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CANADIAN MAGAZINE OF Science and the Industrial Arts. Patent Office Record.

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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.*

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

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THE INFLUENCE OF SCIENCE UPON LITERATURE.

By R. W. BOODLE.

Ever since Plato's days something like antagonism has existed between science and literature. Sometimes influencing one another, as in the present age, at other times one has reigned supreme to the exclusion of the other. So that, though one would suppose that there should not exist in the nature of things any antagonism between the *true* and the *beautiful*, there is still much truth in the old saying of Plato, "there is a quarrel of long standing between philosophy and poetry"—for philosophy occupied in his day the position now filled by what we term Science.

At the present moment science may be said to be definitely in the ascendency. It threatens to exclude literature from the curriculum of schools. As the object lesson it claims precedence of the story book as a means of moulding the growing intellect of the child. Between two rival schools of historians, the one led by Professors Seeley and Stubbs, the other by Professor Bryce and appealing to the great names of Macaulay and Carlyle, a battle is being fought in our own days for the possession of the field of History; the new critical school aiming at converting History from a branch of Literature into a Science. In his recent "Recollections," Renan declares himself against the study of History upon any terms. "It is by chemistry at one end and by astronomy at the other, and especially by general physiology, that we really grasp the secret of existence of the world or of God, whichever it may be called. The one thing which I regret is having selected for my study researches of a nature which will never force themselves upon the world, or be more than interesting dissertations upon a reality which has vanished for ever." Meanwhile Matthew Arnold urges that, when men "have duly taken in the proposition that their ancestor was a 'hairy quadruped furnished with a tail and pointed ears, probably arboreal in his habits,' there will be found to arise an invincible desire to relate this proposition to the sense within them for conduct and to the sense for beauty. But this the men of science will not do for us, and will hardly even profess to do."

Whatever may be the result of the rivalry between the two branches of knowledges, it is interesting to observe the curious influence that science has already exercised over literature. I propose to call attention to a few instances of this.

The professed object of science being the investigation of the laws of existence, the discovery of fact; the wider cultivation of science which marks our century should naturally result in bringing literature more strictly in accordance with the facts of nature. And this we find to be the case. The scientific spirit as it passed into literature is hardly disguised by the phrase "Truth to Nature," which has exercised such a potent influence upon fiction in prose and verse ever since the days of Wordsworth. In his epoch-making Preface to his "Lyrical Ballads," Wordsworth tell us the object he proposed to himself in the volume, viz., "to choose incidents and situations from common life, and to relate or describe them, throughout, as far as was possible in a selection of language really used by men, and, at the same time, to throw over them a certain colouring of imagination, whereby ordinary things should be presented to the mind in an unusual aspect; and further and above all, to make these incidents and situations interesting by tracing in them, truly though not ostentatiously, the primary laws of our nature." And the spirit of which Wordsworth was the leading exponent has been the key-note of modern literature. To illustrate this in detail would be unnecessary. Let the reader, if he wishes to satisfy himself, compare the impromptu songs in "The Spanish Gypsy" with similar songs in earlier literature. *The difference is striking. George Eliot's songs are* such as a minstrel might possibly improvise. Those of her predecessors are elaborate poems. Without doubt literature has gained on the whole from its submission to the teachings of the scientific spirit. Yet the results have not in all cases been as satisfactory as in the works of Thackeray and George Eliot; for Walt Whitman and Zola are also products of the Realistic school.

Another result of the influence of the scientific spirit is to be found in the stricter application of the laws of verse. This is perhaps nowhere more manifest than in the difference between the modern English sonnet and its predecessors. At one time any poem in fourteen lines was entitled to rank as such. The sonn has now to be written in strict accordance with the laws of the best Italian sonneteers. As is natural, the strict application of law to a language and literature, like English, remarkable for its lawlessness and disregard of fixed rule, has resulted in an artificiality, which has had a very deteriorating effect upon literature at the present day. It will be sufficient to refer to the Sonnets of D. G. Rossetti as an instance. The attempts, too, of Mr. Swinburne and others to introduce French forms of verse into the English language have been far from happy in their result.

Perhaps in no case has the scientific spirit won greater triumphs than in the change it has effected in the manner of translation from one language into another. One of the best specimens of translation in the old style is Edward Fairfax's version of Tasso's "Jerusalem Delivered." It is delightful reading as an English poem, but with Tasso's meaning the greatest liberties are taken. Chapman who executed his translation of Homer in the reign of Elizabeth shows no scruple on several occasions about expanding a single line of the original into several of his own. Macaulay's joke about Homer becoming "translated" in Pope's hands is proverbial. To the old theory of translation there is little fear of our ever returning. Not only the exact meaning of the original has to be preserved, but its manner and spirit. In the case of poetry, analogous metres have to be selected. No one has done better work in reforming our theories of translation than Matthew Arnold whose lectures on translating Homer were delivered in 1861. Milman, Conington, Bayard Taylor, Longfellow and Lewis Campbell may be mentioned as some of the most successful among modern translators; while Sewell's translation of the "Georgics" and Robert Browning's version of the "Agamemnon" are instances of the modern theory pushed to a ridiculous extreme.

VIBRATORY MOVEMENT OF BELLS.—M. Mathieu, a French experimenter, has recently studied the vibrations of bells, considering the case of an ordinary bell in which the thickness in any meridian increases from summit to base. The essential differences between the vibratory movement of a bell and that of a plane plate is that, while in the latter the longitudinal or tangential movement and the transverse movement are given by independent equations, the normal and tangential motion in the former are given by three equations which are not independent. The pitch of the notes of a bell does not change if the thickness varies in the same relation throughout every part, since the terms depending on the square of the thickness may be neglected, at least for the graver partials. It is impossible to construct a bell so that it shall vibrate only normally, and with a hammer the tangential vibrations are of the same order as the normal vibrations. A purely tangential motion can be realized only with a spherical bell of constant thickness.

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.

As the heading implies, the following specifications are *general* in their nature; they are intended for *ordinary* iron highway bridges and are designed to present to parties interested in bridge construction, more especially those upon whom falls the responsibility of letting bridge contracts, what in the writer's opinion are the requisites for a good structure. The part of these specifications relating to the proportioning of main members and details is in accordance with the writer's previous papers on "Bridge Pins—Their Sizes and Bearings," "A System of Designing Highway Bridges," and "Details in Ordinary Iron Bridges," while the parts relating to tests of material is taken from Prof. H. T. Bovey's excellent little work on "Applied Mechanics." A few other portions are copied from approved specifications.

By ordinary highway bridges are meant simple truss bridges, having no novel and peculiar features, such as a combination of arches and trusses, cantilevers, etc, in short the bridges which one meets with every day in travelling through the United States. These specifications are general enough in their nature to include all the ordinary styles of truss, but are more particularly applicable to the Pratt and Linvill, which are by far the most common trusses for iron highway bridges in America.

Highway bridges may be divided into three classes, viz.: those for cities and their suburbs which are subjected to the *continued* application of heavy loads, those for cities and their suburbs which are subjected to the *occasional* application of heavy loads; and those for country roads, where the traffic is lighter. Let us call these divisions classes A, B and C.

Live Load.— SPECIFICATIONS.

Span in feet.	Moving load per square foot.	
	Classes A and B.	Class C.
0 to 50	100 pounds.	80 pounds.
50 to 150	90 "	80 "
150 to 200	80 "	70 "
200 to 300	70 "	60 "
300 to 400	60 "	50 "

Dead Load.—The dead load is to include the weight of all the iron and wood in the structure excepting those portions resting directly on the abutments, and whose weights do not affect the stresses in the trusses; also, if necessary, an allowance for snow, mud, paving or any unusual fixed load, that may ever be placed upon the bridge. Pine lumber is assumed to weigh two and a half lbs. per ft. C. m. and oak lumber four and a third lbs. per foot. C. m. Should in any bridge of, or below, two hundred feet span the calculated dead load differ more than seven per cent., or in any bridge above two hundred feet span more than four per cent. from that assumed, the calculations of stresses, etc., are to be made over with a new assumed dead load.

Wind Pressure.—The wind pressure per square foot for bridges in unusually exposed situations is to be assumed as fifty lbs. for spans of one hundred feet and under, forty-five lbs. for spans between one hundred and one hundred and fifty feet, and forty lbs. for spans above one hundred and fifty feet.

For bridges in positions not unusually exposed, these numbers can each be diminished by ten.

The total area exposed to the wind is to be determined by adding together the areas of the floor, joists, and lower lateral rods, and twice the area of the truss, hand-rail, hub plank, guard rail and the rectangles circumscribed about the ends of the floor beams.

Limiting Length of Span for Different Clear Roads.—The maximum lengths of span for the different clear roadways are to be one hundred and forty feet for twelve feet roadways, one hundred and ninety feet for fourteen feet roadways, two hundred and sixty feet for sixteen feet roadways and three hundred and fifty feet for eighteen feet roadways. By 'clear roadway' is meant the distance between the inner edges of the batter brace plates.

Limit of Clear Headway.—The least allowable clear headway is to be fourteen feet, unless some local consideration cause this number to be increased. By 'clear headway' is meant the vertical distance from the upper face of the flooring to the lowest part of the portal or overhead bracing.

Limiting Length of Span for Pony Trusses.—The greatest allowable length of span measured from centre to centre of end pins, or, in case of rivetted connections at the shoes, between the intersections of the centre lines of lower chord and batter braces, is to be sixty-five feet for pony trusses or bridges without overhead bracing.

Limiting Depth of Pony Trusses.—The greatest allowable depth measured from centre to centre of chords for pony trusses without side bracing is to be six feet, and that for pony trusses with side bracing nine feet.

Limiting Slope for Batter Braces of Pony Trusses.—The least allowable slope for batter braces of pony trusses is to be two horizontal to one vertical.

*Limiting Length of Span for Double Intersection Bridges**.—The least allowable depth of span measured from centre to centre of end pins, or in case of rivetted shoe-connections, between the intersections of the centre lines of chord and batter braces for double intersection bridges is to be one hundred and fifty feet.

Side Braces.—The least allowable batter for side braces in pony truss bridges is to be five inches to the foot, and all side braces are to be made to resist both tension and compression. In no case are they to have less strength than that of a $2\frac{1}{2}'' \times 2\frac{1}{2}'' = 5$ lb to foot angle iron.

Limiting Sizes of Sections.—No rods less than three-quarters of an inch in diameter are to be used in a bridge. No channels less than five inches in depth are to be used for chords, batter braces or posts, or less than inches four in depth for lateral struts. No bars less than one-half inch thick are to be used for diagonals, nor any iron less than one-quarter inch thick anywhere in the bridge.

Expansion.—Any span above fifty feet in length, resting on stone, concrete or iron foundations, shall be provided with some means of allowing the bridge to expand and contract longitudinally with the variations of temperature; and, in spans of fifty feet and under, care must be taken especially when the bridge is erected in cold weather, to see that the stonework of the abutments will not prevent a little sliding of the shoes.

Anchorage.—At least one end of every bridge must be anchored to the foundations. If the overturning moment of the greatest assumed wind pressure be more than half the resisting moment of the weight of the bridge, the latter must be anchored at the roller end also, but in such a manner as not to interfere with the expansion.

Sliding.—At the roller end of a bridge, if the frictional resistance to the sliding of the shoe in the direction of the length of the rollers be not more than double the tendency to slide, produced by the wind pressure, a resistance equal to the difference of these two quantities with a factor of safety of two must be provided.

Continuous Spans.—Except in the case of swing bridges, consecutive spans are not to be made continuous over the points of support.

Cambre.—The cambre of all bridges must be such that when they are subjected to their heaviest loads, the middle point of the centre line of the bottom chord shall be at least one inch above the line joining the centre of end pins.

Vertical Sway Bracing.—In all deck bridges and in all through bridges, where the depth from centre to centre of chords is twenty-four feet or over, vertical sway bracing is to be used, and is to be proportioned so as to carry all the wind pressure concentrated at the upper and intermediate panel points (if there be intermediate struts), on the windward side and at the upper panel point on the leeward side to the lower panel point on the leeward side.

Portal Bracing.—The portal bracing is to be proportioned not only to resist the direct thrust caused by the wind pressure, but also the bending caused by the stresses in the knee bracing, according to the method given in Burr's work on "Stresses in Bridge and Roof Trusses." Portal struts subjected to bending must first be proportioned for direct stress due to both wind pressure and the initial tensions on the rods meeting at the end of the strut, and then to their section must be added sufficient area to resist the bending.

Bending Effect on Posts and Batter Braces.—But the bending effect in the posts and batter braces caused by the stresses in the intermediate struts or knee braces need not be considered to occur when the bridge is fully loaded; so unless the dead load stresses and the bending together call for more section than the dead and live loads combined, the bending in these members may be neglected.

Bending Effect on Lateral Struts.—Nor need there be any bending supposed to be caused by stresses in the knees connecting upper or intermediate lateral struts to posts, as the use of these knees may be considered simply to prevent vibration, and as, owing to the fact that these struts resist bending in the planes of their greatest dimensions, there is already a surplus of strength.

Stresses in Upper Lateral Struts.—The stresses in the upper lateral struts are to be calculated for the wind

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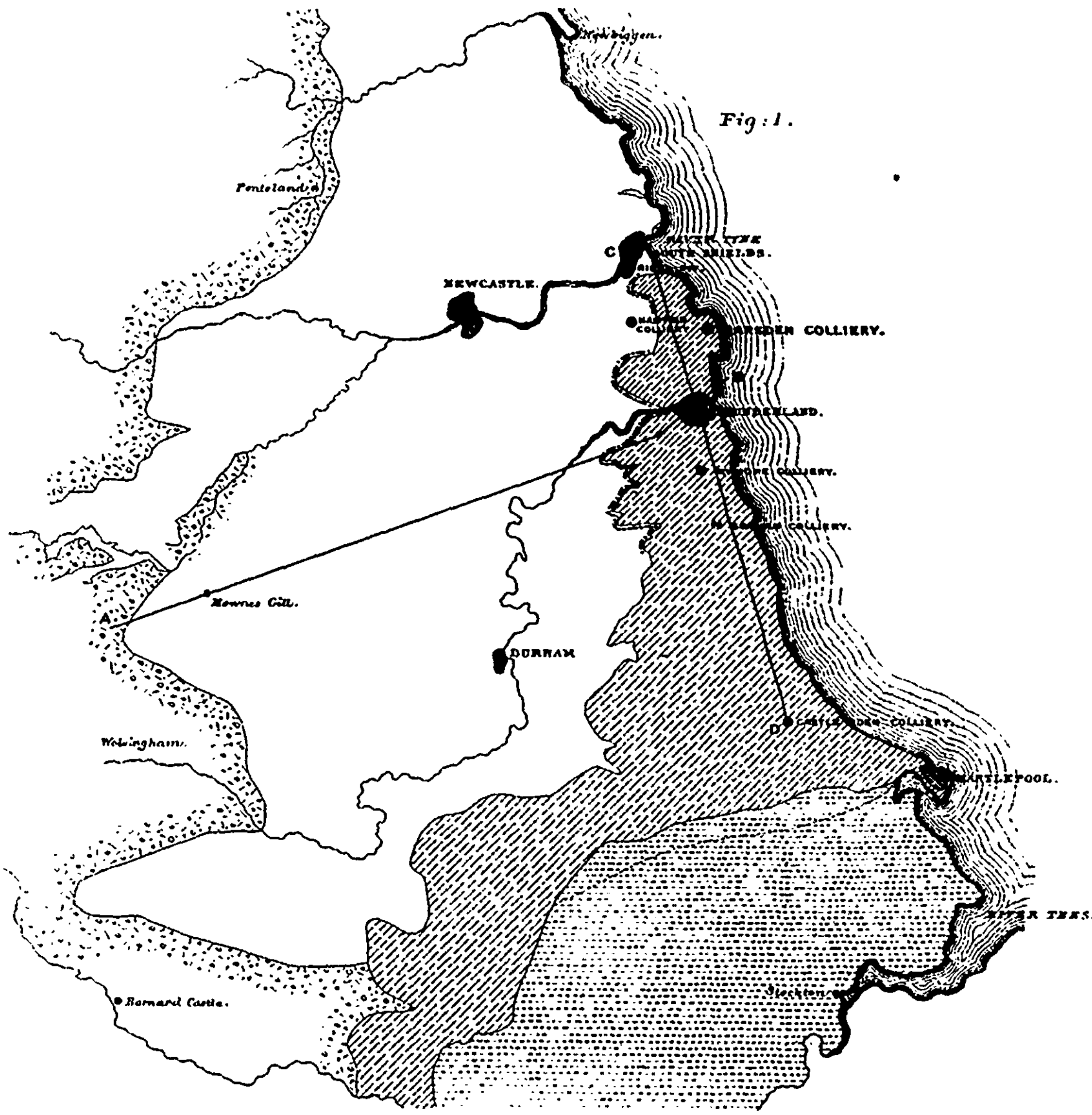
* For later investigations concerning this limiting length, see "Economy in Highway Bridges," in the Proceedings of the Engineers' Club of Philadelphia.

SINKING OF TWO SHAFTS AT THE MARSDEN COLLIERY.

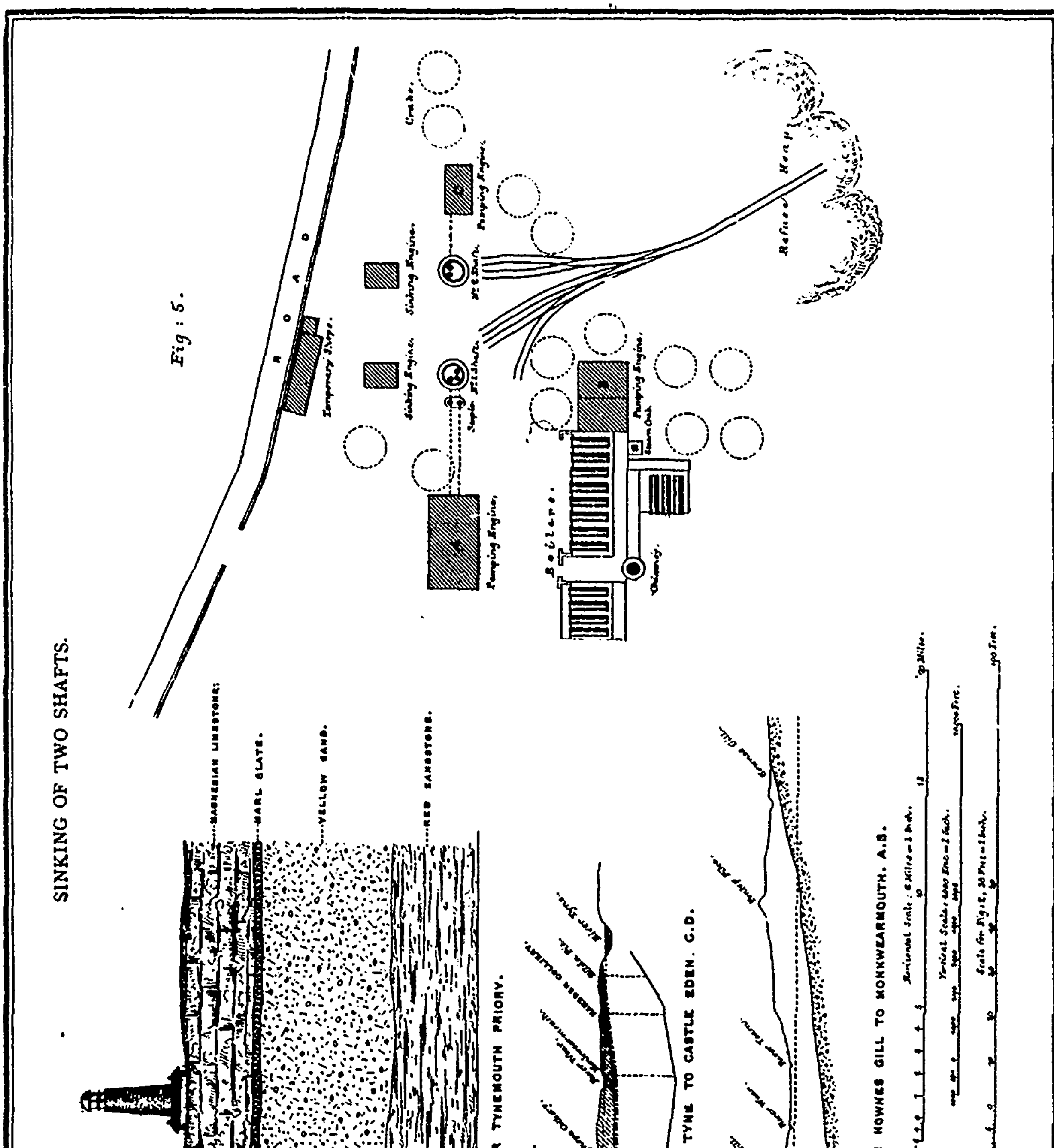
See page 231, *&c*



JOHN DAGLISH, DEL.

Scale 6 Miles = 1 Inch.

SINKING OF TWO SHAFTS.



SECTION OF CLIFF NEAR TYNEMOUTH PRIORY.

SECTION FROM RIVER TYNE TO CASTLE EDEN. C.D.

SECTION FROM HOWNES GILL TO MONKWEARMOUTH. A.S.

pressure plus the sum of the transverse components of the initial tensions in the rods meeting at one end.

Initial Tension.—To allow for the stresses caused in adjustable members, the stress in each such member is to be increased by the amount given in the following table :

½ in.	0.50 tons.	1½ in.	2.00 tons.
¾ "	0.75 "	1⅝ "	2.25 "
1 "	1.00 "	1¾ "	2.50 "
1⅛ "	1.25 "	1⅞ "	2.75 "
1¼ "	1.50 "	2 "	3.00 "
1⅜ "	1.75 "		

Square or flat bars are to receive the allowance for equivalent round rods.

Connection for Lateral Systems.—Whenever it be possible the lateral rods of both upper and lower systems are to be connected directly to the chord pins. But if the rod exceed one and three-quarters inches diameter, bent eyes are not to be employed. Lower lateral rods are not to be attached to the floor beams unless the latter be rivetted to the posts. To make the lateral rods clear the joists, wooden lateral struts resting on the floor beams, and having wrought iron jaws at their ends attached to the chord pins, are to be employed for the joists to rest upon. These wooden struts are to be bolted every two or three feet through the top flange of the floor beam by half inch bolts. Should the sizes of the lateral rods be such as to prevent the use of bent eyes, pins dropped vertically through the jaws are to be employed.

Stresses in End Lower Lateral Struts.—In figuring the stresses in a lower lateral strut at the roller end of a bridge the stress caused by the wind pressure is to be added to the transverse component of the initial tension in the end lateral rod, and from the sum is to be substracted the product of the pressure on the windward shoe, when the bridge is empty and subjected to the greatest wind pressure, by the co-efficientof friction of iron upon iron, which is about 0·25 for this case.

Stiffened End Panels.—In any panel of a bridge, where the longitudinal component of the greatest allowable working stress in the lower lateral rod exceeds the tension in the lower chord of that panel caused by the dead load alone, the bottom chord of that panel must be made to resist both tension and compression.

Where two channels are employed for the lower chord section, the effective area of the webs alone must be counted upon to resist tension.

Top Chord and Batter Brace Sections.—The top chord and batter braces shall consist of two channels with a plate above and latticing below, the lattice bars being rivetted together where they cross. Broad lacing with two rivets at each end may be substituted for the latticing.

The top plates must be of the same section throughout, the increase of section from the ends to the middle being obtained by thickening the webs of the channels.

Post Sections.—Posts are to consist of two channels with lattice bars rivetted together where they cross, or as in the chords and batter braces, broad lacing may be substituted for the latticing. The upper ends of the posts may be either rigidly attached to the upper chords by plates or may be hinged on the upper chord pins.

Upper Lateral Strut Sections.—Upper lateral struts are to be formed of two channels bars laced or latticed and rigidly attached at their ends to the chords.

Sections of Bars.—Wherever practicable, the ratio of the width to depth of bars is to be made as nearly as possible equal to one to four.

Working Tensile Stresses.—The intensities of working stresses for iron in tension in the various members are to be as given in the following table :

Members.	Working stresses in tons of 2,000" per sq. in.	
	Class A.	Class B and C
Main diagonals and lower chord bars.	5.00	6.25
Centre diagonals, counters and hip verticals.	4.00	5.00
Flanges of rolled beams.	5.00	6.00
Flanges of built beams (net section.)	4.00	5.00
Lateral rods and vibration rods.	7.50	7.50
Beam hangers.	3.00	4.00

Working Compressive Stresses.—For struts composed of two channels with plates or lacing or latticing the following formula are to be used in finding the intensities of working compressive stresses.

For chords, batter braces and posts in bridges of class A.

$$p = \frac{\dfrac{f}{1+\dfrac{H^2}{C}}}{4+\dfrac{H}{20}} \cdot \text{ and } p = \frac{\dfrac{f}{1+\dfrac{H^2}{C}}}{4+\dfrac{H}{30}}$$

For lateral struts in class A and all compressive members in classes B and C, p being the intensity of working stress,

$$H = \frac{\text{length of strut.}}{\text{least diameter of strut.}}$$

$$f = \begin{cases} 38{,}500 \text{ for two fixed ends.} \\ 38{,}500 \text{ for one fixed end and one hinged end.} \\ 37{,}800 \text{ for two hinged ends.} \end{cases}$$

$$\text{and } C = \begin{cases} 5{,}820 \text{ for two fixed ends.} \\ 3{,}000 \text{ for one fixed end and one hinged end.} \\ 1{,}900 \text{ for two hinged ends.} \end{cases}$$

Where I beams are employed for intermediate lateral struts or end lower lateral struts, the intensities of working stresses are to be found by dividing the ultimate resistances, as given by the maker, by the product of the area of the sections and the expression

$\left\{4+\dfrac{H}{80}\right\}$, $\dfrac{H}{-}$ being the number of diameters.

For the flanges of rolled beams the intensities of working compressive stress are to be taken equal to five tons for bridges of class A, and six tons for bridges of classes B and C. For the flanges of built beams the intensities of working compressive stress are to be taken equal to four tons on the gross section for class A, and five tons on the gross section for classes B and C.

Working Shearing and Bending Stresses.—The intensities of working shearing stresses on pins and rivets are to be three tons for bridges of class A, and three and three-quarters tons for bridges of classes B and C. The intensities of working bending stresses on pins are to be seven and a half tons for bridges of class A, and nine and three-eighths tons for bridges of classes B and C. For pins belonging wholly to the lateral systems in bridges of either class, the intensity of working bending stress may be taken equal to eleven and a quarter tons.

Where steel pins are employed the intensity of working bending stress must not be taken greater than twelve tons for bridges of class A, or fifteen tons for bridges of classes B and C, unless special experiments on the steel used show a greater ultimate resistance than sixty tons per square inch, in which case a factor of five may be used for class A and a factor of four for classes B and C.

Sizes of Upper Lateral Rods.—In many cases the stresses in the upper lateral systems in through bridges or the lower lateral system in deck bridges call for sections of rods which would be practically too small; the limits for the diameters of the end rods in such cases are to be taken from the following table:

Diameter of end rod.	Length of Span.	
	from	to
¾ in.		60 in.
⅞ "	60 in.	80 "
1 "	80 "	100 "
1⅛ "	100 "	140 "
1¼ "	140 "	170 "
1⅜ "	170 "	200 "

Hip Verticals.—Hip verticals in bridges of classes A and B are to be proportioned for a live load of one hundred pounds per square foot, and those of class C for a live load of eighty pounds per square foot, irrespective of the length of span.

Stiffened Hip Verticals in Pony Tresses, Trussing.—Hip verticals in pony tresses are to be stiffened so as to resist compression. In these members and in the posts of small pony truss bridges, where there is an excess of strength, trussing may be used, but in no other case.

Upset Rods.—Middle panel diagonals, counters, lateral rods, vibration rods, and all other adjustable rods are to have their ends enlarged for the screw-threads according to the table given on pages 126 and 127 of "Carnegir's Pocket Companion."

Minimum Dimensions of Chord and Batter Brace Plates.—The minimum dimensions for the top plate in top chords or batter braces are to be taken from the following table. Should the width employed exceed that given in the table by from forty to sixty per cent, the thickness must be increased by onesixteenth of an inch; if it exceed from sixty to eighty per cent., the thickness must be increased by one-eighth of an inch.

Depth of Chan.	Min. Thickness.	Min. Width.
5 in.	¼	7 in.
6 "	¼	8 "
7 "	¼	9 "
8 "	¼	10 "
9 "	[illegible]/16	11½ "
10 "	5/16	12½ "
12 "	⅜	15 "

(*To be continued.*)

ON THE SINKING OF TWO SHAFTS AT MARSDEN, FOR THE WHITBURN COAL COMPANY.*

BY JOHN DAGLISH, M. INST. C.E.

It has long been known that the North of England coal field extends under the sea on the coasts of *Northumberland and Durham*; but although the coal has been worked up to the coast line at several points many years ago, no operations had been carried on under the sea on the east coast of England until within the last few years.

Recently, however, leases of the under-sea coal have been negotiated by various large mining companies from the Crown, along nearly the whole coast line from Newbiggen on the north, to Castle Eden on the South (Page 228, *Fig. 1*). And at several places (Seaham and Ryhope to the South, and Monkwearmouth to the north of Sunderland, and North Seaton to the North of Blyth) where the existing pits were comparatively near the coast, the workings have now been extended to a considerable distance under the sea. At other points, however, the coal-field under the sea cannot be reached by any existing pits, and and special pits will be necessary for working these portions.

An important Geological feature of this district is the outcrop of the Permian rocks about midway on the coast line of this coal field, at the mouth of the River Tyne; the Coal-Measures, which appear on the surface between the River Coquet, at the northern extremity of the coal-fields, and this point, here dip under, and are overlaid by the Magnesian Limestone as far as the southern extremity of the field at Castle Eden, near which point the coal-field is again overlaid by the red marl of the Trias formation. The dip of the magnesian beds being southerly, they gradually increase in this direction, from a thickness of a few feet under the Priory at Tynemouth to upwards of 600 feet at Castle Eden (Page 228-9, Figs. 1, 2, and 3). Underlying the Magnesian Limestone and stratified conformably with it, and unconformably with the Coal-Measures, is a bed of sand varying in thickness from a few inches to 100 feet; and in quality from hard rock to almost incoherent sand. This bed is well developed under the Priory rock at Tynemouth (Fig. 2), and in the railway cutting at Ferryhill. Where this bed is of of great thickness and of incoherent character, it has been the cause of a large expenditure of capital and time, at many of the colliery sinkings in the south east part of the Durham coal-field, and notably at the Murton Colliery.[1]

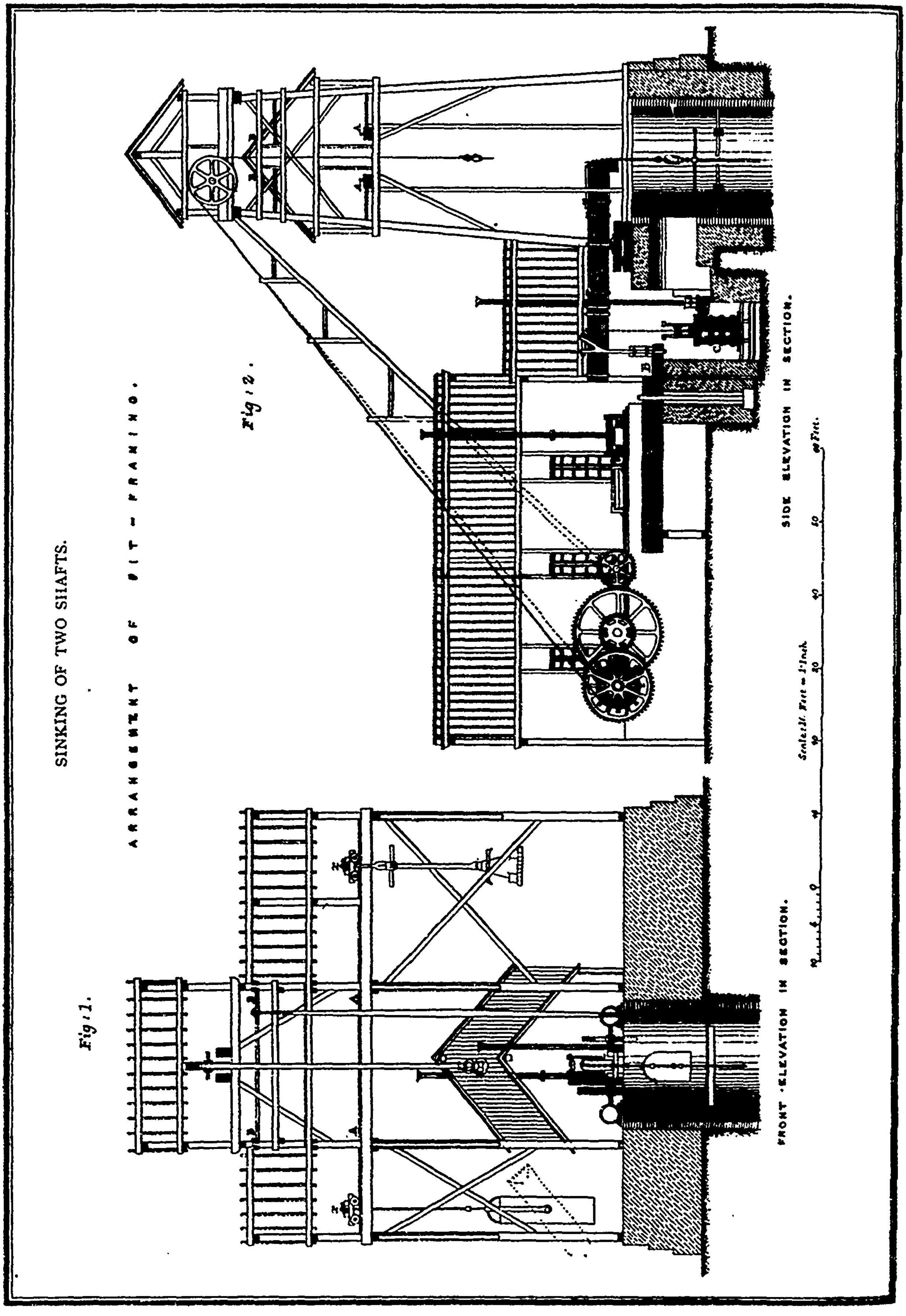
A considerable area of submarine coal, extending for a distance about three miles along the coast, intermediate between the town of South Shields and Sunderland, was acquired by the Whitburn Coal Company in 1873, together with a portion of the land coal adjoining. To win this area it was decided to sink two or more shafts near Marsden, at a distance of 500 yards south of the Souter Point Lighthouse and 400 yards from the sea. As these shafts had to pass through a considerable and unknown thickness of Limestone, which always contains large quantities of water, and as the thickness and character of the underlying Yellow Sand were also unknown, it was from the outset anticipated that difficulty would be encountered in sinking them to the Coal-Measures, especially in passing through the Sand. A preliminary boring was made, by the ordinary process, which proved the thickness of the Limestone to be 340 feet, and fortunately the entire absence of the Yellow Sand at this point.

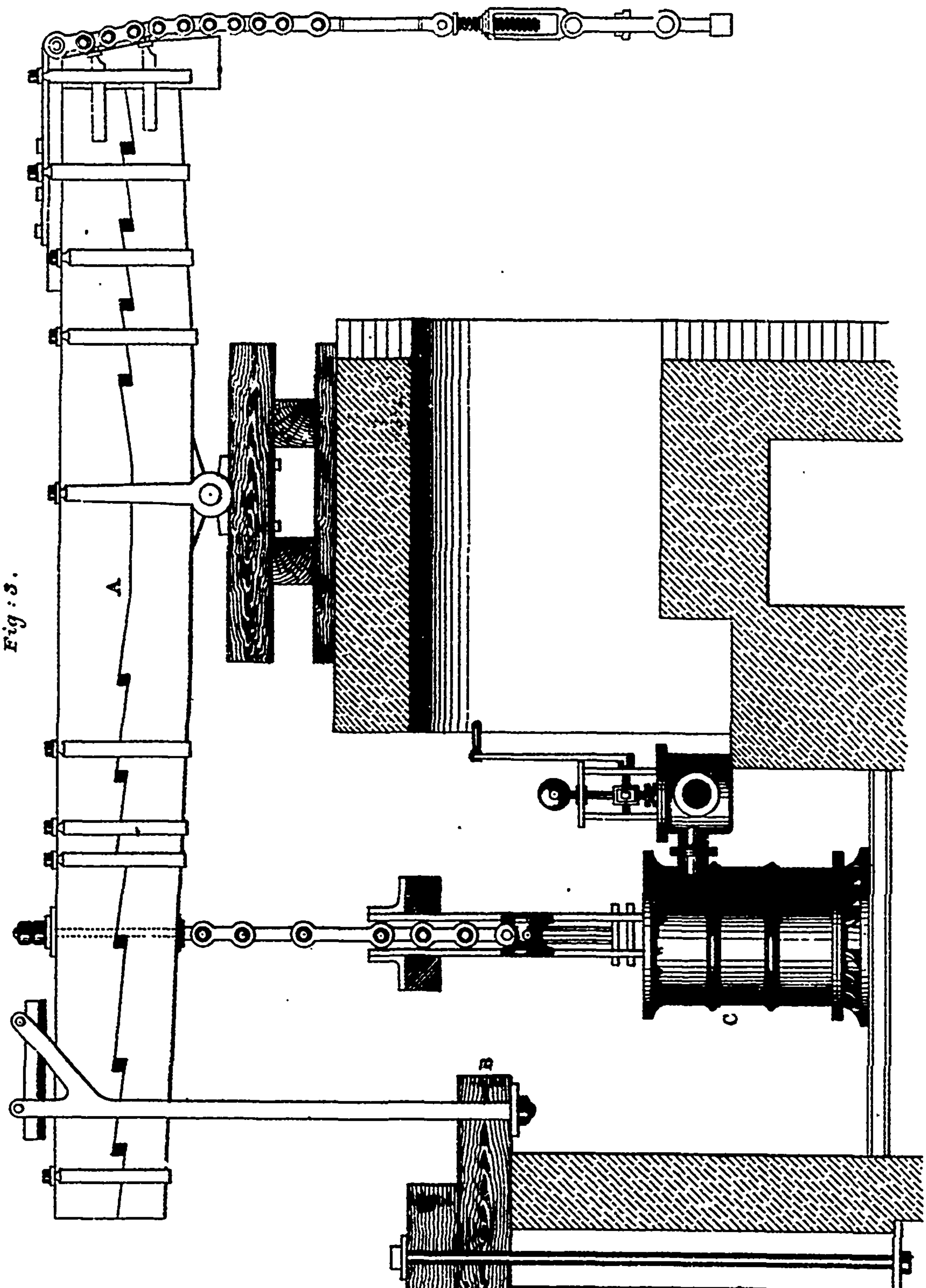
The same general arrangements which a few years before had been successfully carried out by the Author at a similar sinking at the adjacent Silksworth Colliery, *the property of the Marquis of Londonderry*, were followed at Marsden. In the first instance an engine (A. Fig. 5), with two cylinders each 48 inches in diameter, capable of being employed as a pumping engine during sinking, and afterwards to be used for winding or drawing coals, was erected at No. 1 pit. This engine is a duplicate of the one erected at the Silksworth Colliery,[2] and that erected more recently at the adjoining Boldon Colliery. A second engine B, having to two cylinders, each 44 inches in diameter, hereafter to be used for driving the ventilating machine, was also arranged for pumping out of No. 1 pit, and a third and smaller engine (C), with two cylinders each 26 inches in diameter, for pumping out of No. 2 pit. This was intended to be used as a temporary coal-drawing engine, and ultimately as an underground hauling engine.

* Reprinted for the Proceedings of the Institution of Civil Engineers.

1 North of England Institute of Mining Engineers. Transactions (1856-7), vol. v., p. 43.

2 North of England Institute of Mining and Mechanical Engineers. Transactions, vol. xxv., p. 201, and vol. xxix., p. 3. Bulletin de la Société de l'Industrie Minérale. 2e série. Tome vi. 1877, 2e partie, p. 411.


SINKING OF TWO SHAFTS.
ARRANGEMENT OF PIT-FRAMING.
Fig. 1.
Fig. 2.
FRONT ELEVATION IN SECTION.
SIDE ELEVATION IN SECTION.



SINKING OF TWO SHAFTS.

Fig: 3.

The sinking was commenced on the 23rd of December, 1874, and at a depth of 35 yards the *water-bearing stratum* was reached 2 feet below high-water mark of ordinary spring-tides. After sinking a few feet further, a large feeder, or spring of water was met with and the first set of pumps was put in. With these engines 3,200 gallons of water were pumped per minute; but it was soon found that the water could not be successfully kept under by these appliance. The engines having still a larger surplus of power, it was decided to procure extra and larger pumps, to endeavour to overcome the water by pumping in the ordinary way. The arrangements then carried out consisted of the following, viz.:—

No. 1 Pit.—Two 30-inch sinking sets, with 6 feet length of stroke, were attached to one end of a double-ended quadrant, and worked by the large engine (A). These lifted to two similar sets (in a staple) attached to the other end of the quadrant. One 20-inch sinking set, with 5 feet length of stroke, lifting to another, was attached to the second engine (B).

No. 2 Pit.—Two 20-inch sinking sets, with 5 feet length of stroke, lifting to the surface, were worked by the engine (C).

With the assistance of these pumps, the pits were sunk to a depth of 51 yards from the surface, or 16 yards below the level of saturation, when it was found *impossible to continue* the sinking further against the enormous quantity of water. By this time the water had become strongly saline, and it was clear that an influx had set in from the sea, through the open gullets in the limestone, and that sea-water was being pumped.

It was then decided to discontinue the sinking for a month, and endeavour to drain the district of the land waters by steady pumping. The engines were accordingly set to work at the following speeds:—

Engine.	Strokes per Minute.	Pumps.		Quantity of Water Pumped in Gallons per Minute.[1]
		Number of.	Diameter.	
			Inches.	
A	17	1	30	6,120
		1	30	
B	26	1	20	1,820
C	27	2	20	3,672
				11,612

This quantity of water was pumped for a month without accident; and indeed during the whole of the period of four months of pumping, no accident beyond the breaking of two Spears occurred. The above is probably the largest quantity of water ever pumped at one mine, and also the highest speed at which such large pumps have been worked.

This enormous drainage-power succeeded in overcoming the water sufficiently to enable the sinkers to resume operations in the pit; but the influx of water was so rapid that it was evident the cost of sinking in the ordinary way would be too great to be continued. The influx of water into the shaft when the pumping stopped was at the rate of 12 feet in height in the shaft in two minutes.

The arrangements of the various engines and crabs on the surface are shown in Page 229, Fig 5.

It was then decided to adopt the Kind-Chaudron process for the further prosecution of this undertaking, the Author having given considerable attention to this method prior to the sinking of the Silksworth Colliery. In that case, however, as the quantity of water met with in sinking through the Magnesian Limestone never exceeded 1,000 gallons per minute, it was overcome by a single 20-inch set of pumps; and therefore that sinking was more rapid and economically completed by the ordinary process.

Kind-Chaudron Process.

On the 2nd of May, 1877, steps were taken to remove the head-gear at No. 1 shaft (which had been erected and used for the ordinary sinking), as it was intended to utilise this shaft, so far as it was already sunk, and to continue the sinking of a somewhat smaller pit within by the Kind-Chaudron process. The diameter of 14 feet 3 inches was ultimately chosen for this shaft, on account of its having been the largest size hitherto sunk by this system on the Continent. The whole of the tools were purchased secondhand, and had been used and tested in previous sinkings. This not only considerably reduced the cost, but also eliminated the risk that attend the use of new tools.

[1] At one time the rate was somewhat faster, and a total quantity (by calculation) of more than 12,000 gallons per minute was pumped.

The first operation was the lowering of a wrought-iron tube, ½ inch thick, and *riveted with countersunk rivets* so as to form a smooth surface, 54 feet long and 14 feet 4 inches in internal diameter, from the top of the water to the bottom of the shaft, so as to ensure that no stones could fall from the sides during the boring. This was safely accomplished on the *16th of August, 1877*, and the space between the tube and the sides of the shaft were then filled in with concrete, and the boring commenced by the Kind Chaudron process at a depth of 155 feet, on the 24th of September, 1877

As this process of boring out pits has been fully described in Papers read before the North of England Institute of Mining and Mechanical Engineers,[1] in May, 1871, by Mr Warrington W. Smyth, and before this Institution, in March 1872, by Mr Emerson Bainbridge, Assoc. M. Inst. C.E.,[2] the Author will only very briefly allude to the tools employed, and give in greater details the particulars wherein the operations at Marsden differed from those previously described.

Description of Tools, &c.

A substantial Headgear was erected, strongly framed together with timbers (p. 232, Figs. 1 and 2). The whole of this is covered in with wood cleading, so that the workmen are always protected from the weather. At 37 feet from the ground, two rails are laid on stout balks A A of timber, which carry travelling carriages X X, on which the heavy tools are run backwards and forwards. At 52 feet from the ground similar rails, on longitudinal balks of timber B B, support *small carriages* (p. 237, Fig. 8) for carrying the boring-rods, this great height being necessary in order to obtain sufficient length of rods. It is this system of carrying and moving the tools on traversing carriages which enables the operations to be conducted with so *small an amount of manual labour.*

Description of the Process.

The Kind-Chaudron process consists of two distinct series of operations.

1st. *Those connected with the boring out of the shaft*, on a system closely resembling that first adopted by Mr. Kind many years ago for boring deep holes for artesian wells. 2nd. That of lowering down the shaft a water-lining or Tubbing.

The first process therefore at Marsden was the boring of a centre hole *in No 1 pit, 4 feet* 11 inches in diameter, by a small Trepan or chisel (p. 236, Fig. 1). This Trepan, 7 tons in weight, is attached to the massive wooden Lever (A, p. 236, Figs 2 and 3 by rods of the best pitch pine, 5 inches square (A, p. 236, Fig. 4), and 58 feet long, with iron terminations, having tapered screws. One end of each rod is fitted with a male screw (A, p. 236, Fig, 5), and the other with a female screw. The screws have coarse threads carefully cut, so that, after having entered, a few turns are sufficient to screw the joint quickly home.

The Lever is attached on the opposite end to a steam cylinder (C, p. 232-3, Figs. 2 and 3), 39 inches in diameter, actuated by a single valve only on the top side. The valve is worked by hand, the rods are lifted by the pressure of the steam on the top side of the piston, and they fall by their own weight when the valve is opened to the atmosphere. The length of stroke is regulated by the machinist, and varies from *6 to 18 inches* according to the hardness of the rock. An important adjunct to the Lever is the spring beam (B), against which the Lever strikes at the termination of each stroke. The number of strokes per minute varies from nine to eighteen. In very hard *rock comparatively few and light blows only can be given.* When the rods are suspended at the end of each stroke, they are turned through an angle of 2° to 4° by four workmen holding a crosshead lever, walking round the top of the pit, similarly to an ordinary boring.

An *essential* part of the boring tools is the Sliding Piece (p. 236, A, Figs. 1 and 3), by which the Trepan is connected to the rods through the medium of a slot 12 inches long. This permits the Trepan to strike the bottom without communicating a severe shock to the rods, which continue their descent until arrested by their buoyancy in the water, aided by the Spring Beam striking against the inner end of the Lever Except for the play thus allowed, it would be impossible to strike even a light blow without fracturing the rods.

An apparatus called the Freefall (p. 236, Fig 2) is sometimes also attached. On the descent of the rods the Trepan is

[1] Transactions, vol. xx., p. 187.

[2] Minutes of Proceeding Inst. C.E., vol. xxxiv., p. 43.

caught up by a pair of jaws (A), which are locked by a wedge. The wedge being withdrawn by means of a large disk of wood (B), at the commencement of the return stroke, permits the Trepan to fall nearly 2 feet without being detached from the rods. This apparatus was attached to the small Trepan in boring the No. 2 small pit between the depths of 284 feet and 334 feet. A disk, 5 feet 2½ inches in diameter, gave most satisfaction, the diameter of the small pit being 6 feet 6⅔ inches.

After the boring has been continued about three hours, in moderately hard rock, the Trepan is withdrawn, and the Sludger (p. 237, Figs. 6 and 7), with a capacity of four cubic yards, or 10 tons, is lowered. The Sludger is sometimes attached to the Lever, and worked up and down by the rods, and at other times by the rope only. The *débris* rises into it through the valves in the bottom, it is then withdrawn and emptied. The emptying of the Sludger, and the unshipping of the Lever, to allow of the rods being removed, are effected by ingenious and time saving arrangements, which must be seen to be understood.

After the centre boring is advanced 30 or 40 feet, the large Trepan (p. 236, Fig. 3), 16 tons in weight, is put in, and the large pit is similarly bored, the *débris* falling into the small pit, which requires to be frequently cleared out. This was the process in the first instance adopted at Marsden, but it was afterwards modified. In every new sinking by this system slight variations are found in the character of the rock, which entail modifications in its application. At Marsden the rock proved to be harder than in any locality where the system had been previously in operation.

During the boring out of No. 1 small pit no difficulty was found in raising the *débris* with the ordinary Sludger; but in boring the large pit it would not rise into the sludger, and became solidified at the bottom of the small pit. This was probably due to the particles being larger than those produced in the boring of the small pit. To remedy this, at first clay was thrown down the pit, and the small Trepan was again introduced to loosen the *débris*, and mix it with the clay, which could then be withdrawn by the ordinary Sludger. But the process was a long one, the re-boring taking quite as much time as the original boring. It was therefore determined to lower the Sludger into the small pit, release the rods, and leave it there to catch the *débris* as it fell. Accordingly the Sludger was lowered to the bottom of the small pit, and left there, as shown in Plate 4, Fig. 1. On attempting to withdraw it, however, it was found that the mud which had settled in the water at the bottom of the pit, or which had passed the sides of the Sludger, imbedded it so far that great violence had to be used to extract it, which would have certainly, sooner or later, resulted in serious accidents. Arrangements were then made to suspend the Sludger on the edge of the small pit at the top by Claws (p. 240, Fig. 2), and the two inner of the interior teeth of the large Trepan were removed to avoid striking these claws. This plan succeeded imperfectly, and on several occasions when the Claws were struck the Sludger fell down the small shaft, and was only extracted with difficulty, and with a liability to accidents.

A successful attempt was then made to form a ledge within the smaller pit, by taking out all the teeth but the two outer, and the Sludger was thus suspended about 1 foot from the top of the small pit. This operation, however, entailed so many changes of the teeth, etc., that it was attended with great loss of time. But having found the correct principles on which to proceed, it was not difficult to devise a plan for leaving a suitable ledge within the smaller pit. To effect this, the outside tooth of the small Trepan on each side was enlarged 3 inches, the tool was again introduced, and the small pit bored to a diameter 6 inches wider than previously, leaving a ledge of 3 inches all round (p. 240, Fig. 3), on which the Sludger was suspended by an angle-iron ring.

In No. 2 pit a third Trepan was used, having a diameter of 6 feet 6 inches. By this Trepan the small shaft was bored to a depth of 383 feet, not only through the Limestone, but 50 feet into the Coal-Measures, and 6 feet 6 inches below where it was intended to place the Moss-box of the Tubbing, and therefore below, and entirely clear of, all future operations with the large Trepan.

The smallest Trepan was then introduced, and the boring continued 32 feet 9 inches further, leaving a ledge of stone 9½ inches in width all round, on this ledge a cast-iron ring was deposited, to form a permanent bed for the Hanging Sludger to rest on. This arrangement acted perfectly, never having been the cause of the slightest accident throughout the sinking of the second shaft.

The cast-iron ring was adopted in the second pit, because the weight of the Sludger soon wore away the ledge of stone by being suspended from it. At first the Hanging Sludger was lowered into its seat by the regular screw, which was left slightly slack, all the other screws of the rods, as they were lowered in, being tightly screwed home. When the Sludger was deposited on its bed, by turning the rods backwards, the slack joint yielded, and the rods were unscrewed at this point and drawn away. It did, however, happen occasionally that some of the other screws became detached, and then the remaining rods and sludger had to be fished up. A double hook (p. 237, Fig. 11) was next adopted for lowering the Hanging Sludger into place, it was simply fastened on to the bow of the Sludger, and when the latter was lowered and rested on its bed, the rods were let down a few inches further, and turned half round, so as to free the hook entirely from the bow, they were then drawn away, leaving the Sludger in place.[1]

The Author has described this portion of the operations in detail, being the first instance in which the Hanging Sludger was used in the Kind-Chaudron process for shaft boring, although it had been used by Mr. Kind, on a somewhat similar designs in boreholes.

Safety Tools.

No small part of the success of this process arises from the ingenious arrangements, and forms of tools, for picking up material at the bottom of the shafts, and for taking hold of broken spears, etc., which, from the character of the operations, must be of frequent occurrence. These are termed "safety tools," and consist of the following apparatus:—

1st. The Catching Hook (p. 237, Fig. 12), which, on being swept round the shaft below the top of the broken spear, guides the spear into the angle made by the hook and its rod, where a properly-shaped recess is formed, into which the ironwork of the spear falls, and can by this means be retained and withdrawn.

2nd. The Spear Catcher (p. 237, Fig. 13) is a fish-head, with a pair of serrated jaws, which on touching the top of the broken rod, and the wooden chock keeping the jaws open being forced out, the teeth press firmly against the ironwork of the Spears, enabling them to be withdrawn.

3rd. The Grappling Tongs (p. 237, Fig. 14) being a pair of large rakes) which can be opened and shut by levers worked by ropes. By moving and working this across the bottom of the shaft, any pieces of material larger than 2 inches square, can be extracted with ease.

The Tubbing.

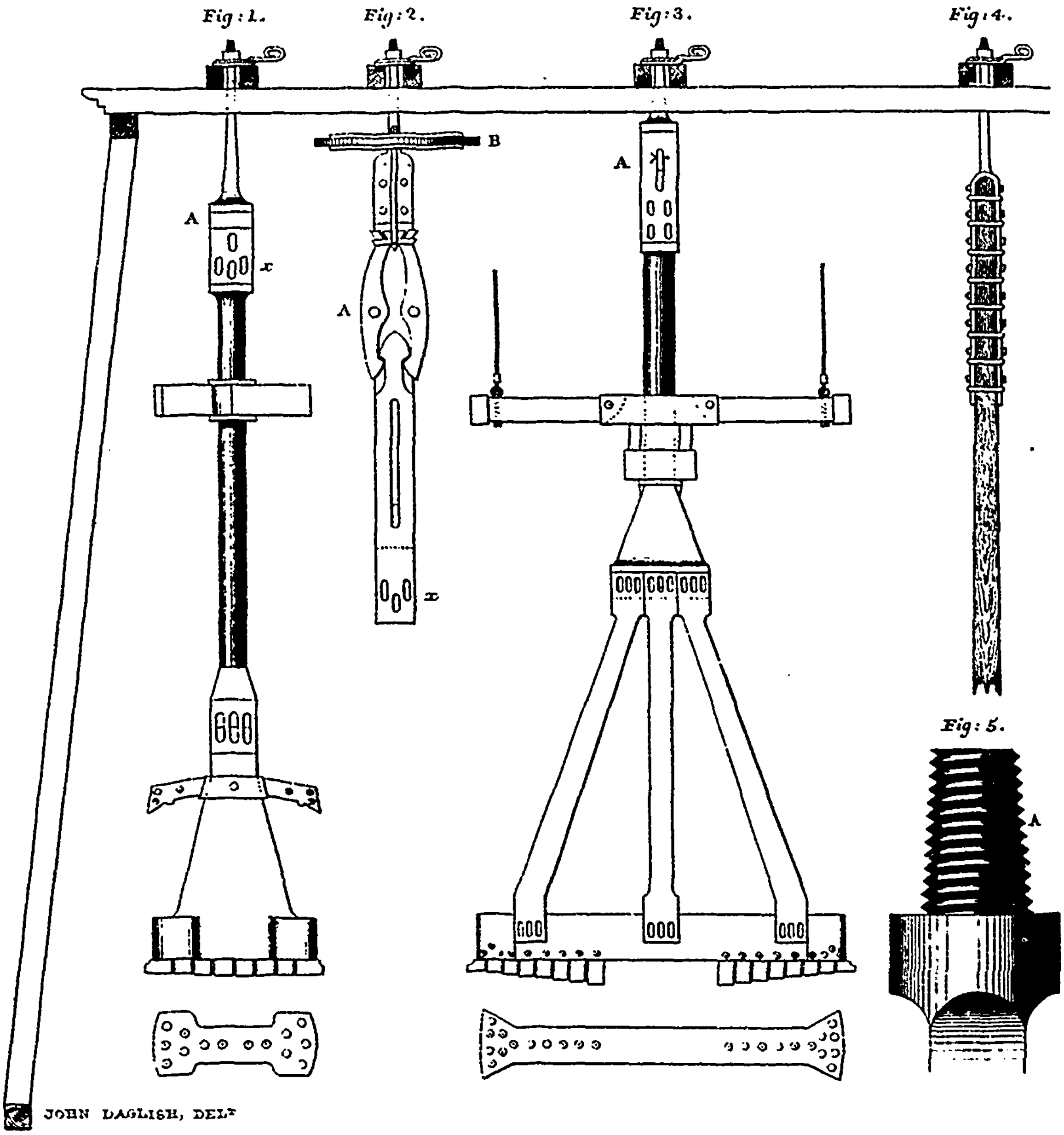
The most importarnt part of the process, and that attended with the greatest risk, is that of lowering into the shaft the metal Tubbing. At the Marsden Sinking, the dimensions of each ring or cylinder were as follows (p. 241, Figs. 6 and 7):—

—	No. 1 Pit.			No. 2 Pit.		
	Feet	Inches.		Feet	Inches.	
Internal diameter	12	7½		13	8½	
External "	12	9½		13	11¼	
Thickness of top cylinder	0	1		0	1⅜	
" " bottom "	0	1¼		0	1⅞	
Height of each cylinder	5	0		5	0	
Total height of Tubbing	280	0		285	5	
—	Tons	cwt.	qrs.	Tons	cwt.	qrs.
Weight of top cylinder	5	4	0	6	10	1
" " bottom "	7	0	0	8	19	2
Total weight including bolts and lead joints	400	0	0	450	0	0

The flanges of each top cylinder are 3½ inches wide by 2 inches in thickness; and between every ring is placed a plain lead wedge 4⅝ inches wide, by ⅛ inch thick, covered on each side with red lead. The cylinders are attached to each other by

[1] The bottom of the rods where they are attached to the Sludger by a female screw is fitted with a small inverted funnel (Plate 4, Fig. 5), to guide the male screw which is attached to the Sludger, into the female screw at the end of the rods, as they are lowered; an arrangement successfully carried out through the whole of the boring of both pit, without failure or difficulty, even at a depth of nearly 400 feet.

SINKING OF TWO SHAFTS.



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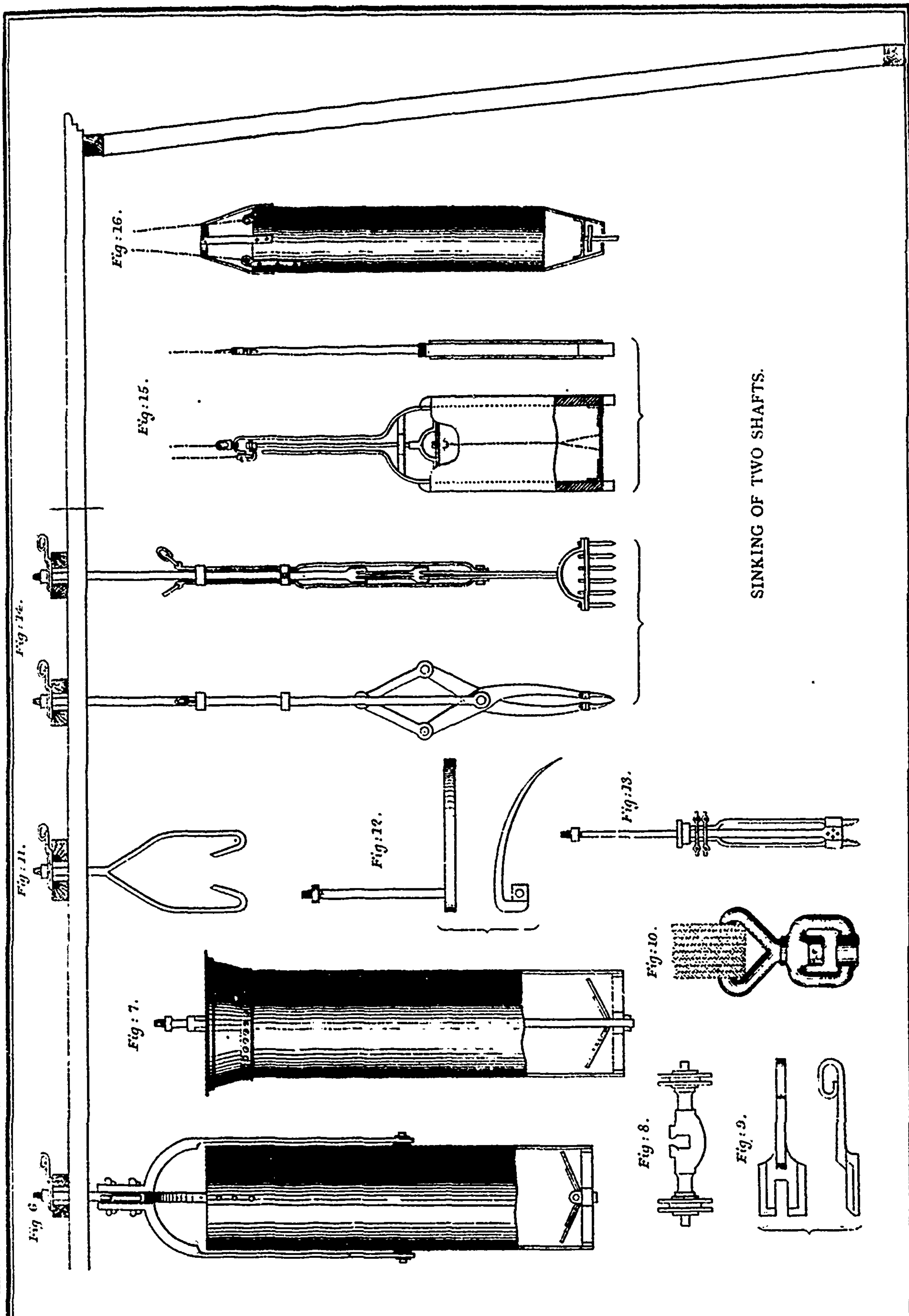

SINKING OF TWO SHAFTS.

sixty 1 $\frac{3}{16}$ inch bolts of best iron. The whole of these cylinders are alike, save in varying thicknesses, excepting the bottom three pieces. The bottom pieces A and B are telescopic, with outside flanges C and D, 6 inches and 7½ inches respectively; the bottom piece, B, was suspended to the upper piece by rods in No. 1 pit, and in No. 2 pit, by an internal flange which permits of the second piece (A) sliding downwards on the outside of the first piece. Whilst being lowered, the outside flanges of the bottom pieces, which are called the Moss Box (and which are the only two cylinders with outside flanges), are 5 feet apart, and the interval is filled with tightly compressed moss. When the lowest pieces rests on its bed, at the bottom of the pit, the remainder of the cylinders continue to descend, compressing the moss with the whole weight of the Tubbing, namely, over 400 tons.

In the middle of the third cylinder from the bottom there is an extra internal flange E, 3½ inches wide, on which is screwed, by sixty-four bolts, a flat ring or circle of cast iron F, 5¾ inches broad. The ring admits of the False-Bottom G being withdrawn up the interior of the Tubbing to the surface, when the operation of lowering the Tubbing has been completed. A *massive dish plate F, of cast metal 1⅛ inch thick*, is bolted to the bottom, having a flange H on the upper side, for attaching the column of pipes. The object of the False-Bottom is to float the Tubbing whilst it is being lowered.

After carefully securing together by their respective flanges and attachments the three pieces of Tubbing intended for the bottom, they are lowered to the level of the water by an arrangement of screw-rods worked by six powerful winches, with two men to each; additional cylinders and central pipes are then added one by one, causing the whole of the Tubbing to sink until it floats by the displacement of the water. In the Marsden No. 2 pit the Tubbing floated when cylinder No. 9 was attached. The rods are thereupon removed, and as each additional cylinder is added, a certain quantity of water is run inside to cause the Tubbing to sink. In the Marsden No. 2 pit the addition of cylinder No. 10 caused the Tubbing to sink 1 foot 9 inches, and of cylinder No. 56 at the top 1 foot 1 inch.

In both pits this operation was completed without leakage, either at the joint of the cylinder, or of the central column of pipes, the work, however, requires great care and watchfulness, being attended with risk, as any leakage would cause the Tubbing to sink to the bottom.[1]

CONCRETING.

This operation consists in filling with concrete the annular space between the exterior surface of the Tubbing and the sides of the shaft, from the Moss-box upwards to the top of the Tubbing (I, p. 241, Figs. 6 and 7) The concrete is lowered simultaneously all round the pit by four rectangular boxes, 3 feet long 18 inches broad, and 4½ inches wide, shaped to the radius of the pit (p. 237, Fig. 15).

A large gullet was passed through in No. 2 Pit at a depth of 56 yards from the surface, the width of which was nearly the whole diameter of the shaft. When concreting at this point, 20 cubic yards of small stones and concrete were filled in, and 80 and 40 cubic yards at smaller gullets lower down (p. 261, Fig. 8), without sensibly raising the level of the concrete

ACCIDENTS.

The only accident that occured during the execution of the works at Marsden of special interest was the loss of one of the teeth of the small Trepan in the No. 1 Pit. The difficulty attending this accident arose from the tooth having been deeply embedded in the rock at the bottom of the borehole by repeated blows of the Trepan, before its loss was discovered, after having fallen from its socket Upon withdrawing the Trepan the Grappling Tongs were introduced, and the position of the tooth accurately *determined, but so firmly was it embedded that the* Tongs were unable to raise the tooth. It having been thus ascertained that the embedded tooth was at the edge of the pit, in the position occupied by the teeth at the extreme edge of the Trepan, these end teeth were removed, and the Trepan lowered again, and boring recommenced and completed *to the* depth of the height of the teeth of the Trepan, thus leaving a solid ring of stone round the edge of the pit; the Trepan was again withdrawn, and after the outside teeth had been replaced, the boring was recommenced close on one side of the embedded tooth, and continued until the other end of the Trepan reached it on the other side, when it was lifted over and commenced work again on the other side. This was continued until the whole of the ring of stone was removed, excepting two small parts opposite each other, on one of which the embedded tooth lay. A few sharp blows of the Trepan released the embedded tooth, which was then without trouble picked up by the Grappling Tongs. When it is remembered that this operation was performed at the bottom of a pit 258 feet from the surface, and full of water, the skilfulness of the arrangements will be appreciated.

GENERAL RESULTS.

It will be seen from Tables in the Appendix that the absolute time taken from commencing to finishing the Boring was one *year five months in No. 1 pit, and one year seven months in* No. 2 pit. There was, however, a delay of several months in No. 2 pit on account of the Tubbing not being ready; the depth of boring was also 40 feet greater. The time occupied in lowering the Tubbing and concreting, etc, was three and a half months in No. 1 pit and four months in No 2 pit. The total time taken to complete each pit was one year eight and a half months in No. 1 pit, and a year *eleven months in No.* 2 pit

The average distance bored in No 1 small pit in the Limestone was 1 foot 3¼ inches per shift of twelve hours, and in the Coal-Measures 1 foot 8¾ inches In No 1 large pit in the Limestone it it was 7¾ inches, and 8¼ inches in the Coal-Measures. In the small No 2 pit the average distance bored in the Limestone was 10¾ inches per shift of twelve hours, and in the Coal-Measures 1 foot 4 inches. In No 2 large pit in the Limestone it was 8½ inches, and 9¼ inches in the Coal-Measures.

The success of the Kind Chaudron process at Marsden may be attributed—

1st. To the primary adoption of a size of pit no larger than had previously been successfully completed by this process elsewhere.

2nd. The use of tools which had already been thoroughly tested in the sinking of a previous pit.

3rd. In the purchasing of the necessary additional tools from firms accustomed to their special manufacture.

4th. To the excellent workmanship and quality of the metal of the Tubbing supplied by the Elswick Ordnance Works.

5th. To the entire absence of soft strata in the shafts.

6th. To the efficient and experienced staff of officials supplied by the Kind Chaudron Company for the carrying out of this work; and to the cordial co-operation of the Belgian and English Engineers, foremen, and workmen.

The terms of the contract were that no payment had to be made to the Kind-Chaudron Company for the patent right and superintendence unless the following conditions were fulfilled, —that the Tubbing when completed should not be more than 6 inches out of the perpendicular, and not let pass more than 40 gallons of water per minute. On the formal examination by the Engineers of the Whitburn and Kind-Chaudron com*panies, it was found that in No. 1 pit the Tubbing was only* 1 inch out of the perpendicular, and let pass about 1 gallon of water per minute, and this only at the wedging joint below the Moss-Box. In No. 2 pit the Tubbing was only 2 inches out of the perpendicular, and no water passed. In both cases the Tubbing itself from top to bottom was absolutely dry.

The paper is accompanied by numerous diagrams and small scale drawings, from which plates 1, 2, 3, and 4, have been prepared.

PAPER FROM MOSS.—A new branch of industry has sprung up in Sweden lately—the manufacture of paper from moss, *not from the living plant*, but from the bleached and blanched remains of mosses that lived centuries ago, and of which enormous masses have accumulated in most parts of Sweden. A manufactory of paper from this material has begun operations near Joenkoeping, and is said to be turning out paper in all degrees of excellence, from tissue to sheets three quarters of an inch in thickness.

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[1] In the deep sinking at Ghlin near Mons, now in operation, the depth bored is 1,026 feet, with an internal diameter of 14¾ feet. The *thickness of the Tubbing at the top being 1 inch, and at the bottom* 3½ inches, the total weight being taken at 1,772 tons, at a cost of £12 per ton, brings the cost of the Tubbing alone for the two pits to more than £40,000. The bottom of the hard rock was bored through at a depth of 381 feet, and below this, before reaching the impervious Coal-Measure (in which the Moss-Box will be laid at a depth of 1,030 feet) 80 feet of running-sand, gravel, and clay were bored through, and a wrought-iron tube was inserted to protect the sides until the main Tubbing is lowered down.

THE FLORA OF ANCIENT EGYPT.

(Concluded from page 221.)

The wreaths of Amenhotep I. (who was found during the twentieth dynasty still intact in his coffin, and who, according to Brugsch, preceded Ramses II. by three centuries) are more varied. Among them are some composed, like those of Ramses II., of the leaves of *Mimusops* and the sepals and petals of the two species of *Nymphæa*, while others are formed of the leaves of *Salix safsaf*, Forsk., which serve as clasps for the little balls of flowers of *Acacia Nilotica*, Del., portions of the heads of flowers of *Carthamus tinctorius*, L., or the separate petals of *Alcea ficifolia*, Cav.

Nobody could recognise either the *Salix* or the *Alcea* among the hundred Egyptian plants enumerated by Pliny, or in the writings of other ancient authors; whereas the *Acacia* and the *Carthamus* occur under the names of *Acanthos* and *Cnicus*. Concerning the former, Pliny (lib. xiii. p. 19) mentions the employment of its wood in boat-building, the use of its gum, of its pods in tanning; he speaks of the spines, even, which are found on the leaves; in short, he indicates the distinctive feature of the species, adding that the flowers are effective in wreaths. Several of the old authors treat of this tree. With regard to the *Cnicus* or *Knekos* (Pliny, xxi. p. 53) it is only recognisable by the indication that it is spiny, that its large wide seeds yield an oil, and that there are in Egypt both wild and cultivated species, which is true. The flowers of *Carthamus* found in the wreaths of Amenhotep I. have retained their red colour, and resemble those of the species cultivated everywhere in Egypt at the present day. The colour, as in recent herbarium specimens, has changed from cadmium red to a brownish red or orange. In water the colouring matter is rapidly excreted, and we behold these flowers of some thirty to thirty-five centuries ago intensely colouring the liquid in the phial containing them. All four of the plants which I have just mentioned have now, for the first time, been actually found in an ancient Egyptian tomb. The leaves of *Salix safsaf*, which form the greater part of the wreaths of Amenhotep I. and Aahmes I., do not differ in the least from those of the present day, and the species is common in Egypt. They are young—that is to say small and pale—thus indicating an early season of the year. In this respect they are in contradiction with the blue and white petals of *Nymphæa* found in the same coffin, though not, it should be stated, in the same wreaths as the *Salix*, but in the wreaths with leaves of *Mimusops*. The latter very closely resemble those found on the mummy of Ramses II. Perhaps at the time of the removal of the kings of the eighteen and nineteenth dynasties from one vault to another, and finally to the place concealment at Deir-el-Bahari, when a new coffin was made for Ramses II.—perhaps, I say, they renewed a part of the wreaths of the other kings, or having ascertained the condition of the mummies (whether under the twentieth or under the twenty-first dynasty), they added some new wreaths to the original ones. This would explain the presence in the same coffin of flowers belonging to different seasons of the year.

Salix safsaf, which occurs on a wild state on the banks of the Nile in Nubia, is in Egypt proper only a riverine fugitive, like many other plants, whose real home is in the south. Away from the river it only exists on sufferance, chiefly near wells and canals. To my mind it is an example of the wild flora which agriculture has caused to disappear. *Alcea ficifolia*, Cav., is now found in Egypt only in the ancient Arabian gardens of Cairo and other towns—that is to say, in gardens dating before the introduction of European horticulture by Barillet in 1869, where it grows almost as wild as a weed. I have found it in wild state in Syria and the Lebanon. Boissier, in his "Flora Orientalis," has not clearly defined it, and gives one or two other forms (*A. lavateræfolia*) as distinct species, which they are not. The petals of the *Alcea* contained in the wreaths of Amenhotep I. leave no doubt that they belong to the species named. Their shape, the distribution of the veins, and especially of the hairy callosity on the inner surface of the claw, as well as the size even, confirm the identity of the species. Moreover one perceives in the petals of the ancient wreaths traces of a purplish tint corresponding to the crimson of the living plant. The ancients probably esteemed the plant alike for its beauty and its medecinal properties.

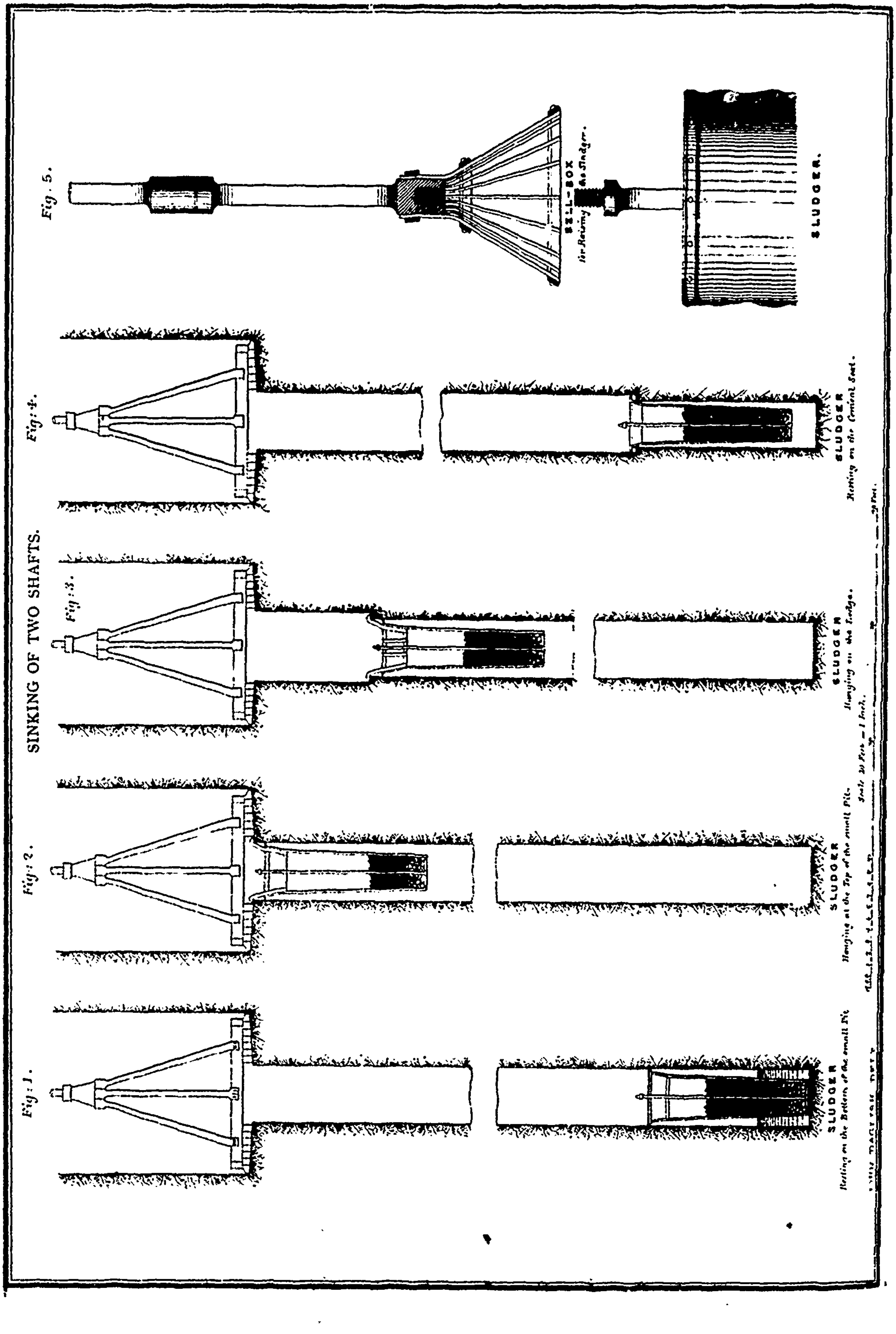
I have examined a head of flowers of *Alcacia Nilotica* coming from one of the wreaths, and I found that the flowers agreed in the minutest details with fresh ones, with the characters of which I am sufficiently familiar. The proportions of the peduncle, the position of the annular bract, the shape of the bracteoles, the calyx, the petals, and stamens of each flower do not exhibit the slightest differences. This tree, which is planted or tolerated by man all over Egypt, is nowhere completely wild except on the White Nile between 11° and 22° N. lat., where it constitutes large riverine forests.

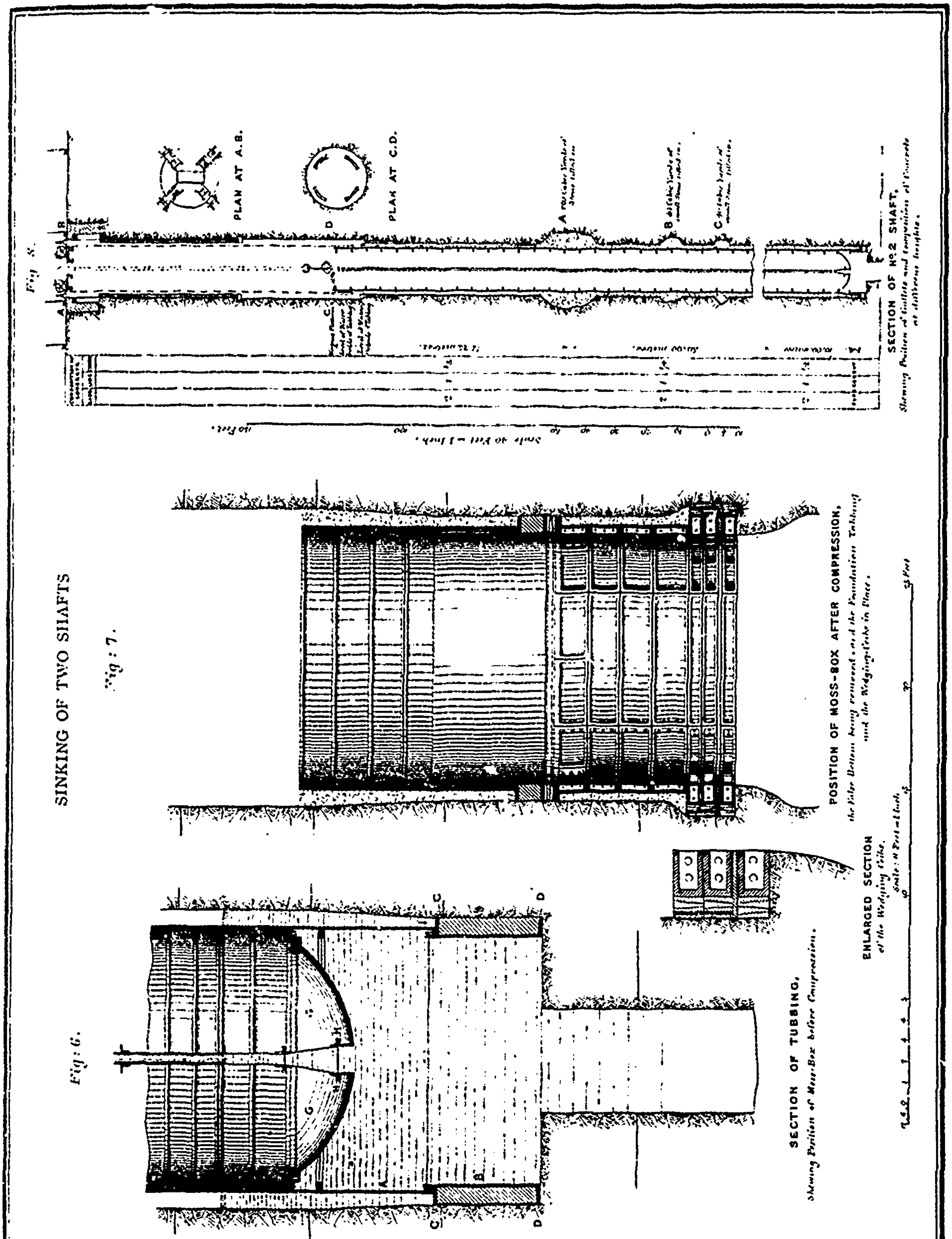
The wreaths which were found in the coffin of Aahmes I., the great founder of the eighteenth dynasty (1700 B.C., according to Brugsch), are the most varied, and astonish the eyes with the bright colours they have retained. They are partly compose of leaves of the Egyptian willow (*Salix safsaf*), containing separate flowers of *Delphinium orientale*, Gay, of *Sesbania Ægyptiaca*, Pers., petals of *Alcea ficifolia*, or flower-heads of *Acacia Nilotica;* and partly of the leaves of *Mimusops*, serving as clasps for the petals of the two species of *Nymphæa* like the wreaths of Ramses II. and Amenhotep I. The *Delphinium* and the *Sesbania* has not hitherto been authenticated from ancient Egypt. The colours of their flowers are admirably preserved, the deep violet of the former being especially striking, but the specimens I have communicated to you in a phial of alcohol have lost their colour, just as fresh flowers of our time would. *Delphinium orientale* is now spread over a very wide area of the Mediterranean region. The two nearest localities Egypt where it has been found are Algeria and Northern Syria, near Raldoun. It is not impossible that it still occurs in some parts of Egypt, while it is equally possible that it was cultivated by the ancient Egyptians as an ornamental plant. In the event of our being able to prove that some of the wreaths of Aahmes I. and Amenhotep I. were removed at the time of the twentieth dynasty, together with those of Ramses II., we should be justified in the assumption that this plant and *Alcea ficifolia* were introduced through the conquest of Syria. A minute analysis of the flowers, and comparison with those from various localities, leaves no doubt that they are of the species mentioned, and if I had had access to a large number of flowers of the plant of the present period, I am certain that I should have been able to have exactly matched the ancient ones. The differences that I was able to detect between the ancient flowers and recent ones from Algeria, the Caucasus, Phrygia, and Lycia, kindly supplied by Mr. E. Boissier, may be set forth in a few words. In the first place there are two narrow linear bracteoles, exceeding the peduncle in length, and reflexed; then the ovary is less pubescent, and the sepals are narrower and less acute. With regard to the bract, the thickened peduncle, the shape, number, and disposition of the stamens, the stigma, and especially the single petals, I have seen recent flowers in which these organs are absolutely identical. It will be seen that the characters in which they differ are only of individual value. Further, the species in question, commonly cultivated at the present time, comprises a considerable range of forms. Thus there are varieties in which the single petal is merely three-lobed, whilst in others the intermediate lobe is again divided. Both conditions occur in the ancient flowers. These flowers are so well preserved that under the influence of boiling water the spur of the posterior sepal is easily separated from that of the petal projecting into it. That is to say, the latter may be extracted without injury. The numerous details of the petal, its intricate venation, the coloured glands on the margins, the claw with two lateral folds—all correspond to recent specimens. The colour of the ancient flowers is rathey a deep bluish violet than a reddish violet, as in the plant of our time.

I have also carefully analysed the flowers of *Sesbania Ægyptiaca* from the wreaths of Aahmes I. They belong to the typical form of the shrub, which still springs up on the borders of cultivated fields and on roadsides in Egypt, though it is not really spontanous below the Soudan. The flowers are so perfectly preserved that the minutest detail did not escape my scrutiny. Submitted to the action of boiling water they scarcely differed from flowers taken from my herbarium. One circumstance shows how hurriedly these funeral wreaths were made. The flower torn from its pedicel and pinched with the finger nails always retains only a part of the calyx cut through the middle.

In the find at Deir-el-Bahari other objects besides the wreaths were found for the first time. Thus in the coffin of the priest Nibsoni, of the twentieth dynasty, the leaves of *Citrullus vulgaris* were scattered between the body of the mummy and the sides of the coffin; and flowers of *Nymphæa cœrulea* were found fixed beneath the outer bandages of the same mummy. The Egyptian Museum of Berlin already possessed seeds of this *Citrullus* in the collection of Passalacqua, though the epoch to which the collection belongs is unknown. *Citrullus vulgaris* is found wild in the greater part of Central Africa,[1] and its

[1] I have gathered it in that state in the island of the White Nile.


SINKING OF TWO SHAFTS.
Fig. 5.
BELL-BOX
for Raising the Sludger.
SLUDGER.
Fig: 4.
SLUDGER
Resting on the Conical Seat.
Fig: 3.
SLUDGER
Hanging on the Ledge.
Fig: 2.
SLUDGER
Hanging at the Top of the small Pit.
Fig: 1.
SLUDGER
Resting on the Bottom of the small Pit.
Scale 20 Feet = 1 Inch.



SINKING OF TWO SHAFTS
Fig: 6.
Fig: 7.
Fig: 8.
PLAN AT A.B.
PLAN AT C.D.
SECTION OF No. 2 SHAFT,
POSITION OF MOSS-BOX AFTER COMPRESSION,
ENLARGED SECTION
SECTION OF TUBBING,
Shewing Position of Moss-Box before Compression.

fruit is smaller than that of the cultivated race, and less palatable, though otherwise like it. Among the broken remains in question I found one who leaf, which enabled me to fully study its specific characters. Placed in cold water it recovered its original flexibility, so that it could be spread out flat and dried again The chlorophyll was perfectly preserved, as what was curious, it was absorbed by the water to such a degree, that the glass of water in which the leaf and portions of leaves were placed became of an intense green colour. The problem to solve was whether the leaves were those of the water-melon or those of the colocynth, a species spread over the whole desert region, and only differing from the former, which has long hairs on the young fruit, by the complete nudity and spongy nature of its bitter fruit with a hard rind, and by the seeds. The leaves of the water-melon often very closely resemble those of the colocynth, especially in the variety called *Gjurma* (*Gyurma*) in Egppt, which bears fruit no larger than that of the colocynth, though it is always sweet. Nevertheless the large leaves of elongated outline and having less numerous lobes, are rare in the colocynth, and only in places well watered by rains. There is an association of characters in the leaves from the mummy of Nibsoni, that enables one to refer them to varieties of the cultivated water-melon, rather than to the wild colocynth. I have compared them with a long series of specimens of the water-melon from all parts of the Nilotic region, and with a no less numerous series of specimens of the colocynth ; and I have come to the conclusion that they may be regarded as belonging to the former species. The uses of the two species would render them equally admissible in a coffin of ancient Egypt. As a funeral offering an alimentary plant might serve as well as a medicinal one. Still the fact that there are seeds of the water-melon in the Berlin Museum from an ancient tomb supports my first supposition. The leaves found on Nibsoni are about a palm long, and of a pinnatisect form, with obtuse lobes. If those leaves were distinctly hairy there would be no doubt of their belonging to the water-melon. Yet, as already mentioned, there is a variety widely spread in Egypt which has not the long and numerous hairs attached to the tubercles with which the leaves are covered, but merely short bristles, which is also the case in the colocynth.

This variety of water-melon, which I have named *colocynthoides*, is the *Gyurma* of the Egyptians, and is cultivated in dry neglected ground in Upper Egypt. It is probably the primitive condition of the species before it had reached its present state of perfection. The leaves of the *Gyurma* are sometimes hairy, as in the water-melon, sometimes only provided with short deciduous bristles, as in the colocynth. The leaves from the coffin of Nibsoni exhibit only the latter condition. It may be that they have lost a great part of these deciduous hairs during the long period that has elapsed. I found one character, however, that the *Gyurma* has in common with those in question. There are on the petiole, and especially on the under surface of the leaf in the middle, among the round tubercles with which it is beset, other tubercles or callosities of an elongated linear form and arranged in rows corresponding to the secondary veins. On these leaves. as well as on those of the *Gyurma*, these elongated tubercles are much more prominent than they are in the colocynth. Moreover, the numerous specimens that I have compared of the last have all of them leaves more densely furnished with the round tubercles than is the case with those of the water-melon, of the *Gyurma*, and the ancient leaves.

The secret vault of Beir-el-Bahari, besides the coffins of so many illustrious kings, also contained numerous funeral offerings deposited there by the later kings of the twenty-first dynasty who used this collective tomb, so well concealed by the topographical conditions. Among these offerings, I was able to recognize dates, raisons, and pomegranates. There was also a basket filled with a lichen (*Parmelia furfuracea*, Ach.) which at the present day is sold in the bazaar of drugs in every town of Egypt. It is now called "Cheba" (Sheba), and is used to leaven and flavor the Arabian bread. Medicinally, also, it is in great request. The presence of a lichen of solely Greek origin, mixed with the species named, and which also occurs in the modern drug, excludes all doubt as to its being a commercial product. *Ramalina Græca*, Muell., Arg., which was mixed with the *Parmelia*, has only been found in the islands of the Greek Archipelago, and the Arab merchants regard that country as the source of their drug. As there is no locality in Egypt where *Parmelia furfuracea* could grow, the only explanation of its presence in the offering of the twenty-first dynasty (1000 B.C.) is that it was derived from Abyssinia or Greece. In the latter case the find at Deir-el-Bahari would prove the existence of commercial intercourse with Greece at about the time of the Trojan war. Among the *Parmelia* (which was perhaps the *Sphagnos* of Pliny) were fragments of *Usnea plicata*,[1] Hoffmg, and the straw of a grass (*Ogmnanthelis longera*, Anders.) of Nubia, which at the present day is used by the natives as a remedy against affections of the chest and stomach. On searching through the copious remains of this plant I succeeded in finding a few well-preserved flower-spikes, which I carefully examined and determined beyond doubt to belong to the species mentioned. In Arabic it is called "*mahareb*." The odour even of this grass was preserved to a certain extent in the mixture of the offering. The fragrant secretion is of the same nature as that of the allied section *Schænanthus* of *Andropogon* of India. Besides the lichens and the grass, this offering contained the hairy buds of some *Composita*, probably an *Artemisia*, with pinnatisect leaves , tendrils of some *Cucurbitacea*; seeds of the coriander ; and numerous berries and seeds of the eastern Juniper (*Juniperus Phœnecia*). Inasmuch as we have here to do with plants coming from opposite regions of Africa and from Europe or Asia, it was not an easy mater to pronounce an opinion on the *Cucurbitacea* and the *Composita* mentioned. The coriander is a plant of early cultivation in Egypt, being mentioned by Pliny as one of the best products of the country. The berries and seeds of the juniper (the latter free in consequence of the decomposition of the former) could only have been derived from Syria or the Greek islands. I carefully compared them with the allied species, including the Abyssinian *Juniperus excelsa* (which has larger berries and much thicker seeds, to the number of six), and there can be no doubt that they belong to *F. Phœnicea*, L. Kunth had previously determined this species in the collection of Passalacqua.

Among the fragments of the offerings and repasts found scattered on the floor of the vault of Deir-el-Bahari when it was first inspected by Brugsch Bey (some of the objects had already been disturbed by Arab robbers) was a tuber of *Cyperus esculentus*, L., some specimens of which from ancient Egypt are also preserved in the Berlin Museum. It is common in a wild state, and generally cultivated in the country.

In bringing this enumeration to a close I have only to mention the finding of a bundle of the grass called *Halfa* by the Egyptians (not the *Halfa* of Tripoli and Algeria), *Septochloa bipinnata*, Hochst, syn. *Eragrostis cynosuroides*, Retz. This bundle probably formed part of an offering representing the productions of the black and fertile soil of the valley of the Nile, of which this grass was a good sample.—*Nature*.

IMPROVED PROCESS OF MAKING WHITE LEAD.

In the United States, the manufacture of white lead is conducted according to the Dutch method. Plates or gratings of lead are exposed to the fumes of vinegar, in vessels set in tan, or stable manure, which acts as a hot-bed to warm and volatilize the vinegar. As the lead is corroded, it becomes covered with the carbonate, which is removed with hammers and ground. The process is tedious, slovenly and unhealthy, and many attempts have been made to improve it, but none of them have yielded a product equal to that which results from corrosion. Microscopically examined, the carbonate of lead formed upon the metal, is found to consist chiefly of minute crystals, which are hydrated, laminated and transparent. These are mingled with a smaller quantity of exfoliated particles of the carbonate, which are opaque. These particles, it is claimed, impart to the white lead its remarkable power of resinifying oils, as well as what the trade calls its body, *i. e.*, its property of completely covering objects painted with it. By the new process workmen are not required to detach by hand the carbonate from metal which remains uncorroded, and the product is said to consist almost exclusively of the valuable opaque particles. To effect this, the lead is first brought to the porous or spongy form, by which the surface, exposed to the slow carbonating process, is enormously enlarged, the thin mass being seemingly composed of open interlaced fibres. This is put in a close chamber, and there exposed to a mixture of atmospheric air, carbonic acid, and the vapor of acetic acid. The carbonic acid, generated by combustion, is cooled and purified before it is driven into the chamber. The air passes in warm, and care is required to maintain the proper degree of moisture. The carbonate is the shape of the metal upon which it is formed, and the material is not removed until the corrosion is complete.

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[1] Dr. J. Mueller of Geneva, undertook the naming of the lichens.

A NEW AND IMPROVED LATHE.

(*See Page* 245.)

Only a few years ago Western mechanics were dependent almost wholly for fine tools on Eastern manufacturers. But now lathe planers, drill presses, milling machines, and all kinds of wood-working machinery are made in various sections of the west fully equal in every respect to those produced by Eastern manufacturers. In Cincinnati the manufacture of these tools is an important part of the city's industry, and some of the finest work in this line is turned out by Messrs. Conway & Co., of this city.

The accompanying engraving is an illustration of a new twenty-inch swing-lathe from their shop. They claim for this lathe several new improvements in construction, which will be of interest to all machinists, and which we propose briefly to note for the information of our readers.

The spindle, which is made of high-grade hammered steel, with large journals, is not turned down in steps like an open telescope and tapering to a small end, as is usual in other lathes; on the contrary, it is the size of the front journal its whole length, through the cone to the back bearing.

This of course gives great stiffness to the middle of the spindle, and, the makers claim, does away with all tendency to shatter and jar, which has always more or less been the great trouble with lathes doing heavy turning. They also claim greater smoothness and ease in running, and that this improvement in construction causes the back thrust of the spindle to be borne alike by both the box and cap of the end bearing, instead of only on the lower half of the box, as is usually the case. The bearings are solid castings of Irido copper—a composition of copper and iridium, for which Messrs. Conway & Co., are the sole agents, and which they claim is superior to any other composition for journal bearings in the market. Further, this lathe is made with worms to actuate the feed; these slide with the carriage over the lead screw, and the lead screw is used only for screw cutting.

Finally, the studs, small gears, and actuating screws are of steel. All the sliding parts are brought to a perfect surface, and the lathe generally is finished in elegant style, and makes a fine appearance. We may add that every one of these lathes is belted and thoroughly tested before it is allowed to leave the shop.

For further information regarding price, etc., apply to Messrs. Conway & Go., Cincinnati, Ohio.

Colour-Blindness.—At a recent meeting of the Physical Society, Mr. H. R Troop read a paper treating of the subject of colour-blindness, or Daltonism, in which he showed that the hypothesis of three fundamental colour sensations was not the only one which satisfies the well-known equation of Maxwell: $X = v\,V + c\,C + u\,U$, where X is an unknown tint; V, vermilion; C, chrome yellow; U, ultramarine; and v, c, u, given quantities of the same. A recent case of colour-blindness would indicate that there were two pairs of colour senses; and the author gave reasons for adding a fifth sense—namely, that for white.

HISTORICAL NOTES IN PHYSICS.

BY PROF. SILVANUS P. THOMPSON.

I.—*The Discovery of the Electric Light.*

In looking through an old volume of the *Journal de Paris*, I came across the following entry, for the date 22 Ventôse, An X, (March 12, 1802), which clearly relates to an exhibition of the electric arc light:—

"Le citoyen Robertson, auteur de la fantasmagorie, fait dans ce moment, des expériences intéressantes, et qui doivent sans doute avancer nos connoissances sur le *galvanisme*. Il vient de monter des piles métalliques, au nombre de 2500 plaques de zinc, et autant en cuivre rosette. Nous parlerons incessament de ces résultats, aussi que d'une expérience nouvelle qu'il a faite hier avec deux charbons ardens. Le premier etant placé à la base d'une colonne de 120 élémens de zinc et argent, et le second communiquant avec le sommet de la pile, ils ont donné, au moment de leur réunion, une étincelle brillante, d'une extrême blancheur, qui a été aperçue par toute la société. Le citoyen Robertson répétera cette expérience le 25."

The individual who thus came before the public was named Etienne Gaspard Robertson, a name suggestive of Scotch descent. He was better known for his "Phantasmagoria" exhibited a few years later in London. Of this invention a notice appears earlier in the volume from which the above passage is taken; and in an earlier volume of the *Journal de Paris* in the month "*Fructidor*, An viii.," there occurs a mention of some of his experiments on the *couronne de tasses* of Volta.

It is worthy of casual notice that in the number where Robertson's "Phantasmagoria" is advertised, the very next advertisement on the page is one of an exhibition to be given by Citoyen Martin at the Hôtel de Fermes, wherein as part of a "spectacle extraordinaire et amusant de physique," &c., was to be shown "l'expérience du télégraphie plus rapide que la lumière d'un effet extraordinaire et amusant.

The usual date given for the invention of the electric light by Sir Humphry Davy is 1809; but I was aware that earlier notices existed both in Cuthbertson's "Electricity" (1807) and other works. I was under the impression that some earlier reference to the matter existed in Davy's own works The finding of this notice in the *Journal de Paris* induced me to consult the early volumes of the *Philosophical Magazine* and of *Nicholson's Journal*.

In the *Philosophical Magazine*, vol. ix. p. 219, under the date February 1, 1801, the following passage occurs in a paper by H. Moyes of Edinburgh, in which experiments with a voltaic pile or column are described;—

"When the above column was at the height of its strength its sparks were seen in the light of the day, even when taken with a piece of charcoal held in the hand."

In the *Journal of the Royal Institution*, vol. i. (1802), Davy describes (p. 106) some experiments on the spark yielded by the pile, and states: When instead of the metals, pieces of well-burned charcoal were employed, the spark *was still larger* and of a vivid whiteness." On p. 214 he describes and depicts an "apparatus for taking the galvano-electrical spark in fluids and aëriform substances." This apparatus consisted of a glass tube open at the top and having a tubulure at the side through which a wire tipped with charcoal was introduced, another wire, also tipped with charcoal, being cemented in a vertical position through the bottom.

But earlier than any of these is a letter printed at p. 150 of *Nicholson's Journal* for October, 1800. This letter is entitled "Additional Experiments in Galvanic *Electricity, in a Letter* to Mr. Nicholson." It is dated "Dowry Square, Hotwells, September 22, 1800," and is signed by Humphry Davy, who at that time was assistant to Dr. Beddoes at the old Philosophical Institution in Bristol. The letter begins thus:—

"Sir.—The earlier experimenters on animal electricity noticed the power of well-burned charcoal to conduct the common galvanic influence. I have found that this substance possesses the same properties as metallic bodies in producing the shock and spark,* when made a medium of communication between the ends of the galvanic pile of Signor Volta."

In none of these extracts, however, is anything said of the properties of the *arc* as a *continuous* luminous spark. These were made known in Davy's later researches. Yet the electric light attracted attention as we see before the special property of continuity was observed.

II.—*The Invention of the Telephone.*

In the *Journal of the Physical Society of Frankfort-on-the Main* for 1860-61 (p. 57) may be found a memoir on telephony by the galvanic current, in which its writer says: "I have now succeeded in constructing an apparatus by means of which I am in a position to reproduce the tones of divers instruments, and even to a certain degree the human voice." The inventor further says: "Since the length of the conducting wire may be extended for this purpose just as far as in direct telegraphy, I give to my *instrument the name 'telephone.'*" Towards the end of the memoir it is stated that until now it had not been possible to reproduce the tones of human speech with a distinctness sufficient to satisfy everybody: "The consonants are for the most part tolerably distinctly reproduced, but the vowels not yet to an equal degree." The author of the memoir in which these remarkable statements occur was Philipp Reis. The paper from which the preceding quotations have been taken contains many other points of interest, and in particular a com-

* Here Davy adds a footnote: "The spark is most vivid when the charcoal is hot."

parison of the action of the transmitting part of the instrument with that of the human ear upon which it was founded. The author says. "How could a single instrument reproduce at once the total action of all the organs operated in human speech? This was ever the cardinal question. At last I came by accident to put this question another way. How does *our ear* perceive the total (or

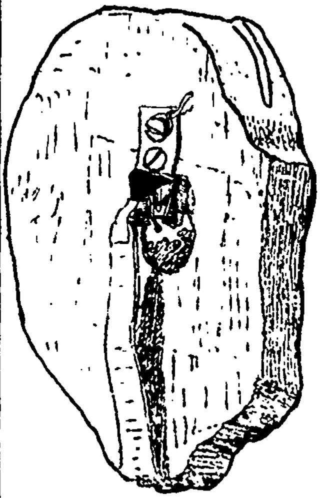


FIG. 1.

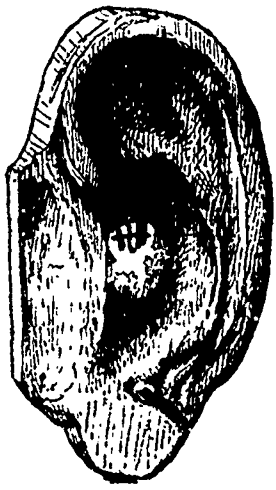


FIG. 2.

resultant) vibrations of all the simultaneously operant organs of speech?" He then goes on to describe the action of the auditory ossicles when made the recipients of sound-waves, and points out how they execute movements and exert forces upon one another in proportion to the condensations occurring in the sound-conducting medium and to the amplitudes of vibration of the tym-

FIG. 3.

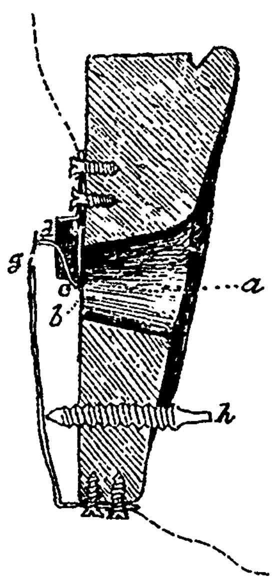


FIG. 4.

panum. Having stated this law of proportion between the cause and its effect, he goes on to speak of the graphic method of representing varying forces, such as those of sound-waves, by curves; and emphatically lays down that the ear is absolutely incapable of perceiving anything more than can be expressed by such a curve. After giving samples of undulatory curves corresponding to musical tones and to discordant sounds he makes the following significant remark: "So soon therefore as it is possible, at any place and in any manner, to set up vibrations whose curves are like those of any given tone or combination of tones, we shall then receive the same impression which the tone or combination of tones would have produced upon us. Taking my stand upon the preceding principles, I have succeeded in constructing an apparatus," &c. He concludes his paper by saying that the newly invented phonautograph of Duhamel may perhaps afford evidence as to the correctness of the views which he has asserted respecting the correspondence between sounds and their curves.

The actual apparatus figured in this memoir and exhibited to the Frankfort Society in October, 1861, is now in my possession; and I have also temporarily intrusted to me a still earlier experimental telephone made by Philipp Reis in the form of a model of the human ear.[1] This interesting instrument is depicted in its actual condition and size in Figs 1, 2, and 3, and in section in Fig. 4. It is carved in oak-wood Of the tympanic membrane only small fragments now exist. Against the centre of the tympanum rested the lower end of a little curved lever of platinum wire, which represented the "hammer"-bone of the human ear. This curved lever was attached to the membrane by a minute drop of sealing-wax, so that it moved in correspondence with

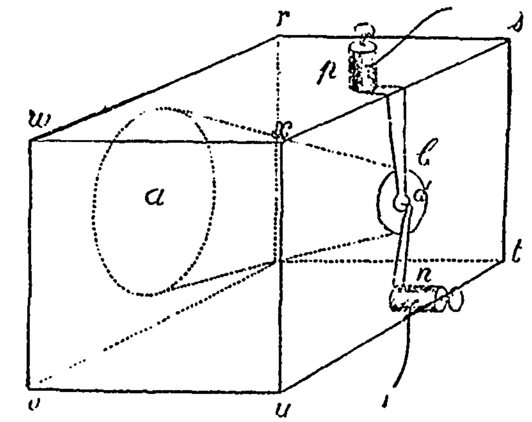


FIG. 5.

every movement of the tympanum. It was pivoted near its centre by being soldered to a short cross-wire serving as an axis. The upper end of the curved lever rested in loose contact against the upper end of a vertical spring, about 1 inch long, bearing at its summit a slender and resilient strip of platinum foil. An adjusting screw served to regulate the degree of contact between the vertical spring and the curved lever. Conducting wires, by means of which the current of electricity entered and left the apparatus were affixed to screws in connection respectively with the support of the pivoted lever and with the vertical spring.

If now any words or sounds of any kind were uttered in front of the ear, the membrane was thereby set into vibrations, as in the human ear. The little curved lever took up these motions precisely as the "hammer"-bone of the human ear does; and, like the "hammer"-bone, transferred them to that with which it was in contact. The result was that the contact between the upper end of the lever and the spring was caused to vary. With every rarefaction of the air the membrane moved forward, and the upper end of the little lever moved backward and pressed more firmly than before against the spring,

[1] The property of M. Léon Garnier Director of Garnier's Institute at Friedrichsdorf, near Homburg, where Philipp Reiss was formerly Teacher of Natural Sciences.

making better contact, and allowing a stronger current to flow. At every condensation of the air the membrane moved backward, and the upper end of the lever moved forward, so as to press less strongly than before against the spring, thereby making a less complete contact than before, and by thus partially interrupting the passage of the current, caused the current to flow less freely. The sound-waves which entered the air would in this fashion throw the electric current, which flowed through the point of variable contact, into undulations in strength. Reis himself termed the contact-part of his telephone an interruptor. That it was not intended to operate as an abrupt make-and-break arrangement, as some persons have erroneously fancied, is evident; firstly, because the inventor introduced delicate springs to give a following-contact, and so prevent abrupt breaks from occurring; secondly, because abrupt breaks would have violated the fundamental principle to which he refers in the sentence immediately preceding his description of the instrument shown to the Frankfort Society, namely that of creating tones whose curves were like the undulatory curves imparted at the transmitting end of the instrument; thirdly because (in another article) he described his instrument as opening and closing the circuit in proportion to the sound-wave, which obviously an abrupt "brake-and-make" apparatus without a spring-contact could not possibly do. The mechanism which Reis thus invented—and which is substantially alike in all his instruments—might be appropriately described as the combination of a tympanum with an electric current-regulator, the essential principle of the electric current-regulator being the employment of a loose or imperfect contact between the two parts of the conducting system, those parts being so arranged that the vibrations of the tympanum would alter the degree of contact, and thereby vary the resistance offered at the point of contact to the passage of the current, and so regulate the strength of the current that it should magnetise and demagnetise the core of a distant electro-magnet in a manner corresponding to the undulations of the tympanum of the transmitter.

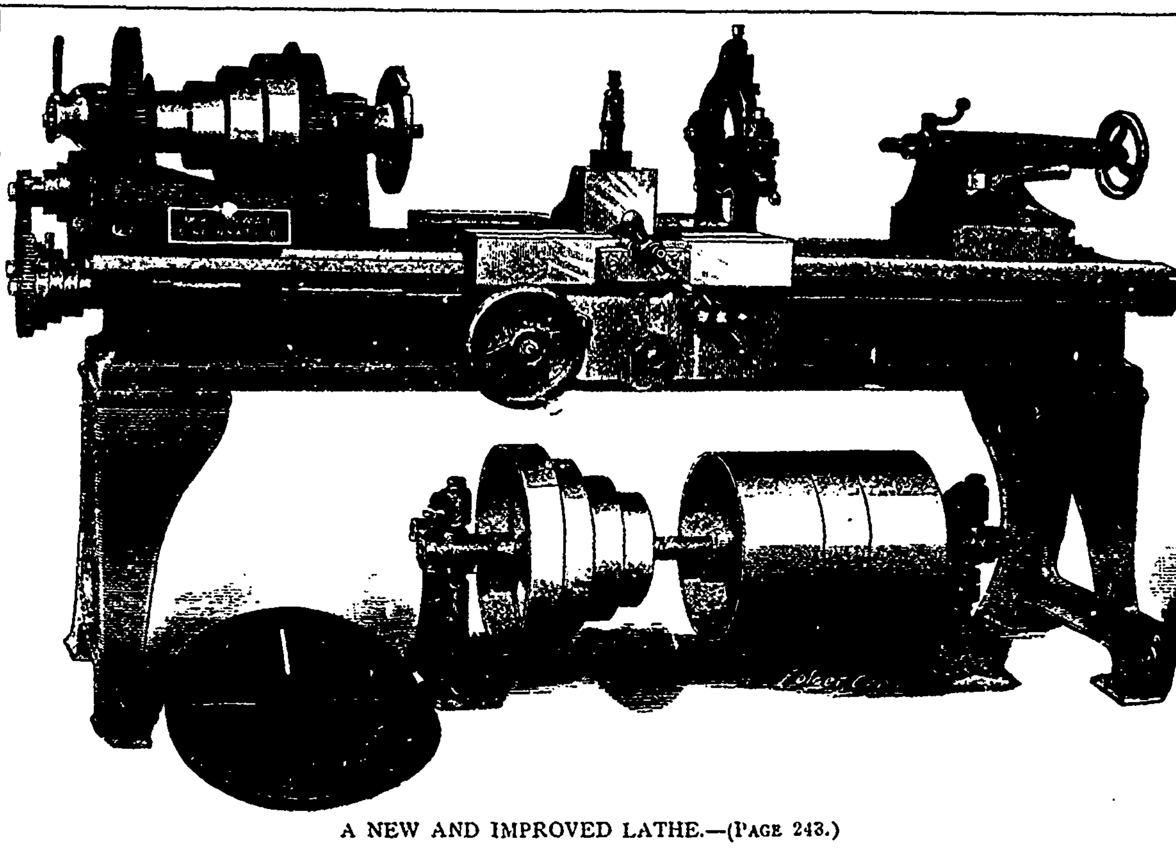
The particular form of the instrument shown at Frankfort in 1861, and described in the *Journal*, is somewhat different from the "ear." The figure (5) and description are taken from the *Journal*.

"In a tube of wood, *r s t u v w x*, there is a conical hole, *a*, closed at one side by the membrane, *b* (made of the lesser intestine of the pig), upon the middle of which a little strip of platinum is cemented as a conductor of the current. This is united with the binding-screw, *p*. From the binding-screw, *n*, there passes likewise a thin strip of metal over the middle of the membrane, and terminates here in a little platinum wire, which stands at right angles to the length and breadth of the strip. From the binding-screw *p*, a conducting-wire leads through the battery to a distant station."

In the original instrument there is also an adjusting-screw to regulate the contact, though this is not shown in the drawing.

The receiver used to reproduced the sounds transmitted by these telephones is also described in the memoir of Reis. It consisted of a steel needle surrounded by a coil of wire. This was at first set up for the purpose of increasing the sounds by resonance, upon the top of a violin, later it was mounted upon a pinewood box, to which still later a lid of thin pine was added against which the listener could press his ear. The sounds emitted by such a wire during magnetisation and demagnetisation were well known before, but to Reis is due the discovery that other tones than the natural vibration-tone of the wire could be electrically imposed upon it by the varying magnetising force of the current in the surrounding coil. Reis explained the reproduction of the transmitted sounds by supposing a magnetic attraction between the atoms of the steel wire to work synchronously with the fluctuations of the current. He later devised a different receiver in which an electro-magnet was provided with an elastically mounted armature of iron which it threw into vibrations corresponding to those of the original sound-waves. With this apparatus and a transmitter with a small curved lever like that in the "ear" he was able (see Kuhn's "Handbuch der Angewandten Elektricitätslehre," 1866, p. 1021) not only to reproduce melodies with astonishing exactness, and single words as in speaking and reading (less distinctly), but even to transmit the inflexions of the voice expressive of surprise, command, interrogation, etc.

Considering how far these early researches were carried, it is remarkably that their historic value has been so greatly overlooked.—*Nature.*



A NEW AND IMPROVED LATHE.—(Page 243.)

THE NEW YORK AND BROOKLYN BRIDGE.

So much has been said by way of description and explanation concerning this, the largest bridge at present in existence, throughout the press of the country, that in view of our limited space, we deem it alone advisable to recapitulate some of the more important figures, more to serve as a reference than for any distinctive purpose of description.

	Ft. In.
Total length of bridge and approaches	5989 0
Length of main span	1595.6
" " spans over land, each	930 0
" " Brooklyn approach	971 0
" " New York approach	1562 6
Width of bridge	85 0
Height of bridge in the clear at 90° above mean high water.	135 0
Height of floor at towers above mean high water	119 3
Height of towers above mean high water.	276 8
Terminal elevation at New York, above mean high water	33 3
Terminal elevation at Brooklyn, above mean high water	61 4
Grade of roadway per 100 feet	3.3

The bridge comprises six trusses. The centre trusses are 17 ft. high between pin centres 12 ft. 8 in, apart clear of posts. The side trusses have a height between pin centres 8 ft 9 in. The transverse floor beams are 86 ft. long and 32 inches deep.

Number of main cables	4
" of strands to each cable	19
" of wires to the strand.	278
Diameter of main cable, when wrapped	15¾ in.

The wire is of galvanized steel, coated with oil and laid straight. The gauge of the cable wire is No. 7, and of the wrapping No. 10. Area of section, solid, of each cable, 144 834 sq. in.

There are 208 suspender from each cable for the main span, and 86 for the land spans. Estimated strength of each suspender, 70 tons. Maximum load, 10 tons.

	Tons.
Weight of suspended structure from anchorage to anchorage	14,680
Weight of suspended centre span, including cables	6 740
Estimated maximum load on centre span	1,380
Total weight, load and structure, central span	8,120
Amount of above weight borne by steel wire stays	1,190
Estimated stress on cables due to load.	11,700
Ultimate strength of cables	49,200

The anchorages are 129ft. × 119ft. at base, and 117ft. × 104ft. at top. Height above mean high water at front, 89 ft., and at rear 85 ft. The weight of each is 60,000 tons. There are eight anchor plates 16 ft. × 17 ft. 6 in. by 2 ft. 6 in. thick at centre, and each weighs some 23 tons.

The total cost of the bridge so far has been something over $15,000,000.

The caisson for the Brooklyn tower was towed into its berth on May 2, 1870, and the first granite blocks laid on it June 15. Excavation commenced July 10. It was filled with concrete, and left in final position, March, 1871.

The New York caisson was placed in its berth in October, 1871, and was left filled and completed in May, 1872.

The Brooklyn tower was completed in May, 1875, the New York tower in July, 1876.

On Friday afternoon, August 25, 1876, Mr. E. F Farrington, the master mechanic, made his trip over the endless traveller rope, and immediately after the work of running the cables was pushed. The running and regulating of the cable wires was begun June 11, 1877, and completed October 15, 1878.

On May 24, 1883, as all our readers well know, the great bridge was formally opened to public service. *The American Engineer.*

NOTE ON SETTLING-TANKS IN SILVER MILLS.

BY ALBERT WILLIAMS, JR., WASHINGTON, D. C.

(Read at the Boston Meeting, February, 1883.)

A large proportion of the work performed in wet-crushing silver mills is devoted to the handling and re-handling of pulp between the battery and the pans. There seems to be no generally applicable substitute for the settling-tanks, and in the present system of constructing mills the tanks involve an amount of labor which may be regarded as disproportionate and unnecessary, in view of the automatic improvements which have been introduced in other directions.

This difficulty has been met, however, by Boss's continuous process, in which the pulp flows directly from the mortars to the first of a series of constantly working overflow-pans. This method has been adopted at the Noonday mill, Bodie, California, the Harshaw, Arizona; the Sierra Grande, New Mexico; and the Prietas, Sonora. The continuous process, while giving excellent results with special ores, and under peculiar local conditions (such as a deficiency in water supply), is not, I believe, claimed to be available for all raw-amalgamating mills, notwithstanding its well-merited popularity for certain work. Some trouble has been experienced from the tendency to concentration in the pans, though this can be avoided by skilful manipulation. It has also the disadvantage inherent in combinations of distinct operations; it requires a very nice adjustment of the water supply to obtain full battery efficiency without running the pans too thin, though the latter defect is partially compensated for by the gradual thickening of the pulp as it proceeds through the series of pans. The objection is similar to that which holds in a parallel duplex process, that of combining roasting and smelting in a single furnace, where each operation is injuriously affected by the necessity of fitting it in with another and entirely different one.

In the prevailing type of wet crushing silver mills the battery sands after settling are manipulated in one of the three following ways: They are either shovelled into wheelbarrows or cars, and thus conveyed to the pans; or they are dumped into heaps upon the platform immediately back of the pans, from which they are again spaded into the pans; or, if taken from the row of tanks nearest the pans, they are sometimes thrown directly from the tanks into the latter by a single handling. Each of these methods may be applicable in a single mill, according to the arrangement of the tanks relatively to the pans. Thus of the force employed in six Comstock mills (the Brunswick, California, Mariposa, Morgan, Scorpion, and Trench) which in 1880 numbered 215 men, no less than 49 were tankmen, and of the crews of two mills in Owyhee County, Idaho (the Ellmore and Jones & Adams), 6 were tankmen in a total of 19. The wages were $4 per shift of 10 and 12 hours, These eight examples show that 24 per cent. of the labor in the mills named consisted in handling the tank pulp. The instances cited include all the data I have at command, and probably show a fair average of the practice in mills of the same type. Remembering the notable saving which has been effected in other details of modern amalgamating mills it appears that here is a possible opening for improvement.

The object of this paper is to throw out a hint which may invite discussion, and may suggest to the builders of the mills of the future a remedy for the existing clumsy, slow and expensive mode of handling tank pulp. Instead of the laborious shovelling of the heavy, tenacious pulp to higher levels from the tanks, why not utilize the always obliging force of gravitation? This is already done in passing the ore from the bins successively through grizzlies, rock-breakers, and ore-feeders to the stamps, and in settling the pulp, and after leaving the pans the pulp flows downward to the settlers and thence to the agitators and sluices. In all these stages the movement is steadily downward, and is effected by gravity; it is only when the settling tanks are reached that an *interruption occurs.* Suppose now that instead of the ordinary tanks we introduce a series of hopper-shaped boxes provided with gates at the bottom, placing the pans 6 to 8 feet below the usual level, and discharging the settling-boxes into movable troughs leading to the charging-holes of the pans. The position of these self-dumping tanks would be the same as that of the ordinary ones; the grade of sluices from the battery to the tanks would not be changed; and the arrangement of overflow gates would be identical. The tank capacity could also be kept the same while diminishing the area; for the capacity of the common tank is determined by the limit of depth from which a man can conveniently shovel—this depth ranging in present mills from 24 to 40 inches, and seldom exceeding 30 inches. The proposed system would allow the compartments to be smaller in area because of their correspondingly greater depth. The gates at the bottom of the tanks could be actuated by levers extending above the pan floor. Perhaps the best arrangement would be to employ hinged bottoms surfaced with burlap, sheet-rubber, or other packing. Any slight leakage would not be objectionable; for the water would be strained as it escaped, and all drippings would collect in a large fixed trough underneath the tanks, from which the water could be conducted to the slime ponds or used in diluting the pans and settler charges. The details of construction can be elaborated by any mill designer.

The plan of using gravity-discharging tanks is, I admit, open to certain objections. It demands steeper grades inside the mill, to allow room for a half floor beneath the tanks, and to give sufficient fall for the sluices from tanks to pans. The work of excavation for foundations would be increased, and the mortar beds would need somewhat heavier backing. On the other hand the area occupied by the building could be slightly reduced. The expense would depend largely upon the natural grade of the site. For a 20 stamp mill the addition to the first cost (given a favourable site) should not exceed $1000 —an amount which could be saved in wages of tankmen in a three months' run.

Microscopic Animal in Bricks.—The weathering of brick walls into a friable state is usually attributed to the action of heat, wet and frost; but by recent observation of M. Parize, the real destroyer is a microscopic creature, and the action played by the weather is only secondary. He has examined the red dust of crumbling bricks under the microscope, and found it to consist largely of minute living organisms. A sample of brick dust taken from the heart of a solid brick also showed the same animalculo, but in smaller numbers. The magnifying power of the instrument was 300 diameters. Every decaying brick showed the same kind of population, but the harder the brick the fewer were noticed.

A NEW INDUSTRY.

Consolidating Loose and Bulky Material into Self-Cohesive and Solid Blocks.

The machine and process which are illustrated (p. 248,) and described, for consolidating loose and bulky materials into compact or solid forms, are the achievements of the scientific research and practical experiments conducted through several years by Mr. W. H. Smith, of this city, aided and encouraged by a company of prominent business men, incorporated as the Smith Consolidation Company.

The results obtained give assurances of the development of an industry producing great public benefits, and rivalling the foremost manufacturing interests of the land. The system involves the reduction into merchantable forms of the bulky offals of the flour-mills, the waste wood products of the saw and planing mills, and the screenings and dust *from the* coal mines. It also applies to all such bulky articles as tanbark, cotton, cotton waste, cottonseed hulls, hay, straw, etc., fertilizers, and many others.

The machine illustrated consists of a heavy steam-hammer operating upon the material *contained in one* of the group of three steel moulds. The moulds being passed through one-third of a revolution at each movement brings them under the hopper for filling, the steam-hammer for consolidating, and the discharging-hammer for discharging the mould of the block just formed, in such manner that the three operations occur simultaneously. One blow of the hammer usually suffices to consolidate the block, which weighs from ten to thirty pounds, according to the material of which it is composed. Four blocks per minute can be readily made. The capacity of the machine represented is 8,000 pounds of fuel per hour from white pine sawdust.

The process, as applied to the majority of the substances named, consists in heating the material sufficiently to soften the inherent resin, gluten or bitumen, and, while it is in this state, subjecting it to the operation of the consolidator. No foreign substance is in any case admixed.

To meet the ordinary requirements of the mills for a machine to compress bran or other offal into packages of such density as will make a freight equal to or better than sack-flour, and which will leave the material in its natural condition when removed from the package, the process is modified by the omission of heating the material, and it is spouted directly from the mill to the mould, where it is subjected to the same operation as for consolidation, forming a block which has sufficient cohesion, with the assistance of the package into which it is discharged, *to* retain its density and shape, but which resumes its natural bulk and condition upon being released from the package.

The importance of this invention to the milling interests of the country will be apparent when the results obtained with bran and mill offals are considered.

Bran has always been an article of forced sale, because of its bulky nature, being both expensive to store and unprofitable for export or shipment to points distant from the milling centers: whereas bran can now be reduced to one-fifth its natural bulk, rendering it at once a practical and valuable commercial article which freights better than sack-flour, as the latter measures about 47 cubic feet to the gross ton, while the consolidated bran measures but 36 cubic feet to the gross ton.

Consolidated bran has proved to be of two-fold advantage, since, air and moisture being excluded, it is not liable to damage by climatic effects, and blocks of bran made by this process over two years ago still remain as sweet and good as when made. This result alone is of immense value, for the reason that bran and other mill products may now be shipped to warm climates or may be kept in store for military campaign purposes for an indefinite time, which is not the cas with these materials in their natural condition.

Sawdust, shavings, wood waste, coal-dust, screenings, and cottonseed hulls for fuel are consolidated into self-coherent blocks by the same means and in the same manner as heretofore described: and something of the industrial revolution about to be created by this method of disposing of the waste products of the saw-mills may be appreciated, when it is considered that they represent fully one-third of the log measurement, amounting annually to millions of tons of now more than useless material, much of which can be manufactured into fuel having an ascertained value of $3.25 per ton in Chicago. This is done at a total expense of 70 cents per ton for the consolidated blocks on board vessel or cars at place of manufacture.

The value of these blocks as fuel, in comparison with Illinois steam coal, has been found to be such as to induce several large city consumers to place standing offers for quantities at the price above-named. The blocks possess the further merits of cleanliness, burning almost smokeless and ashless and entirely clinkerless. For domestic purposes they are especially desirable, as they can be made of any shape or size.

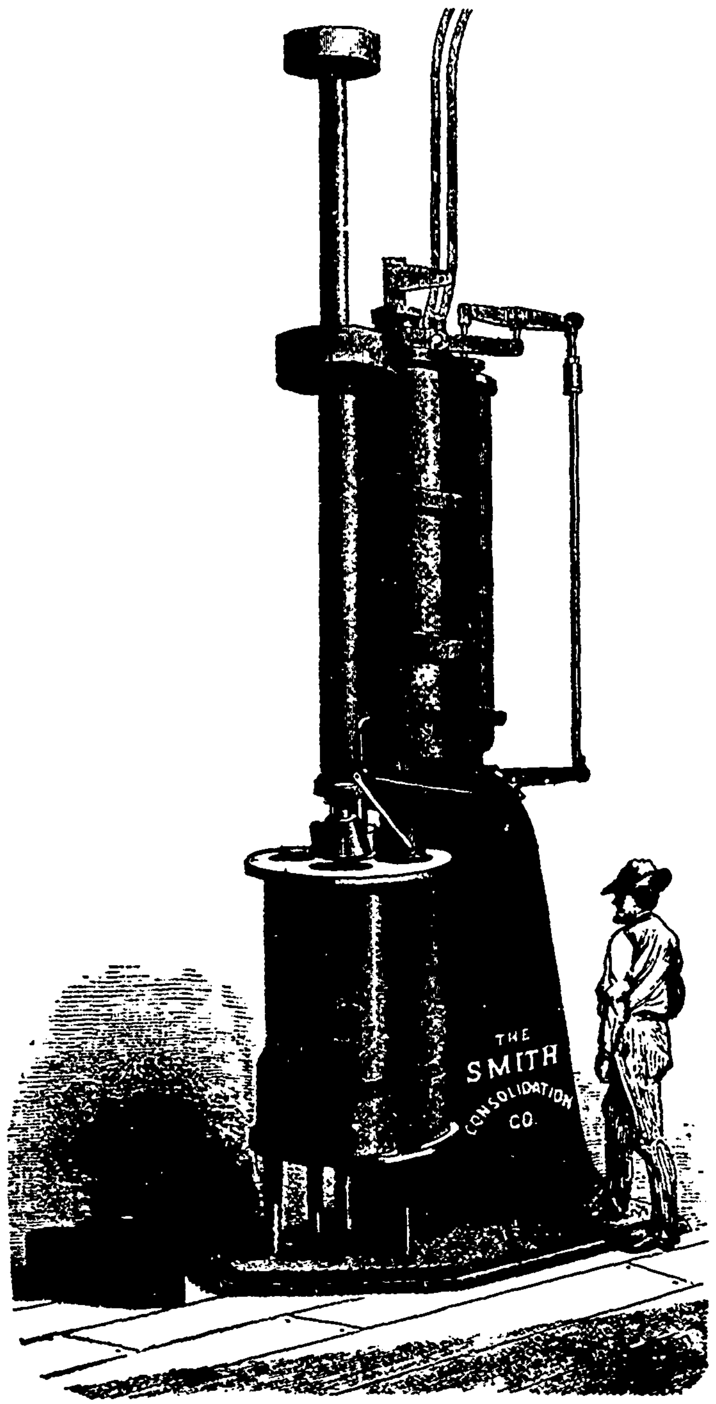
The aggregate possible value of fuel from this source alone defies calculation, and still, in place of being a burden to the manufacturer, it disposes of a nuisance and source of danger about the saw-mills, and the expense incident to the construction and operation of costly furnaces or burners with conveyers, etc., for consuming these heretofore valueless products.

This applies with equal force to planing-mills, where the presence of an accumulation of shavings is especially hazardous; and it is estimated that the out-put of the large planing-mills of this city during the busy season yields as high as 200 tons of shavings per day.

Cottonseed hulls and much of the straw and grasses abundant in many sections of the West are by the same means reduced to a fuel equaling in value coal or wood.

COMPARATIVE TABLE SHOWING THE REDUCTION OF VARIOUS MATERIALS BY CONSOLIDATION.

	Bulk unconsolidated per ton of 2240 lbs. Cubic Ft.	Bulk consolidated per ton of 2240 lbs. Cubic Ft.	Bulk unconsolidated per ton of 2000 lbs. Cubic Ft.	Bulk consolidated per ton of 2000 lbs. Cubic Ft.	Wt. unconsolidated per cubic foot. Pounds.	Wt. consolidated per cubic foot. Pounds.
Bran	172	34	153	31	13	65
Middlings	86	32	76	28	26	70
Ground Feed	86	32	76	33	26	60
Corn Meal	64	37	57	31	35	65
White-Pine Sawdust	448	34	400	33	6	60
White-Pine Shavings	896	37	800	33	2½	60
Yellow-Pine Sawdust	373	34	333	31	6	65
Yellow-Pine Shavings	746	34	666	31	3	65
Tan-Bark	140	35	125	31	16	64
Cotton compressed	93	40	....	..		66
Hay, Straw and Grasses in mow	560	34	600	31	4	65
Hay, in common bale	160	34	142	31	14	65
Bituminous Coal-Dust	44	28	40	25	50	80



THE SMITH CONSOLIDATOR.

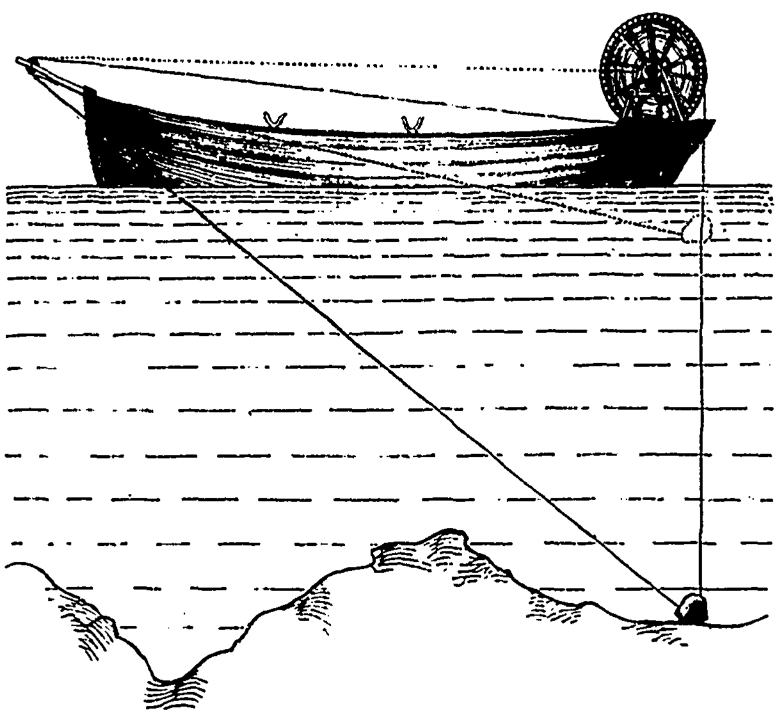
A superior article of stone of great density and beauty can be produced by machine from any of the elements composing natural stone. The stone made by this process weighs from 150 to 160 pounds per cubic foot, or 10 to 15 pounds more per cubic foot than Ohio sandstone.

The possibilities shown with the few substances before-named apply in a greater or less degree to an indefinite number of articles. We have instanced enough concerning the products of this process to excite general interest in the particular mechanical devices by which they are procured.

The Smith Consolidation Co., have this machine and many of its products fully protected by letters patent of the United States and Canada. They are prepared, with ample means, to pursue the business of constructing machines for any specific material or for the disposition of territorial rights, and will be pleased to offer upon application more detailed information to any who may want it.

The offices, of the company are: James L. Houghteling, president, C. H. Mc Cormick, Jr., vice-president; Horace Williston, treasurer; John Landes, Secretary. The company's office is at 254 South Water street, Chicago.—*Chicago Industrial World.*

SUTCLIFF'S SOUNDING APPARATUS.



This Apparatus was designed with a view to the carrying on of an extensive system of Soundings at and about the River Entrances to the New North Docks at Liverpool, and its use there proving to be most advantageous, it has been matured and modified to meet the general requirements of Dock, Canal, River, and Coast work.

It provides for the taking of Soundings more accurately, expeditiously, and with much less labour than is possible by any other existing means. It admits of Soundings reduced to any datum level being obtained direct and without calculation. And it enables the operations of taking Soundings and plotting the same to be performed simultaneously and by one person.

The Apparatus consists of a Sounding-Machine, a Distance Recorder, and a Section Plotter.

The Sounding Machine consists of a wheel with a spiral reel attachment, around its periphery is wound a wire by which a lead is suspended, and the spiral reel carries a preventer-line, one end of which is passed through a leading block fixed at the forward part of the boat on which the Apparatus is mounted, and from thence it is taken back to the lead, to which it also is attached.

The function of this preventer-line is to obviate the trailing astern of the lead when the boat is being moved ahead, and thereby to render unnecessary the casting of the lead forward for each dip or sounding to be taken, and to allow of the lead being worked within a range of a few feet of the bottom to be sounded, in order that its surface may be closely and expeditiously traced.

To this end the horizontal distance from the lead to the before-mentioned leading block is treated as the base of any right-angled triangle, of which the depth below that base to the lead is the perpendicular, and the distance from the lead to the leading block is the hypothenuse.

The wheel and the reel are so proportioned relatively to each other and to the base that they both pay out or take in the required amount of their respective lines to maintain the lead vertically under the after end of the base line at all depths of its range.

The weight of the lead causes the wheel to revolve and pay out the sounding and proventive lines simultaneously; slack line, due to over-running of the wheel, is taken up by a spring which counteracts the paying out movement, and the lead is raised by turning the wheel by hand.

The wheel is ten feet in circumference, and its rim is divided into feet and tenths of a foot.

One end of its axle has a sleeve bearing that may be revolved within its pedestal, and to this sleeve are attached a long pointer and a short one, the longer pointer to indicate readings on the rim of the wheel and the shorter one to shew the reading on a fixed disc which is marked similarly to the wheel.

This arrangement admits of Soundings reduced to any datum being obtained direct and without calculation, thus: On commencing to take Soundings the lead is lowered to the surface of the water, or to any convenient depth below the same, and the pointers are set to the figures representing the position of the lead in relation to the datum level, the lead is then lowered to the bottom, and the sounding, reduced to datum, is indicated at the longer pointer.

Any change in the level of the water during the progress of Soundings operations is provided for by turning the pointers in the direction and to the extent of such change, indicated by the shorter pointer on the fixed disc, and the longer pointer continues to shew deduced soundings.

The Distance Recorder consists of a drum on which a fine crucible steel wire is wound; the drum is rotated by the moving away of the boat from the starting-point, to which one end of the wire is attached, unwinding the wire which is kept taut by means of a brake on the drum spindle, and the revolutions of the drum are made to indicate on a counter the length of wire paid out, or to register the same in connection with the Section Plotter hereinafter described.

The Sounding and Distance Wires are kept lubricated by being made to pass through oiled pads.

The Section Plotter consists of a paper feed roller or rollers actuated through suitable gearing by the drum of the Distance Recorder, so that the travel of the paper represents to the required scale the paying out of the distance wire. In cases where a measuring wire cannot be used, motion is given to the paper carrier by clockwork. A block sliding in guides, carries a marker across the paper at right angles to the line of its travel. it is actuated by a cord from a small barrel clamped to one end of the axle of the Sounding Wheel, capable of being turned about the same for adjustment, and so proportioned as to indicate to the required scale the rise and fall of the lead by the motion it imparts to the marker

In using the Section Plotter the lead is placed on the surface of the water, or at any convenient depth below the same, and the Sounding Marker is set to a line on the paper representing that level, which may be termed the trial datum line; such line may have been previously drawn or struck by passing the paper along with the marker in contact, or by the use of a second marker it may be produced while the Soundings are being taken. The plotting of the Soundings is effected by simply tapping the marker, which is kept clear of the paper by a spring, each time the lead is felt to touch the bottom, and thus there is produced a dotted section to a trial datum, from which, and a tide guage record, the true datum line may be plotted, time having been noted at each end of the line.

The position of cross sights, bearings, &c., may be indicated by holding the marker in contact with the paper while the lead is being raised, so as to produce a vertical stroke, against which their designation may be written.

NOTE ON THE INFLUENCE OF HIGH TEMPERATURE ON THE ELECTRICAL RESISTANCE OF THE HUMAN BODY.

BY W. H. STONE.

The experiments which I have now for some years been carrying out as to the various forms of medical electricity have begun to furnish trustworthy results. Some of these, with the help of Dr Kilner, were incorporated in a paper read before the Society of Telegraph Engineers on March 9, 1882. We there stated that at present "we are hardly in a position to say how far the resistance of the body varies in health; but in disease it can be fairly stated that it sometimes diminishes and sometimes augments." Of this fact we gave illustrations.

It had often occurred to me that the temperature of the human body very probably influences its resistance; and some experiments had been made with a view of testing the amount of such influence. But in pathological researches it is often difficult to find a case not open to exception, and it is frequently necessary to wait a considerable time before, in the impossibility of experiment, accident presents one possessing the necessary conditions. Such a case I have now met with, and it is worth while to place it on record, if only to enable other observers to prosecute this line of investigation.

The patient is a young and intelligent gunsmith aged twenty-two. He had rheumatic fever severely twelve years ago, which, as is usual in young subjects, has left permanent heart disease behind it. This did not, however, prevent his following his trade until the beginning of April in the present year. He then began to suffer from morning rigors, occurring at first at the interval of from seven to ten days, but, since Easter, daily. He came into my ward in St. Thomas's Hospital on April 28. It is not necessary to detail the medical history of the case in a scientific periodical; it will be sufficient to state that about 8.30 a.m. he was in the habit of suffering from severe attacks not unlike these of ague, in the course of which the temperature rapidly rose to 105° F. In the afternoon it sank to the normal human temperature of 98° or 99° F. The cause of this remarkable symptom is still somewhat obscure, it has completely resisted the action of quinine and other antiperiodics, as well as salicylic acid, aconite, and other approved lowerers of temperature. It is probably due to ulcerative endocarditis slowly advancing. The most remarkable part of the case is that it causes the patient no suffering or inconvenience whatever. His mind is clear, and, except the feeling of chilliness during the period of heat, he makes no complaint. He is able to take interest in the determinations which I proceed to give.

It occurred to me that this unusual range of daily temperature (7 F.) afforded the opportunity I had long been seeking. But it was some time before I could arrange suitable apparatus for its examination. A hospital ward is an awkward place for Wheatstone's bridge and delicate galvanometers. Moreover I had before found that from the peculiar conditions of the human body, the testing current, to produce accurate results, requires to be frequently reversed, for fear of opposition currents of polarisation. I am glad to see a confirmation of this observation in a verbal communication of Prof. Rosenthal to the Physiological Society of Berlin on April 13.

It was partly to overcome this difficulty that I devised, at Mr. Preece's suggestion, a dynamometer for alternating currents, of which the general arrangement was described in *Nature* some time ago. It was also brought before the Physical Society at their June meeting in Oxford. Although severely criticised by some members of that learned body, it works extremely well, and may be, I hope, an addition to medico-electrical appliances. For the purpose of the present experiment I found that an ordinarily sensitive galvanometer, considerably damped by air-resistance, was sufficient, since by the zero methods of balancing, it is only necessary just to see the deflection before commutating, when balance is obtained, commutation has no effect on the needle of the bridge.

It would require more space than could probably be here afforded to give all details of the experiments, which, moreover, by the courtesy of Capt. Douglas Galton, I hope to bring before the British Association of this autumn. But a brief summary of results is as follows:—

On June 5 I reached the ward at 9.40 a.m. The rigor had begun at 8.30 and was beginning to decline; I had time, however, for the following determination:—

9.40	R. 4140 ohms.
9.55	" 3470 "
10.10	" 2900 "

These measurements were taken with a very small E.M.F. of about 9 volts. On June 9, I succeeded in reaching the ward during the beginning of the rigor, and took the following measurements, this time with corresponding temperatures:—

10.30 a.m.	Temp. 102° 4	R. 4550
10.40 "	" 104° 2	" 4030
10.50 "	" 104° 2	" 4930

At this point the rigor, temperature, and resistance began to descend. I visited the patient again at

2.15 p.m.	Temp. 103°	R. 2300

The apparatus in these observations was left untouched, so as to prevent any accidental change. The measurement was made with a double E.M.F. to those preceding, namely, 18 volts. I determined on each occasion the resistance of the leads and terminals, which I found to be on each occasion 2 ohms.

I cannot help thinking that the difference, which is as nearly as possible twice the smaller amount, is too great to be accounted for by any instrumental error, and that the human body, in spite of its large amount of liquid constituents, follows a similar thermal law of resistance to that influencing solid conductors, though in a very much higher ratio.

Only one other point requires comment, namely, the mode of making contact between the body and the testing apparatus. Prof. Rosentha in the communication quoted above draws attention to the high insulating powers of the epidermis. In the above experiment I passed the current through the two legs, from one foot to the other, in alternate directions. The feet were previously soaked in salt and water; two large pans containing about a quart of brine each were then placed under the feet, and in each was immersed a plate of copper five inches square connected with the bridge by stout cables. I have found in other experiments that after half an hour the resistance ceases to decrease, and in this experiment it actually increased to the amount of 480 ohms. The whole foot was immersed its sole resting directly on the copper plate. I have two other methods of making contact in use. The first consists of rubbing the skin with the oleate of mercury; which to the diffusion power of oleic acid adds the conductivity of its base, and then immersing the part in metallic mercury The other consist of inserting small silver claw forceps, known to surgeons as "serrefines," through the epidermis into the tissue below This is rather painful, but not more so than I find medical students eager in the pursuit of knowledge can and will easily undergo.—*Nature*.

COLOURING DIAMONDS.—It appers that if common yellow African diamonds are immersed for a few minutes in an aqueous solution of aniline violet, they acquire a fine steel-blue tint peculiar to the best stones.

Health and Home.

HINTS ON SLEEP.

The question of chief importance to most people in these overwrought wakeful days and nights is how to get good sleep enough. Dr. Corning drops a few simple hints which may be of value. In the first place, people should have a regular time for going to sleep, and it should be as soon as can well be after cunset. People who sleep at any time, according to convenience, get less benefit from their sleep than others; getting sleep becomes more difficult; there is a tendency to nervous excitability and derangement; the repair of the system does not equal the waste. The more finely organized people are, the greater the difficulty and danger from this cause. The first thing in order to sleep well is to go to bed at a regular hour, and make it as early as possible. The next thing is to exclude all worry and exciting subjects of thought from the mind some time before retiring. The body and mind must be let down from the high pressure strain before going to bed, so that nature can assert her rightful supremacy afterward. Another point, is never to thwart the drowsy impulse when it comes at the regular time by special efforts to keep awake, for this drowsiness is the advance guard of healthy, restorative sleep. Sleep is a boon which must not be tampered with and put off, for if compelled to wait, it is never so perfect and restful as if taken in its own natural time and way. The right side is the best to sleep on, except in special cases of disease, and the position should be nearly horizontal. Finally, the evening meal should be composed of food most easily digested and assimilated, so that the stomach will have little hard work to do. A heavy, rich dinner taken in the evening is one of the things that murder sleep. Late suppers with exciting foods and stimulating drinks make really restorative sleep next to impossible. Narcotics are to be avoided, save as used in cases of disease by competent physicians. The proper time, according to Dr. Corning, to treat sleeplessness is in the daytime, and it must be treated by a wise and temperate method of living rather than by medicines. This is good common sense, says the *New York Star*, from which paper we copy, and doubtless a vast deal of the debility, nervous derangement, and insanity of our time would be prevented by more good, restful, natural sleep.

ANALYSES OF FOODS.

In a long and interesting article in the *Pharmaceutische Centralhalle* on the nourishing powers of various natural and artificial foods for infants and invalids, Dr. Stutzer, of Bonn, gives the following results as far as concerns their nitrogenous constituents'

FLESH FORMERS.

	Per cent.		Per cent.
Caviar	25 81	Condensed milk	8 79
Revalenta	19 93	White bread	7 20
Smoked Ham	18 92	Biscuit	6 71
Fresh Beef	18 53	Oysters	5 70
Fowl (breast)	16 56	Cow's milk	4 00
White of egg	13 48	Extractum carnis	3 48
Yolk	13 01	Malt extract	0 78
Infant's food	9 90		

The above table gives rise to some curious reflections. The wonderful nourishing power attributed to oysters is found to dwindle into insignificance when compared with other food; for instance, a single hen's egg contains as much nourishment, that is to say, as much flesh-forming material, as fourteen oysters, while one-quarter pound of lean rumpsteak is equal to about five dozen of these delicious, but delusive molluces.

With regard to condensed milk, it contains much less flesh-forming material than is generally supposed. Taking four per cent. for cow's milk as a fair average, the directions on the can, if followed out, give unexpected results. For children's use, we are told to dilute the condensed milk with four or five parts of water. Taking the lowest figure we should then have five parts of diluted condensed milk which, according to Dr Stutzer's figures, would only contain 1.76 per cent. of flesh formers, instead of four per cent., while the milk sugar would be increased from 4.5 to 10.85 per cent. We know that woman's milk contains more sugar than cow's, but still not in the above surprising proportions. Now that so much canned milk is used for infants brought up by hand, it becomes a question how far mothers who cannot suckle their children are responsible for the health and even lives of their children by giving them milk from the tin cow instead of that of the living animal.

Dr. Stutzer further exposes the often exposed superstition about the nourishing power of beef-tea. He extracted all the extractible matter from one hundred grams of beef with one hundred grams of water, and a good proportion of salt, at a gentle heat for four hours, but could only succeed in obtaining in solution one-twelfth of the nourishing matter of the beef, the remaining eleven-twelfths remaining behind in the *bouilli*. In other words, we should have to take half a gallon of beef tea made with a pound of beef to each pint of water before we got as much nourishment as it contained in a quarter of a pound of steak. We might, it is true, evaporate our beef tea down to, say, half a pint, but we doubt if it would be palatable to the least squeamish invalid. The high value of eggs, too, is well shown; in fact, roughly speaking, a couple of eggs weighing three and a half ounces are about equal to two ounces of good rump steak.

Dr. Stutzer in the course of this article, mentions three samples of cocoa warranted free from fat (*entölter Cacao*) from different houses, which contained respectively 33. 48, 32. 31, and 30.95 per cent. of fatty matter of some sort. The highly nourishing powers of caviar will no doubt strike the "general" with amazement. With the law of libel in its present condition, we have been obliged to omit names, but Dr. Stutzer either has not the fear of the law before his eyes, or they "order these things"—legally, at least—"better in Germany."

NATURAL GAS FUELS.

Years ago, in their eagerness to tap from the earth its hidden treasures of oil, drillers generally expressed disgust when nothing but gas rewarded their efforts. Later, some enterprising men began to turn their attention to this great source of caloric, and, one by one, a number of iron and glass manufactories in Pennsylvania carried the gas into their mills. The *Engineering and Mining Journal* says they have not made much bluster over what they were doing, and have quietly pocketed the increased profits which their saving of fuel, due to the use of gas, has given them. Of late, however, the subject is attracting considerable attention in a quiet way, and recent developments indicate that the territory, which we may possibly be able to draw upon for the new supply of the fuel, is much greater than is generally believed. Gas wells have been opened and are utilized as far west as Detroit, and as far south as West Virginia, and Pittsburg is now getting excited over the extension of the business of Murraysville well in Westmoreland County. Pipes have been laid down to a number of glass and iron works in the eastern part of the great Smoky City, and a rapid extension of the field of the gaseous fuel is looked forward to. The belief is expressed by men whose opinion is worthy of much consideration, that the number of localities capable of being supplied with gaseous fuel in the States of New York, Pennsylvania, Ohio, West Virginia, and Michigan is much larger than the majority have any conception of, and the permanency of the flow of some of the older wells gives rise to the hope that it is a reliable fuel supply. Its cheapness and cleanliness are, of course, matters which are beyond all doubt. There are indications that during the present year a considerable number of companies will form to sink wells, and a "boom" is looked forward to that may bring forth the usual crop of unsound enterprises.

TRICHINÆ.

J. E. Morris, M.D., in the *Clinical Brief*, says in regard to trichinæ in swine that it is a well established fact that the real source of infection in swine lies entirely in the rat. A committee of Vienna physicians found in Moravia thirty-seven per cent. of rats examined trichinous, in *Vienna and its environs* ten per cent.; and in Lower Austria about four per cent. The well-known voracity of the hog, and its special fondness for meat, cause it to feed upon the flesh and excrements of other animals infested with these parasites, and especially rats and mice. To prevent trichinous swine it is highly important to to cut off all the sources of disease in the diet of these animals.

AN ELECTRIC RAILWAY.—An electric railway was to be laid down at Wimbledon this year for the National Rifle Association, the line being a mile long, and the train consisting of six vehicles, each carrying twenty-four persons.

STRAIGHTENING UP TIMBERS BY WEDGING.

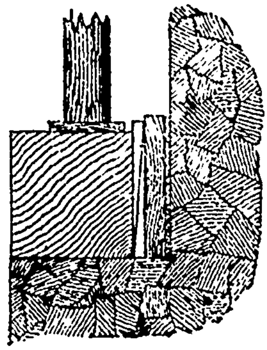


Figure 1.

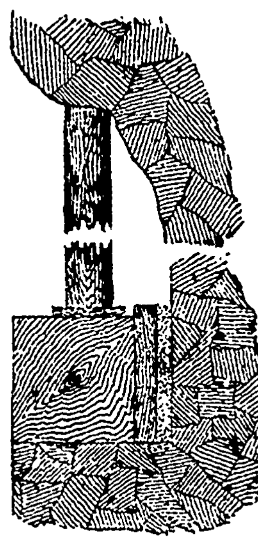


Figure 2.

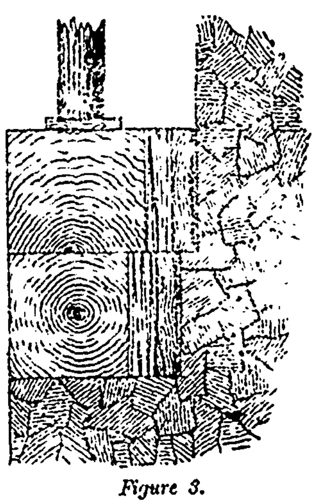


Figure 3.

The accompanying engravings show the means employed to move the heel or foundation of vertical timbers when it becomes necessary to do so. It sometimes happens that the movement of the ground cants the timbers. Again, it is sometimes necessary to swedge the timber out at the heel to get solid work. Fig. 1 shows where the wedges are driven, and Fig. 2 shows the same. Fig. 3 is a further illustration of the method of moving the timbers. The wedges are seen between the timber and side wall. The engravings are self explanatory.

THE FORMATION OF LUNAR CRATERS.

M. Jules Bergeron says, in a paper communicated to the French Academy of Sciences, and republished in *La Nature*: "I have noticed that when gases or vapors pass through a mass having the consistency of paste, they leave behind them funnel-shaped holes. Struck with the analogy which these holes present with the craters of the moon, I have endeavored to reproduce the phenomena on a large scale. To simplify my experiments as much as possible, I used alloys, melting at re-

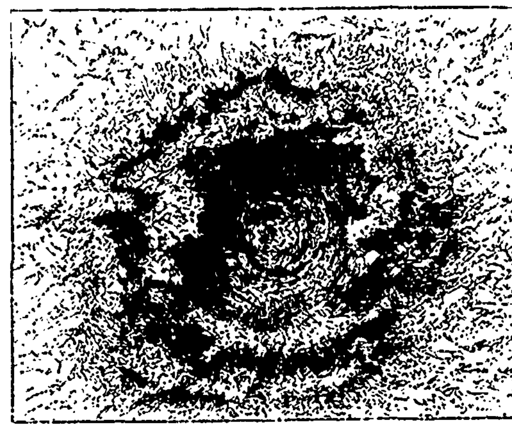


FIG. 1.—ARTIFICIAL CRATER OBTAINED WITH AN ALLOY.

latively low temperatures, taking the first Wood's alloy, of seven parts of bismuth, two of cadmium, two of tin, and two *of lead, which melts at about 158 ° Fahr. Having introduced* into the mass, melted in the salt-water bath, a current of warm air by means of a tin pipe, I allowed it to cool slowly while the inflation of warm air was still continued. The ebullition

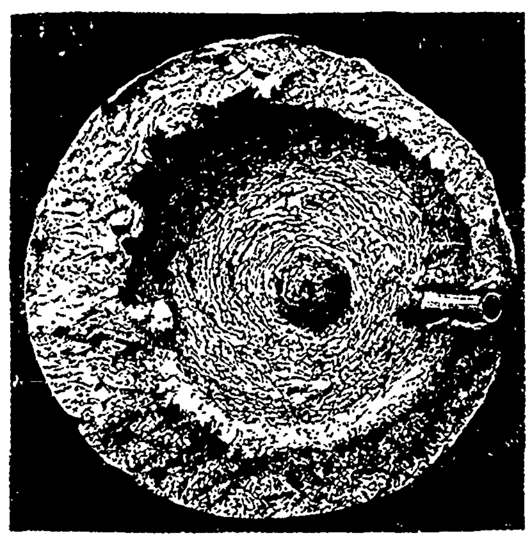


FIG. 2.—ACTION OF A CURRENT OF AIR ON A MELTED ALLOY.

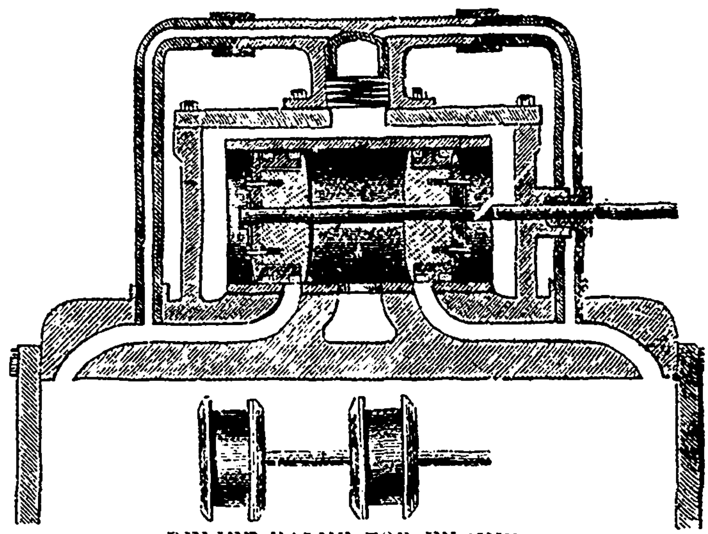
which took place reach all the parts—which were begining to solidify and form a pellicle—over a considerable surface; and there was formed before me a large circle, around which the edges gradually rose under the continued inflation, till it began to assume the appearance of a crater. At the same time, the metallic mass becoming thicker as the cooling went on, while it was *still blown out by the air, could no longer drive the solid* particles away from itself, and rose above the crater in such a way as to form a cone, which grew visibly more prominent. The crater also became more hollow, with its inner walls more inclined than the outer walls, and I had before me a formation strikingly analogous to the craters of the moon. The same phenomena were observed, whatever alloy I employed.

"Similar processes have possibly taken place on the moon. Instead of gas the reliefs may have been proceeded by the vapors, which rose freely from the body while it was in a fluid state; but the superficial part of the planet being cooled much more rapidly than the interior, the latter, still fluid, continued to emit vapors after the surface had become quite thick. The vapors found their way along the superficial envelope, and came out only particular points, where, doubtless, the process of solidification was least nearly accomplished. The vapors may consequently have been condensed, or absorbed, by the substances substituting the rock of the moon.

"As my first experiments were made in a capsule, the objection might be made that the circular form of the crater was produced under the influence of the shape of the walls of the vessel. To obviate such criticism, I employed a rectangular basin, in which I melted an alloy of four parts of lead, four of tin, and one of bismuth. The phenomena were produced as in the former case; but I found that the aspect of the mass after the formation of the crater varied according to what metal was used. With Wood's alloy, which is very fusible, the projections that fell on the edge of the crater flowed away, and left no trace of their passage. With the second alloy the projections all continued visible, and gave a *rent aspect to the crater.* Moreover, since the warm air was not hot enough to melt the metal, the projections might eventually overhang the bottom, as appears in Fig. 1.

"The second experiment was marked by a very interesting incident. Two concentric circular areas were noticed, the one nearer to the center being the higher. This was due to an interruption to the passage of the air during the formation of the crater. The edges of Copernicus, Archimedes, and several other lunar craters are marked by analogous features.

"A formation like a dike appears to rise in the center of a considerable number of craters on the moon. I have been able to produce something analogous to this also, a representation of which is visible in Fig. 2. After I had ceased blowing in air, a last bubble was formed, which uplifted the mass, but could not protect it above the edge of the crater. The lunar dikes are very probably formed in this way, by the action of the gas, at the end of the active period of the craters."—*Popular Science Monthly.*



RELIEF VALVE FOR ENGINES.

RELIEF VALVE FOR ENGINES.

The invention illustrated in the cut provides a main valve for engines of various kinds, the design being to admit the steam into the cylinder without any retarding pressure and to relieve the piston from back pressure caused by the pumping of air when running light.

Both ends of the cylindrical casing in this engine being open, the pressure of steam is equal and continuous at each end of the valve, and as the casing protects the circumference of the valve from pressure it is therefore perfectly balanced and will perform its duty without appreciable friction, and consequently with great economy of power.

When this valve is applied to a locomotive there is provided an automatic safety relief valve, which has a spiral spring for holding the valve against its seat, closing the connection between the interior of the steam chest and two pipes, the steam within the chest imparting the pressure necessary to insure a steam-tight joint. When the steam is cut off the automatic relief valve may be easily pressed clear of its seat. Should the engine be running without steam the air within the cylinder is compressed by the movement of the piston, having no exit through the posts from the point where the steam is cut off till it commences to exhaust.

This improvement was invented and patented by Messrs. Livingston & Kennedy, of Toronto, Ont.—*American Inventor.*

THE ORIGIN OF THE BALLOON.

Notwithstanding that "The Montgolfier Brothers" are credited with the invention of the balloon, Mr. Seth Green tells us of an older aeronaut. He says that if you anchor a pole in a body of water, leaving the pole above the surface, and put a spider upon it, he will *exhibit marvellous intelligence* by his plans of escape. At first he will spin a web several inches long and hang to one end while he allows the other to float off in the wind, in the hope that it will strike some object. Of course this plan proves a failure, but the spider is not discouraged. He waits until the wind changes and then sends another silken bridge floating off in another direction. Another failure is followed by other similar attempts, until all the points of the compass have been tried. But neither the resources nor the reasoning powers of the spider are exhausted. He climbs to the top of the pole and energetically goes to work to construct a silken balloon. He has no hot air with which to inflate it, but he has the power of making it buoyant. When he gets his balloon inflated he does not go off on the mere supposition that it will carry him, as men often do, but he fastens it to a guy rope, the other end of which he attaches to the island pole upon which he is a prisoner. He then gets into his aerial vehicle, while it is made fast, and tests it to see if it is capable of bearing him away. He often finds that he has made it too small, in which case he hauls it down, takes it all apart and constructs it on a larger and better plan. A spider has been seen to make three different balloons before he was satisfied with his experiment. Then he will get in, snap his guy rope and sail away as gracefully and supremely independent of his surroundings as could well be imagined.

Now who knows but this fellow gave the Montgolfiers their first notions of travelling through the air. When these men constructed their first balloon, in 1782, no human being was bold enough to go up in it, but they placed in the car a sheep a rooster and a duck. They all came down safely, and a young Frenchman named Rosier and the Marquis of Arlandes soon made a successful ascension.

One of the Montgolfiers' balloons fell in a village, and the villagers, supposing it to be a demon (its bound along the ground, the noise and smell of the escaping gas confirming the idea), shot at it and beat it to pieces with clubs.

It seems strange that the mind of man, which has made such wonderful discoveries in steam, electricity and general science, has not done much with it, as a means of travelling, since its invention a hundred years ago.

Inventions.

Boiler Explosions.—M. Treve publishes in the *Moniteur Industriel* a plan for diminishing boiler explosions, which are due to leaving the boiler full of water, which by boiling parts with its air. M. Boutigny had previously proved that water in this condition is in the spheroidal state, and liable to explosion. M. Treve advises the injection of air before reheating the water, and the use of a thermomanometer, which would indicate whether the vapor pressure is below that to be expected from the temperature of the water.

Incombustible Paper.—At a recent meeting of a French Society, Mr. G. Meyer has exhibited a new paste combination designed for the manufacture of incombustible cardboard or paper of all sorts and shades. The inventor did not wish to make known at the time the chemical composition of the paste, and also of a new ink exhibited with it, as the patents he had applied for in Germany and America, had not yet been obtained. He made known the fact, nevertheless, that asbestos was the principal thing employed in the manufacture of his incombustible paper.

He presented specimens of writing, printing, engraving, etc., made with his inks of different colors, and also showed a water-color drawing that had been submitted to the fiery ordeal of the potter's furnace. The painting had preserved all its brilliancy and the paper all its flexibility. By request, the inventor for a few minutes exposed to a gas flame a sheet of his paper, upon which he had written with ink of his composition. Neither the ink nor the paper changed. In order to demonstrate by a most conclusive test how great a heat the paper and ink were capable of withstanding, Mr. Meyer then placed a lithograph, fifteen by sixteen centimeters, between two layers of glass in a state of fusion. On removal, the paper was found to have completely resisted the action of the heat, and the engraving to have preserved all its sharpness.

Preservation of Railway Ties.—A few interesting facts are published in the English journals, showing the relative value of different methods of injecting railway ties. Upon the road from Hanover and Cologne to Minden, fir ties injected with chloride of zinc required a renewal of twenty-one per cent. in eleven years; birch ties injected with creosote required a renewal of forty-six per cent. at the end of twenty two years; oak ties injected with chloride of zinc required a renewal of about twenty-one per cent. at the end of seventeen years: while the same kind of ties in their natural state require a renewal of at least forty-nine per cent. at the end of a like period. The conditions in each of these cases were very favorable for obtaining reliable proofs; the sub-soil of the road was good; the non renewed ties showed, when cut, that they were in a sufficiently good state of preservation.

Upon another line where the oak ties were not injected, it was necessary to renew the ties in the proportion of seventy-four per cent. at the end of twelve years; these same ties injected with chloride of zinc required a renewal of only 3·29 per cent. at the end of seven years, while such ties injected with creosote required a renewal of only 3.09 per cent. at the end of six years.

A Scheme for Dredging the Red Sea.—Now that so many persons are engaged in making what they can out of Egypt it is interesting to find one disinterested person proposing a specelation of which the object is not to put money in the pockets of the promoter, but to implant or confirm faith in the breasts of all men. The Abbé Moigno has written a preface to M. Lecointre's "Compagne de Moise pour la sortie d'Egypte," in which he advocates the promotion of a joint stock company, with a view of exploring the bottom of the Red Sea, and especially the bitter water lakes. In a German account of the project, it is justly described as "one of the boldest." "It is nothing less," continued the writer, "than to search the bottom of the Red Sea to discover there the proof of that great event narrated by Moses 3 000 years ago. To provide the needful funds to carry on excavations which would have for their results the restoration to light of the remains of the Egyptian armies engulfed in the Red Sea, with the chariots, horses, arms, treasures, archives and perhaps the King himself--that Pharoah who was conquered by Moses—this will indeed be a noble enterprise. Buried in the masses of salt of the bitter lakes, concealed at different places by thick beds of salt, these historical remains are perhaps in a state of preservation unexpected to us." The Abbé estimates the cost of the excavation at 300,000 francs, and against expenditures he places nothing in the way of possible returns. It may be suggested without irreverence, however, that if the Abbé Moigno should succeed in disinterring but one indubitable wheel of Pharoah's chariot he might make no end of money.

The steamer City of Fall River.—The steamer City of Fall River, which has been recently added to the Fall River line between New York and Boston, exhibits some decided innovations. The engine, of 2,000-horse power, was designed and built by Messrs. A. & W. Fletcher of New York City. It is a compound beam engine, fitted with the Morgan feathering paddle-wheels, and supplied with steam by a Redfield boiler, all of which features are unusual. The steam-cylinders are 44 inches diameter by 8 feet stroke, and 68 inches by 12 feet stroke. The wheels are 25 feet 6 inches in diameter. The boilers are of Otis steel, and are tested to 150 pounds pressure per square inch. The boat is 260 feet long, 41 feet beam, 17 feet deep. Over the guards the breadth is 73 feet. The draught of water, loaded with 600 tons of freight, is 12 feet. This steamer has made the 181 miles from port to port in 10½ hours, and has made 17 an hour. The coal consumption is small, -20 tons per round trip.

Rubber Stamp Inks.—The following proportions are said to give an excellent ink, which, while not drying up on the pad, yet will not readily smear when impressed upon the paper, Aniline red (violet), ninety grains, boiling distilled water, one ounce; glycerine, one half teaspoonful, molasses, half as much as glycerine. The crystals of the violet dye to be powdered and rubbed up with the boiling water, and the other ingredients stirred in. Another indorsing ink, which will not dry quickly on the pad, and is quickly taken by the paper, can be obtained according to the *Papier Zeitung*, by the following recipe: Aniline color in solid form (blue, red, etc.), sixteen parts; eighty parts boiling distilled water; seven parts glycerine, and three parts syrup. The color is dissolved in hot water, and the other ingredients are added whilst agitating. This indorsing ink is said to obtain its good quality by the addition of the syrup.

A Useful Kind of Solder.—A soft alloy which attaches itself so firmly to the surface of metals, glass, and porcelain, that it can be employed to solder articles that will not bear a very high temperature can be made as follows:—Copper-dust obtained by precipitation from a solution of the sulphate by means of zinc, is put in a cast-iron or porcelain-lined mortar, and mixed with strong sulphuric acid, specific gravity 1.85. From 20 to 30 or 36 parts of the copper are taken, according to the hardness desired. To the cake formed of acid and copper, there is added, under constant stirring, 70 parts of mercury. When well mixed the amalgam is carefully rinsed with warm water to remove all the acid, and then set aside to cool. In 10 or 12 hours it is hard enough to scratch tin. If it is to be used now, it must be heated so hot that when worked over and brayed in an iron mortar it becomes as soft as wax. In this ductile form it can be spread out on any surface, to which it adheres with great tenacity when it gets cold and hard.

Miscellaneous.

Sea-Water.—Hercules Tonrœ and L. Schmelck state that they have been examining sea-water drawn at different depths and at remote points, and have detected but very slight differences in composition. Certain variations in the specific gravity were due to a dilution of sea-water by the continued introduction of ice or fresh-water, but the respective proportions of the various salts remained the same.

Causes of the Fertility of Land in the Canadian North-West Territories.—Robert Bell showed, that, with local exceptions, a vast fertile tract stretches from the Red River valley to the Lird River, a distance of some fourteen hundred miles, characterized by a dark loamy soil of varying depth and nearly homogeneous consistency. The primary cause of the fertility of this region may be found in the character of the subsoil, which consists largely of cretaceous marls and the comminuted material of the glacial drift. The speaker ascribed to moles and other burrowing animals the chief agency in the process by which the black loamy soil was formed out of this subsoil. Darwin had proved that in England and some other countries earth-worms played the chief part in the formation of mould. These worms appear to be absent in the north-west, as well as in most cold and sparsely settled countries, perhaps due to the depth to which frost penetrates. But in the north-west he believed the ground squirrels and moles more than made up for the absence of worms. In the fertile area referred to, the old and new mole-hills cover the entire surface, rendering it "hummocky," as is easily observed after a prairie fire. These animals are very active in autumn, digging many more burrows than would appear to be of any use to them. Each hummock thus thrown up covers about a square foot, and buries all the grass, etc., on this space. In this manner large quantities of vegetable matter were ultimately incorporated with the soil, which was also refined by the fact that the stones and coarse gravel are left undisturbed below the surface, so that in time they are more deeply buried by the layer of mould produced. By an interesting coincidence at the season when these burrowing animals are most active, the prairie vegetation is mature, and contains the greatest amount of substance. The coldness of the soil during a great part of the year tends to preserve the organic matter in it. While the circumstances given were the direct cause of the fertility, the ultimate reason was perhaps to be looked for in the climate, which fosters the growth of such vegetation as forms both the fertilizing material and the food of the little workers, who mingle it with the mineral portion of the soil. The action of frost in comminuting the soil does not account, by itself, for the introduction of the organic matter upon which its fertility depends, and which is due to the co-operation of the circumstances and agencies described.

Growth of the Skull in Dogs.—M. Lacassagne having communicated to the biological society of Lyons a paper on the cranial dimensions in man in their relation to social condition and intellectual culture, Dr. Arloing has followed up the subject upon dogs. Discarding the merely instinctive faculty, attention was paid only to the intellectual. The subject of weight and race was so far considered as to render it easy to make allowance for these, since the average weight of the well-known breeds is known everywhere. The following table tells its own story:—

	Weight of the skull.	Weight of brain.
	Grams.	Grams.
St Bernard	100.39	387
Large spaniel (Grand epagneul)	85.5	695
Bull, medium size	81.14	205
Bull, small size	53.2	110
Little spaniel	50.7	67
Loulou	53 9	62
Havana	73.6	60
King Charles	50.7	45

The brain of a small ape weighs from seventy to seventy-five grams. We see from the table that the weight of the head is doubled, while the weight of the brain is eight times greater, between the extremities of the table. The difference would be much greater if we could compare the weight of the brain with that of the body. The conclusion reached is, that education increases the dimensions of the skull in animals as in man.

The Liquefaction of Nitrogen.—MM. S. Wroblewski & K. Olszewski announced to the Académie des Sciences on the 23rd of April the complete liquefaction of nitrogen. Nitrogen cooled in a glass tube down to—136°, and submitted to a pressure of 150 atmospheres, remained gaseous—nothing could be seen in the tube. If the gas is allowed to escape slowly, and the pressure is not allowed to fall beyond fifty atmospheres, the nitrogen is completely liquefied, presenting a very distinct meniscus, and evaporating rapidly.

Fairy Rings.—An interesting contribution to our knowledge of so-called "fairy rings"—those circles of dark green grass which not unfrequently occur on pasture-land—will be found in a late number of the *Journal* of the Chemical Society. The luxuriant growth of the grass constituting the ring is connected with the decay of certain fungi which pre-existed on the spot and have yielded mineral and nitrogenous products which serve as manure to the grass that succeeds them. Sir J. B. Lawes, Dr. J. H. Gilbert, and Mr. R. Warington have analysed the soils of the fairy rings with the view of throwing light on the source whence the fungi derive their nitrogen. It seems fair to conclude from their experiments that the fungi obtain this element not from the nitrogen of the atmosphere, as formerly supposed, but from the organic nitrogen of the soil.

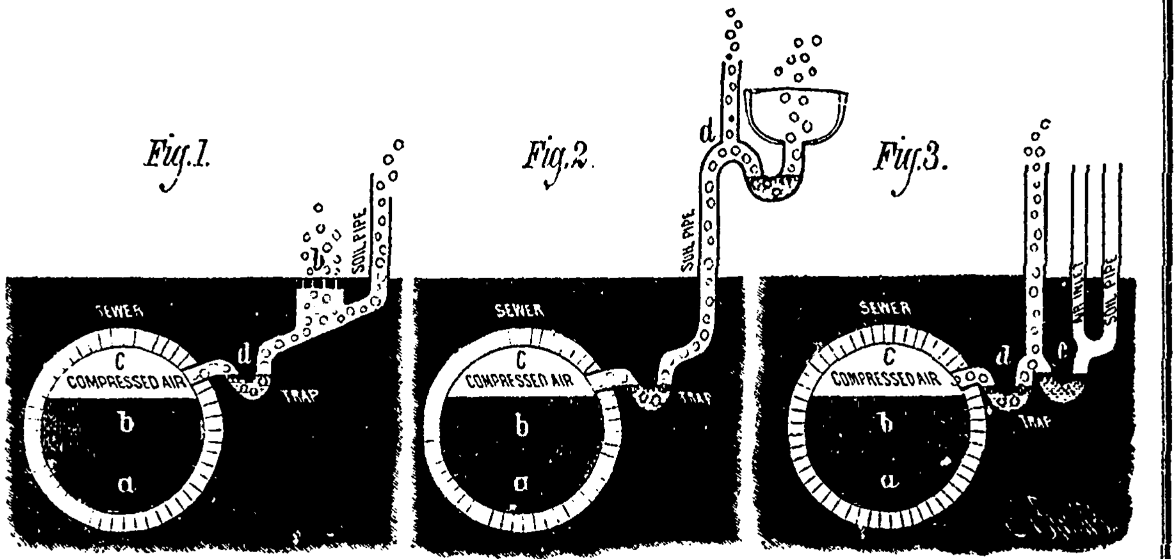
Formation of Comets' Tails.—In a recent paper, Mr Ranyard gives some further details with regard to his theory as to the formation of comets' tails. He points out that the experiments of Prof. Graham and the more recent investigations of Prof. Wright show that all classes of meteoric bodies hold gas as a sponge holds water. When the meteorites are heated in the laboratory the occluded gas escapes, and as a swarm of meteoric stones in space comes up to perihelion and is heated by the sun, the occluded gases must be driven off. At a distance from the heated nucleus, where radiation into space can take place freely in all directions, Mr. Ranyard conceives that a mist is formed by the condensation of the less volatile gases. The particles of mist will be bombarded on the side towards the nucleus by the swiftly moving molecules of the more volatile gases escaping from the heated meteors. Condensation on the surface of the mist particles and evaporation from their sunward sides will be set up, and repulsion of the mist from both the sun and nucleus will follow. According to Schiaparelli's theory a comet's nucleus consists of a swarm of meteoric stones; according to Mr. Ranyard's development of this theory the tail is due to a very thin mist formed from the condensation of occluded gases, the particles of which are driven backwards by the recoil due to evaporation towards the sun.

Glaciation of Norway.—H. M. Cadell describes the plateau mountains of Norway as an old surface of denudation, now lifted above its former base level of erosion, and greatly roughened by subsequent erosive action. He agrees with Penck in maintaining that there is a fundamental difference between Swiss and Norwegian glaciers; the former originating in sloping fields of *névé*, while the latter are overflows of upland ice-sheets. Three glaciers descend from the ice of the Folgefond, and twenty-three from the great Justedal ice plateau. These upper sheets are regarded as small examples of the present Greenland ice, and as remnants of what once "extended over the whole of northern Europe." The fiords are described as "most typical examples of true ice formed rock-basins," and it is stated that there is no evidence of fracturing or faulting in the rocks about them (although Kjerulf has shown the contrary statement to be true).

Increased Demand for Butter.—A German technical journal points out that the increase of population, with a decrease of cattle in civilized countries, increases the demand for butter to such an extent that before long all the available fat will be demanded for making "compound"; and as the makers of that can afford to pay a higher price than soap-boilers, the latter will have to dispense with fat altogether.

An Old Idea Upset.—Dr C. C. Abbott, of the Trenton, N. J., Natural History Society, has destroyed another old belief in weather lore. For twenty years he has kept a record of the building of their winter houses by the musk-rats, the storing of nuts by squirrels, and other habits of the mammals which are commonly regarded as indicating the character of the coming winter. His conclusion is that the habits referred to have no connection with the rigour or mildness of the approaching season.

THE INFLUENCE OF STORMS UPON WATER TRAPS.



A recent issue of the *Sanitary Record* (London) contains a valuable article on "The Influence of Storms upon Water Traps," by Henry Masters. The points he makes have application in cities in which the sewers are not ventilated. Strangely, there is considerable opposition to sewer ventilation, or, at the least, indifference to it; the result is indicated below.

There are three influences which affect the water seal of a trap, viz., the diffusion of gases, the absorption of gases by the trap water, and pressure by storm water; it is the latter influence which I propose in this paper to describe. I will suppose a common sewer to be cylindrical, and in dry weather the quantity of sewage passing through it is shown by the horizontal lines at *a*, Figs. 1, 2, and 3, and the space, *b* and *c*, above the average sewage contains sewer air; so long as the sewage does not rise above the average height, *a*, no pressure exists (except by the diffusion of gases, with which at present we have nothing to do). But suppose a storm occurs, and sufficient water passes into the sewer by way of the street gullies and house drains to raise the water in the sewer to the perpendicular lines, *b*, a certain amount of pressure will be the result, and the air, *b* and *c*, will be compressed into the smaller space, *c*, and in the proportion of *b* to *c*. The condition of the sewer air will now be much more dense and elastic, and press equally upon the intrados of the sewer and on the surface of the sewage, and if there were no escape for the compressed air, and the storm water rose higher and higher, the air would become denser and denser, until the pressure of the imprisoned air became equal to the entrance supply column of storm water, and then the water would cease rising; in our unventilated sewers this condition of things would exist, if it were not that a large number of house drains join the common sewer somewhat in the manner shown in my diagrams.

I have shown upon Fig. 1 an open disconnecting trap, *d*, and what would be the influence of water rising (as I have described) upon such trap. The compressed sewer air is being forced into the house drains, as shown by a series of circles; in the first place, the air will force the trap at *d*, and then may escape into the open air through the perforated cover, *b*. But if the soil pipe, *c*, be open at its top, or there be any defect in it or in the house drains, there is a possibility of an up or inward current being established, and a portion of such sewer air will be drawn into the house drains and escape by way of the soil pipe, or into the house; thus, to a large extent, the house drains will not be effectually cut off from the common sewers, for sewer air by entering the house drains neutralizes to a considerable extent the value of the disconnecting trap.

Fig. 2 shows a common arrangement of trapping drains, and, also, a common arrangement of four inch soil pipe ventilation by the extension of the soil pipe less in capacity than the soil pipe itself; it is not an uncommon thing to find such extension pipes varying from three-eighths of an inch to three inches in size. The effect of pressure *in such cases is as I have* again shown by circles (see Fig. 2). It will be seen that the compressed air ascends freely until it reaches the bend of the soil pipe at *d*, and at this point a portion escapes up by the small soil pipe extension and into the open air, as shown by small circles, but the major part forces the closet trap, and, of course, enters the house, thus showing for effective ventilation the absolute importance of soil pipes being extended their full size, and, if terminals of any kind be fixed upon their upper ends, the openings of such *terminals must be at least of the* same area as the soil pipe, for any less size would check the ascension of the air, and an undue pressure be put upon the closet trap water, and the chance of the water seal being broken in consequence.

The effect of air pressure upon a double water seal trap is shown in Fig. 3, and although the compressed air, as in Figs. 1, and 2, forces its way through the trap, *d*, nearest the sewer (the escape being of the same area as the drain itself), the inner trap, *c*, will not be *affected by* pressure; *the sewer air is* effectually prevented from entering the house drains by this precaution, showing the importance of two complete water seals to a main trap, and, also, that a large escape pipe should be set between the traps.

In dealing with large soil pipe drains, great difficulties exist in effectually arranging the drainage of a house so as to exclude sewer gas, and to exclude this no one will doubt to be of primary importance. If a disconnecting chamber, or an escape pipe, be the safeguard adopted, *the perforated grating, or pipe,* should be of equal area to the drains it has to relieve; thus, a nine inch drain must be provided with perforations or pipe equal to about sixty-three superficial inches; a six inch drain, twenty-eight inches; and a four inch drain, thirteen inches. Perfect safety cannot be obtained unless this rule is made absolute.—*Scientific American.*

NOTICE OF MEETING.

AMERICAN INSTITUTE OF MINING ENGINEERS.—The Autumn Meeting of the Institute will be held in Troy, N. Y., during the second week in October. This meeting will be mainly devoted to the reading and discussion of papers. Members who wish their papers fully discussed at the meeting can have them printed and circulated in advance, if they are sent to the Secretary early in September. Thomas M. Drown, Secretary, Easton, Penn.