial processes and in the heating of houses, as well as into the operation of the existing laws for smoke abatement; and that the Council of the National Smoke Abatement Institution be requested to urge upon the Government the desirability of appointing a Royal Commission for the purpose."

This was seconded by Sir Wm. Siemens and carried.

We are glad to see that it was acknowledged that the stated objects of the Smoke Abatement Institution, and the success which has attended its past efforts, had established a claim not only to the support of the meeting, but to that of the City of London and other great cities and towns.

We must congratulate the Council of the new institution upon the energy which they are displaying, and we believe that in a few years the success they will then have met with will lead one to hope that in process of time the smoke nuisance which kills its tens of thousands annually, and makes life in a great city like London almost unbearable, will to a certain extent be done away with.—*Nature.*

THE RATIONAL DRESS EXHIBITION.

(*See page* 280.)

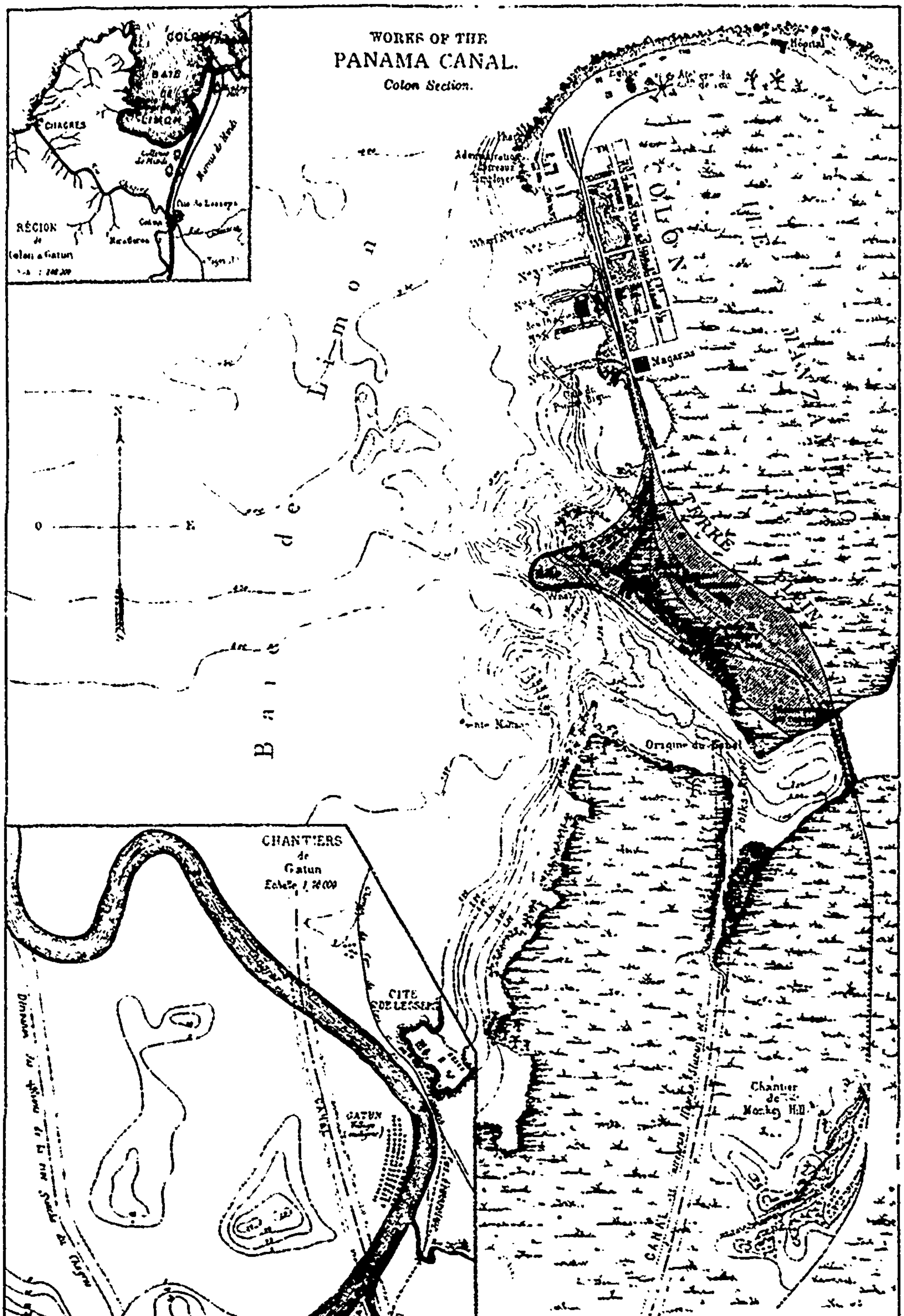
The Rational Dress Association have at last done something towards putting their ideas of dress reform into practical shape, and the exhibition now open to the public at Princess' Hall, Piccadilly, will be eagerly visited by all who desire to see what the reformers have to institute for women's attire as at present in fashion. It will be admitted, with some exceptions, that modern ladies' dress is a decidedly more artistic arrangement of drapery than that worn a few years ago. There is a closer study of the figure aimed at; the draperies hang with more grace, and are modelled with greater regard to the wearer's ease and movement. The Rational Dress Association appear to be rather divided in their views, and one of the chief differences between the would-be reformers is, to what extent the "divided skirt," as it is called, should be introduced into the new attire. The change, after all, amounts to the wearing of trousers—more or less ample, and concealed by the skirt, which Mrs. King would have reduced to shorter and more convenient proportions—instead of petticoats as an undergarment. The advocates of reform are agreed upon one thing—namely, that there shall be no longer a wilderness of frill and insertion below a lady's skirts. On the score of economy alone, there might, perhaps, be an advantage in substituting materials for the undergarments which required fewer changes. The association have drawn up certain rules, and offered prizes. A prize of £50 is offered for a dress fulfilling the following requirements:—That it should allow freedom of movement, an absence of pressure over any part of the body, that there must be no more weight than is necessary for warmth, and both weight and warmth must be evenly distributed; that beauty and grace are to be sought and combined with comfort and convenience; and that the new costumes must not depart too conspicuously from woman's ordinary dress. It will be admitted that these are rational conditions, and accord with medical opinions that have been constantly advanced.

Looking at some of the costumes in the exhibition, some of which we have sketched herewith, it will be easy to find fault with details which a little more careful study of the figure would have avoided. The chief of these are the rather ill-modelled "dummies" on which the garments are shown. Mrs. King's red and black trousered suit (Fig. 4) is upon one of these frames, which certainly does not recommend the costume. Madame Brownjohn exhibits a very useful travelling dress, which can be easily converted into a dinner dress in five minutes without assistance. The style of the costume need not offend the most conventional taste. It consists of a rich plum-coloured merino with the addition of a figured satin skirt, which the wearer can assume for evening attire at a moment's notice. Lace trimmings can be buttoned on the upper garments, and a handsome dress is at once produced. A robe with divided skirts giving full freedom of movement and weighing only 1lb. 10 oz., is made all in one. There is a sort of open jacket body and vest buttoned up with pearl buttons in front with elastic waist, made of washing silk (a small blue check), a skirt of the same material. The vest trimmings are of a dark navy blue material. The skirt is not too short, and the trousers of washing silk with a bottom pleating show below it. The latter garment is, in fact, the usual riding trousers worn by ladies. Another model shows a still more pleasing costume for a girl of 12 of a light figured material, and made on the same lines. The mantilla of silk exhibited by Madame Brownjohn is a decided improvement upon the usual constricted style of those garments. The arms, instead of being tied or held back, as is generally the case, are free of movement, and the effect is as graceful as the most approved form of mantilla now worn. We illustrate one or two of the costumes. Confining our attention to dresses suitable for exercise, we find, with few exceptions, they are made up of dark grey or warm-coloured merinos and serges, with divided undergarments. A cricketting costume, with a short, loose tunic and trousers, is a highly rational dress for such a pastime. In another case we see a walking dress, consisting of a divided skirt and polonaise, with flannel combination garments underneath of silk, sent by a Manchester modiste. A calisthenic dress, by Miss Fowler, exhibits a tunic and short skirt tied in at the waist with short gathered knickerbockers, which do not conceal the lower part of the legs, very well adapted for active exercise. A dress for tricycle riding, by Mrs. King, is a combination garment of the ordinary riding trousers and knickerbockers, and answers very well for the free movement of the legs. Lawn tennis, as a fashionable ladies' game, has not been forgotten by the new costumiers of rational garments. It is a divided skirt and body of woollen or serge material, with smocked sleeves giving free movement of the arms and waist. The colour is a bluish green. The dual divided skirt and tunic by Mrs. Beck, of Hyde Park-square, is also noticeable. While some of these possess all the requisites required by the committee, and avoid constraint of the body, we cannot altogether lose sight of the fact that there is a bagginess and fulness in them which are not very attractive to the admirers of the feminine figure, especially the bust. Nearly all of them have adopted the loose-fitting jacket-body or tunic, and double continuations or trousers, generally kilted or gathered. In a few the trouser legs are baggy, and so large as to give rise to the objection that the substitution of them for the ordinary undergarments would not add to the comfort of the wearer. The general principle of suspending the dress appears to be to distribute the weight upon the shoulders, and

not to let it rest on the hips. A working-woman's costume of grey linsey, a combination vest and trousers with a loose tunic over, seems well suited for women engaged in factory work. One of these costumes is described as consisting of a stocking suspender, a combined suit of thin flannel, worn next the skin, with, for winter wear, a high-necked sleeved suit of thick flannel, and for summer a low-necked, short-sleeved suit of calico; a skirt, with shaped band, buttoned on the outer combined suit, of bats'-wings, felt or alpaca, and relieved by long kilts at the bottom. The figure is well sustained by a short of crinolette. There are other models · one with a loose serge jacket, vest, and pegtop trousers and cloth gaiters; and another, exhibited by Mrs. Boecklin, of the United States, a kind of short paletot, with long vest and pegtop trousers. Both these are without skirts, and have been adopted by ladies in the United States for some time. A light serge boating dress, with long continuations, is a sensible costume for ladies who are fond of rowing. Our notice of the exhibition would be incomplete were we to omit to mention one or two very attractive evening costumes, one of which we illustrate (Fig. 8). It is exhibited by Madame Worth and Co., a *Parisian modiste*, and shows a figure of a lady in a light dress of blue surat, large, loose, Albanian sleeves, freely suspended from the shoulders. The skirt is short, and, with the trousers, is hung from the waist. There is an elegance in the lines of draperies, which, however, may be deemed rather full, and the long, flowing character of the bodice is quite out of scale with the short frilled skirts. A dancing costume of blue satin and silk, trimmed with lace, waistcoat and jacket-body, is certainly an improvement on the dresses often worn at balls; and so is Madame Grace and Co.'s trouserless costume, though it departs little from the modern style.

It is rather too soon to offer any very decided opinions upon the merits of the new dress. Public taste and criticism are invited by Mrs. King and her colleagues; but we think there can be but one general opinion that the "divided skirt" or trouser costume, as we are here confronted with it, is not that best fitted for the female form. Even Mrs. King herself, in her lecture on "Dress" which we reported, has doubts in her own mind as to the propriety of the trouser as a proper covering, for she is willing to allow that it is not a very beautiful garment. To our mind, it is far less graceful than the knickerbocker. To see two frilled trouser legs appearing just above the boot, and a few inches below the skirt, as in one Manchester model, might suggest a man in a woman's skirt; but nothing can be uglier. The Bloomer costume, and many of the peasant costumes worn on the stage, would be far more artistic as models. Everyone will readily admit a shorter skirt than that usually worn is desirable and proper for ladies' walking dress, and for working and factory women and girls it is absolutely necessary. The hanging of graceful drapery about the waist without restraining or fatiguing the body is almost essential to a perfect costume for women. Few of the reformers have been very happy in their ideas. One of the most successful attempts by Messrs. Debenham and Freebody we have illustrated (Fig. 3). Here the navy blue close-fitting jersey conforms to without restricting the figure, and the skirt hangs in graceful folds. Mrs. Nettleship has also shown some good taste in her girl's dress, and for young girls the short skirt and simple gathered waist, with kilted terminations, are very becoming and exceedingly pleasing (Fig. 2). The smockfrock-like gatherings to the wrists and neck are very suitable, and give an elegance and finish. A portion of this work is drawn in detail.

The exhibition must, of course, be viewed as a transitory stage of the dress reform movement. Invitations are offered for designs for the dress of the future, for both gentlemen and ladies, upon the conditions laid down; though, as regards the last one, a greater departure from ordinary dress is permitted. It is remarkable so few have attempted anything in the reform of gentlemen's dress, and, to our thinking, it was chiefly in the dress of the male portion of society that an artistic reform was needed.—*The Building News.*



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THE COLON SECTION OF THE PANAMA CANAL.

(*See Page* 281.)

In any enterprise the means adopted should be in direct proportion to the importance of the work to be done. At Panama the problem is a gigantic one; hence the preparation for work to be accomplished will necessarily assume similar proportions. The isthmus can supply but few of the needs of this great enterprise; all must come from Europe or the United States; and, this being the case, among the first requirements was a port of entry, with all its marine and industrial outfit, its docks and workshops. After this a city had to be built to contain the population which the work attracted to itself.

This preparatory work was commenced in January, 1881, and the point first selected on the Atlantic side was the harbor of Colon. This place had many advantages; it was the point of arrival of several lines of steamers from Europe and New York; it was the east end of the Panama Railroad, and most of the wharves were well-equipped for the transfer of material from ships to the railroad. But on further consideration, the company recognized the fact that it could not count upon any of the six existing wharves for its service; they belonged to as many different lines of steamers, and the Panama R. R. wharf, wrecked by storms and the shock of vessels against it, was entirely out of service.

The company soon found itself much embarrassed in the handling of its material, having no especial place for unloading; and as the day of arrival and departure of the steamers was fixed in advance, all material had to be hastily unloaded from the Canal Company's boats, and as hastily removed from the wharf to make room for the new arrivals. It was at first intended to buy and reconstruct the Panama R. R. wharf for the exclusive use of the company. But supposing this action would solve the question of handling the material, the problem yet remained of providing storehouses, workshops and houses for the employés; for the Island of Manzanillo, upon which is built the City of Colon, is, properly speaking, a mere swamp, in the interior of which it is impossible to erect any buildings. The west coast is already occupied by a few farms, by the city, and by the railways and wharves; the north coast presents only a narrow strip of land between the swamp and the sea. This last spot, however, is the best on the island, as it is exposed to the direct sun breeze; but room was wanting for the required constructions, which would necessarily cover a large space, and furthermore it was too far removed from the Panama R. R. wharf. Some other point than the island of Manzanillo must evidently be selected for the use of the company.

We ought to here remark that Colon has always had an unpleasant reputation for its unhealthiness. Without repeating all the stories told of this unhappy country, we are obliged to admit that a stay in this city is not agreeable. It is, in a word, the most sickly point in the Isthmus, and the chances of being stricken by disease are further enhanced by the gross ignorance and filthy habits of the colored natives. They seem to think that it is handy to have an open sewer before their doors, into which all manner of unclean things are daily thrown, to fester under a tropical sun.

M. Blanchet, failing to find a seaport, resolved to found a port on the River Chagres, as a solution of the problem presented. About six miles from Colon, following the line of the railroad, and about nine miles from the mouth of the Chagres, is the town of Gâtun, which is surrounded by uplands sufficiently elevated to seemingly promise a healthy location. One of these hills is situated upon the right bank of the Chagres River; the railroad passes at its foot alongside the river, and canal will be located on the left bank and about a thousand feet from the Chagres. Between the sea and Gatun, the Chagres is from 23 to 26 ft. deep; but a bar at the mouth of the river reduces this depth to about 13 ft. While the present water is sufficiently deep over the bar, for most of the vessels using it, a dredge can easily make and maintain a deeper channel when required.

M. Blanchet now gave the order to abandon the unheathy and crowded ports of Colon, and to create an entirely new port, with its docks and workshops, at Gatun; and put the houses of the men upon the top of the hill. This was the *Cité de Lesseps*. work was rapidly pushed, the top of the hill levelled off, and a sufficient number of buildings erected; at this place the first excavators were put together ready for work. But unhappily the climate declared itself against this enterprise. The first officials sent to Gatun, not having as at Colon the advantages of hotels, at least habitable, were compelled to lodge either in the huts of the Indians, or in the unfinished barracks. The swamp fever broke out; some died, and the remainder, panic stricken, declared Gatun more unhealthy than Colon. The scheme of an interior port was then condemned; fault-finders abounded; and this idea, conceived in a proper and humane spirit, was made a reproach to its author and looked upon as a gross blunder. The first mistake was the first step toward the grave of the unhappy Blanchet.

In abandoning Gatun, where the new city stood sad and deserted, it was necessary to return to Colon. But if Colon, with its certain insalubrity, was preferred to the perhaps accidental state of affairs at Gatun, the necessity did not the less exist for founding an entirely independent port, and providing land for the required structures. The entrance to the canal being fixed in the arm of the sea which separates the Island of Manzanillo from the mainland, it was decided by M. Hersent to fill in the marshy coast lying between the railroad and the southwest shore of the island; and even to reclaim a certain area from the sea, by pushing out into the Bay of Limon a mole destined to protect the future entrance port against the heavy gales and waves from north and northwest. This filled in ground took the name of the *Terre plein de Christophe Colombe*, and the entire force of this section was directed toward the speedy completion of this indispensable work.

Having finished the historical portion of our paper, we will now return to the question of the practical execution of the works of the company.

As the construction of the Terre-plein would consume much time, it was found necessary to buy or rent a number of small properties on the habitable portions of the island. In this way an establishment was founded on the northwest point of the island, near the light-house comprising the administration residency, the offices, barracks for workmen, a shed for the mounting of locomotives, a work-shop and a saw-mill. Between wharves 4 and 5 (see plan) a slip was built for setting up the dredges and lighters; to the south of Wharf No. 6 was a slip for setting up the great floating crane of 40 tons capacity. The temporary storehouses were placed a little behind the south end of the town, and different houses in Colon were finally utilized for offices and lesser storehouses etc. All this was, of course, very inconvenient, and necessitated for the employés fatiguing journeys and much loss of time. This period of provisional organization brings to mind some of the saddest memories connected with the history of the canal. All who were present must recall the chief of service at Colon, laboring 16 hours per day, filling every rôle, even that of nurse, who, after exhausting his forces, succumbed to disease at the end of three months of his superhuman labor. This chief was M. Etienne Antoine, an engineer well known, an old student of the *Ecole centrale*, and before entering that school, a workman to the age of thirty. It was difficult to find a successor, and the post remained a long time unfilled; then it was given to an engineer who remained but a short time on the Isthmus. A third was seized by the fever after a sojourn of two or three months. At last a fourth appeared—to whom we wish a sturdy and long resistance to climatic influences—and since August 1882 he has held the reins of this perilous government. From an administrative point of view, the organization of service at Colon has been somewhat modified. Originally Colon formed a general depot for the works, comprising the work properly so called, the workshops, material and the storehouses. It was thought finally that this service was too complicated, and there were other objections and inconvenient features in leaving in the hands of a chief charged with the execution of the work at Colon, the care of the workshops and storehouses, and the furnishing of materials and all machinery needed on the other portions of the Isthmus. Evidently this chief ought to be free to provide first for the needs of his own works. The general superintendency at Colon has now been suppressed, and the service has been reorganized under separate and distinct heads, or sections, including works, workshops and material, and general storehouses.

We will commence by giving for each of these sections a description of the labor required.

Of the general magazine we shall have nothing to say except that the company is compelled to provide *all* necessary material, not only for the works but for the material life of its employés. The storehouses are amply furnished with food, furniture, bedding, and even laundries; all, in fact, that the laborers need to keep them in good condition on leaving the work. M. de Lesseps was opposed on principle to an organization which was certainly disastrous to local trade, but he has practically admitted the right of the men to have the opportunity of securing easily and in a cheap market all articles of prime necessity. The opinion of M. de Lesseps was inspired by proper notions of general equality and liberty, but on second thoughts it was better to endure the recriminations of the traders rather than the just complaints of the laborers who, exposing themselves each day, have a right at least to demand of the company a material existence as much as possible exempt from care. The running expenses of the general magazine amount each year to "several million francs."

The section devoted to workshops and to material receives all the heavy material sent from Europe and the United States, which must be set up before it can delivered to the different sections on the line of the canal. A few figures will show the importance of the work done by this department. Of the 60 locomotives ordered in Europe, 27 have been sent to the Isthmus, and 20 have been set up and sent to their proper sections since the commencement of 1883. Of dirt-cars of 4, 5 and 8 cubic yards capacity, platform cars, carts, etc., about 2,000 have been ordered; of these 600 have been forwarded, and the greater number of these are in service. These cars are set up, some at Colon and some at Gatun, which is again becoming, as we foretold, a centre of labor. More than fifty excavators with endless chains or buckets (of the Couvreux or similar design) have been ordered; 18 have been sent to the isthmus and are at work. Several American excavators of the "dipper" type have been ordered by the contractors, and some of them have arrived and are set up. The dredging plant comprises four dredges of 60 horse-power each actually in service; these machines were completely mounted, even to the riveting of the hulls, at Colon.

The boats for carrying material, lighters and dump-scows, to the number of 64, sent from Europe, have all been put together or are in process of erection here, excepting two large steam lighters, built in Scotland by Mr. Lobintz, which traversed the Atlantic complete in all respects. These last mentioned boats are about 138 ft. long and 25 ft. beam. Each carried on the voyage two steam launches. Mr. Lobintz has also sent from the same place a marine dredge intended to work in the harbor of Colon. This dredge left Gareloch (Scotland) April 10 last, passed Madeira on 21st of same month, the Isle of St. Lucie (Antilles) May 6 and arrived at Colon May 16. Its principal dimensions are, length 171 ft., beam 26 ft., depth of hold 12 ft. The two engines, one to work the chain of buckets, the other the propellor, are 250 horse power. Mr. Lobintz is constructing a second dredge, similar to the one described, and destined for work at Panama. We wish a happy voyage to the brave sailors who will have to traverse the Straits of Magellan and double Cape Horn in this novel ocean steamer. Of the two floating landing stages, one is in service, the other is being put together at Colon. The naval outfit is completed by a flotilla of steamboats, launches for exploration, and tugs for towing, of 50 to 150 horse-power. Two of these last have traversed the Atlantic by their own power. All the rest have been set up here, except the small steam launches carried complete.

For the general shops and the works on the different sections, 34 stationary engines, all from the shops of Mr. Weyher, at Richmond (England), have been sent to the Isthmus. We mention finally among the general plant, one floating crane of 40 tons lifting capacity, the hull of which was riveted and launched at Colon. This machine is actually in service. One crane of 5 tons capacity, upon an iron hull, is also ready; and about 15 cranes of 2 to 6 tons capacity, worked by steam and by hand, are either mounted or are in process of erection at Colon.

As the work advances the repairs of machinery will become an important item. At present Colon is provided with only one small shop devoted to this service. The tools on hand will be soon insufficient for the work to be done. The company, foreseeing the necessity of an extensive shop for the mounting and repairing of machinery, had originally intended to found such an establishment at Colon. But as the health of this city is not always reassuring, and as the sections which will require most of the material are near the middle of the Isthmus, they have decided to create three principal systems of shops instead of one. The first will be at Colon, the second and most important at Gorgona, near the middle of the Isthmus, and the third on the Pacific coast, near Paraiso. By this means they will avoid the transportation of material to too great a distance, and in case of an epidemic breaking out in one set of shops, two others will still be in service.

Coming to the works proper in the Colon section, they can be divided under three heads:

1. The building of the *Terre plein de Christophe Colomb.*
2. The excavation at the port of entry to the canal.
3. The excavation of the canal itself from its entrance to a point near Gatun, at Sta. Kilometer 9.

The next section has started shops at Bahio, Soldado, at Sta. Kilometer 20. The limits of the two sections will be fixed at some future time between the last point and Gatun.

The Terre-plein.—The construction of this work will require about 470,000 cubic yards of filling material. It would certainly have been more advantageous to have used in this portion of the work the material excavated from the canal or its entrance. But, especially nearest to Colon, this excavation would have been in mud, containing living madrepores or corals, and these spread over a large surface and exposed to the sun's rays would certainly have had a bad effect on the health of the workmen. And further, the dredging plant was less advanced than the dry-excavating plant. The first thing to do was to find a soil sufficiently dry and compact, and easy to excavate; this condition of affairs was discovered at the small Mindi hills on the line of the railroad, and about 4,000 ft. from the Island of Manzanillo. These hills rise to a height of about 50 ft. above the level of the sea, and are composed of a compact clay with a decomposed tufa.

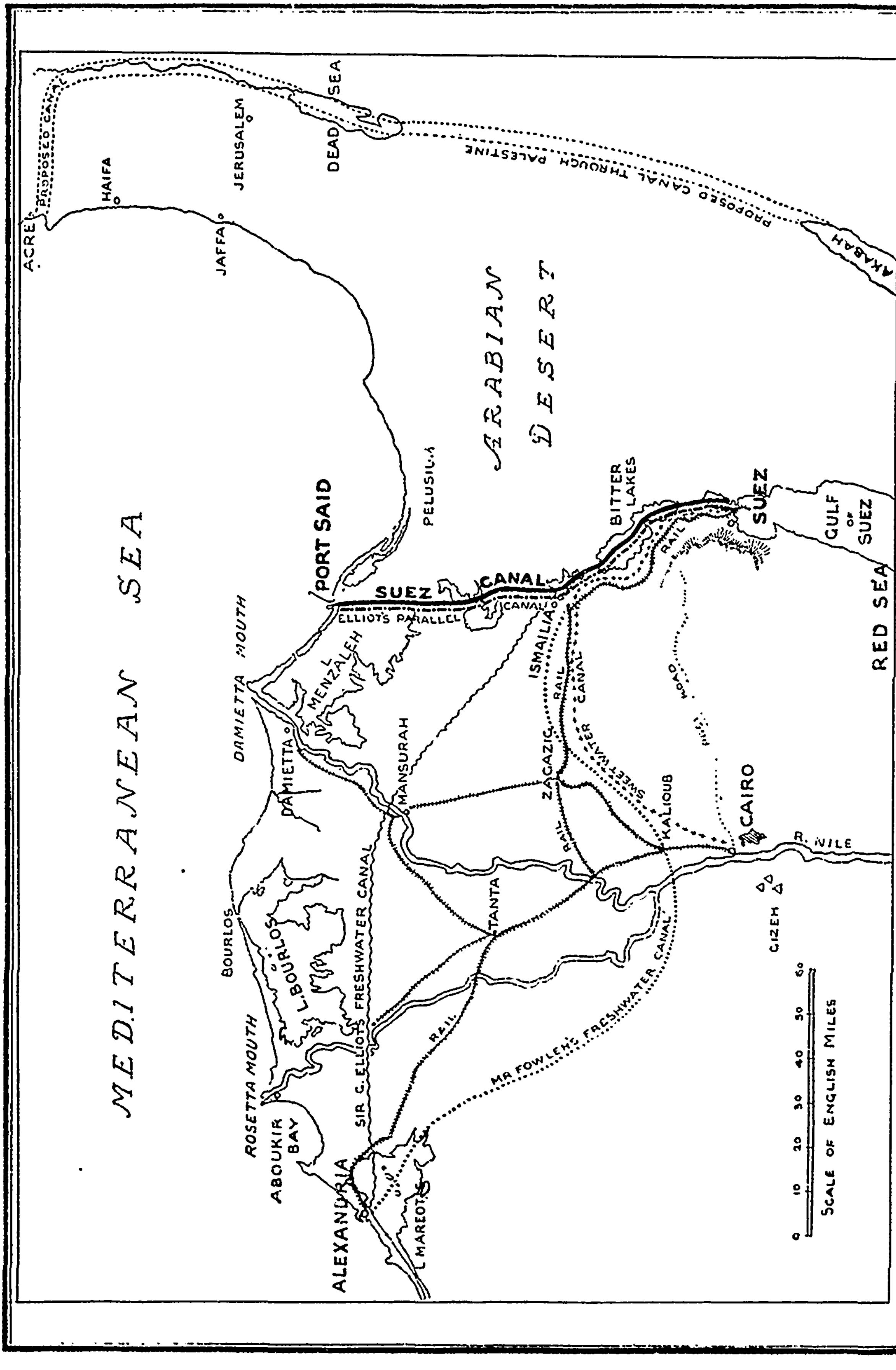
The first excavators fitted up were put to work on these hills, attacking them at the base, on the level of the railroad. The material being very compact, it took a very steep slope, even overhanging sometimes. In this way the breaking off of the upper part would frequently catch the buckets and overstrain the driving drums, causing breakages. To prevent these accidents, workmen were stationed to throw down the earth a little at a time without waiting for it to break off of its own weight. At the commencement of 1883 the plant at Monkey Hill included two Couvreux excavators, two American excavators and several picking machines. All of this machinery was not at work at one time. The American machines, among others, have proved that they are not capable of regular and continuous work.

But this material had to be transported as well as dug out. To use the Panama R.R. was to be at the mercy of a company which would always find some obstacle to retard the movement of the earth trains. So in June, 1882, it was decided to build a second way alongside the one existing already. Thanks to this special line the work of Monkey Hill has been carried forward with all desirable activity; and up to the commencement of 1883, 20,000 to 25,000 cubic yards have been each month carried to the *Terre-plein.*

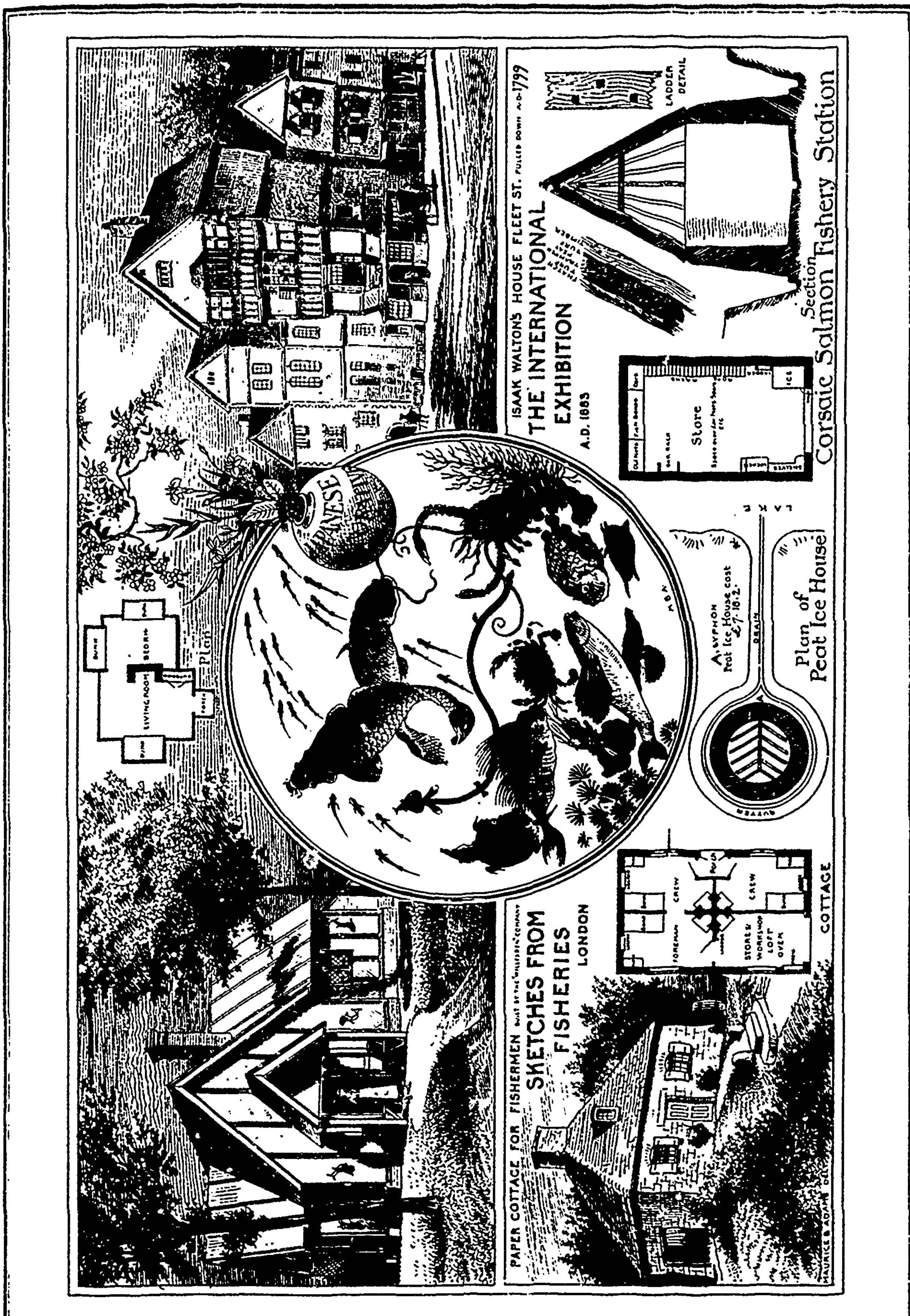
The exterior contour of the *Terre plein* being exposed to the action of the waves, is protected by rip-rapping; to procure the necessary stone a quarry has been opened on the west side of the Bay of Limon, at Kenny's Bluff. The working of this quarry was for some time in the hands of several American subcontractors, but it became necessary to cancel these contracts, the parties failing to meet their obligations. The same thing was attempted at Monkey Hill but did not result in good. It is desirable that the canal company, taught wisdom by a series of similar disappointments, should end by recognizing the fact that they can with safety depend only upon the co-operation of its European employés, generally capable, devoted and carefully chosen, rather than upon strangers of whom it knows neither the aptitude, good will or antecedents. Kenny's Bluff under the company's directions sends each month about 1,600 cu. yds. of large stone blocks to the *Terre plein.* This is a small amount, but the difficulty of loading and transportation must be taken into account. The American contractors did not handle half this amount.

Having now seen where and how the material necessary for the construction of the *Terre-plein* is obtained, we will now describe the work itself.

The filling is almost completed, it covers an area of 74 acres reclaimed from a very low marshy soil, and from water almost 27 ft. deep. At the N.W. end the *Terre-plein* extends 660 ft. in length and has a mean width of 383 ft., forming a vast mole. The line of quay proper for the landing of ships, and which shelters this mole, is 3,070 ft. long, or rather will be when the necessary dredging is finished. At present there is upon the inside of the mole a wharf upon wooden piles, measuring 445½ ft. along the sea front, which is reached by depths of water from 16 to 26 ft.; its width is 41¼ ft. This will be finally entirely covered to protect goods just landed. This wharf is made up of 270 piles in 54 bents of 5 piles each; the bents are about 10 ft. apart; the piles in each bent are a little more than 8 ft. apart. The piles are driven to a solid bottom in a bank of coral; they are shod, and covered with sheets of



PLAN OF THE SUEZ CANAL AND PROJECTED ALTERNATIVE ROUTES OF SHIP TRAFFIC.



PAPER COTTAGE FOR FISHERMEN
SKETCHES FROM FISHERIES
LONDON
COTTAGE
Plan
ISAAK WALTON'S HOUSE FLEET ST.
THE INTERNATIONAL EXHIBITION
A.D. 1883
LADDER DETAIL
Store
Section
Corsaic Salmon Fishery Station
Plan of Peat Ice House

the copper to protect them from the teredo. The railway used in the filling process occupy the position they will finally have in tying together the different establishments with the Panama Railroad.

The houses of the employes will be on the outer line of the *Terre-plein* facing the sea; they are in two rows, forming a street called *Charles de Lesseps*, in honor of the voyage made by the son of the president of the company to the Isthmus. These houses are of three types, intended for one, two or four employés. The smallest have two rooms, a kitchen and verandah, with the entire ground floor raised somewhat. The second type is really formed of two abutting houses of the first kind; the third is like No. 2, with the addition of a second story. The living rooms are 10 x 13 ft. in all cases, the kitchen is 10 x 8 ft.

We might here add that the Panama Wharf (No. 5) has been bought and repaired, and being now united by a special track to the *Terre-plein*, forms an important annex.

Dredging of the Port.—The present purpose of this dredging is to allow ships to approach the side of the *Terre-plein*, and to open up a passage for the transport of the material, etc., needed in digging the canal. So far the dredging has been delayed by frequent boisterous seas in the waters to be deepened, and before the construction of the mole there was no shelter in case of bad weather. The marine dredges, of which we made mention before, will do good service, on account of their dimensions, shape of hull, and above all, the facility with which they can move themselves by their propellers, riding the waves or seeking shelter when the seas become too heavy. But in the absence of these machines, taking advantages of calm weather and the shelter of the mole measured by the rate of its advancement, the dredges mounted at Colon have been utilized. Two of these have been pretty regularly at work; each moving from 1,100 to 1,300 cu. yds. per day. The coral reefs have several times arrested work; when one of these is met with, charges of dynamite are exploded upon the surface, which disintegrates the mass sufficiently for the dredges to remove the débris.

The map shows the area dredged out at the end of February, 1883; the depth attained is 16½ ft. The dredges are now deepening that part of Folka River lying against the railroad jetty. This will be an excellent harbor for all the naval outfit, and slips for repairs will be located upon the corresponding bank of the *Terre-plein*.

Dredging of the Canal.—At the point where the company's dredges stop work commences the canal proper, From this point to Gatun the excavation has been let by contract to Huerne, Slaven & Co., of San Francisco, Cal. The principal clauses of their contract are as follows:

The contractors are to furnish all their own *material*; to commence work in August, 1882, and to be in full working order three months thereafter, that is to say, to handle in December 12,000 cubic yards of material per day.

The digging is to progress in three successive stages the first cut to be 82½ ft. wide at the water surface and $8\frac{2}{10}$ ft. deep, to assure speedy communication with Gatun. The second excavation will make the depth of water 15 ft.; the third will reach the final depth of 28 ft. and the completed width of 165 ft. at water level.

These three stages of excavation to be finished as follows: The first, one year from the day fixed for the commencement of the work, the others, 2½ years after this same day

The price paid per *cubic meter* (1⅓ cu. yds.) dredged, up to 6,000,000 *cubic meters*, is *one franc fifty centimes* (30 cents). For all dredging exceeding the quantity above named the price per *cubic meter* is reduced to 1¼ francs (25 cents) In case the ground should require the use of powder, special contracts will be made for such excavations. To judge of the manner in which Messrs. Huerne & Slaven will execute the work undertaken by them, it will be necessary to wait and see them at work.

We are obliged to admit that at present they seem to attach little importance to several clauses of their contract. In fact, the first dredge, which ought to have been at work in August, 1882, only arrived at Colon in April, 1883. The contract period of active work commenced in December last, when three dredges should have been in operation, handling 12,000 cu. yds. of material per day, as yet, not an actual hour's work has been done. Will the promises made for the completion of each of the successive stages of the contract be better kept? We doubt it, especially in view of the fact that the first cut was to be finished in August next.

The American journals have given certain dimensions to these dredges which do not seem to accord with the work to be done. The Huerne dredges, which are of the endless chain type, are 100 ft. long, 60 ft. wide, and 12 ft. depth of hold. They have to dig a canal in solid ground, and in consequence must open a way large enough to enable them to swing from side to side without touching, with the angles of the hull, either slope. The first trench to be dug will be 82½ ft. wide at the water surface, and will have a bottom width of only 56 ft., that is 4 ft. less than the width of the hull of the dredger. The dredge will thus find itself, so to say, boxed up in the ditch, without being able to execute the swinging movements necessary to advance the digging. It is true that the contractors, in constructing machines capable of digging out the canal to its full width in one operation will not be compelled to work in a ditch where the circulation of the company's material would always be troublesome to them.

To finish our description of the Colon section we must now go to Gatun, where a company's dredge arrived in April, 1883, by way of the Chagres. This is now at work on a cut destined to divert the waters of the Chagres to the west of the Indian village and the canal. This done, floods will no longer effect the trench of the canal; and later, when the waters of the Chagres itself will have been thrown back toward the other bank—that is to say, on the side of the railroad—this new channel will catch all the streams flowing in on the left bank.—*Engineering News and American Contract Journal.*

Inventions.

A New Kind of Mountain Road.—An exchange says that a tramway is to be built up Pike's Peak, which will overshadow the Mount Washington railway. The plan is to construct three of these tramways, each nearly three miles long, one beginning at the end of the other. The first will start at the rear of the iron springs, at Manitou, Col., and the last will be terminable in front of the signal station on Pike's Peak, an elevation of 14,200 feet. The supports will be made of trees not less than eight inches in diameter, and about twenty-four feet high, braced above and below. On these an endless wire cable, of one inch bore, will revolve, and upon which will be fastened, at intervals of about 100 feet each, a large covered armchair, in which two persons can comfortably sit. This will be suspended about eight feet from the ground, and pass at entering and discharging points along a movable platform to load and unload, without stopping. The lower section will be propelled by an engine at the lower end. The centre one will be driven by water power, utilized on the mountain side through a turbine wheel, and the third by an engine erected on the summit of the peak

Mid-Ocean Telegraphy.—The idea of telegraphing from ships at sea is not a new one, and crops up from time to time. Mid ocean telegraph stations have been proposed and will probably be carried out some day. The chief difficulty in the way of their adoption has hitherto been the necessity of keeping the ship connected by a branch cable to the main cable lying on the bottom, and anchoring her so as to maintain this communication in all weathers and depths desirable. But Professor A. E. Dolbear has proposed a plan which may render this fixed *communication unnecessary*. A large metal plate attached to an insulated conductor is lowered from the ship to the bottom on the track of the cable and another plate is merely submerged. Between these two plates a battery and Morse key is inserted. On working the key the Morse currents induce other currents in the cable, which can be heard in telephones attached to the cable on shore.

Mill-engines.—The Southwark iron foundry has constructed for Messrs. Cheney Brothers of South Manchester, Conn., a compound "Porter-Allen" engine, having steam-cylinders 12 and 21 inches diameter, 2-feet stroke, to run at 180 revolutions per minute. The power is given at 200 horse-power. The ratio of expansion is 16. The expenditure of water was 18.5 pounds per horse-power and per hour. Of this, 11.75 was accounted for by the indicator: the rest was wasted by condensation in the steam-cylinders and by leakage. In these engines the low pressure cylinder is steam-jacketed, and the exhaust from the high-pressure cylinder passes into an intermediate reservoir, from which the large cylinder is supplied. The reservoir acts as a separator for the water carried in with the steam; and this water is trapped off, and does not reach the low-pressure cylinder.

CANADIAN TELEGRAPH EXTENSION.—The government will, during the present season, undertake the further extension of Dr. Fortin's telegraph system along the north shore of the Gulf of St. Lawrence. The line is now completed to Bersimis, and it is intended to lay a cable from that point to Godbouh River, near Point de Monts, a distance of 80 miles; thence a land line 75 miles long will run to Moisie River. Next year it is intended to push the land line as far as Esquimaux Point, 15 miles from Mingan Harbour, and 65 miles from Moisie River. Owing to the rugged nature of the country, the numerous deep harbours and fiords with which the coast is indented, the difficulty of constructing a land line east of Mingan is so great, that it is proposed to lay short cables from each important harbour or fishing station until Forteau is reached. This harbour is just inside the Straits of Belle Isle, and only five days's sail from Moville. The completion of the telegraph line to Forteau, it is claimed, will prove a great advantage to shipowners and merchants, as communication can be made with steamships going *via* Belle Isle during four or five days of the voyage from Montreal to Europe.

ELECTRICAL NAVIGATION.—The new launch constructed for the Electrical Power Storage Company by Messrs. Yarrow & Co., made a trial trip between the Temple Pier and Greenwich. A daily paper professing to have the *largest circulation in the world* describes her as a new *steam* launch, and her most remarkable features as being the complete absence of either boilers, funnel, or smoke. The following figures are stated to be her proper dimensions, but we are not quite sure of their correctness:—40 ft. long, 6 ft. beam, and having 3 ft. draft of water aft. She was fitted with eighty Sellon-Volckmar secondary batteries, having a weight of 60 lb. each, or in all about two tons, very neatly packed beneath the floor. The screw is 18 in. in diameter, with a 13 in. pitch, and making 680 revolutions per minute, being attached direct to the Siemen's dynamo. The speed attained on the voyage was over 7½ knots; the passage down the river, immediately after the turn of high water, being made in 37 minutes, including the clearing of the screw from a floating basket which had fouled it.

A CANADIAN ON THE CHANNEL SCHEME.—It will be interesting to Canadians to draw attention to a book published some years ago by a Canadian, James Chalmers, upon the subject of "The Channel Railway connecting England and France." The second edition which is before us was published by E. and N. Spon, 16 Bucklersbury, London, in the year 1867. The plan proposed by Mr. Chalmers is by means of submerged tubes, the total cost of which he estimates at twelve million pounds sterling. The annual revenue he calculates at one million, three hundred thousand pounds; the amount of annual expenditure at eighty-five thousand pounds. The book is illustrated by a chart of Soundings and Lithographed Plans.

NEW ENGINE FOR ELECTRIC-LIGHTING.—Mr. E. D. Farcot has designed a new form of compound engine for electric-lighting machinery. It consists of two cylinders, the larger set above the smaller. The space between the two pistons is undivided, and is in communication with the interior of the engine-frame, and is never put in connection with the steam-supply pipe. The steam first enters the small cylinder, and is thence exhausted into the large cylinder, thus driving the pistons, which are both on a single rod, in opposite directions by a system of intermitted expansion. The engine is thus seen to be of the "Wolff system." The space between the two pistons is made to communicate with the larger space in the frame, merely to secure a reduced variation of uncounterbalanced pressure. No stuffing-box is needed in this engine in any inaccessible part of the machine. The valve-gear is of the plainest possible description, and the whole engine is built with a view to simplicity and small cost in construction and operation. It is intended to be driven up to four hundred revolutions per minute.

HEATING BY SUPERHEATED EXHAUST-STEAM.— Mr. Levi Hussey has devised a method of heating buildings in winter by the exhaust-steam from engines by first passing it through a superheater in the flue, and there taking up heat which would otherwise be sent up the chimney and wasted. The steam is thus deprived of all moisture, and then heated to so high a temperature that it will heat more thoroughly, and with less obstruction by back-pressure, than saturated and wet steam. Heat is thus obtained without cost, and rendered effective for useful application to a greater extent than has hitherto been possible.

THE WIMBLEDON ELECTRIC RAILWAY.—The latest experiment in electric railways has not been very brilliantly successful. It was announced, with some little flourish of trumpets, that the miniature railway to the camp on Wimbledon Common was this year to be worked by electricity. It was not, however, till the last day but one of the meeting that the electricity could be brought into action, and even then the service of steam could not be dispensed with. The trial was again renewed, but the loss of power was very great, and it was as much as the twelve-horse power engine could do to get the cars along the line. Down an incline they ran well enough, but, as at Chiswick, where a similar experiment had similar results, they showed considerable reluctance to move whenever the gradient was against them. There is no doubt that electric railways can be made to work under favourable conditions—although hitherto nothing is known as to their cost as compared with that of steam—but for the ordinary tramway, or such a rough-and-ready temporary railway as that on Wimbledon Common, electricity cannot yet be regarded as a rival of steam.

ENGINES OF LAKE STAMERS.—One of the steamers of the Western transportation line has engines of the "compound" type, two low and two high pressure cylinders, of 20 and of 40 inches diameter and of 40 inches stroke. The steam is cut off at 8 inches in the high-pressure cylinder, and the consumption of steam amounts to but 19 pounds per hour and per horse-power. The boat is 256 feet long, 38 feet beam, and 16 feet draught. The engines and boilers weigh about 100 tons. The latter have 100 square feet of grate-surface, and 3,366 square feet of heating-surface. Another vessel, the E. B. Hale, has simple engines, carries 1,600 tons of freight at 14 feet draught, makes about 10 knots an hour on 1,400 pounds of coal. The engines are 36 by 36, and are supplied with steam by one boiler 12 feet in diameter by 18 feet long.

ELECTRIC STOP FOR STEAM-ENGINES.—Mr. Tate, an English engineer, has combined the Leclanché battery, an electro-magnet, an auxiliary steam-cylinder, and a stop, to the closing of the stop-valve of the steam-engine, if its sudden stoppage should become necessary. It has been supplied by Mr. Tate to the driving-engines of his large woollen-mills in Bradford. The mechanism consists of a weighted suspension rod attached to the stop-valve by a bracket, and actuated by a small steam-cylinder, the piston of which is supplied with steam through a valve which is opened by the action of the electro-magnet and the weighted rod. The movement of this auxiliary engine shuts the stop valve of the engine in a small fraction of the time usually required to close it by hand. The wires of the battery are carried to various parts of the mill, so that the engine can be "shut down" at any instant, and from any one of a number of promptly accessible points. This arrangement is proposed to be attached to the engines of steam-vessels, the wires being led to the bridge, and to other parts of the vessel where the officers can easily reach the button.

"COMPOUND" LOCOMOTIVES.—M. Mallet communicates to the French society of engineers a note from M. Borodine, giving the results of experiments to determine the relative economy of the simple and the compound system of engine for locomotives. The engines experimented with were those designed for the railway from Bayonne to Biarritz by M. Mallet. The trials extended over a considerable period of time, and the comparisons were made fairly complete. The result showed the compound system to have an economy of from ten to twenty per cent., according to the conditions under which they are carried out. The variation in the ratio of expansion is very greatly restricted in the compound engine. The use of the steam jackets with which the engines were provided did not prove to be of advantage. The expenditure of steam was greater when they were in use than when they were shut off.

ZINC PAINT FOR CAST OR WROUGHT IRON.—A process of painting, as a substitute for galvanizing, has been invented by Messrs. Neujean & Delaite, of Liege. It is specially intended for objects of large dimensions, which cannot well be moved, and therefore cannot well be dipped into a bath of melted zinc. The zinc, when finely pounded, is simply mixed with oil and siccative. In this way a varnish is obtained, which is applied with a brush in the usual manner. A single layer is sufficient, but two are preferable. The coated objects can be left as they are, or bronzed or painted as required.

Miscellaneous.

THE BIRTH OF THE BRITISH ISLES.—Under the title of "Contributions to the Physical History of the British Isles," Professor Edward Hull has lately published an interesting, if somewhat hypothetical, contribution to Palæo-physiography. Perhaps the most remarkable conclusion to which the author has been led by his studies of the evolution of the British Islands is that which relates to the period of their birth. He believes that until the close of the carboniferous period the British area had no existence as continuous dry land. But at that epoch a series of subterranean distubances upheaved the sea-bottom in that part of the world, and at the same time threw what is now the eastern part of America into a great succession of ridges or folds. These violent upheavals were accompanied by depressions in the intermediate area, and thus the North Atlantic Ocean came into existence contemporaneously with the origin of the British area. In discussing the genesis of the Atlantic Ocean the author strongly combats the popular dogma relating to the permanence of oceanic and continental areas. Nevertheless he admits that the old mountainous tracts of the north and west of Britain and Ireland, when once formed, have ever since retained their prominent position, and have been rarely, if ever, submerged. For the details of these interesting arguments the original work must be consulted.

THE EARLIEST TRACES OF MAN IN AMERICA.—Dr. Hoffman, curator of the museum of the Washington Anthropological Society, is of opinion that the footprints found at Nevada, which have the appearance of being produced by a gigantic human foot clothed in sandals or mocassins, and one of which has been subsequently obliterated by that of an elephant, are veritable impressions made by tertiary man, indeed by two distinct individuals of the upper pliocene period. The mocassins, however, show these pristine men in so new a light that the scientific imagination refuses to answer the call upon it. M. de Nadaillac, who has recently published an excellent work on "Prehistoric America," does not accept this evidence. He says that in America, as in Europe, all serious proof fails of the existence of man at an earlier period that the quaternary.

ORIGIN OF THE NEW YORK AND BROOKLYN BRIDGE IDEA.—The question by whom the idea of erecting a bridge between New York and Brooklyn was originally conceived, is apparently settled by a communication to the *Journal of Commerce*, in which journal, moreover, the first public mention of the scheme was made. A correspondent of that paper writes: "In the month of February, 1853, my uncle, the late John A. Roebling, accompanied by his wife and son Washington, then a lad of fifteen years, came from Trenton to my house in Hicks street, South Brooklyn, to attend the christening of my infant daughter Amelia Returning in the afternoon by the Hamilton ferry, the boat was caught in the ice, and drifted round in a helpless condition for three or four hours. A boat load of soldiers who were cast away from Governor's Island were rescued on the trip Mrs Roebling was in great anxiety of mind, having left an infant child at home Mr. Roebling then took a solemn vow, in the presence of the hungry, half-frozen passengers, that if his life was spared he would yet build a bridge across the East river. * * * His vow and the crowning idea of his life have been carried out, not by the father, but by the son who stood so nobly by his side"

A NEW HYDROID POLYP.—Professor E. D. Cope described an interesting form of hydroid polyp found in large numbers on the bark of submerged trees in Upper Klamath Lake, Oregon. Its coenoecium is a mass of creeping yellowish stems embedded in sarcode Each zooid is of an elongate oval form, sessile, and with six rays of equal size, each one-half as long as the body. The zooids are translucent, but with two oval bodies in the lower half of the body-cavity of a yellow color. These are collected in masses as large as the fist. The length of each zooid is one millimetre They did not extend themselves beyond this length, neither did the rays elongate to beyond half the same during the time they were observed. They retracted themselves on being irritated. They do not possess any fringes like the arms of the polyzoa As the possession of a coenoecium distinguishes this genus from all the fresh-water hydroids, it was proposed to distinguish it as the type of a new genus with the name *Rhizohydra*, the species being named *flavitincta*. An attempt to preserve some of the masses of zoöids in alcohol was not successful.

HISTORY OF GUNPOWDER.—A writer in the North China Herald, on the history gunpowder in China, asserts that this explosive was known in the seventh century of our era. The alchemist of the Han dynasty, and subsequently in the fourth and following centuries, worked with salpeter and sulphur, as well as cinnabar, red oxide of lead, and other common compounds. But in the seventh century we find gunpowder used to make a crackling sound, and to afford an agreeable sight to the Court of Sui Yang-ti, the Emperor of that time. The earliest exhibitions of fire works mentioned in Chinese history belong to that date. The substances used in the composition of gunpowder are all native to China, and the writer appears to prove conclusively that the Arabs derived the art of firework making, as well as gunpowder, from the Chinese. The discovery once made, the Chinese alchemists, owing to the badness of their hypothesis and the futility of their aims, were slow at improvement But the doctors of the Arab colonies in China carried to Bagdad the germs of the Chinese discoveries, and there they were elaborated into new forms. In short, in many arts and sciences the Arabs learned from China, and, assisted by Nestorians, Jews and Greeks, improved on what they learned. In course of years, cannon, matchlocks and shells, for use in sieges, were brought to China from Mohammedan countries.

There are faint traces in the eleventh century of rude fire arms; in the twelfth and thirteenth centuries the records of their use in the Chinese wars became frequent and distinct. The Golden Tartars, in their wars with South China, in the twelfth century, used cannon, which they called "heavy shaking thunder." In an iron tube was placed powder, which was "set fire to, and would burn down half a square li of houses and pierce a coat of mail of iron rings." It is expressly stated that Genghis Khan, the mongol conqueror, used cannon in his wars. Kublai Khan also used these weapons at a siege celebrated in Chinese history—that of Siang-yang. Hearing, it is said, the sound of the explosion, which shook the sky, and seeing that the balls entered seven feet into the earth, the Chinese defenders of the city capitulated. It is clear that China owed its knowledge of artillery to the Mohammedans. In the fourteenth century commenced the European intercourse *with China, which then abandoned the Arabs* and took the Portuguese as teachers in the construction of weapons of warfare.

VIBRATION OF SOLID BODIES IN CONTACT WITH LIQUIDS.—Recent investigations as to the effect of liquids contained in glass vessels upon the pitch of the sound produced when the latter are set in vibration have yielded the following results. 1. The geometrical lowering in pitch (ratio of number of vibrations) produced by a liquid contained in a cylindrical glass completely filled by it is less in proportion as the pitch of the empty glass is higher. 2. The arithmetical lowering of pitch with a cylindrical glass of mean pitch is approximately proportional to the reciprocal of the square root of the number of vibrations of the empty glass. 3. The lowering of pitch when the glass is completely filled is not noticeably dependent on its height. 4. The geometrical lowering of pitch produced in cylindrical glasses of different widths is greater in proportion as the glass is narrower. 5. The arithmetical lowering of pitch with cylinders of different widths is inversely as the square root of the width. 6. The arithmetical change of pitch is inversely proportional to the square root of the number of wave lengths of the sound given by the empty glass contained between the walls and axis of the cylinder. 7. The lowering of pitch is greater as the density of the liquid is greater. 8. It is greater in proportion as the compressibility of the liquid is less.

BRAIN-WEIGHT OF BOYS AND GIRLS.—In the final result of the comparison of the two sexes in the human race, anatomical researches will form an important factor. Many anatomists have recognized this fact, and have instituted comparisons between the sexes from various points of view M. Gustave le Bon reviews the work of M. Manouvrier and that of M. Budi, both of whom aver that "sex has no influence on brain-weight. *With them the influence of sex is nothing more than* the influence of height, and if the females as a whole exceed the males in brain-weight, it is simply because the weight of the body in the females is much below that of the males." M. le Bon puts the theory of his adversaries to the test in a very ingenious manner by comparing the brains of males and females having about the same weight. By this investigation it is shown that in the great majority of cases the male children surpass the females of the same weight in their cranial circumference.