CANADIAN MECHANICS MAGAZINE AND PATENT OFFICE RECORD

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SANITARY ARCHITECTURE AND APPLIANCES.

IN this very important subject a great deal has lately been written in the *London Builder* and other English scientific papers, and if they find so much cause to blame the Sanitary Architecture of a country in which the profession of an Architect is looked up to and more respected than in this Colony, and which is backed up by the law in designing and carrying into execution the most approved appliances for the ventilation and drainage of houses, what can we expect in this country where the Architect has no legal recognized standing, where his best designed plans are often set to naught and changed, where nineteen out of twenty proprietors are their own builders, where we have only a Building Inspector in *name*, and where the Municipal Laws of this City regarding drainage are almost a dead letter. Knowledge of the vital points of health is being discussed and spreading slowly, but so very slowly, that we fear it will be a long time indeed before the proper remedies are applied and proper Inspectors appointed to carry out the law to its fullest extent. The Sanitary Education of Montreal in this respect, must begin in the cradle, and from the cradle too comes the plaintive cry of thousands of little babes who are dying prematurely under the poisonous effects of the mephitic gases arising from our foul drains, and the imperfect ventilation of our crowded houses. Our children are poisoned even in their mothers arms, are poisoned in their beds, are poisoned in our schools, and are poisoned whilst playing in the streets from the gases from the sewer-gratings: and the apathy that is shown by almost the entire population to the presence of this death dealing agent, is almost incredible, if we were not so well aware of the fact. Diptheria, typhoid fever, scarlet fever, fevers of various kinds; sore throats, and a general depression of the system comes upon us, and we scarcely ever give a thought as to the primary and actual agent that brings on these diseases and is carrying to the grave the loved members of a family. On the other hand when one of a family feels seriously ill, no matter at what hour of the night it may happen, even if 30 deg. below zero, or in the heaviest storm of rain and wind, we willingly rush from the house to seek for a doctor; we sit up night after night watching the sick one, attending to the instructions of the medical adviser; the body is worn with fatigue and want of sleep, and the mind is borne down with grief — for *death* is in the house. The fatal agent has done its deadly task, the body of the lost one is carried to the grave and the members of, perhaps, several families thrown into mourning. Doctors bills, undertakers bills, mantaumakers bills, tailors bills, and other heavy expenses are incurred, and all because the tenant, or landlord, was too apathetic too careless, or too stingy to spend a few dollars— perhaps not five dollars in all—to see that the drains *inside* his house were in order, and their ventilation perfect. We build on filth, on bones—some of them human bones—on a debris of putrid animal, vegetable, and refuse matter. We use no precautions to prevent the miasma that must ever he issuing therefrom, from arising and circulating through every room in the house. We allow privies to be without ventilating shafts, we allow them to overflow into yards, we allow the wooden pavements and boarded yards to be saturated with vile matter thrown upon them from windows and galleries, we allow the gas from the street sewers to issue forth and roll into our open windows in summer, or to poison the breath of the passer-by. Our Court-houses are pest houses; schools are over crowded and not half ventilated, and in most instances the system of ventilation is to open a window by which the children get severe colds, sore throats, and congestion of the lungs—the remedy being equal to the disease—and yet we talk loudly of the evil, and very learnedly of the remedies to be employed, and that is all; the engine is there, but no steam, no motive power. Sometimes we call a public meeting to make inquiries into these matters, and we nominate a Lord Bishop, a member of Parliament or some persons who are fond of public meetings and public speaking, but who from their positions in life, their obligations to other, and, to them, more important matters, or, from their incompetence, are no more fit to grapple with the evil or to attend to the obligations imposed upon them by the public, (and which they have accepted merely as a sort of necessary compliment) than so many children. We do not go so far as to say that there are not some exceptions in such cases, but unfortunately upon these exceptional cases fall the heaviest task, when the active members eventually withdraw from it in disgust, and the matter is forgotten, until some pestilence is again bred and fed into fatality by the foul fat vapours that issue from the drains.

If we look to many of our houses of the poorer sort they are damp, stuffy, and fetid, they are overcrowded; while in residences of greater cost, the appliances may be perfect but the construction imperfect, gases leak out in different places and finding their way under the doors, accumulate at night in sealed up bed-rooms, when the system being relaxed in sleep is more easily affected by the poison. The effects of an atmosphere so foul, from the imperfect æration of the blood and its accumulation on the lungs, soon cuts short the thread of life in the young, and renders the adult more readily susceptible to attack from epidemics or diseases of an inflammatory form. The youngest children fall most readily under its attacks, but its effects may be seen in the pale faces and debilitated constitutions of many who are ever complaining of headaches and want of vital power, without ever dreaming of the source from whence they arise.

If we look to our public buildings there is little less to be condemned; and the drainage in the mercantile part of the city, and the filthy state of the privies in that locality is a disgrace to the merchants, but a greater disgrace to a Corporation who allow such a state of things to exist.

The time has arrived when this state of things must *cease to exist*, and there must be a more general demand for Sanitary Architecture. Houses must not be built merely to *sell* or to *let*, they must be built to live in, and all those arrangements carried out which make life vigorous and healthful. Ask the clergymen of this city, who have had so many opportunities of visiting the poorest classes, what is the proportion of bed-rooms they enter into which have little or no means for changing air, where each inmate has not a hundred feet of space; and what is the consequence? why a degraded condition of health, a kind of half life, no energy, no power, the mind becomes half paralyzed. More than two-thirds of the children born in such places die before they are five years of age, and the death rate in such localities is five times as high as it is amongst people living under more healthy conditions. There is a cry in this city at present, "Let us have light," we echo the sentiment, and let the light purify the air, the want of which, brings debility, fever, *death*; widowhood, orphanage and pauperism. The rich man often after building a splendid villa containing within its walls, all the comforts and conveniences that experience and modern appliances can devise, expecting to spend a few more years of life in quiet enjoyment and the comforts and pleasures of a beautiful home, is suddenly cut off by fever, caused by insidious gases issuing from hidden sources beyond his power to examine, and beyond his comprehension to understand; when everything that money could buy had been obtained to make the drains perfect—except *workmanship and brains.*

It would be well now to enter into some details with respect to Sanitary Architecture. Commencing with the foundation of a house. If the foundation is built on the original soil, and it is dry, no difficulty exists; but if, as frequently happens in cities, the foundation has to be laid upon a made soil, formed from the rubbish and refuse of yards and streets, too great precaution cannot be taken to prevent foul air continually arising therefrom. Again in swampy localities, or in places where quicksand, resting upon blue clay, under-lies the super-strata, as in the case of that locality immediately above Sherbrooke st., on each side of St. Lawrence street, and where the basements are for ever damp—a good layer of cement concrete should be spread over the whole area, and a "damp-proof course" in the walls just above the ground line. The custom, however, is to lay the flooring over the damp earth without any means of air circulating beneath, and the result is damp musty basements, and in a few years the whole flooring is destroyed by dry rot. The value of concrete as a building agent in certain localities is very great, and is coming much into use in Great Britain.

But it is from the effluvia from the drains of our houses whence the main source of all zymotic diseases arise. These are often ill-formed and of permeable material, frequently laid without proper fall, and often with fall the wrong way, so that the solid matter remains in them. Often the junctions are at right angles to the main drain and upon the same level: but what is worse than this, the joints are so imperfectly cemented, that there is a constant leakage until the whole sub-soil of the house is completely saturated with filthy oozings: the condition of the lower parts of some of our houses, if laid bare, would be perfectly startling. All drain pipes should be so laid that they could be examined at any moment without the necessity of taking up the flooring.

Now as regards the traps that are used, and considered by so many as perfect safety guards against all foul gases, and thereby lulling suspicion, it has been ironically said that they are well named *traps*. "Traps to catch a fever" the connexion of waste-pipes from cisterns, and pipes from sinks with drains, has produced deadly results, it is at the connexion of the drain-pipes with traps that all the foul gases accumulate, and when a rush of water passes through the trap, a vacuum is caused and the gases are forced upwards into the house. The pressure of gases at this point, when the wind is in a certain direction, is so great, that they are forced through the water in the trap. There have been several improvements made recently in traps (including a cowl to aid in ventilating the soil pipe.) It is so formed that the solid matter rapidly passes away, holds sufficiently to seal the end of the soil-pipe, and has attachments to ventilating tubes, this is one of the great improvements which lately has been well laid hold of by the public in England—the necessity of the ventilation of the house drain. On the latter subject, some excellent suggestions have been submitted by R. T. Godfrey, Esq., M.D., Professor of Hygiène, &c., McGill College, Montreal, founded on personal experience, and which, with some modifications to suit localities, will probably be generally adopted for the future in this city. A most useful ventilator for ventilating sewers has been patented by Mr. Stott, England. An air-tight sheet-iron door is fixed to the ash hole of a boiler and connected with the drain by stoneware pipes: the fire is thus fed by the noxious gases, and a continual flow of air drawn from all adjacent sewers, it has been found, however, necessary to trap all the openings within a radius of 300 or 400 yards, thence to the extent of the district the gullies can be open to admit air to fill the partial vacuum formed by exhaustion. This plan if carried generally into use would have the effect of producing a down-draught through the street gratings and thus, during the day time, prevent the gases from rising into the streets.

We consider, however, that great precautions would have to be taken, when the furnaces were in use, to shut off the foul air, or to ensure its being carried up the chimney shaft.

An excellent plan for ventilating drains, and very similar to the one proposed by Dr. Godfrey, has been brought forward by Alderman McLaren, an illustration of which will appear in the *Canadian Illustrated News* of the 19th inst., but as the subject is to be discussed soon by the City Council, we shall postpone our remarks on this plan for a future number

In a future number we shall furnish illustrations on the most approved methods of ventilation and drainage of cities.

SOCIETY OF ENGINEERS.

November, 1st, 1875.

Mr. W. H. Adams, President, in the Chair.

(See page 80.)

Mr. Griffiths has latterly advanced certain views respecting the mode of fitting screw propellers. He advocates, first, the inclosing of the screw within a tube-like case or shield, to which the water coming to the screw can only obtain access from below; the diagram No. 1 shows the arrangement. The author will not enlarge on the scheme, it is one which has provoked much controversy. Mr. Griffiths claims as regards the inclosure of the screw, that the water is more equally fed to the screw, more closely confined to it, and is led from it in such a direction as is best calculated to economise the engine power and give the best working results. He also claims that the inclosing of the screw protects it from fouling and from danger of fracture. Mr. Griffiths likewise advocates the duplication of screws, not on the ordinary twin principle, but in the manner shown in diagram No. 2, one screw being placed in the head and another at the stern of the vessel.

In a paper which Mr. Griffiths read before the Institution of Naval Architects he stated that his attention was first drawn to the necessity of having bow and stern screws from the danger attending the use of the long steamers now employed, that danger being increased by making the safety of the ship dependent on a single set of machinery, an arrangement also that increases the difficulty of constructing machinery, owing to the immense castings and forgings necessary to develope the great engine power demanded to secure high speed. The opponents of the shield-tube over that while the screw has less chance of becoming fouled, should it become fouled it would be infinitely more difficult to clear than an uncovered screw. As regards the use of the tunnel as a water feeder to the screw, Mr. Griffiths cites the case of the Dwarf, which, with a speed at first of about 9 knots, was subsequently reduced to about 3½ by planking up the after run of the vessel; this result he attributes solely to the circumstance that the alteration of lines obstructed the flow of water to the screw.

In a second paper, Mr. Griffiths stated that, in the course of experiments with a model, he found that when he divided the power and applied one-half to the stern and another to the bow screw, each screw being enclosed within a tunnel, the speed of the model was increased nearly as the square root of the power, but when the power was doubled alone on the bow or stern screw, then the increase of speed was only as the cube root of the power. The way Mr. Griffiths accounts for this is that a better water supply reaches the screw.

Having said so much of a particular and important innovation in existing practice in screw propulsion, the author will now proceed to say a little about the nature of that practice, as carried out by the best firms in the present day. The diagrams illustrate a somewhat singular diversity of practice amongst engineers, the various screws varying greatly from each other, both in the shape and proportion of their blades and the number of blades forming each.

Diagrams No. 3 illustrates a three-bladed screw, fitted to H. M. S. Lapwing by Messrs. Rennie. The diameter of this screw is 8 ft. 6 in., the pitch varying from 9 ft. 6 in. to 13 ft. 6 in. This screw is a fair example of a Griffiths three-bladed propeller, and was designed to comply with those conditions discovered by Mr. Griffiths as regulating the most efficient action of his propeller. It has a boss, which tapers outwards, and the blades are slightly curved forward, the pitch of the screw is uniform. The nominal horse-power of the Lapwing's engines was 80, the indicated power 502, or 6·25 times the nominal; the diameter of the propeller was 3¼ times of the boss.

Diagram No. 4 illustrates a double two-bladed Mangin screw, fitted to H. M. S. Bullfinch. It is 7 ft. 3 in. in diameter, pitch uniform, nominal horse-power of engines, 80; indicated horse-power, 458·5; or about 5⅝ the nominal. This form of screw is frequently made with a varying pitch, and is also made as shown in diagram No. 5, which is a more modern form than that of the screw of the Bullfinch. In February, 1868, H.M.S. Blanche was officially tried, being fitted with a Mangin screw; diameter, 14 ft. 7 in.; pitch of the leading portion of the blade, 15 ft. 7 in., and of the trailing portion 17 ft.; the mean length of blade on keel line being 12 ft. The speed of the ship was 13·631 knots an hour the screw making 88½ revolutions with full boiler power; half boiler power gave 11·78 knots. The official report stated that the use of full power created a heavy thumping acting upon the ship's stern, the same action being very marked during comparative trials with the Shannon about ten years ago,

Diagram No. 6, illustrates a common two bladed screw by Messrs. James Watt and Co., 16 ft. in diameter, and 20 ft. pitch; length of blade on keel line, 3 ft. 4 in.; indicated horse-power of engines 458. A propeller of this kind, provided with lifting gear, was fitted to H.M. troopship Simoon.

Diagram No. 7 illustrates a two-bladed Griffiths propeller fitted to H.M.S. Collingwood by Messrs. Rennie. The author is not in possession of any particulars of its performance.

Diagram No. 8 represents a six bladed screw having a diameter of 15 ft. 9 in., and a pitch varying from 17 ft. 6 in. to 21 ft. 6 in., fitted to the Egyptian Government steamer Charkieh, and the theory of its action was, that by sub-dividing the surface of the blades into many parts, a greater uniformity of action results; but comparative experiments with this and a three-bladed screw demonstrates that little advantage rested with either. The first-named screw was used from Malta to Alexandria; the latter screw was used from Venice to Alexandria, and the hourly consumption of coal was 34 cwt. 0 qr. 9 lb.; mean speed, 10·69 knots.

Trials of the Charkieh with a six bladed propeller and a three-bladed propeller:—

Kind of screw.	Consumption of coal per hour.	Mean speed.
6 bladed	33 cwt. 3 qr. 15 lb.	10·65 knots.
3 bladed	34 cwt. 0 qr. 9 lb.	10·69 knots.

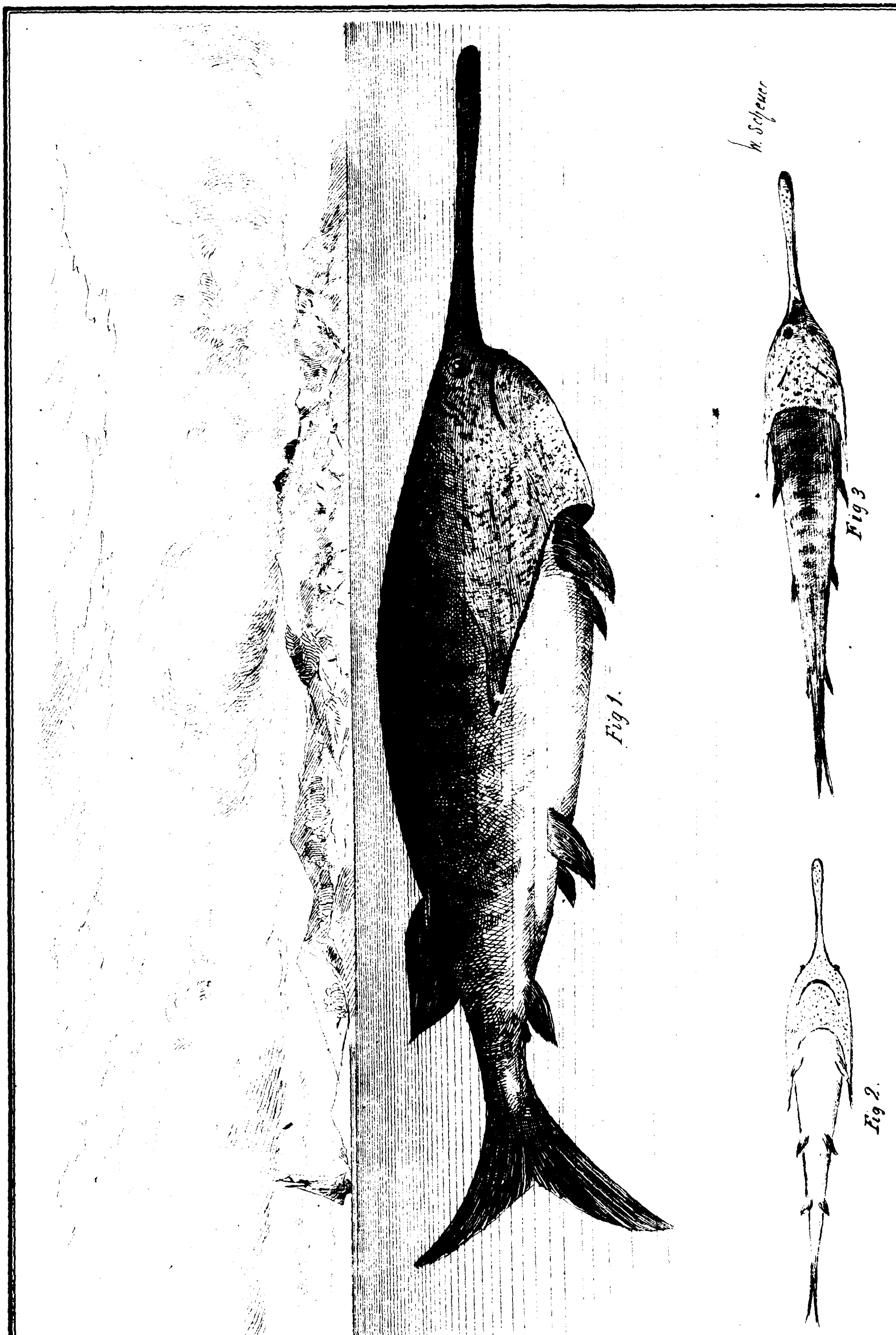
The six-bladed propeller, however, caused the least vibration.

The following table shows the comparative particulars of this vessel with a six-bladed propeller and those of the steamship Ruahine:—

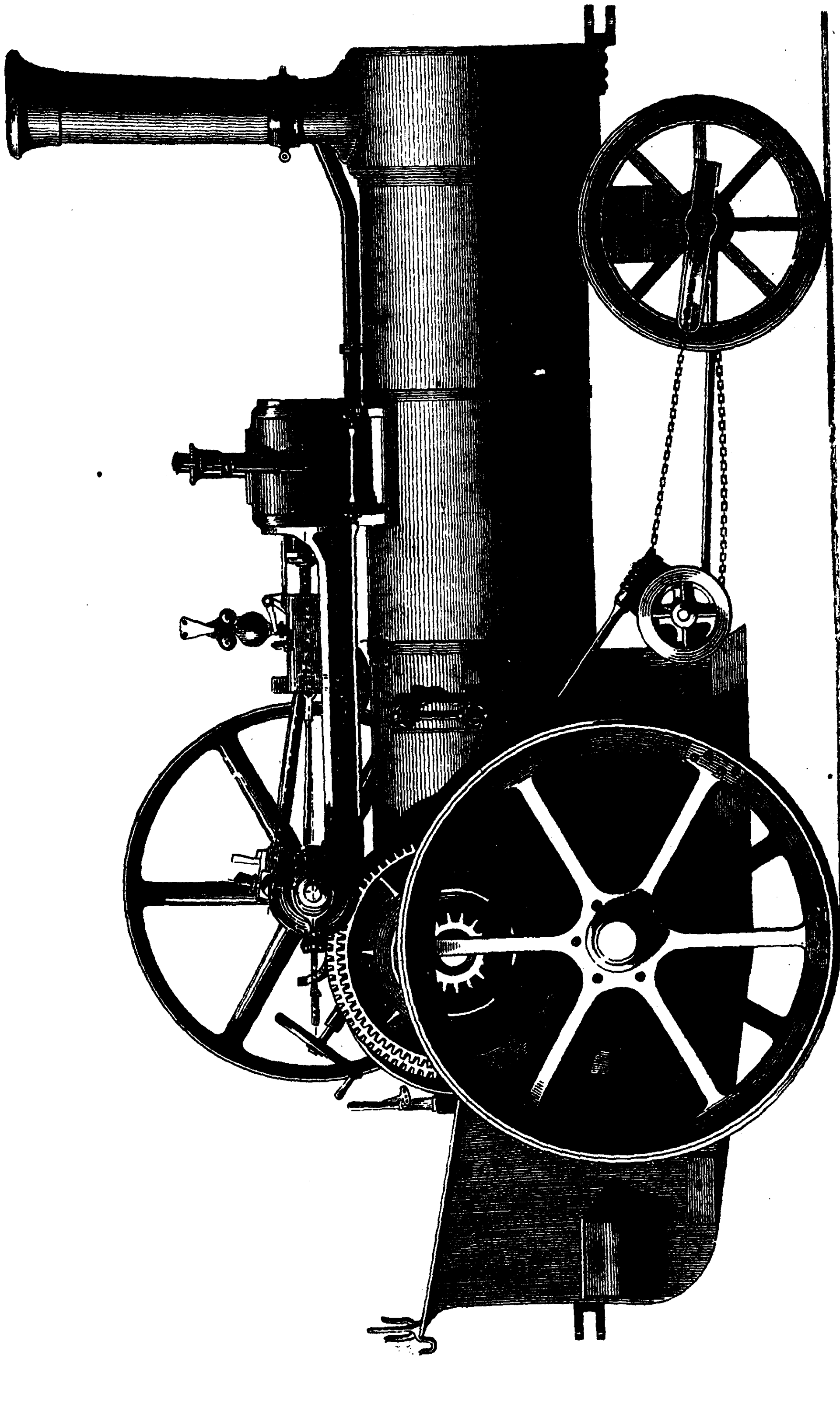
Charkieh and Ruahine.

Name of ship.	Displacement in tons.	Area of midship section in square feet.	Indicated horse-power.	I. H. P. / Area of midship section.	Displacement in. / I. H. P.	Speed in knots per hour.	Area of mid-section in square feet. / Total area of propelling surface in square feet.	Speed 3 — mid-section. / I. H. P.	Speed 3 — 3 — displacement. / I. H. P.
Charkieh .	2200	462	1475	3·192	1 491	11 4	8·105	459·30	169·19
Ruahine . .	1850	424	1540	3 632	1·2	13	10·408	604·88	215·4

Diagram 10 illustrates the propeller of the latter vessel. Diagram No. 9 represents the two-bladed Griffits screw fitted by Messrs. Maudslay to H.M.S. Lord Warden and Lord Clyde, which are sister ships. The diameter of the screws is 23 ft.; mean pitch, 23 ft. 6 in., varying from 21 ft. to 26 ft.; the indicated horse-power of the engines is 6705; number of screw revolutions, 63·3; speed of ship, 13·49; displacement, 9000 tons.



EXTRAORDINARY FISH CAUGHT IN LAKE HURON.



SIX-HORSE POWER TRACTION ENGINE.—END VIEW. (See page 69.)

The following table shows the relative performances of H. M. S.'s Minotaur, Agincourt and Bellerophon.

The next propeller to which the author would direct attention is the Lowe-Vansittart, and Table No. 7 shows the performance of this screw as contrasted with the Griffiths, fitted to the same vessel, the Scandinavian, while Table No. 8 shows the results attained with H. M. S. Druid. With the former vessel it was found that the speed attained while using the Griffith four-bladed screw, diagram No. 10A, was 11¾ knots, while with the Vansittart screw, diagram No. 10B, the speed was twelve knots, the indicated horse-power being equal in both cases. Each screw had four blades and was 25 ft. pitch.

Minotaur, Agincourt, and Bellerophon.

Name of ship.	Displacement in tons.	Area of mid-section in square feet.	Indicated horse-power.	I. H. P. / Area of mid-section in square feet.	Displacement in tons. / I. H. P.	Speed in knots per hour.	Area of mid-section in square feet. / Total area of propelling surface in square feet.	Speed 3 — mid-section. / I. H. P.	Speed 3 — 3 — displacement — 2 / I. H. P.
H. M. S.									
Minotaur....	10275	1322	6193	4·684	1·659	14·16	9·713	606·71	216·616
Agincourt	9000	1187	6867	5·785	1·310	15·43	8·600	635·38	231·242
Bellerophon	7369	1207	6199	5·135	1·181	14·05	—	540·37	169·229

VANSITTART TABLE.

*SS. Scandinavian, Liverpool to Montreal and back.—**Registered tonnage**,* 1811.

Nominal H. P.	400 ..	400
Indicated do, average	1800 ..	1800
Number of revolutions	54 ..	47½
Steam pressure	30 lb ..	30 lb
Average speed, knots	11¾ ..	12
Displacement	5375 tons ..	5375 tons
Diameter of propeller	18 ft. ..	18 ft.
Pitch of do	25 ft. ..	25 ft.
Description of do	Griffiths ..	Lowe-Vansittart
Number of blades, steel	4 ..	4

H. M. S. Druid, 350-*H. P.*

Immersed mid-section, in square feet	413·3 ..	413·3
Revolutions per minute, mean ..	96·8 ..	95·03
Indicated H. P	2373·74 ..	2271·71
Speed of ship, knots..	12·986 ..	13·064
Speed 3 — mid-section, I.H.P. ..	381·3 ..	403·0
Description of propeller	Griffiths ..	Lowe-Vansittart
Slip per cent	10·37 ..	8·01
Number of blades	2 ..	2, gunmetal Henrietta Vansittart

Place of trial, Maplin Sands, on measured mile, by order of the Admiralty, December, 1869.

A trial was made in Stokes Bay with H.M.'s gunboat Fancy, to test the Vansittart and the common screw, and it was observed that there was an almost total absence of vibration when the former was used. The reversing of the propeller backed the boat in a perfectly straight line. The common screw is shown at diagram. No. 11, and the Vansittart screw is shown on diagram No. 12, while Table No. 9 gives particulars of both.

Trial of H.M.S. Fancy with the Lowe-Vansittart propeller, made on the 24th June, 1868, against the common screw manufactured by Messrs. Penn.

Description of propeller	Common screw in gun-metal ..	Lowe-Vansittart in iron
Where tried..	Portsmouth	
Draught of water forward ..	6 ft. 8 in.	
" " aft ..	7 ft. 1 in.	
Area of mid-section, immersed	134 square feet	
Steam pressure in boilers ..	40 lb.	
Mean pressure in cylinders ..	35·39 ..	37·69
Mean revolutions per minute	180·19 ..	153·3
Indicated horse-power	194 ..	176
Speed on measured mile, mean of 6 runs	7·9 ..	7·9
Duty performed, or speed 3 x mid-section, I.H.P..	347·5 ..	377·8
Diameter of propeller	6 ft. ..	6 ft.
Pitch of do	6 ft. ..	7 ft. 1 in.
Remarks as to vibration	Considerable ..	Very slight.

Diagrams 13 illustrates a propeller designed bp Captain Rothwell, of the Cunard steamship Parthia. His object was to reduce the vacuum or back drag, and to give greater strength and efficiency to the blades without adding to the weight. To attain this end, the propeller was arranged as shown, a small blade being placed partly behind the larger one, and set a little coarser, both blades being set so that the leading edge of the rear blade and the rear edge of the large or leading blade are parallel with the line of shaft, both blades being curved, the large one convexed aft, the small one convexed forwards, both peripheries being connected. This form of blade cannot be broken, it is claimed, by a sea striking it. The rear blade receives a clean thread of water and throws it off with the same velocity as the leading blade, thus destroying the back drag or vacuum of the large blade and reducing it to what would be found behind the small or rear blade. Also partially preventing the water from fouling or honey coming the foreside of the blade, as the blade let could be made to bolt on to the large blade, thus saving a new propeller, as some ships wear a propeller very quickly from that cause. Captain Rothwell says :—"I have great faith in it reducing the vibration, on account of its peculiar construction, rotating in a volume of irregular density, this being the chief cause of vibration in ships propelled by the screw ; a ship plunging into a heavy sea, as her stern falls the descending blade has an immense resistance opposed to it, while the opposite or ascending blade had its burden greatly lightened, causing the pressure of propulsion to be so unequal that if there is the least chance of looseness in the stern gland, or the shafting or bearing blocks not very firm, the result is great vibration, independent of what may be caused by the engine racing when the screw rises out of the water In respect of the action of the propeller on the helm, with a right-handed screw, steaming full speed, most ships carry a little starboard helm. If one of such ships were to have her engines suddenly stopped and reversed full speed astern, the helm being placed amidships, then her stern will incline to starboard. I have always noticed that ships with a longfore-gripe turn very badly either way, and when moving either ahead or astern."

The next propeller for notice is that of Dr. Collis Browne, shown in diagram No. 14. It appears to be a right and left-handed screw, but it is not so, as the four blades really represent the action of but two, as it will be seen that one of either pair of blades is one portion of the same spiral as that of its companion. The performances of this propeller on board the Galatea, Trinity-house launch, were such that the same work was done by it by 60 lb. of coal per hour as was done by a Griffiths screw with a consumption of 80 lb. per hour.

Diagram No. 15 shows an arrangement for employing a supplemental screw to assist in steering a ship. Three mitre wheels transmit the motion of the main shaft to the supplemental screw mounted within the rudder. From the mode of arrangement it will be seen that the rudder has perfectly independent action, while at the same time the action of its contained screw is to force aside the ship's stern either to port or starboard. It is the invention of Mons. Victor Lutschaunig, Professor of Naval Architecture to the Imperial Academy at Trieste. He read a short paper on the subject before the Institution of Naval Architects in March last year. In it he stated that the idea of swivelling the propeller of a ship in order to make it serve also as a means of steering dates back to the year 1862, but that the practical difficulties of working the scheme with large ships were such as rendered that idea utterly impracticable. He therefore devised his scheme by which the main propeller is left to fulfil its legitimate functions another independent screw being added for steering purposes. He further stated that this scheme was applicable to balanced rudders, but that they would no longer be requisite where his plan was adopted with his supplemental screw, it being preferable to balanced rudders ; that critics of his system have suggested universal joints instead of toothed gear, but that his reply has been to them, first, that as it is expedient that the supplemental screw should revolve in a direction opposite to that of the main screw, toothed gear becomes a necessity ; and secondly, that by the use of a universal joint the rudder could not be unshipped. The advantages claimed are great increase of steering power ; the possibility of turning the vessel from her position of rest, with the first revolutions of the engines ; from the use of two screws revolving in opposite directions, the evil of a ship moving with a port or starboard helm is obviated ; and that the rudder can be unshipped or shipped while the vessel is afloat.

(To be continued.)

S. A. T. says : To stick leather, paper, or wood to metal ; to a gill of glue dissolved in water add a tablespoonful of glycerin.

ANCIENT ENGINEERING, ITS METHOD AND APPLIANCES.

No. I.

(See page 77.)

(Continued from page 38.)

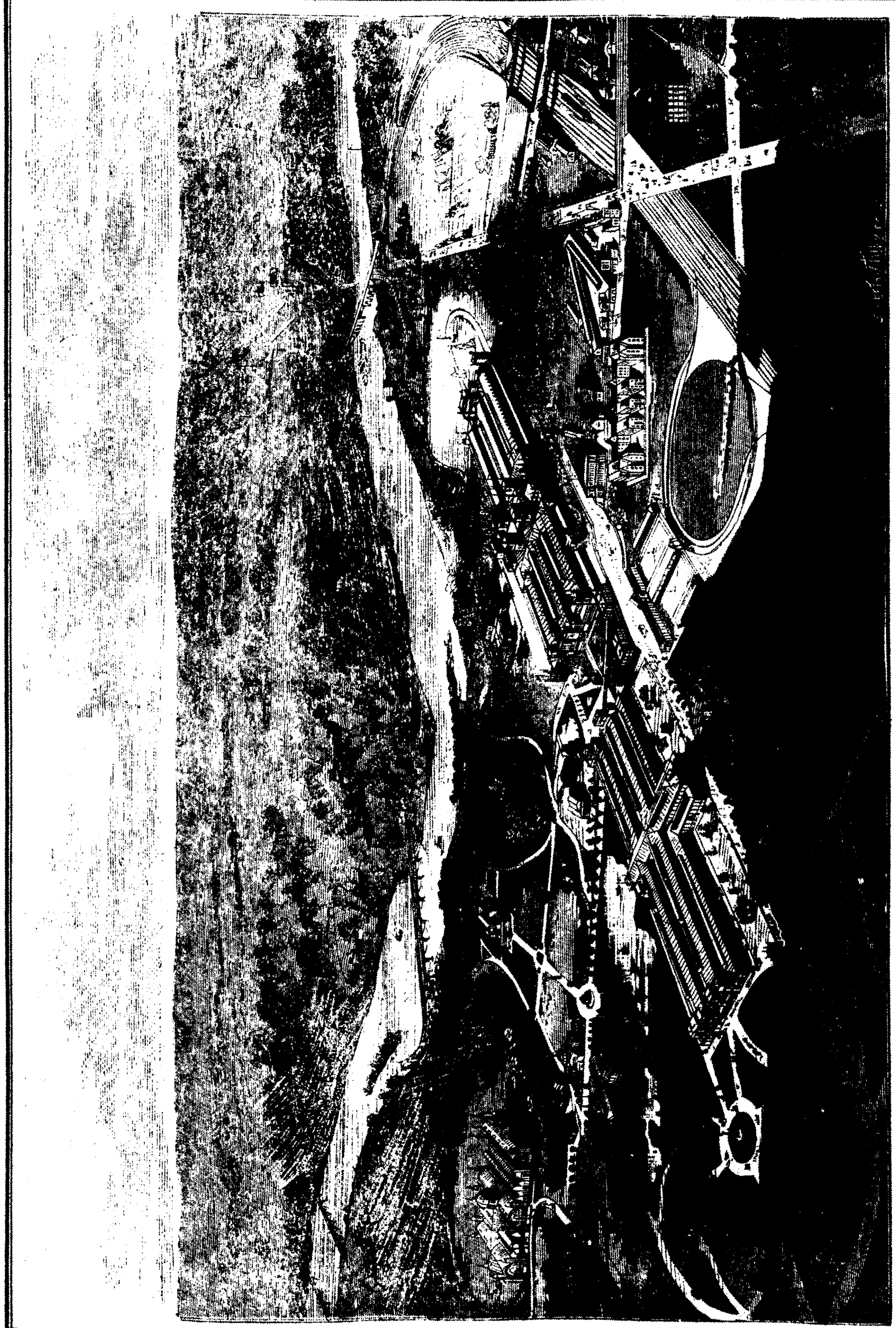
The arched aqueduct popularly called the Pont du Gard is the grandest monument of ancient Roman skill in bridge construction which remains in France, and can scarcely be said to find a rival in the modern aqueduct of Roquefavour, which supplies Marseilles with water. The general character of the Pont du Gard may be seen in side elevation and transverse sections in Figs. 1 and 2, 3, 4, and 5. It consists of three tiers of superimposed semicircular arches, crossing the river and the valley of the Gardon at about thirteen miles from the city of Nismes, which it anciently supplied with water derived from two natural sources at the northern side of the valley. The name of its designer is unknown, and the exact date of its construction can only be guessed at. It is believed to have been commenced about eighteen years B.C., while Agrippa, the son-in-law of Augustus, was governor of Gaul and resident at Nismes. The foundation of the structure is laid on the solid rock, which extends in flat beds with but slight inclination over the entire breadth of the valley. The river channel ordinarily runs in a very deep course which it has excavated for itself, at the northern side of the valley. In high floods, however, the water occasionally covers nearly the whole bottom of the valley, and runs through nearly all the lower arches. The entire structure, with the exception of the channel which conveyed the water across the valley, which is placed above the third tier of arches, consists of cut ashlar masonry in large blocks, and laid dry or without mortar, the material being hard cretaceous limestone. The arches of the lower tier vary in span from about 52 feet to 80 feet, which is that of the arch which crosses over the river channel, and the spans of the second tier of arches coincide with these, so that the piers of the first and second tiers are superposed. In the third tier of arches the spans are about 15 feet, and superimposed upon these is the water conduit, consisting of two side walls of rubble masonry, laid in hydraulic mortar and lined to the thickness of about two inches with beton, consisting of hydraulic lime and coarse sand mixed with fragments of red tiles, whose colour is still fresh on fracturing the cement. It is probable that the watercourse was broken during the civil wars that convulsed France about the end of the fourth century, and during the four hundred years or thereabouts in which water ran through the channel, which has been now dry for about fourteen hundred years, a deposit upon both bottom and sides had been formed from the water of rather less than a foot in thickness, which is still visible, and is shown in Figs. 3, 4, and 5. This deposit is but slightly coherent, and consists of clayey mixed with calcareous matter. The water channel is covered with large slabs of stone, most of which remain, so that it is possible to walk at this elevation from one side of the valley to the other. The rectangular piers, from which all three tiers of arches spring, are constructed of ashlar masonry laid dry, the joints of which are broken in the usual manner in the successive courses, and this is also the character of the masonry forming both the lateral faces of the arch spandrils. The arches are also constructed of large ashlar voussoirs, but these present the remarkable characteristic that they are not laid in "break joint," but with joints transverse to the courses of voussoirs which run continuously from one springing of an arch to the other, thus dividing the arch into so many separate arch rings abutting against each other. Thus, in the first tier of arches, Fig. 4, the entire breadth measured along the soffit being 21ft., the entire arch is divided into four abutting arch rings, each ring consisting of single voussoirs of about 5ft. 3in. in length. In the second tier, likewise, each arch consists of three such abutting rings, and the upper tier of two such rings. This very peculiar construction is shown on the transverse section, Fig. 4, in which is also shown the modern common road bridge which was constructed in 1743 by the estates—or Parliament of Languedoc, and which, though close to the aqueduct at the down-stream side, forms no part of the ancient structure, though it is probable that this bridge originated the modern popular name of Pont du Gard, by which the aqueduct is known. We have been indebted for these sections to the Commission des Monuments Français, inaugurated during the late empire to obtain complete and authentic drawings and details of the great historic monuments of France; they may, therefore, be looked upon as exact, which cannot be said of any of the sections which have been elsewhere published; none of which that we have ever seen take any notice of this singular disposition of the thorough or continuous cross joints of the voussoirs. We might expect to find it noticed by Gauthey in his "Traité sur la Construction des Ponts," which comprises details of all the remarkable bridges structures of the world, and also in Labord's "Monuments de la France," but neither say a word as to the arch jointing. The late Mr. George Rennie, in the discussion of his paper descriptive of Roquefavour aqueduct—"Minutes of Proceedings, Inst. C. E." vol. 54, page 236—gives a long list of authors that have more or less generally described this structure, and appears to notice some peculiarity in the jointing of the voussoirs—but in terms which, whether from a manuscript misread by the printers or otherwise, are to us at least perfectly unintelligible.

None of these authors, however, offer the slightest reasons for the adoption of this peculiar mode of arch jointing; nor appear to have asked themselves the question why an architect competent to design the grand structure should have so far departed from the established practice of breaking joint in the arched courses, and adopted one in its stead which certainly diminishes the general stability of the structure, and that without any adequate reason being apparent for the departure. It is not until after we have examined some of the other minuter features of the building and seen what reference they may bear to this peculiarity in the arch jointing, that we are enabled to see some points of connection between them from which we can infer, in the writer's opinion, the reasons for the peculiarity, and the sound judgment with which they were adopted. On examining carefully the external faces of the several tiers of arches at both sides of the structure as it now stands, we find a large number of stones projecting from twelve to fifteen inches from the general face of the work. These are in various stages of preservation, and some are altogether decayed away, but enough remain to enable us to see, both on the ends of the piers and the spandrils of the arches, that a certain determinate arrangement both in the horizontal and vertical directions was observed in the placing of these projecting stones, and that they were obviously intended to support ledgers or other longitudinal timbers, and as footings for struts and braces to be employed in constructing the work above. On the faces of the piers beneath the arches, as well as projecting from the intrados of the arches themselves up to a certain height, we find other similar stones. Examining further the intrados or soffits of the arches, we find this singular feature, that in all the lower tier of arches, except the two extreme and land arches at the north and south sides of the valley, three successive courses of voussoirs project several inches below the level of the intrados of the arch, and these projections run continuously from one side to the other of the aqueduct.

These projecting courses are found to be situated at such a height above the springing of the arch that a line drawn radially through the middle of the three projecting courses, makes an angle of from 28 deg. to 32 deg. with a horizontal line passing through the springing of the arch. Examining the second tier of arches we find similar projecting courses, except in the two land arches. Now, what was the use of these singular projections, and why placed as we have described? As ornament they could not have been intended, for they are rather a deformity, and why are they absent in the land arches? When we mentally connect these projecting courses and the single stones projecting also from the arches with the through cross-joints, we shall arrive at the key to the whole mystery, and be able to discern that the reason was a thoroughly practical one, and had for its purpose the economising of time, labour, and material, and especially in the timber, and construction of the centering whereon the arches were turned. If the cross joints of the courses of voussoirs were arranged in the usual break joint style, it is obvious that centering must have been provided extending to the entire width of one or more arches, and for arches of this magnitude the centering would require much timber, and most of it in very long lengths, and we may reasonably presume that such timber was not easily obtained at or near the site of the aqueduct.

For although at the commencement of our æra France was much more largely afforested than it is now, the indigenous trees were not generally of a sort producing long, straight timber, nor, probably, were there pine forests such as those which still adorn Dauphine and other hilly regions in the south-east of France existing in the neighbourhood of the intended work. Roads also, with the exception of the great Roman military ways, fitted for the easy transport of heavy timber, scarcely existed, every inducement therefore existed to economise the mass of timber required for the centering, as well as to economise the amount of carpentry and of iron fastenings required in the centering. Limiting our view for the moment to the lower tier of arches, it is manifest that if each single ring of arched voussoirs of 5ft. in length could be turned separately and in succession until the whole width, consisting of four such rings, was reached, the amount of timber and of centering required, though not perhaps reduced to one-

THE UNITED MILL, OLDHAM, ENGLAND.



BIRD'S EYE VIEW OF THE INTERNATIONAL EXHIBITION BUILDING AND PARK, PHILADELPHIA.

fourth, would still be greatly less than would be necessary if the whole arch were turned at once, and this supposing the centering in either case carried up from the level of the springing. But a further economy was obtained by commencing the centering, not at the springing level, but at one higher up—namely at the level of the projecting voussoirs already described. It is a fact well known to bridge builders that in a semicircular or other arch of large curvature the successive courses of voussoirs may be carried up from the springing level without any centering up nearly to such a level in the arch that the slope of the uppermost voussoir bed shall approximate to, but not reach, the angle of sliding one block of stone upon another. The sliding angle may be taken at from 28 to 30 deg. for dressed stone work, which is about the angle at which the projecting voussoirs are here found, the friction of the voussoirs upon their successive beds being sufficient to prevent their sliding forward ; and the equilibrium of the curved mass upon its springing base being preserved by sufficient back weight, so as to keep the centre of gravity of the whole within the intrados at the springing line. This method has been frequently employed in the building of light arches or those of small span ; and in such cases, with the help, if necessary, of a few struts to secure the position of the voussoirs up to the height in question, but little risk is incurred. In arches such as these, however, if this method were attempted for the whole breath of the arch at once, the ponderous mass of overhanging voussoirs might present some difficulty, which would disappear in the event of the mass being so considerably diminished as it would be if the impeding arch ring were only about 5 feet in width. Carried up to the level of the courses of voussoirs projecting downwards, the projecting part of these became a footing for the centering proper, which above that level sustained the remainder of the ring of voussoirs until the keystone was placed in position. One ring being thus constructed, the whole of the struts and centering beneath it admitted of being struck and removed, and re-erected for the like purposes of building the next adjacent arch ring, and so on until the whole breath of four such rings constituting the entire arch was reached. In attempting mentally to reconstruct the system of timbering and centering thus employed, many possible modifications suggest themselves, and it would be impossible now to decide which of these may have been that actually adopted. One of these, for the mere purpose of illustration, is shown in Figs. 6 and 7, in which no framed together centering is employed, carpentry frames in centering being probably but little used at a time when iron fastenings were scarce and local carpentry but rude. But though the details of the centering employed can only be matter of conjecture, it may be inferred with a high degree of probability that the peculiar arrangement which has been described as respects the through cross joints, and the projecting courses of the voussoirs were designed as they are found to be, with the object of enabling each arch to be turned in successive narrow rings, each standing independent of the others, the end to be obtained being the economy of material and of workmanship, and most probably considerably increased rapidity in execution thus attained ; the whole of the arches being laid dry and without mortar, almost no sensible subsidence could take place on striking the centering from beneath any one arch ring ; the soffits of all the rings constituting the same arch would therefore, be smooth and fair when completed, which would scarcely be the case if the voussoirs had been bedded in mortar, resulting, probably, in unequal subsidence in different rings. What has been described with reference to the lower tier of arches equally applies to those of the tier above, with this difference, that whereas the struts and uprights for the lower tier had their footings on the rock of the foundation, those of the second and third tier rested on the work of the tiers below

From what has been described it can easily be inferred why the projecting courses of voussoirs were omitted in the land arches as already mentioned, the height of the arches in these above the level of the rapidly rising banks being such as admitted of direct support from the ground and the commencement of the centering at the springing level at little more cost than if commenced higher up. So also as respects the uppermoust tier of arches, the spans and the height being also small, there was nothing to have been gained by commencing the centering above the springing line of the arches. If we be correct in these inferences, we cannot but admire the ingenuity and boldness of construction by which the architect must have saved probably from one-half to two-thirds of the cost of timber in centering. How far the idea of this curious method af arching was absolutely original with the unknown architect may admit the possibility of a doubt ; for the cylindrical vaulted and highly sculptural roof of the commonly called Temple of Diana, or of the Nymphs, situated in the city of Nismes, close to the spot where the water conduit from the aqueduct once delivered part, at least, of its waters, was constructed in arched rings, essentially the same in constructive character, though differing in form, from those of the aqueduct, The voussoirs of this temple are cylindric shells, each voussoir being about 5 feet square and 9 inches or 10 inches in thickness—five or six of these abutting, and forming a complete semicircular arch ring. They are of white cretaceous limestone, the soffits being finely sculptured, and are put together without any mortar. Inscriptions prove that this temple was built during the reign of Augustus, but whether before or after the aqueduct is unknown.

There are two partial, but scarcely more than apparent, applications of this method of construction to be found in two of Telford's works, viz., in the Dean Bridge of Edinburgh, and that over the Tyne waters which carries the Edinburgh and Coldstream road. In both these a narrow ring of a segmental arch, consisting of single voussoirs of about 5 feet in length, has been constructed for the purpose of adding width to the roadway ; but the ends of some of the voussoirs are bonded into the spandril walls of the main structure—a masonry construction admitting of much doubt as to its propriety.

It seems scarcely to admit of doubt that this ingenious and economical method of arch construction might in many places be applied with advantage in our own day, especially if conducted with the aid of framed centering, partly of iron, so arranged as to admit of "easing down" by screw supports, and of facile transposition from beneath one arched ring to the next.

The great Roman bridge across the Tagus, situated near the little fortified town of Alcantara, in Estramadura, close to the frontier between Spain and Portugal, shown in elevation and section in Figs. 8 and 9, presents a problem as to the methods of construction employed for its centering, &c., which might still, perhaps be solved by a careful examination of the technical details presented by it, reasoned upon in the same manner as has been here applied to the Pont du Gard. This gigantic structure of granite ashlar work, laid dry, is of a magnitude, and was constructed under conditions which might tax to the utmost the skill and courage of the ablest engineers of our own time. The span of the centre arch is 115 feet, and the height from the ground surface to the springing is rather more than 98 feet, and the total height of the structure from the level of the summer surface of the river is no less than 203 feet. Gauthey—"Traité sur la Construction des Ponts"—states that the enormous elevation of the bridge was determined on to meet the prodigious rise of the river in times of great floods ; and from the construction of the bridge itself, as well as from that authority, we may infer that on such occasions the depth of the water passing beneath two of the central arches may occasionally reach about 100 feet. But were the depth only half this, the skill and caution of any engineer would be taxed to the utmost in designing centering for an arch of 115 feet span, and situated at such a height that should firmly resist the pressure of so tremendous a volume of flood water. The bridge itself has been described, though much too briefly, by Gauthey, page 17, and has been noticed with admiration by Telford in his article "Bridge" in the Edinburgh Encyclopædia ; but no attention has been given, so far as we are aware, to the centering, or other structural appliances, that must have been employed, and some of which might, perhaps, be still inferred from a careful examination of the structure itself, This was one of the great bridges constructed during the reign of the emperor Trajan in the Roman provinces, and founded about A.D. 105, its architect being Caius Julius Lacer, who was buried somewhere near the bridge, which is at once the monument of his skill and of himself. The central piers of this bridge are about 30 feet in thickness, and in view of such an immense occasioned rise of flood waters it seems not improbable that temporary piers of dry ashlar work were brought up from the bed of the stream contemporaneously with the building of the permanent piers, dividing the span of the arch into perhaps three or four equal spaces, and that from the summits of these temporary piers, and above the level of the highest flood water, the huge centering was supported ; but all this awaits the future examination of some competent engineer or architect.

A CHINESE FRIAR BACON.—A learned Chinaman has fitted up a laboratory at Shanghai with a completeness and variety which have got him the nickname of the Chinese Friar Bacon. With extraordinary perseverance he succeeded in finding out by himself the processes for photographing, after he had procured the implements from Europe. He studied medecine for some time with an European doctor, and brought out a remedy against opium poisoning. Electric bells, printing and the improvement of musical instruments are among the pursuits of this gentleman.

ARCHER'S STONE-BREAKER.

(See page 81.)

We annex illustrations of Archer's stone-breaking machine as now made by the Dunston Engine Works Company, of Gateshead-on-Tyne. Referring to the engraving it will be seen that the movable jaw is suspended from the upper end, the lower extremity being acted upon by a powerful lever receiving its motion from the crankshaft driven by steam or other power. The spring formerly used to return the swing-jaw is dispensed with, and an eye-bolt running loosely through the lever and fastened by a hand-nut to the back of the latter entirely removes the annoyance and expense formerly caused by the spring becoming weak and useless. Another point to be noticed is that the connecting rod or link which connects the lever to the driving crank, is so made as to be capable of being lengthened or shortened as occasion may require, this end being obtained by inserting a liner of any required thickness between the two plummer blocks. In our sketch the two plummer blocks are shown connected by a pair of bolts, but in some machines an encircling strap fitted with a jib and cotter is employed. Varying the length of the connecting link necessarily alters the position of the movable jaw, and regulates the size of the fragments to which the raw material is broken. Thus the same machine is available for several classes of work, while the horizontally fluted roller placed below the fixed jaw, effectually prevents clogging, and assists in the delivery of the crushed substance. Should any piece of stone or ore escape the vertical flutes of the movable and fixed jaws, it would eventually become acted upon by the horizontal flutes of the roller and be broken into a cubical form.

The motion given to the roller just mentioned is varied according to the kind of work to be done. When the material is to be pulverised, as in ore crushing, the roller is made to revolve regularly; this produces a grinding action between the roller and the swing jaw, thus causing the material to be ground to a dust. But by an arrangement shown by the lower view in our engraving, this rotary motion can be made intermittent, it then occurring only during the return stroke of the lever, permitting and assisting the broken fragments to free themselves from the grip and fall from the machine free of dust. As will be seen from our engraving the arrangement consists of a strap placed round a sheave keyed on the axle of the roller. A pawl working on a pin connecting together the two extremities of the strap has its outer arm attached to a rod from the crankshafts, the inner arm or pawl riding over the sheave when taking the backward motion, but directly the forward motion is made (coinciding with the backward motion of the movable jaw), the pawl grips and fastens the band tightly around the sheave, causing the roller to revolve to the extent regulated by a set-screw and necessary for the class of work to which it has been put. This contrivance dispenses with the usual sieve, and causes the roller to break to a cubical shape the work it is set to, sufficient dust only being formed to bind the metal when spread upon the road. Machines, such as we have described, are, we are informed, in use by Messrs. Mowlem, Burt, and Freeman, of London, Sir W. G. Armstrong and Co., of Elswick, and at other places where heavy and constant work has to be done.

THE DANGERS OF CLEANLINESS.

What with doctors and sanitarians the man of the nineteenth century bids fair to be driven into a state of primitive savagism. Whatever we eat or drink somebody enjoins us to avoid, and now the physicians of New York have "concluded" that a terrible amount of disease is occasioned by the use of soap. Not only, we are told, has the diphtheria prevalent amongst washerwomen been traced to impurity in this popular detergent, but lung fever and kidney diseases in adults and many other complaints in children. The cause suggested is the impure condition of the fats used in the manufacture; and toilet soaps, in which the impurity may be masked by perfumes, are reported to be the worst. It would be well that our analysts should turn their attention to this matter, if that which is popularily regarded as a chief agent in promoting health has really become an important source of disease.

A GOOD dentifrice, largely sold and advertised, is made of ½ drachm white Castile soap, dissolved in 1 oz. alcohol, ¾ oz. water, and ¼ oz. glycerin. This is colored with cochineal and flavored with peppermint, wintergreen, and clove oils. The powder which accompanies each bottle is a mixture of precipitated chalk, powdered orris root, and carbonate of magnesia.

FOREIGN BODIES IN THE EYE.

Particles of cinder, dust, or fragments of metal, often get into the eye, and cause a good deal of trouble. Sometimes they are dislodged, and washed out by the extra secretion of tears brought about by the irritation produced by the body. Sometimes this process does not give relief, and it is necessary to resort to some process of extraction. A popular, and often useful plan is to take hold of the lashes of the upper lid, separate it from the eyeball, so that the lashes of the lower lid will slip up in the space, acting as a brush to the inner surface of the upper eyelid. This, of course, cannot remove anything, as a rule, from the eyeball. A better way is the usual one of holding a knitting-needle over the upper lid, close to and just under the edge of the orbit, then, holding it firmly, seize the lashes of that lid by the fingers of the disengaged hand, and gently turn the lid upward and backward over the needle, or substitute used. Movement of the eyeball by the sufferer, in a strong light, usually reveals the presence of the intruding body, so that by means of a corner of a silk or cambric handkerchief, it can be detached and removed.

Should the foreign body be *imbedded* in the mucous membrane covering the eyeball or the eyelid (conjunctiva), a steady hand and a sharp-pointed instrument will usually lift it out.

The foreign body often cannot be seen, but the person assures us that he *feels* it. Often he does not really feel the *presence* of the body, as much as the roughness (really, a wound) left by it. In such a case, or even if the body has been seen and removed, a soothing application to the injury is as useful as the same thing applied to a wound of the hand. Take a spoon or cup, heat it, and pour in a few drops of Laudanum. It will soon become dense and jelly-like. A few drops of water added will dissolve this gummy material, and the liquid thus formed may be applied by the finger to the "inside of the eye," as they say. The Laudanum is Opium dissolved in Alcohol. The Alcohol is somewhat irritating, but is easily *evaporated* by the gentle heat, leaving an Extract of Opium, whic his dissolved in the water afterwards added.

The comfort derived from this simple and always accessible preparation, after injury to the eye by a foreign body getting into it, is of the most satisfactory kind. In no case use any of the popular "Eye Waters," or "Salves."

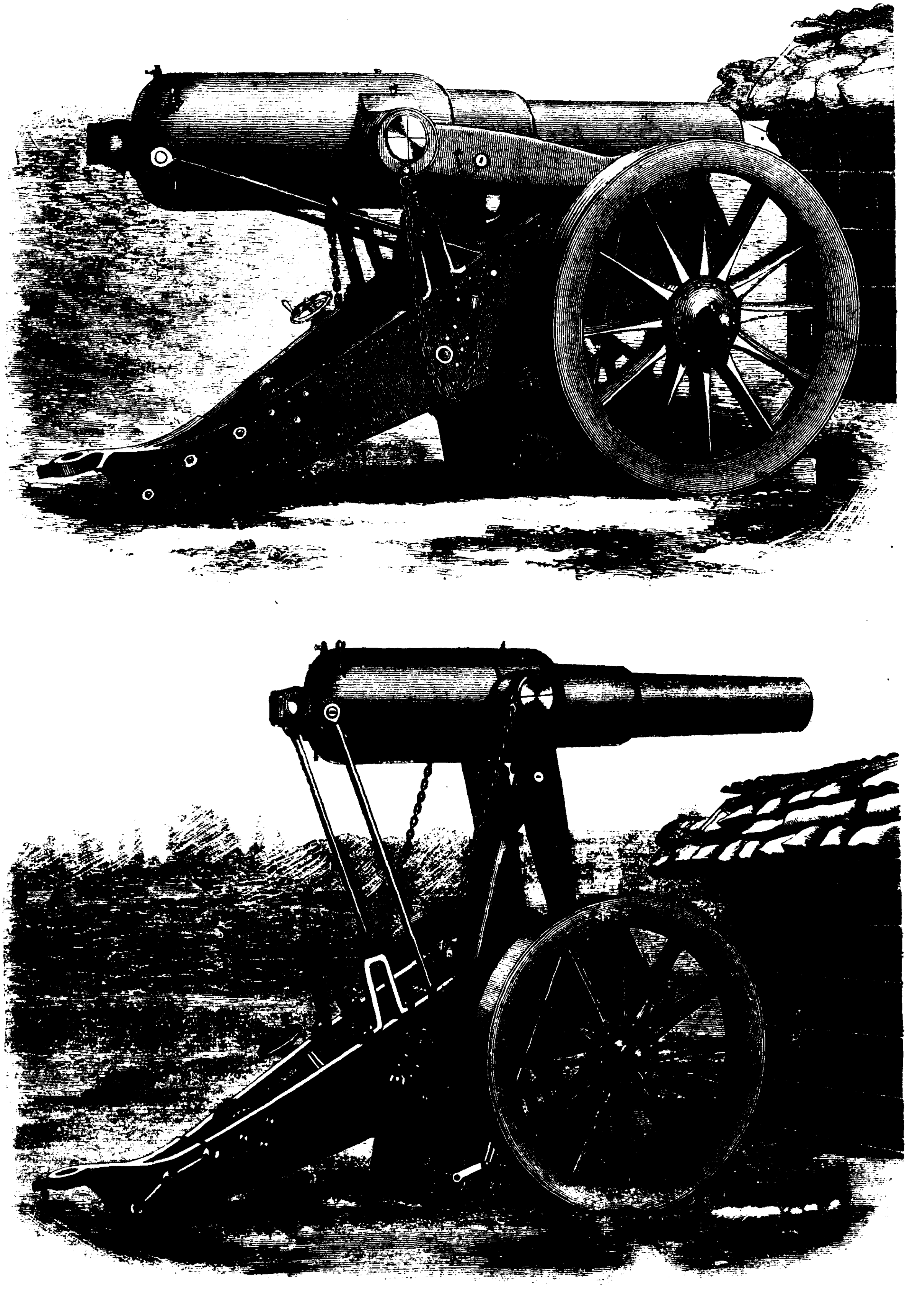
Not an uncommon accident is a *fragment* of lime in the eye. The delicacy of the organ, and the activity of this powerful Alkali, require all that is to be done at once. Do not waste time by attempting to *pick* it ont, but *neutralize* the alkali by a few drops of Vinegar (which is dilute Acetic Acid) in a little water. A few drops of Lemon Juice, in a little water, will answer just as well, if introduced, like the vinegar, into contact with the lime. Even when done rapidly, the ulceration caused by the alkali will be some days in disappearing. In all cases where lime has entered the eye, even when these things have been used, no time should be lost in going to a Surgeon.

RISING IN THE WORLD.

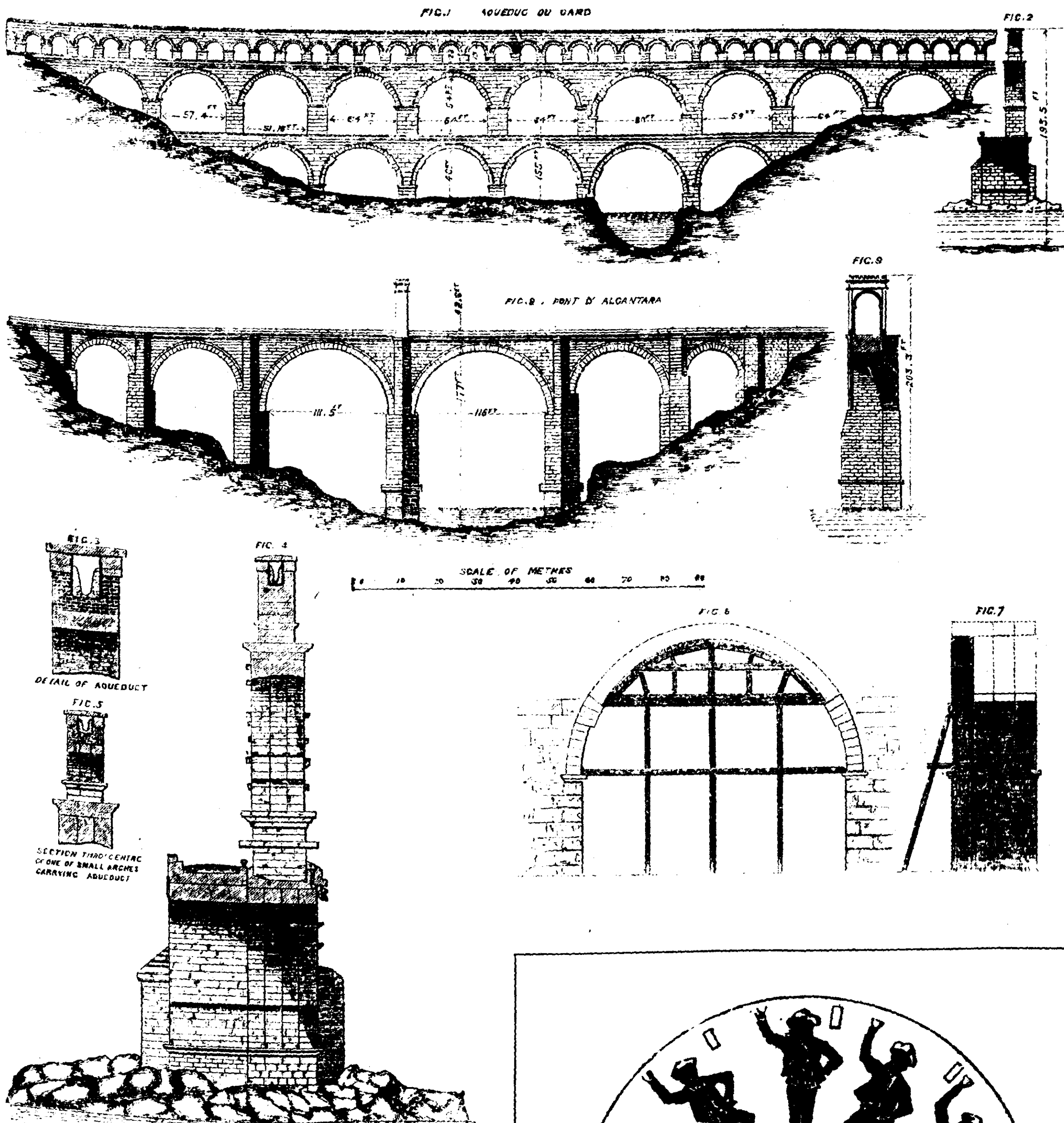
Experience continually contradicts the notion that a poor young man cannot rise. If we look over the list of rich men, we find that nearly all of them began life worth little or nothing. To any person familiar with the millionnaires of the United States, a score of examples will occur. On the other hand, the sons of rich men, who began life with the capital which so many poor young men covet, frequently die beggars. It would probably not be going too far to say that a large majority of such moneyed individuals either fail outright or gradually eat up the capital with which they commenced their career.

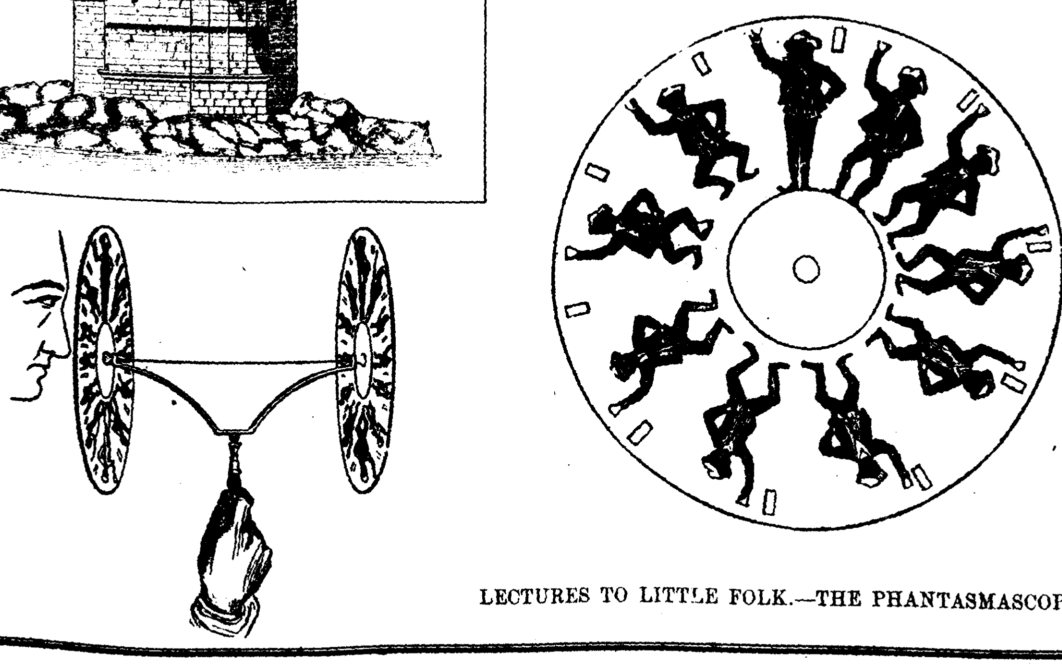
And the reason is plain. Brought up in expensive habits, they spend entirely too much. Educated with high notions of personal importance, they will not, as they phrase it, stoop to hard work. Is it astonishing, therefore, that they are passed in the race of life by others with less capital originally, but more energy, thrift, and industry? For these virtues, after all, are worth more than money. They make money, in fact. Nay, after it is made, they enable the possessor to keep it, which most rich men pronounce to be more difficult than the making. The young man who begins life with a resolution always to lay by part of his income is sure, even without extraordinary ability, gradually to acquire a sufficiency, especially as habits of economy, which the resolution renders necessary, will make that a competence for him which would be quite insufficient for an extravagant person. It is really what we save, more than what we make, which leads us to fortune. He who enlarges his expenses as fast as his earnings increase must always be poor, no matter what his abilities. And content may be had on comparatively little. It is not in luxurious living that men find real happiness.—*Scientific American.*

MONCRIEFF GUN CARRIAGES.



ANCIENT ENGINEERING, ITS METHOD AND APPLIANCES.





LECTURES TO LITTLE FOLK.—THE PHANTASMASCOPE.

STRENGTH OF RAIL JOINTS. *

(See page 78.)

The introduction of the plain fish-plates now ordinarily used was a great advantage at the time to the railway world, mainly for preventing accidents by keeping the rails in position laterally, but since speed has increased, and weight of engines also, the plain fish-plates have been found deficient in one vital respect, viz., that of giving the rail joint the same stiffness and elasticity as the solid rail, so as to obtain one continuous road.

As the stiffness of the joint with plain fish-plates, Fig. 2, depends chiefly upon the section of the rail and fishing angle, often only a third of the stiffness of the joint is afforded as compared with that of the solid rail, but even in the best cases, hardly more than half the rail stiffness is obtained. The result is a broken road, early failure of the rail ends, and broken tyres and springs. Iron rails particularly are exposed to destructiou at the ends before they are half worn out at the middle, and have to be taken up, cut down, and relaid. Even steel-rails, although experience has not gone so far yet on a large scale to prove it, will nltimately fail first at the ends with the ordinary mode of fishing.

This was particularly the case when the joint was on a sleeper with the base plate to hammer on, which led to the use of the suspended joint to obtain a smoother run. Nevertheless, it is found already by experience that one continuous line is not obtained by the simple remedy, inasmuch as the sleepers are sunk down in the ballast wherever there is a weak part of the iron superstructure, and the result is that there are two sleepers to lift up at the joint instead of one. As said before, it was a bad plan to strengthen the joint by taking away the sleeper from under it. Were the sleepers on the road as fixed as the supports in a testing machine, it might have done, but as they are not, there is no gain whatever except what 2 feet centre of supports offers over 3 feet centre, as the former leaves 18 inches clear space only sufficient for stopping.

The introduction of steel rails necessitating the abolition of notches in the rail flange as destructive to the strength of the rail, has led to the French or German fish-plate (*éclisse d'arrêt*), Fig. 4, adapted for suspended joint, but requiring base plates at the joint sleepers (see ENGINEERING, March 20, 1874). Even with this plan the experiments show only two-thirds of the strength of the solid rail is obtained, and as only one fish-plate of this description is generally used, there is still less stiffness. Several other plans exist, more or less complicate but as none have yet given the same stiffness as the rails, combined with cheapness in cost and maintenance, they have not come into general use, and the weak joint, with ordinary plain fish-plates, is still generally adopted.

This has given rise to the following experiments and design of the deep fish-plate for flange rails, Figs. 5, 6, and 7. similar to what has been already adopted for double-headed rail sections on many English railways.

With a rail section having a wide flange, this deep fish-plate is oi course more difficult to roll than for the double-headed rail section, and also than the *éclisse d'arrêt*; but as there is no complication in design, and only ordinary punching required, doing away with base plates, and notching the rail flanges, it is to be hoped that if proved satisfactory and generally adopted, it might be made and obtained for the same price per weight as the ordinary fish-plates.

As to the cost of this improved joint, it would be increased only by the increased weight of the fish-plates, and as the ordinary fish-plates may be taken to weigh about four per cent. of the rails, these will be, say, 8 per cent. of the new fish-plates, saving the base plates altogether. It is true that in the smaller sections where bolts with square nuts are used, it might necessitate exchange for hexagonal nuts to make them turn, which are somewhat dearer than the square ones, but this is partially compensated by the saving in weight, as the hexagonal nut weighs less than the square one for same bolt.

Besides the introduction of this fish-plate on already existing roads, might be gradually effected without changing the nuts where they would not turn round by using one fish-plate of the kind on the bolt head side of the joint, Fig. 4, and a material improvement would be thereby obtained, inas-much as such joint would possess 80 per cent. of the stiffness of the solid rails, as shown by experiments Nos. 10 to 18. As regards the use of two deep fish-plates, the experiments are conclusive as to the great increase in stiffness, being even stiffer than the rail both as regards strength and elasticity.

* Read before the Iron and Steel Institute.

VERTICAL ENGINE.

We illustrate on page 92 a type of vertical engine constructed by Méssrs. Taylor and Challen, of the Derwent Foundry, Birmingham, this engine having been designed for driving a line of shafting coupled to it on each side. The particular engine, from a photograph of which our engraving has been prepared, has a pair of cylinders 11 in. in diameter with 16 in. stroke, the side valves having expansion valves on their backs. The crankshaft is made out of a round bar bent, with the cranks at right angles, and is carried by three bearings, each of which is two diameters in length. The cylinder steam pipes and heater are surrounded with hair felt, and cased with mahogany secured by polished brass straps; syphon lubricators are formed in the castings of each bearing, eccentric strap, and connecting rod. A multitubular feed heater, composed of a cast-iron casing containing a number of solid drawn brass tubes through which the feed-water passes on its way to the boiler, receives the exhaust steam from both cylinders. This heater is at the back of the cylinders, the steam pipes and equilibrium governor valve being clearly shown at the front. The engine is well adapted for the purpose for which it is intended, and at the same time has a good appearance.

UNITED MILL, OLDHAM.

(See page 72.)

The mill illustrated in our present number is one of those emanations from co-operative enterprise. The share capital is 80,000*l.*, in shares of 5*l.* each, and although the office was only open during one day for share applications, the value of the stock applied for amounted to between 300,000*l.* and 400,000*l.* The title given to the company arose from the fact that the Board of Directors was chosen from the united Boards of various limited ootton-spinning companies. The mill is 80 yards long by 43 yards wide, and is practically of six stories in height, one portion of the cellar being 14 ft. high.

The construction of a cotton-mill, as here shown, is that of a large rectangular building, divided into bays of suitable dimensions by vertical cast-iron columns, which support transverse beams, also of cast-iron. These latter carry wrought-iron joists placed about 3 ft. 4 in. apart. From the flanges of the wrought-irön joists are sprung segmental brick arches, filled up and levelled at the haunches with cement concrete, upon which is placed the boarded or flag flooring, as required.

The building, when ready for the reception of the machinery, will have cost about 50,000*l.*; and, including the latter, the cost will reach to about 130,000*l.*—*London Builder.*

THE END OF THE ARTIFICIAL BUTTER.

As we have communicated to our readers the way in which artificial butter was made from suet at a large factory, erected in this city in 56th street, for that purpose, how competition sprung up in Canada, and how it was made in Paris, France, we must now also communicate the final failure of the enterprise, to the great loss of all concerned.

This butter was largely brought into the market in tubs, and looked like good yellow Orange county butter; but it became streaked and speckled, and what was worse, it soon turned rancid, so that the Butter and Cheese Exchange expelled it, and this forced the factory in 56th street to close, and the so-called Oleo Margarine Manufacturing Co. went into bankruptcy. They could not pay their employees, some of whom sued for their wages, and others for money loaned to the company. They obtained judgments for claims and costs, the sheriff went to the factory, but found no available assets to satisfy the judgments, and now suits are being carried on against the individual stockholders, among whom is the well-known professor of chemistry in the New York College, Dr. Doremus, with W. C. Connor, W. R. Gillette, J. B. Mackenzie, and others. A first judgment against them for $662.50 has already been obtained, and other suits are pending.—*Manufacturer and Builder.*

STEEL BRUSHES FOR IRON FOUNDRIES. — Iron castings, on being released from the mold, are often found incrusted with a slag formed from the moulding sand run down with iron oxid. The removal of this is effected in the ordinary way by filling, but Berthold, of Dresden, manufactures brushes of crinoline steel, which are found to preserve their sharpness longer than a file, and to be more handy in use.

INCOMBUSTIBLE WOOD.

The invention of Mr. A. F. Richard, of Dax, France, relates to the preservation and incombustibility of wood by the aid of crystallized chloride of sodium in solution in water at between 6° and 24° by Baumé's aerometer, and of a solution of chloride of sodium and alum at between 4° and 27°, either mixed in variable proportions or employed separately.

BUSINESS OF THE CANADIAN PATENT OFFICE.

According to the CANADIAN PATENT OFFICE RECORD for December, 1875, there were issued in Canada, from October 20 to November 24, 1875, inclusive, 127 patents, of which 81 were granted to citizens of the United States, 39 to Canadians, 6 to subjects of Great Britain, and 1 to a citizen of France. It will be understood from the above that nearly two-thirds of all the fees paid to the Canadian Patent Office are furnished by American inventors.

FIREPROOFING FABRICS AND WOOD.

In nearly all the recipes published for rendering ladies' dresses or woodwork uninflammable, the chief ingredient has been tungstate of soda; and although this salt has been proved to be very competent for that duty, its scarcity and the consequent expense puts it out of the reach of many. The following formulæ of Patera have been recently subjected to careful experiment at Vienna, and have been found most excellent.

1. A mixture of borax and sulphate of magnesia (Epsom salts) is prepared by dissolving 3 parts by weight of borax and 2¼ parts of Epsom salts in 20 parts of water. The efficiency of this mixture is due to the formation, upon the fiber of the cloth or the tissues of the wood, of the borate of magnesia, which is alike insoluble in hot and cold water; and the fiber being enveloped by it, the evolution of combustible gases is very difficult, and the flame is prevented from seizing upon them.

2. Another excellent material for fireproofing is a mixture of sulphate of ammonia and sulphate of lime or gypsum, in different proportions, according as it is to be used upon fine or coarse goods. The sulphate of lime seems to form, with the ammonia salt, a double sulphate which does not (or only in a very slight degree) possess the disagreeable properties of that salt. The action of this mixture of salts, which is capable of extensive use on account of its cheapness, depends, on one hand on its enveloping the fiber, and on the other on the volatibily of the ammonia salt at a high temperature, whereby the flame is smothered; 1 part of sulphate to 2 parts of gypsum may be employed, and woodwork simply painted over with a concentrated solution of the salt is sufficiently protected from fire. The wood is not, indeed, incombustible, but it takes fire much less easily, gives but little flame, and ceases to burn of itself as soon as the igniting body is removed. Since roofs thus impregnated would lose this property because of the salt washing out, Patera sought to protect it by a coat of tar, oil paint, or oil varnish, and found that the fireproof quality suffered but little. If it were allowed to thoroughly penetrate the wood, as it done in protecting timber from rot, the effect would be increased; but no experiments have been made under those conditions. Patera also tried Fuch's proposed method of mixing water glass with an insoluble substance, like elutriated chalk, bone ash, clay, glass, etc., and decided that his process was the best for wood.

ROSIN-OIL SOAP.

One hundred pounds of rosin-oil and 80 pounds of lime slacked to a powder are agitated in an iron pot, and the mixture is heated with stirring, till a uniform paste is obtained, free from lumps and running from the stirring implement like syrup. With this rosin-oil soap, all the different varieties of patent wagon-grease are made as follows:

BLUE PATENT GREASE.—500 lbs. red rosin-oil are heated for one hour with 2 lbs. calcium hydrate, and allowed to cool. The oil is skimmed off the sediment, and 10 to 12 lbs. of rosin-oil soap are stirred in till all is of buttery consistence and of blue color.

YELLOW PATENT GREASE is prepared by adding 6 per cent of of turmeric solution to the blue grease.

BLACK PATENT GREASE.—Lamp-black is used to produce the black color.

PATENT PALM-OIL WAGON-GREASE.—10 lbs. of rosin-oil soap are melted with 10 lbs. of palm-oil; 500 lbs. of rosin-oil are melted with 10 lbs. of palm-oil; 500 lbs. of rosin-oil are then added, and as much rosin-oil soap to make the whole of the consistence of butter, and lastly 7 to 8 lbs. of caustic soda lye.

PARAFINE RESIDUES.—The thick oil which remains in the paraffine manufacture is used as a lubricating oil, partly on account of its not soon solidifying by cold.

In order to thicken, some lead-soap is melted with it. Mixtures of rosin-oil or rosin-oil soap and petroleum, with glycerine also, are often used as lubricants. (32)

GERMAN EXHIBITION IN 1878.—An exhibition of somewhat unusual character will be opened in Berlin in 1878, the plans for it being already under discussion by an executive committee. Its object being to show Germans what Germans can do, and therefore in what points head can be made against foreign competition the whole arrangements will be strictly national. The exhibition will be classified in twenty-one groups, and prizes will be awarded in medals distinguished as for production, manufacture, commerce, art, science and education. Workmen's medal will also be issued.

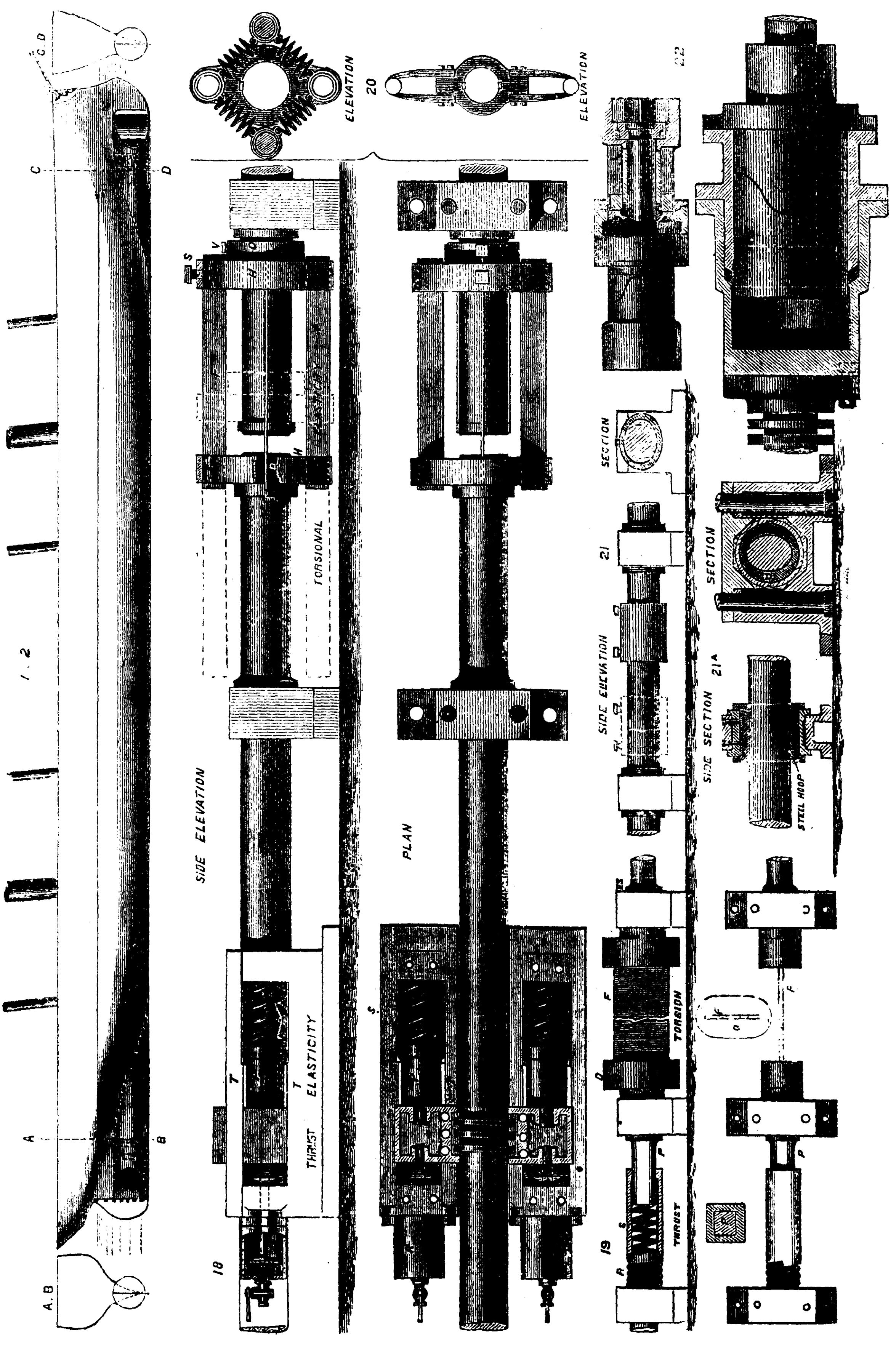
IF we could become ourselves so far fixed, as that the earth, like a school globe, should revolve without us, such would be the rapidity at which the surface would pass beneath our eyes (about 450 miles an hour at our latitude) that we could not possibly distinguish land from water, houses from haystacks; and if not put out of harm's way, by being hung up some five or six miles high in the air, we should be in danger of an awful thump from the summit of some careering mountain!—*Compiled (with trifling alterations) from Jeffery Taylor's "Glance at the Globe."*

FRENCH INDUSTRY.—M. Ducarre has been reporting upon the conditions of work in France. The working population comprises 8,400,000, including women, children and old men. The effective workers are 3,200,000, comprising 800,000 masters and 2,400,000 workmen (three men to one master). Extractive industries employ 14,717 masters and 163,819 workmen—eleven men to one masters and 1,060,444 men—less than two to one master. In France, the average salary of workmen (without board and lodging) is 2s. 10d.; in Germany, Italy and Switzerland, 1s. 7d.; in England, 3s. 4d., living being 20 per cent. dearer than in France.

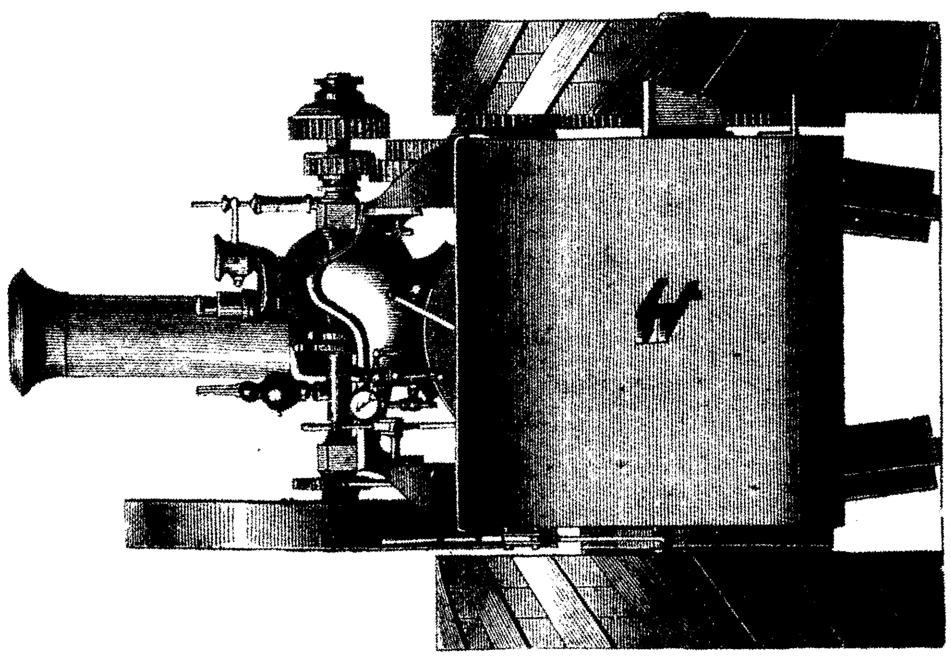
J. Q. R. B. says: Varnish made with alcohol will get dull and spongy by the evaporation of the alcohol, which leaves water in the varnish, as all commercial alcohol contains water. Take thin sheet gelatin, cut it in strips, and put it in the varnish; it will absorb most of the water, and the varnish can be used clear and bright till the last drop. The gelatin will get quite soft; it can be taken and dried, and used again. "I have used this plan for the last two years in photographic varnish, and have never had to throw away one drop."

A PRACTICAL dairyman sends the following about rendering winter churning easy: Strain the milk into pans and set them on a pot of boiling water on the stove. Heat the milk quite hot, but not so as to scald. Set away the pans, and in 36 hours thick cream will have formed. At each skimming stir the cream well together, and, when enough for a churning has accumulated, take care, in cold weather, to have the chill taken off the cream; then scald the churn, put in the cream, and churn gently; and if the butter does not come in less than ten minutes, you may judge that your cream is too cold.

CURIOSITIES OF THE PATENT OFFICE.—A certain A. A. Piel has recently applied for a patent for "An improved apparatus for treading out citron juice on dining tables." We have rarely seen a better thing than this even amongst the translations (so called) of the titles of foreign patents which appear from time to time in the *Commissioners of Patents' Journal*, from which the above is taken. We hope that the law-officer will not refuse the patent so that Piel may keep his invention to himself, as we have no wish to see the practice of "treading out citron juice on dining tables" become general. But stay, perhaps it is after all only a harmless lemon squeezer, as it has just occurred to us that *citron* is French for "lemon."

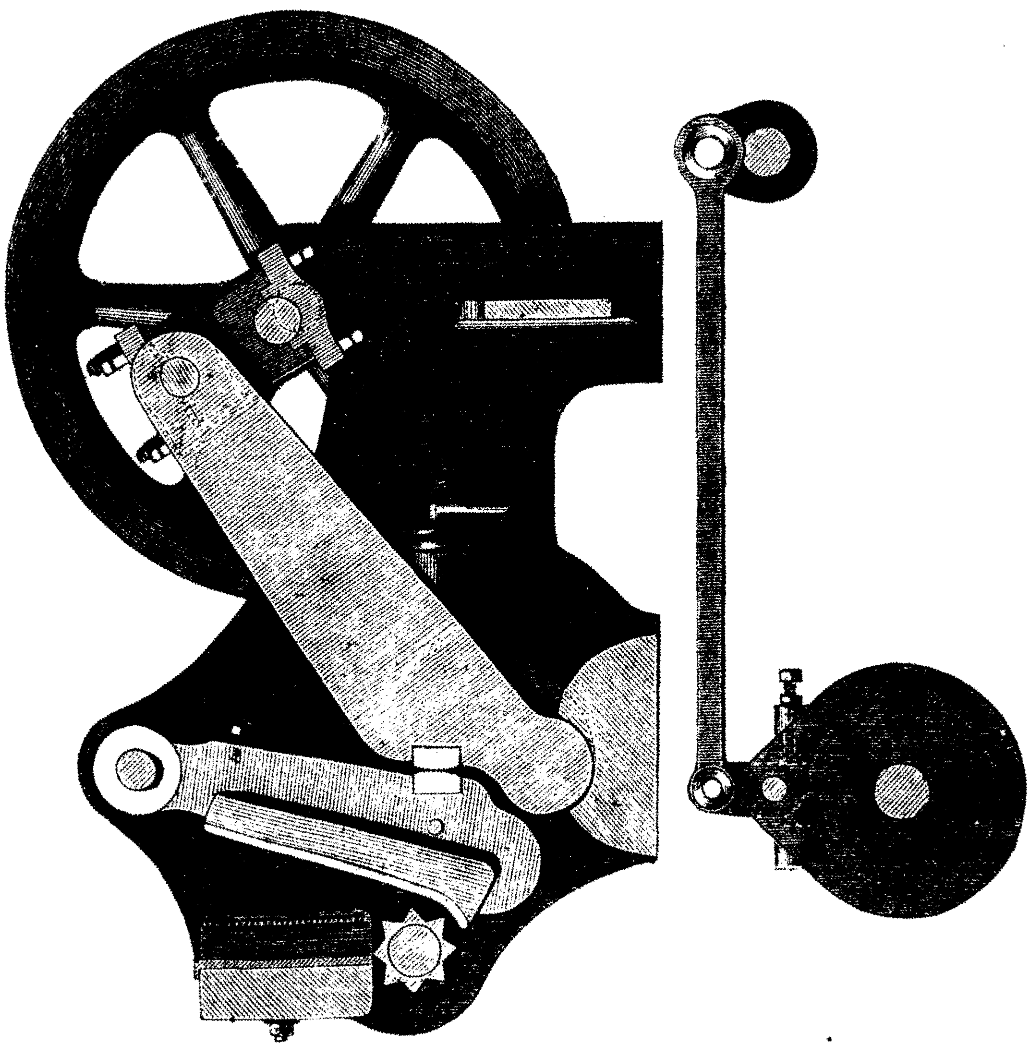


SCREW PROPELLERS, SHAFTS AND FITTINGS.



ROBEY & COS., SIX-HORSE POWER TRACTION ENGINE.

END VIEW. (See page 69.



ARCHER'S STONE BREAKER.

OVERHEAD APPARATUS FOR LATHES.

(See page 85.)

There are many professional turners, and very probably also some amateurs, who are unacquainted with the appendage to the lathe which generally goes by the abbreviated title of "an overhead." Those who are in this position have no idea of the multifarious uses to which a lathe can be put by this simple addition. Soft-wood turners especially, who keep to one class of work, very seldom, if ever, use such an apparatus, but some of the details of their manufactures can be done better and quicker in this way than by the more ordinary methods of work. For ornamental turning, properly so called, however, in ivory and hard wood, comparatively little can be done without it, so that most lathe-makers who supply apparatus for this class of work are accustomed to fit up overheads of more or less elaborate form for their customers. The object of the present paper is to pass these in review, first of all, and then to describe a form devised by a well-known correspondent of ours, "D. H. G." which is altogether different from the usual patterns, and which answers very satisfactorily for all the various uses to which such an apparatus is usually applied. The first idea of making this addition to the lathe arose very probably from the French custom of placing the flywheel overhead, instead of underneath the bed. Many of the lathes figured in Bergeron's work are so arranged, and there is a Rose engine by Père Hulot, in the possession of a friend of the writer, fitted up in a similar manner. In this case, however, the wheel is comparatively light, and is supported between two flat boards of beech, of the shape of Fig. 1, attached below to the broad board to which the lathe itself is fixed. The slide rest of this lathe is very small—not above 6in. in length—and the collars of the mandrel are of pewter, and still in excellent condition. With a fly-wheel arranged above the lathe in this way, the addition of an extra speed pulley or two on the same axle was a very easy matter, and we consequently find this arrangement in Bergeron's work, as in Fig. 2. The primary defect in this arrangement is that it is not independent of the crank axle, and that the second cord, from the pulley to the slide-rest, cannot be tightened without affecting the other. The axle-box in this and in the Rose engine above alluded to, is raised or lowered by a wooden screw, so as to tighten the cord at pleasure. I have myself seen a fly wheel placed above a lathe, with its bearings upon one of the beams of the workshop, and I was told by the workman that the lathe was far more free from shake and more pleasant to work at than when the axle was supported in the usual way by the same standards which carry the bed. Very probably this would be the case, but I cannot speak from personal experience, and the ordinary mode is certainly in most cases the most convenient and essential if a good overhead is desired. I shall therefore dismiss this plan at once as practically defective, and available only under special circumstances. In Hebert's "Cyclopædia" another form is illustrated more like that of modern days (shown in Fig. 3), connected with an apparatus that I have vainly endeavoured to understand, and with which, I am happy to say, I have not now to deal. It is, in fact, a clumsily arranged eccentric cutter, interesting as an early specimen of such apparatus, but decidedly not worthy of imitation, or of being substituted for that in general use at the present time. This overhead in Hebert's book has the pair of pulleys—one fixed, the other adjustable—that we usually find, and the tension is kept up by a cord and weight in exactly the same way as that adopted by modern lathe-makers. The axle of the pulleys is centred at each end upon screws, which pass through the ends of a rectangular frame of iron, the weight and cord acting upon the whole of this frame, which itself turns on centre pins. In the better-class lathes the weight can be increased or diminished at pleasure by the addition or subtraction of a set of smaller weights. (Fig. 3, B), which lie on the top of the larger one. The weight itself is made to hang near the floor to provide against the accident of a breaking cord. The tension is here quite independent of the cord on the main fly-wheel, and the arrangement is thus far satisfactory. It is also light in appearance, and when nicely made, as in Munro's or Holtzappfel's lathes, is an elegant as well as useful addition to the machine. The next form is that represented in Fig. 4, in principle the same as that called in Bergeron's volume the English lathe. Northcott has also figured it in his work. The writer once purchased a lathe with an apparatus of this kind attached, and though old-fashioned and clumsily made, he managed to do fair work with it. There is certainly this one point in its favour, that it is very easily made, and even when wholly made of wood will answer for many purposes. At the same time, for general work, and especially for work to be done upon metal, this overhead is not to be commended. It will carry the cords very well for ornamental work, but wants more solidity. The defect, however, attributed to it, by those who have not tried it, of the cords from which the pulleys depend approaching so as hinder the working, is in reality imaginary. It looks as if such a defect must needs exist for the want of a stretcher bar of some kind to keep the cords apart, but such an addition could not be made without destroying the independence of the two sets of pulleys, which require to be further apart or nearer to each other according to the position of the slide-rest in respect of the mandrel. The four cords, in fact, require to be entirely separate and independent, in order to allow them to arrange themselves to the particular strain brought respectively on each of them. In the English lathe of Bergeron the double pulleys are made to slide upon the horizontal bar without the depending cords, and this has a more favourable appearance, and looks more substantial, and would no doubt be preferred by many. The cord is, nevertheless, more likely to get frayed out against the sides of the pulleys. When these are hung like the first drawing they twist and turn about to adjust themselves to the varying angles of the cord, and the latter run freely and never chafe. If not suspended, then the pulleys should be swivelled to turn about at will, and should not be thus in pairs, but each separate from its neighbour. The suspending cords need not be long, but only sufficiently so to allow the pulleys full play. For light ornamental work, with revolving cutters, this form of overhead is fairly satisfactory. It is true, however, that if the position of the rest and pulley of the revolving cutter is such as to bring it too near the mandrel, the cords, if long, might cross, and the pulleys interfere with each other; but this is not very likely to occur, and if any danger should arise on this score it is only necessary to push the slide of the right hand pulley further away towards the end of the horizontal bar. One advantage this plan most decidedly has—viz., that it needs but a single cord, the length of which is not particular to a few inches, as the balance-weight serves to adjust it readily to the length actually required. As I stated, however, previously, this is by no means a desirable or useful form of overhead for the general work of the amateur, and was never meant for heavier work than ornamentation of wood and ivory with revolving drills and cutlers. We now come, therefore, again to the frame carrying its centre screws or brasses in which the revolving axes of the pulleys may work, such frame being itself suspended overhead upon one or two supports. A very common way is to have such supports attached at the ends of the bed to the standard. If only one is used it generally is used like a crane (Fig. 5), a stout bar of round iron which turns in sockets, or in a pair of iron staples being driven into the standard, and which is on the left hand, so that it can be swung round to overhang part of the bed, or turned back out of the way when not in use. From this crane-like structure hangs a simple frame of iron. Steel or india-rubber springs are so introduced as to sustain the tension of the cords which pass to the mandrel, the fly-wheel, or the slide-rest. In this case there are two or three cords in use at the same time—generally only two—one of which passes from the fly-wheel to the overhead pulley, and a second from another pulley or roller on the same axis down to the revolving cutter, or other similar apparatus. In cutting spirals, however, a third cord is sometimes required. If the frame is suspended simply from a pair of india-rubber springs, which appears the readiest way to effect the desired purpose, I have found practically the following inconvenience: Unless the two cords are equally tight, the shortest acts at one end of the overhead axle, dragging it downward out of the horizontal position, the tension of the other not being sufficient to resist it. The result is that the overhead frame takes up an angular or inclined position as regards the lathe-bed, and the cord or cords slip off the roller. This defect cannot be got rid of if the frame is mounted in this particular way. It is always better, therefore, to have the overhead frame supported firmly on hinges or centre-points, or similar appliance, and not merely suspended from springs—the latter being used only as supplementary means of regulating the tension of the cords after the manner of Fig. 6. There is in this kind of arrangement a very substantial gain in the matter of stability. We require, it must be remembered, an overhead, applicable not only to the purposes of the ornamental turner, but the general mechanic—an overhead that will bear a good deal of tension on the cords, so that it may serve for giving motion to revolving cutters acting upon metal; as, for instance, in wheel and rack-cutting, plain-turning, and, if possible, screw-cutting. We thus are enabled to convert the lathe into a general shaping machine, and put it to a number of uses otherwise unattainable. The weaker kinds of overhead become useless in such a case, as they will not bear the strain absolutely necessary to be put upon them—the cords requiring in many instances to be kept very tight to prevent all liability of slipping. With a firmly-constructed and suitable overhead *there is no slip*, and a very full cut may be taken in metal without danger on that score, although for many years (owing probably to the inefficiency of the ordinary overhead) it has been taken for granted that slip must of necessity occur. Let it be premised that "D. H. G.'s" contrivance was designed as an experiment in order to ascertain by actual trial whether an ordinary lathe could be so fitted as to answer for cutting screws in metal automatically. It is, therefore, not intended as a model in point of beauty of design, but only as an apparatus fit for a workman, and capable of being made by the amateur himself. The mode of suspension is similar to the design last given, but the centre screws on which the frame is hinged may be themselves fixed in brackets projecting from the wall, or in hanging brackets attached to a beam overhead, or on two independent supports rising from the floor. This is simply a question of expediency, and must be settled by the workman according to the means available in his own particular workshop. It is, however, considered by "D. H. G." highly desirable that the supports of the same on either side should be altogether independent of the lathe standards, that the vibration of the one should not be imparted to the other. If the lathe stands near the wall, as in commonly the case, the plan used by "D. H. G." himself, and illustrated here (Fig. 6), is as good as any—viz., a pair of wrought iron brackets, securely fastened to the wall, the bolts passing quite through and secured by large washers and nuts on the outside. Brackets or arms thus constructed to carry the bearings of the centre screws, give a power of adjustment which is often convenient, as the whole frame can be made to come forward over the lathe-bed to a greater or less degree, which of itself may be the means of freeing a cord inclined to chafe by altering the angle at which it depends from its pulley. It also enables the workman when desirable, to reach the hinder part of the lathe at pleasure, and it will, in short, be found advantageous in many cases to have this easily arranged power of adjustment.—*English Mechanic*.

(To be continued.)

STERNE'S RAILWAY CARRIAGE COUPLING.

(See page 84.)

We illustrate herein a neat arrangement of self-acting coupling designed by Mr. L. Sterne, for use on rolling stock fitted with central buffers. The nature of the arrangement will be readily understood on reference to the annexed engravings, in which Fig. 1 is a side elevation of the buffer and drawheads of two contiguous cars with the coupling link between them, while Figs. 2 and 3 are respectively a plan and end view of one head. It will be seen that in Fig. 1 the link is secured at one end in the buffer and drawhead at the right hand while the opposite end of the link has entered the head at the left hand, and is about to push back the spindle which holds up the vertical pin. From the views given it will be seen that the buffer and drawhead is formed with a bell-mouthed cavity at the front, this cavity being traversed vertically by a pin which secures the coupling link when the latter is inserted. In its normal position when a carriage is uncoupled, this pin is held up (as shown on the left-hand side of Fig. 1) by a spindle which passes through apertures in the sides of the head and carries at its ends rollers or wheels, each of which when the parts are not coupled rests in a curved seat at the lower end of an incline. When the rollers are in their curved seats the spindle between them holds up the pin as seen in the left-hand half of Fig. 1, but when the coupling link of the next adjoining car enters the head it presses against the spindle, thereby pushing it with its rollers up the inclines, and the vertical pin being then free immediately falls into and secures the link. The rollers naturally gravitate a little so that the spindle always bears down upon the inner end of the link, the weight of the spindle thus keeping the link in a horizontal position whilst uncoupled, as shown on the right hand of Fig. 1.

The link being always in a horizontal position allows the coupling to be easily accomplished at a variation of loads without the necessity of having large bell-mouth cavities in the buffer heads moreover the cavities in the buffer heads are formed with the particular curves shown for the purpose of keeping the link always projecting a uniform amount even if it be tipped somewhat upwards or downwards by being made to engage with the drawhead of a more or less heavily loaded vehicle, and it thus can be coupled close up. The curved seats for the rollers at the ends of the spindles are sufficiently recessed to prevent the rollers ascending, and thereby letting the pin drop during shunting; the link is of course removed and suspended by a chain or hook during the time of shunting or assembling. The central position of the horizontal spindle upon which the vertical pin rests when the parts are not coupled is reduced in diameter in order that the link need not enter too far for the spindle to clear the vertical pin, and a short link is thus obtained. The coupling we have described if very simple, and it appears to answer its purpose well.

MORGAN'S TUYERE FOR SMITH'S HEARTHS.

(See page 93.)

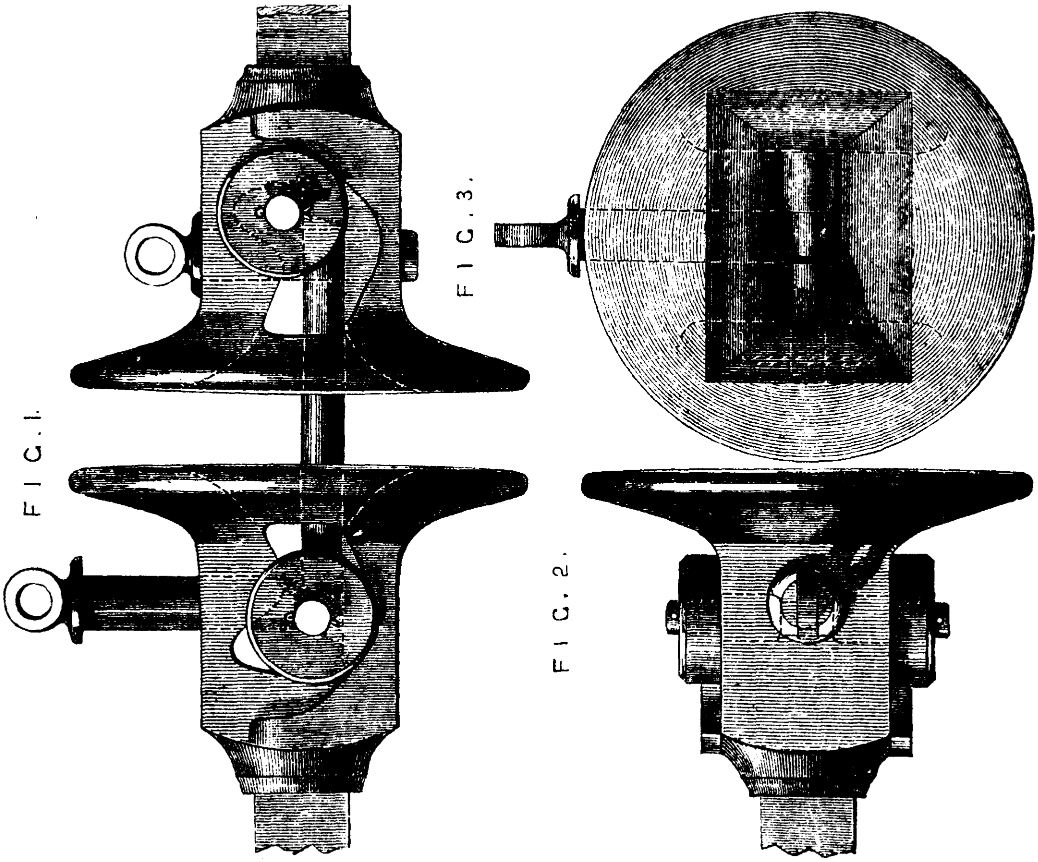
We annex illustrations of a form of tuyere now being introduced by Messrs. Taite and Carlton, of London, with considerable success, it entirely dispensing with the use of water for cooling, while it is readily cleaned and kept in order. The arrangement consists, as shown in the engraving, of a cast-iron chamber placed under the hearth, the upper part of this chamber being fitted at one end with a tuyere block having two openings or ports as shown. The blast enters this chamber on one side and becomes to a certain extent heated before being discharged through the ports.

Within the chamber is a lever which can be worked by an external handle, and by means of which the ports can be cleared when necessary. At the outer end of the chamber also is a sliding door through which any slag or clinkers can be cleared out. We understand that with these tuyeres ,the tuyere block does not melt nor get out of order, and that the fire only requires to be cleared out at each meal time. We understand also that one experiment tried on Thursday, 23rd July, 1874, at the Great Western Locomotive Works, Swindon, Wilts, between the water tuyere and Morgan's patent, resulted in favor of the latter by 3 qrs. 13 lb. coke in 9 hours, which would be a saving at these works on the whole of their forges of 6 tons 14 cwt. 1 qr. 18 lb. per day, or equal to 2097 tons 2 cwt. per annum, quarters and pounds not added, making allowance for stoppages, breakdowns, &c. Altogether the tuyere appears to be well worthy of notice.

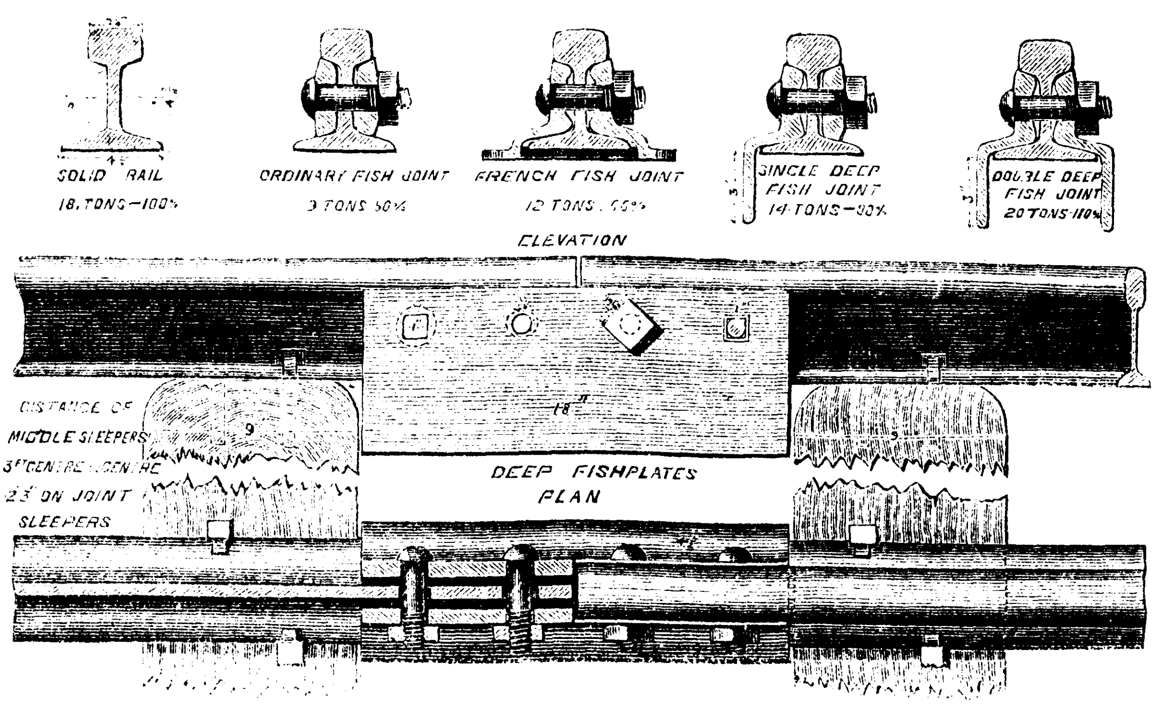
MACHINERY EXHIBITED AT SMITHFIELD CLUB SHOW, ENGLAND.

On page 93 we illustrate a new machine designed by Messrs. Charles Powis and Co., Millwall Pier, E., and called the "combined circular and band-sawing machine, with boring apparatus." It consists of a strong cast iron frame and circular saw bench, with a standard connected thereto carrying a couple of pulleys for the band saw. The bearing of the upper pulley is adjustable by means of a hand wheel and screw to regulate the tension, while a third pulley keyed on the main shaft communicates the motion, and renders the breakage of the saw of less likely occurrence. Augers are fitted to the end of the circular saw shaft, the bearings of which can be lowered in guides for grooving and rebating by the circular saw. For carrying the work, in cross-cutting and shouldering, a cast iron plate works in a groove in the saw bench. Both the "fence" or guide of the circular saw and the band saw table may be canted to any angle up to 45 deg. A driving shaft with fast and loose pulleys is carried on brackets on the end of the saw bench, and another pulley thereon communicates motion to the main shaft. For light work a fly-wheel is added to the driving shaft for turning by hand.

We also show a new arrangement of circular and band sawing machine, by Messrs. Wurr and Lewiss, Walbrook, E. C. In this case the circular saw spindle is hollow, so as to run independently of the band saw. The third pulley of the latter, therefore, runs loose on this shaft, while the upper is provided with screw adjustment for tension. The band saw frame is curved, so as to afford a clear space of 27in. between itself and the saw. The "fence" may not only be canted to any angle, but may be turned completely over on a spindle having bearings on the end of the bench. This spindle is also screwed at one end for the exact adjustment of the fence by means of a movable key. A counter-shaft with striking apparatus is fixed at a distance corresponding to the radius of the arc described by the cradle that carries the bearings of the circular saw in rising and falling. This shaft has separate pulleys and belts for the circular and band saws, so that they may be driven either together or separate. In a mortice in the band saw guide two small blocks of hard wood are carefully fitted, one on each side of the saw, and clipping it; they are tightened up by a steel wedge, which also forms a back



STERNE'S RAILWAY COUPLING.



RAIL JOINTS.

OVERHEAD APPARATUS FOR LATHES.

FIG. 1.

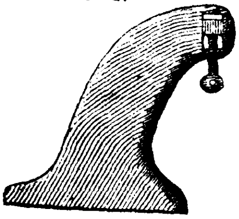


FIG. 2.

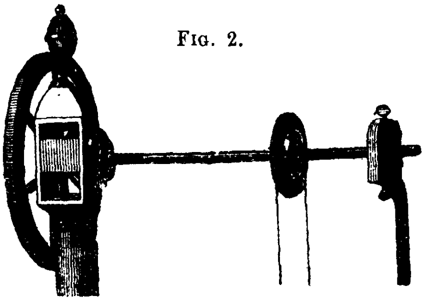


FIG. 3.

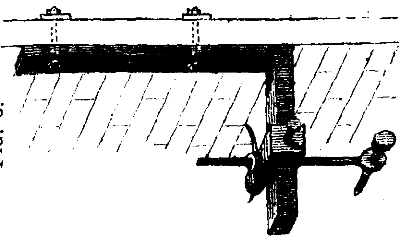


FIG. 4.

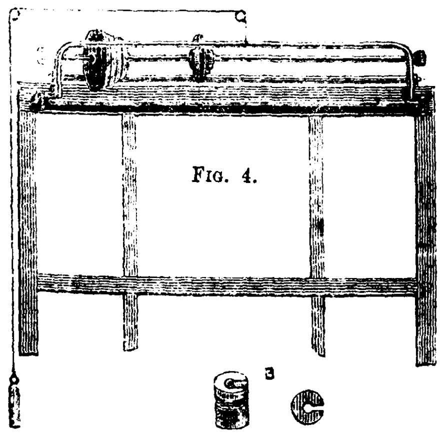


FIG. 5.

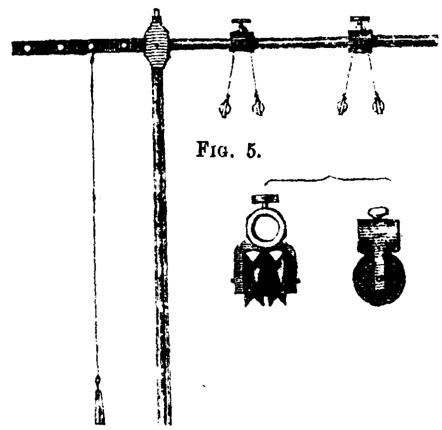


FIG. 6.

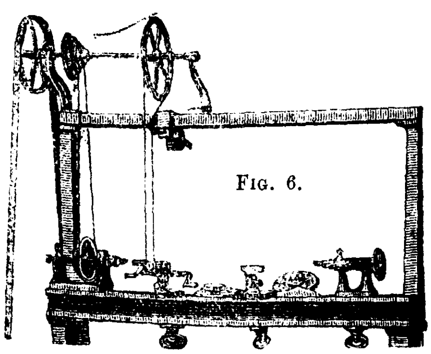


FIG. 7.

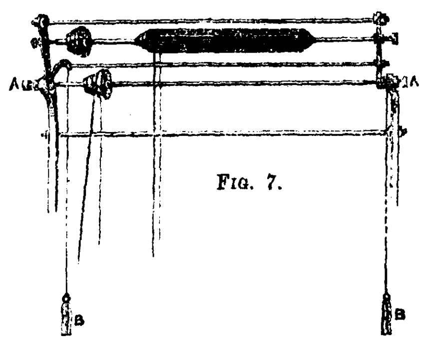


FIG. 8.

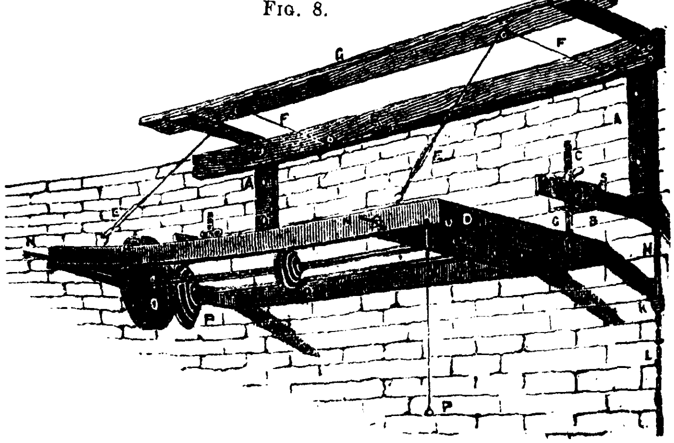
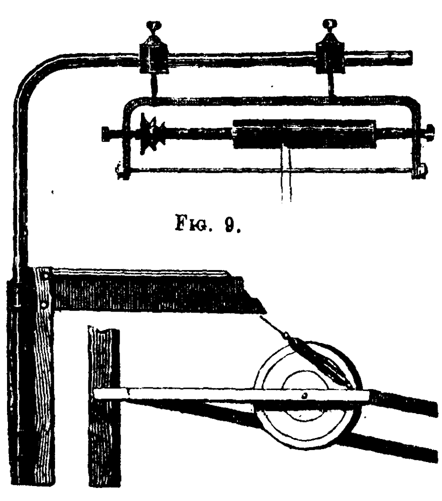


FIG. 9.



support to the saw. This firm also exhibit a smaller machine of a similar character, for being driven by hand ; it is fitted with a simple self-acting feed, so that one man can place the work and then go and turn the handle.—*Engineer.*

TRACTION ENGINE AT THE SMITHFIELD SHOW.

CONSTRUCTED BY MESSRS. ROBEY AND CO., ENGINEERS, LINCOLN. — *(See page 81.)*

We quote the following from the *Engineer* :—

"Of the latter of these engines we now publish engravings which will explain the peculiarities of the design. As we remarked, last week, Messrs. Robey, to relieve the boiler of the strains due to the working of the engine, have interposed between the cylinder and the crankshaft a cast-iron bedplate, one end of this bed forming the cylinder cover while the other carries the crankshaft plummer blocks. In the case of their portable engine, where the cylinder is over the firebox end of the boiler, the cross-head guides and the exhaust pipe are cast solid with the bed-plate, while the latter takes a sliding bearing at the crankshaft end upon two brackets fixed one on each side of the boiler, one of these brackets having the pump made in one piece with it. In the case of the traction engine the bedplate has the cross-head guides cast solid with it, while, as in the case of the portable, the bed from its shape forms a receiver for any oil dripping from the moving parts.

"In the traction engine the expansion of the boiler is accommodated by leaving the crankshaft end of the bedplate free to move between the horn-places, it being held to them by a plate on each side. These plates are made fast to the bedplate, and slide horizontally in slots cut in the horn-plates. The horn-plates reach the whole depth of the fire-box, and are deeply flanged outwards, on both sides, for strength, and for attachment to the boiler and water tank. The second motion shaft is carried in a U-shaped casting let into the horn-plates, and stretching between them. acting thus as a stay and distance piece. The main axle is also carried by the horn-plates, which also form the sides of a part of the water tank. The usual arrangement of steerage gear is modified, the chains being attached to the extreme ends of the axle, by means of grooved castings, so curved as to keep the chains tight in all positions, and facilitate steering. The leading wheels, it will be noticed, are set to a narrower gauge than the driving wheels. The engine is very completely equipped, having water lifter (injector type) for filling the tank from roadside ditch, &c.

"The driving wheels have the arms arranged in two sets, each set of arms being welded to a plate at the centre, which is bored out and fitted with the boss, the rivets holding it up, thus having no shearing strain on them. By the arrangement of the arms in sets, if one arm gets broken the whole set can be removed and a new arm welded on, which is impossible if the arms are cast in the boss.

"The engine is fitted with two speeds, and the arrangement of the cluthes is shown by the detail views. It is also provided with a neat form of high speed governor for use when the engine is employed for thrashing, &c."

MYSTERIOUS FIRES.

We are now arrived at a season of the year when fires are abundant, and mysterious fires especially so. The mystery of a fire is one of three kinds—the mystery of fraud, the mystery of carelessness, and the mystery of ignorance. The latter characterizes people of all ranks in life, and is, seemingly, as persistent as carelessness, and sometimes as culpable as fraud. For instance, how many people know precisely what a defective flue is ? How many know anything about spontaneous combustion ? How many know that hollow walls are actual flues, which have the power of carrying flames from the bottom of a house to the top, almost instantly ? How many know that the heat of a stove, even when separated by some little distance from wood, will, in the course of time, so char it that a spark will fire it ? How many know that, under favorable circumstances, fires will smolder for hours, ready to flash into actual flame when fanned by the opening of a door, or the slightest current of air caused in any manner whatever ? In brief, how many know anything of a hundred and one circumstances that will cause mysterious fires, which a slight degree of practical knowledge might easily prevent ?—*The Index.*

MONCRIEFF GUN CARRIAGES.

On page 76 we furnish an illustration from the *Engineer* of the Moncrieff Gun Carriage, the designs for which were submitted to the British Government in 1870, and referred to a special committee of Royal Artillery and Engineers for consideration.

It appears from their report that the theory involved, although extremely elegant, does not appear of practical application on any but a small scale.

WONDERFUL FISH.

(See page 68.)

This is a sketch of a most extraordinary and rare specimen of ichthyology, which has been on exhibition, at Sarnia, for some time. The Premier and his friends have been to see it, and it has baffled all attempts at classification. It is moreover a "genuine fish" as our artist has seen and felt it himself. It was taken in the seine which it damaged slightly with its horny snout.

It was 4 feet, 11 inches long, and the snout was 11 inches more. In girth it measured 2 feet 6 inches. The hood is most curious, as it is quite detached from the body except behind for about 2 inches where it joins the body. The mouth is shark-like but without its teeth (which in this are very small.) There are six breathing holes, 2 on each side of the junction of the horn with the head, and one on each side of the hood behind the eye. The fish is not known to have been caught in any waters yet, perhaps some one may be able to throw light on it. It died a few days after it was caught, (though everything was done to preserve it) and is now on exhibition.

PROTECTION OF TRADE-MARKS IN THE GERMAN EMPIRE.

The following information has been furnished us for publication, by George Haseltine, LL.D., Solicitor of Patents, London.

The Registration Act of Nov. 30, 1874, which came into operation May 1, 1875, extended the protection to Trade-marks throughout the entire German Empire. The prior registrations in Prussia and the minor states continued in force to Oct. 1, 1875, when the rights under such registrations ceased, and now no penalties can be enforced against infringers unless the Trade-marks are registered under the 1874 Act. The subjects of registrations must be Trade-marks of unobjectionable character. They cannot consist simply of numerals, figures, and words, but must embrace a distinctive design. Trade-marks that are already in use by others cannot be registered. Natives of foreign countries which grant to Germans similar privileges, as well as natives of Germany, may register Trade-marks, but they must elect a domicile at the seat of the German Tribunal of Commerce. They must also prove the Trade-marks are registered, or entitled to be registered, in their respective countries. The duration of registrations is limited to ten years, but the term may be prolonged from time to time at the expiration of the respective terms. The registrations may be vitiated by the acts of the proprietors, and will be cancelled by the Government when the proprietors are removed from the register of commerce ; when there has been a change of proprietors without notice, and when the Trade-marks are not proper subjects of registration. The expenses of registration include a Government fee of fifty marks, and amount to about eight pounds inclusive. The registered Trade-marks belong to the proprietors—firms or individuals—for all classes of goods. The remedies for infringement are civil and criminal. The fines cannot, however, exceed 5,000 marks, nor can the imprisonment for any offence exceed a term of six months.

THE wealth of the farmers is in a great measure the cause of the scarcity of money. Twenty-nine million dollars belonging to farmers is now in the hands of the banks. The bank managers have been afraid of a panic setting in, as the least alarm would cause farmers to rush for their money ; therefore the banks have been more than usually cautious, and have held their cash in reserve ready for any emergency. The danger is now considered past, and money will be asking for borrowers to use it, instead of the reverse.

This, we trust, will cause farmers to improve their farms more, as money will not return them the interest they may anticipate, and no bank or any other kind of investment is as safe and sure as farm property ; no improvements are equal to farm improvements ; no persons deserve more censure than the miserly land holders who will not improve their lands or allow others to do so.

WALLIS AND STEEVENS THRASHING MACHINE.

On page 92 we illustrate an excellent thrashing machine exhibited at Islington by the builders, Messrs. Wallis and Steevens, North Hants Ironworks, Basingstoke. A is the feed mouth which the unthrashed corn is fed into the machine. B B, adjustable mouthpieces for increasing or decreasing the size of the mouth to suit different descriptions of corn. C, the thrashing drum, which has a steel spindle, wrought iron head and rings, and either six or eight ash beaters—according to the size of the machine—fitted with Goucher's patent beater faces and plate iron fronts. D, the concave or breasting made entirely of wrought iron, and provided with adjusting screws, E E, at the hinge F for regulating its distance from the drum. G G, casing behind concave which carries the thrashed corn as it passes through the bars of the concave down on to the upper shoe on the riddle board L. H H, the straw shakers worked by the shaker crank I, each alternate shaker being attached at one end or the other to links J J, turning on centres K K. The shaker shakes out of the thrashed straw any loose corn which may be left in it. L, vibrating shoe on which the corn falls from the drum and shakers. In this shoe is fixed the perforated mahogany riddle M, which separates the short broken straws—technically called "cavings"—from the corn. This, and also the lower shoe, is driven by connecting rods from the riddle crank N. O, the lower vibrating shoe, to which is fixed the first winnowing machine H. Both shoes are suspended from the framing of the machine on spring hangers Q. P, the first winnowing machine, in which are placed an upper perforated zinc riddle marked "blast riddle," which assists the blast in separating the chaff from the corn, and a lower riddle marked "hussy riddle," for taking out the husks containing grains of corn—technically known as "husseys" or "chobs"—poppyheads, &c. S, spout for conveying the corn to the elevators. In the bottom of this spout is a third riddle—not shown in the section—for separating any small seeds which may be mixed with the corn. T, the fan which supplies the blast of air to the winnowing machine P. Slides are provided to the openings in the centre of the fan through which the air is drawn in, by opening or closing which the strength of the blast can be regulated to suit the particular sort of grain being thrashed, and by regulating these and raising or lowering the hinged flaps U at the back of the winnowing machine, the whole of the chaff can be blown over without carrying any of the corn with it. V, the elevator which carries the corn up and delivers it either into the barley horner W, or else direct into the second winnowing machine without its passing through the barley horner at all. W, the barley horner, the steel blades of which are set at an angle so as to throw the corn out at the upper side of the horner casing, where it is marked "opening." By raising the hinge valve X by means of a handle outside the machine, the corn will then fall on the slope board Y instead of on the valve, and so pass direct into the second winnowing machine without passing through the horner at all. This arrangement is of importance, as some sorts of grain, and beans and peas, would be injured by being passed through the horner. Z, the second winnowing machine which has a set of hard wood riddles for thoroughly separating from the grain any chaff, husseys, &c., which may have passed the first winnowing machine, or have been rubbed off in the passage through the horner. It is suspended on spring hangers and vibrated by a connecting rod fixed to the end of the upper vibrating shoe L. A blast of air is blown through the winnowing machine by a fan fixed outside the framing of the machine, shown by the dotted line behind the barley horner. The husseys, &c., removed from the sample by the winnowing machine, as well as the dust and awns from the barley horner, are carried into the spout marked "dust spout," to the bottom of which a sack is attached to catch them. R, the Penney's patent adjustable rotary screen which separates the clean corn into three samples—namely, best corn, best tail, and small tail. A brush is used for keeping the rotary screen clean. Apparatus for lifting and bagging the chaff is often added, in which case the chaff can either be bagged or allowed to fall, as shown in the drawing, at pleasure. This apparatus is shown fixed to the side of the machine in the external view near the front end of the machine.—*Engineer.*

AN author, complaining of the injustice of the press in condemning his new tragedy, said the censures were unjust, for the audience did not hiss it. "No," replied the friend, "*how could they yawn and hiss together?*"

ALBUMEN FOR PHOTOGRAPHERS.

The *Photographic News* gives an account of the recent attempts to produce albumen better adapted for photographic purposes than that ordinarily employed. The most important of these were perhaps the successful experiments made to preserve albumen or eggs in a dried condition. So promising were the results obtained that essays were at once made to produce the material of commercial purposes, and at the present moment there are, we find, several large producers of the desiccated albumen. One of the most important of these is the Effner factory, in Passau, on the Danube, where, we are told, large quantities of the material are now obtained. The contents of the eggs are to be had in commerce in powders of three kinds, one of which is the result of drying the egg-matter as it comes out of the shell—the second consisting of pure white of egg, and the third a powder representing the yolk alone. Egg-powder of the first description may be employed by the pastrycook exactly in the same may as new-laid eggs—three volumes of cold water added to one volume of egg-powder producing an emulsion in taste and smell and materials resembling freshly-broken eggs. The only noticeable difference is, that, on being beaten, there is not so much froth, nor is it so lasting as that from fresh eggs. If, therefore, the egg-powder is to be employed for purposes in which a stiff froth is required a little fresh egg-white must be added. The pastry, we are told, is quite equal to that prepared straightway from eggs, only it is a little whiter in colour.

In mixing the yolk-powder not so much water is added, but in the case of the white of egg, with which the photographer is the more interested, three teaspoonfuls of cold water must be added to every half-spoonful of albumen powder. This forms the normal strength of egg albumen, and photographers would then dilute it to any degree they desired. For most of their wants the albumen is required in the form of a clear, transparent solution, and for this reason distilled water should be employed for mixing with the powder, and afterwards diluting the solution. For albumenising paper this preserved white of egg is, according the *Deutsche Industrie Gazette*, perfectly suitable, as well as for other industrial purposes. The white of egg powder is apparently more in demand than either of the other two descriptions of powder, for the price charged for it by the manufacturers is considerably higher. The white of egg is sold at one mark (one shilling) per 100 grammes, while the other powders may be had at the rate of eight pence. In respect to the comparison of these prices with the cost of eggs, it may be mentioned that Messrs. Gobley and Prout have determined that the yolk from a fresh egg weighs in all about fifteen grammes, of which 52·65 is water; while the white of egg in one shell weighs on an average 25 grammes, and contains as much as 87½ per cent. of water. The 100 grammes of white of egg powder, which cost a shilling, may, therefore, be said to equal the albumen from at least a score of eggs, so that it is a profitable transaction—in this country at any rate—to buy our albumen in this form under most circumstances. As our readers are aware, Dr. J. Schnauss, of Jena, has already borne testimony to the value of the dried albumen in the preparations of dry plates; and as it can be employed in small quantities at a time, there cannot be a doubt as to its being economical to use. The photographer employing the dried albumen may always be sure that he has in hands a material which does not vary in quality or composition; and when prepared in emulsion it keeps good quite as long as the ordinary white of egg solution.

We have had an opportunity of seeing a model in clay of the bust of a well-known merchant in this city, which has just been executed by Mr. François Van Luppen, sculpteur, 255 St. Dominique street. The likeness is most striking and life like. It is rarely that we see any piece of fine art so well executed in this country.

SECTIONS OF THE INTERNATIO HIBITION BUILDINGS OF 1876.

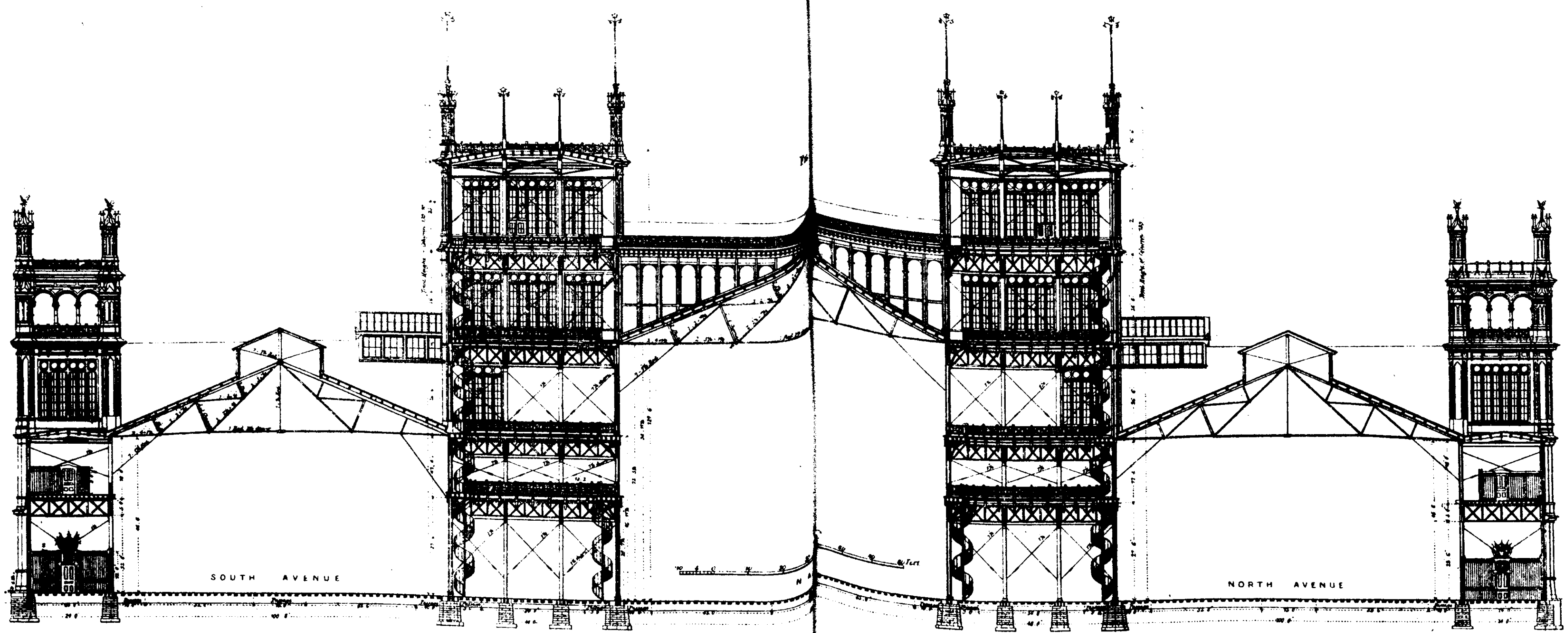


FIG. 2.

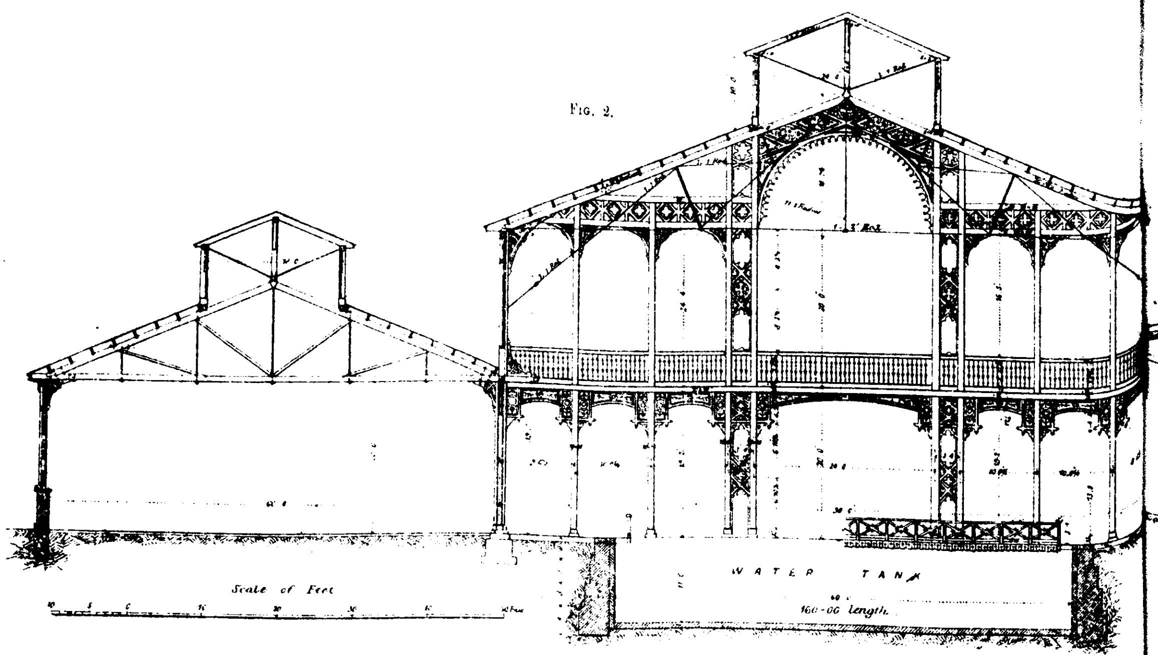
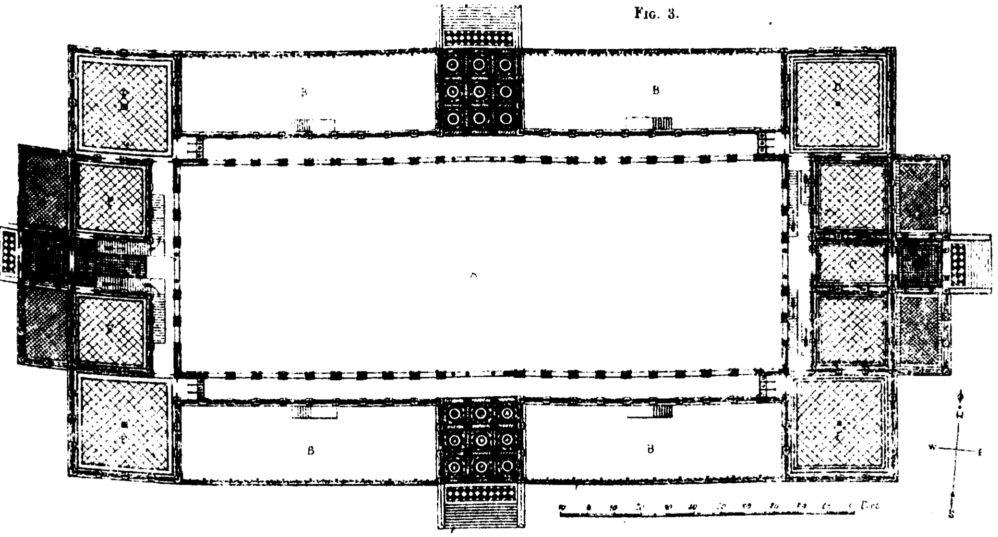


FIG. 3.



QUERIES.

[1009]—E. H. LEWIS, Winnipeg, inquires.—What would be the best means to remove a hard incrustation from the interior of a return tubular boiler?—Would diluted hydrochloric acid do it?

[1010]—I am making a pair of oscillating Engines—stroke 9 in x bore 4 in—and intend casting the cylinders out of a mixture of brass and babbit metal, will it answer for that purpose?

[1011]—What is the best method of placing a coating of copper on an iron surface?

ANSWERS TO QUERIES.

[1008.] The following is an excellent remedy for the Rheumatism, Lumbago, Sprains,, Bruises, Chilblains, (before they are broken,) and Bites of Insects.—One raw egg well beaten, half a pint of vinegar, one ounce of spirits of turpentine, a quarter of an ounce of spirits of wine, a quarter of an ounce of camphor. These ingredients to be beaten well together, then put in a bottle and shaken for ten minutes, after which, to be corked down tightly to exclude the air. In half an hour it is fit for use. Directions:—To be well rubbed in, two, three, or four times a day. For rheumatism in the head, to be rubbed at the back of the neck and behind the ears. This liniment can be made at home for 25 cts.; if not made at home, the chemist should be told to follow the prescription exactly.

WHALE ARTILLERY.

On a small island opposite to the town of Wadso, in the extreme north of Norway, there exists an establishment the like of which is probably not to be met with in any part of the world. Its most appropriate designation would be, perhaps, a slaughter yard for whales; and Mr. Foyn, its proprietor, conducts the business of capturing and cutting up the monsters in a manner peculiarly his own. Instead of fitting out the usual sized vessels, intended to make long voyages and bring home only the most useful parts of the animal, Mr. Foyn employs small—one hundred and fifty to one hundred and eighty tons—screw steamers, shoots his fish with a canon, and has them towed back, one by one, as they are captured, to the shambles at Wadso. As the fishing grounds are within easy reach of the latter, the steamers, as a rule, secure and return with a prize within twelve hours' time. With respect to the cannon employed, it is a gun having a chamber about four feet long; this is mounted on the forecastle of the vessel, and, being very accurately balanced, can be easily moved to allow an exact aim to be taken. The projectile in use consists of a long iron bolt, having at its extreme end four harpoons, bound round with a line so as to be flat, and close to the harpoons a five or six pounder shell. As soon as the steamer has approached sufficiently near to the fish—and whales off that part of the coast are not over shy, allowing a vessel to come within shot—the bolt is fired off, and, if well directed, penetrates deeply into the flesh and blubber of the animal. The whale then naturally rushes off at a furious pace, thinking thus to elude his pursuers. Unfortunately for him, however, no step could be more suicidal, for the effect of his rapid movement is to make the bolt slip back a little, thus setting free the four harpoons from the lines, and, by means of a mechanical arrangement, causing a shell to explode. This generally proves the *coup de grace*, killing the fish outright; but occasionally the animal is not sufficiently hard hit, and its capture is not so easily effected, as it dashes away at a tremendous speed, dragging the steamer after it.—*Scientific American.*

ECONOMY IN MACHINE SHOPS.

The following suggestions, in regard to the care of tools and waste of oil in machine shops, are contained in a paper read before the New York Society of Practical Engineering, by James C. Bayles, editor of the *Iron Age*:

"The proper care of tools is always attended with an important economy. In small establishments this seldom receives due attention. As a rule, a tool belongs to anybody who happens to have it; consequently, no one is responsible for it. It is neglected, abused, mislaid, broken, stolen, or worn out before it has rendered half the service it is capable of performing. In some shops the time of one man, and sometimes two, is constantly lost in looking for missing tools and putting them in order for use when found; and a great deal of capital is wasted by the premature destruction of tools which, with proper care, should have lasted for years. In all manufactories there should be a place for tools not in constant use, and some one should have charge of them. A very good system, which I have always found to work well, provides for the changing of every tool in use to the man using it. When it is returned he receives a credit for it which balances his account with the tool department. For tools added to his individual kit, such as files and other implements supplied by employers, charge is made and no credit is given until the tool is returned broken or worn out, when a credit entry is made, with date, showing how long it has been in use. Such a record induces men to be careful of tools, and, by inculcating good habits in this respect, leads to economy in a direction in which waste and extravagance are easily overlooked.

"Another important saving in many shops would attend a more judicious oversight of the consumption of oil. In machine shops, and to a greater or less extent in all shops where machinery is used and iron worked, the amount of oil wasted constitutes a very large proportion of the total amount used. This waste results from a certain looseness of habit which most men acquire in handling materials which some one else pays for. When a drop of oil is needed, it is customary for the mechanic to pour a stream from his oil can, and wipe off the surplus with a wad of cotton waste. It is no exaggeration to say that half the oil used about many manufactories of machinery and metal goods is wasted, and the waste constitutes a serious item of expense. Oil is almost always used for lubricating purposes, especially in small establishments, yet there are other lubricants that might be kept constantly on hand, which are at once much cheaper and much better than oil, for such purposes as drilling, tapping, screw cutting, etc. There is also a great deal of oil wasted in applying it to machinery and shafting. Whenever we see a drip pan that has not been attended to for a few days, we may be pretty sure of finding it half full of oil which has rendered no service, and which has become unfit for use, being gummy, foul, and filled with foreign impurities. There is no need of this waste, which never occurs when the oiling of the shafting and machinery is properly looked after; but it is an evil against which the manufacturer can guard only by constant watchfulness."

PHOTOGRAPHY.

SPIRIT PHOTOGRAPHY.—At a recent meeting of the Berlin Photographic Society a communication from Dr. Stein was read in which he stated that he had recently met, at a spiritualistic congress, the notorious Parisian spirit photographers, Buguet and Leymarie, and although he exposed them then and there, by taking similar photographs, he failed to convince the audience. The explanation is simple. Dr. Stein had a negative in his pocket, which he copied by the light of a candle, in the dark room, before developing the portrait of the gentleman who appeared with a female "spirit" at his side.—*English Mechanic.*

BLACK SPOTS ON PRINTS.—Mr. J. B. Butterfield, writing to our Philadelphia contemporary, says:—"Last winter I began to be troubled with minute black specks being deposited all over the albumenized surface of my paper while washing my prints before toning, and could not discover at the time the cause. I inquired from a number of photographers in regard to my trouble, and all seemed to agree that it was the paper; so I procured a sample of two or three different makes of paper, and still the same trouble. The paper appeared to be clear when printing, but after washing was full of those black specks, which, on rolling after being mounted, would have a metallic appearance. I began to get very much discouraged, having been troubled for about two months, and experimenting all the time to find the cause of the trouble (having made different silvering solutions, but still the same result), when at last I thought I would silver a piece of paper and not print it, but, after drying, place it in a porcelain dish, and, leaving plenty of light in my room, drew some water directly on it from the tap, and, by examining closely, I could see small particles depositing all over the surface, and which, on examination, proved to be iron-rust, having been loosened from the inside of a short piece of iron pipe by the frost over night, the moisture in the pipes freezing after the water was turned off. I caught and filtered some of the water, and was satisfied, from the deposit on the filter, that I had found the cause of my trouble, and have not used water for washing from that tap since, and have had a clear pictures as I ever had, and shall hereafter discard the use of iron pipes entirely."—*The Photographic News.*

MACHINISTS RECEIPTS.

Belgian Welding Powder.—Iron filings, 1000 parts; borax, 500 parts; balsam of copaiba, or other resinous oil, 50 parts; sal-ammoniac, 75 parts. Mix all well together, heat, and pulverize completely. The surfaces to be welded are powdered with the composition, and then brought to a cherry red heat, at which the powder melts, when the portions to be united are taken from the fire and joined. If the pieces to be welded are too large to be both introduced into the forge, one can be first heated with the welding powder to a cherry red heat, and the other afterwards to a white heat, after which the welding may be effected.

Composition Used in Welding Cast Steel.—Borax, 10 parts; sal-ammoniac, 1 part; grind or pound them roughly together; then fuse them in a metal pot over a clear fire, taking care to continue the heat until all spume has disappeared from the surface. When the liquid appears clear, the composition is ready to be poured out to cool and concrete; afterwards being ground to a fine powder, it is ready for use. To use this composition, the steel to be welded is raised to a heat which may be expressed by "bright yellow;" it is then dipped among the welding powder, and again placed in the fire until it attains the same degree of heat as before; it is then ready to be placed under the hammer.

Tempering Steel Springs.—The steel used should be that called "spring" for large work; for small work, "double shear." After hardening in the usual way, in water, or, as some prefer, in oil, dry the spring over the fire to get rid of its moisture, then smear it over with tallow or oil, hold it over the flame of the smith's forge, passing it to and fro, so that the whole of it will be equally heated, holding it there until the oil or tallow takes fire. Take the article out of the fire and let it burn a short time, then blow it out. This process may be repeated two or three times if the operator fancies that any portion of the spring has not been reduced to the proper temperature, or rather, raised to it.

Tempering Spiral Springs.—Place a piece of round iron inside the spring, large enough to fill it; then make the spring and iron red hot, and, when hot place them quickly into cold water, and stir them about till cold; afterwards rub them with oil or grease, and move them about in a flame till the grease takes fire; the spring will then be reduced to its proper temper.

To Soften Malleable Iron.—When your furnace is charged with fuel and metal, get the fire up to a dull red heat, then pour fluoric acid all over the coke; use ½ pt. to 1 pt. or even 1 qt., adding a handful of fluor spar; it will make the metal much softer.

Chilled Iron.— At Lister's Works, Darlington, England, some articles required turning in the lathe, and cast steel could not be made hard enough to cut them. One man proposed cast metal tools. He was laughed at, of course, but his plan had to be tried. Well, cast metal tools were tried, with points chilled, and they cut when cast steel tools were of no use. The article was turned up with metal tools.

Tempering Liquid for Mill picks.—Rain water, 3 gals.; spirits of nitre, 3 oz.; hartshorn, 3 oz.; white vitriol, 3 oz.; alum, 3 oz.; sal-ammoniac, 3 oz.; salt, 6 oz.; with 2 handfuls of the parings of horse's hoofs. The steel to be heated to a cherry red. A large jug of this preparation should be kept corked tight, to keep its strength from being lost by evaporation.

To File a Square Hole.—To file a hole square, it is necessary to reverse the work very often; a square file should first be used and the holes finished with either a diamond-shaped file, or a half round. This leaves the corners square, as they properly should be.

To Temper Small Springs.— *In large quantities*— First, harden them in the usual manner of hardening steel; then place as many as convenient in a vessel containing oil. Heat the oil containing the springs until it takes fire from the top, then set off the vessel and let it cool. The springs will then be found to possess the required temper.

Black-lead crucibles are made of 2 parts graphite, and 1 of fireclay, mixed with water into a paste, pressed in moulds, and well dried, but not baked hard in the kiln. This compound forms excellent small or portable furnaces.

A good alloy for making working models is 4 parts copper, 1 part tin, and ¼ part zinc. This is easily wrought. Doubling the proportion of zinc increases the hardness.

Tempering Razors, Cutlery, Saws, &c. —Razors and penknives are too frequently hardened without the removal of the scale arising from the forging: *this practice, which is never done with the best works, cannot be to too much deprecated.* The blades are heated in a coke or charcoal fire, and dipped in the water obliquely. In tempering razors, they are laid on their backs upon a clean fire, about half-a-dozen together, and they are removed one at a time, when the edges, which are as yet thick, come down to a pale-straw color. Should the backs accidently get heated beyond the strawcolor, the blades are cooled in water but not otherwise. Penblades are tempered a dozen or two at a time, on a plate of iron or copper, about 12 inches long, 3 or 4 inches wide, and about ¼ of an inch thick. The blades are arranged close together on thin backs and lean at an angle against each other. As they come down to the temper, they are picked out with small pliers and thrown into water if necessary; other blades are then thrust forward from the cooler parts of the plate to take their place. Axes, adzes, cold chisels, and other edge tools, in which the total bulk is considerable compared with the part to be hardened, are only partially dipped: they are afterwards let down by the heat of the remainder of the tool; and, when the color indicative of the temper is attained, they are entirely quenched. With the view of removing the loose scales, or the oxydation acquired in the fire, some workmen rub the objects hastily in dry salt before plunging them in the water, in order to give them a cleaner and brighter face.

Oil, or resinous mixtures of oil, tallow, wax, and resin, are used for many thin and elastic articles, such as needles, fish-hooks, steel pens and springs, which require a milder degree of hardness than is given by water. Gun lock-springs are sometimes *fried in oil* for a considerable time over a fire, in an iron tray; the thick parts are then sure to be sufficiently reduced, and the thin parts do not become the more softened from the continuance of the blazing heat.

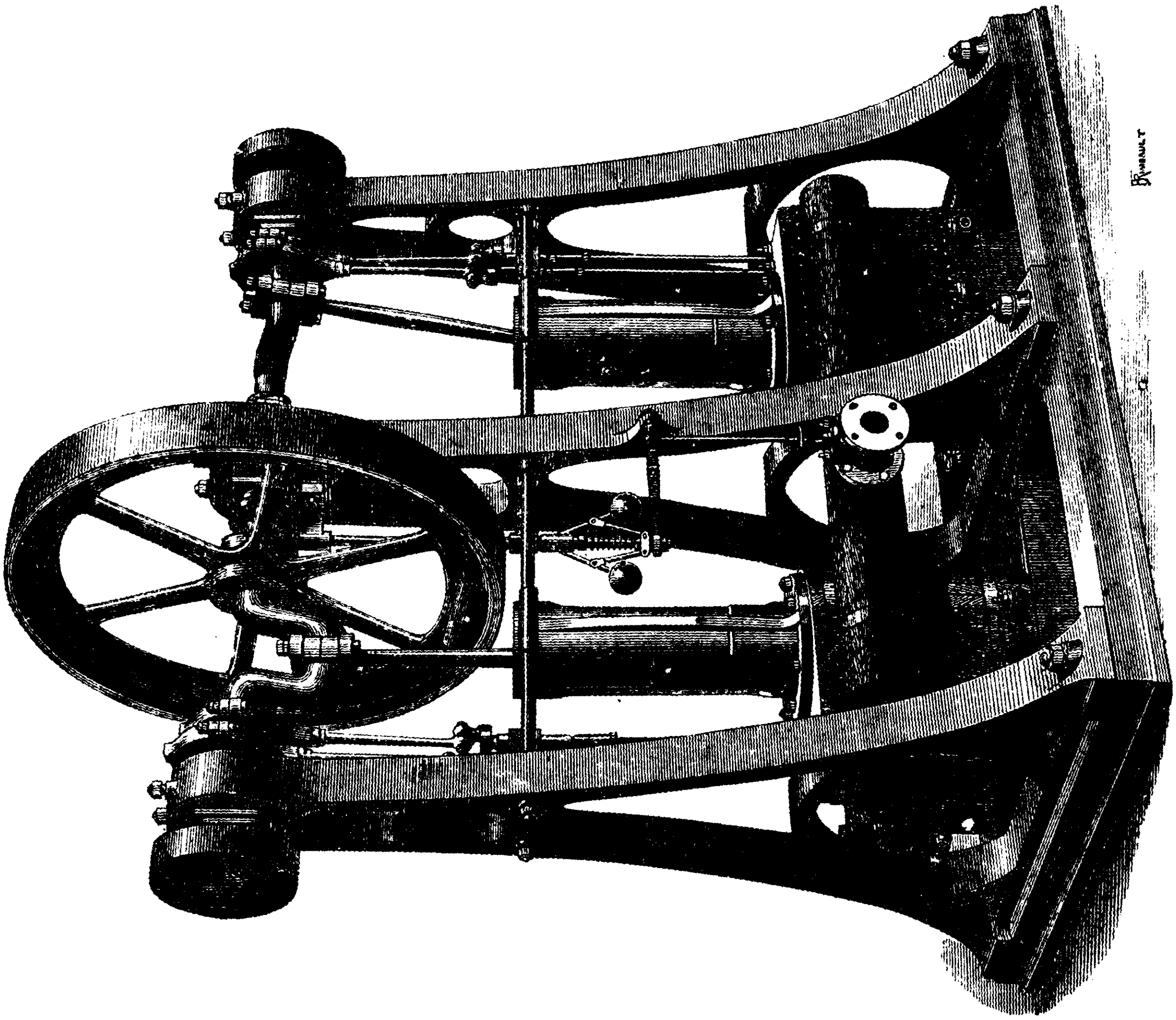
Saws and springs are generally hardened in various compositions of oil, suet, wax, &c. The saws are heated in long furnaces, and then immersed horizontally and edgeways into a long trough containing the composition. Part of the composition is wiped off the saws with a piece of leather, when they are removed from the trough, and heated one by one, until the grease inflames. This is called "*blazing off.*" The composition used by a large saw manufacturer is 2 lbs. suet, and ¼ lb. of bees'-wax, to every gallon of whale oil; these are boiled together, and will serve for thin works and most kinds of steel. The addition of black resin, about 1 lb. to each gallon, makes it serve for thicker pieces, and for those it refused to harden before; but resin should be added with judgment, or the works will become too hard and brittle.

To Reduce Oxide of Zinc.—The oxide may be put in quantities of 500 or 600 lbs. weight into a large pot over the fire; pour a sufficient quantity of muriatic acid over the top, to act as a flux, and the action of the fire will melt the dross, when the pure metal will be found at the bottom of the pot.

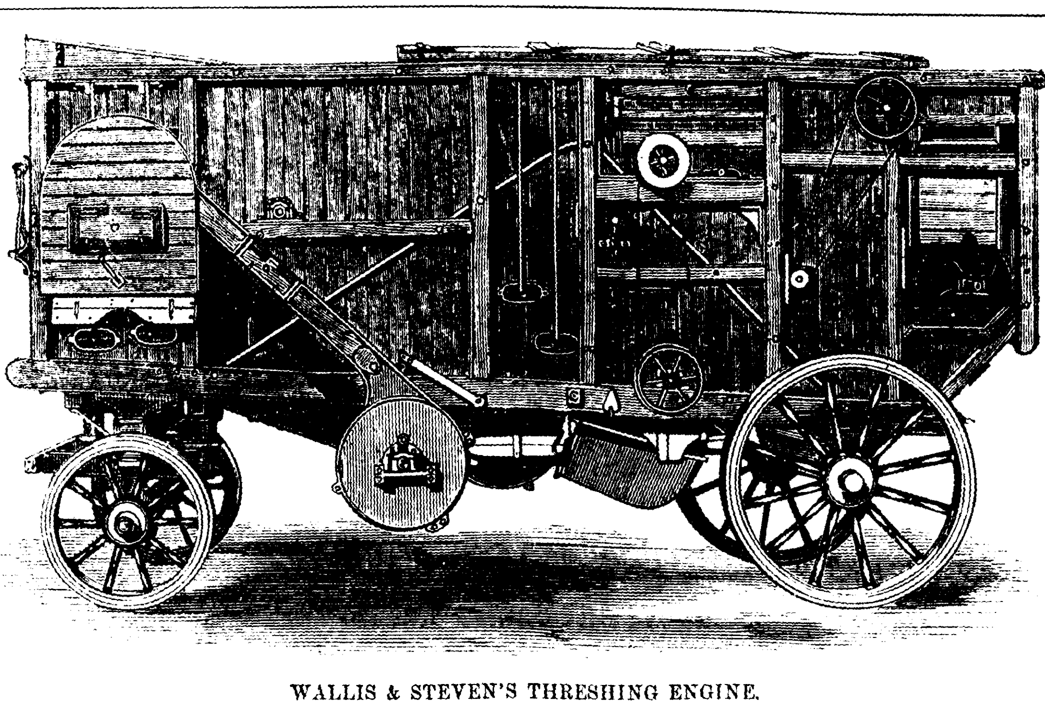
To Temper Taps or Reamers without springing, select your steel for the job, and forge the tap with a little more than the usual allowance, being careful not to heat to hot nor hammer too cold; after the tap or reamer is forged, heat it and hold it on one end on the anvil. If a large one, hit it with the sledge; if a small one, the hammer will do. This will cause the tap to bend slightly. Do not straighten it with the hammer, but on finishing and hardening the tap, it will become straight of its own accord.

SIXTY-FOOT RAILS.

The Edgar Thompson Steel Works have filled an order for 60 foot rails. Several advantages are claimed for rails of this length. They cost no more per pound than 30 foot rails; and as two crop ends are saved, the cost of production is considerably lessened—no way of using crop ends economically having yet been devised. The cost of laying is lessened; fewer fish plates, etc., are required; and as the hammering caused by the rolling stock in passing from rail to rail is lessened by one half, the wear and tear of rails and rolling stock must be greatly diminished. On bridges, also, the strain will be greatly reduced. The practical results of the use of these rails will be awaited with considerable interest. —*Chicago Railroad Review.*

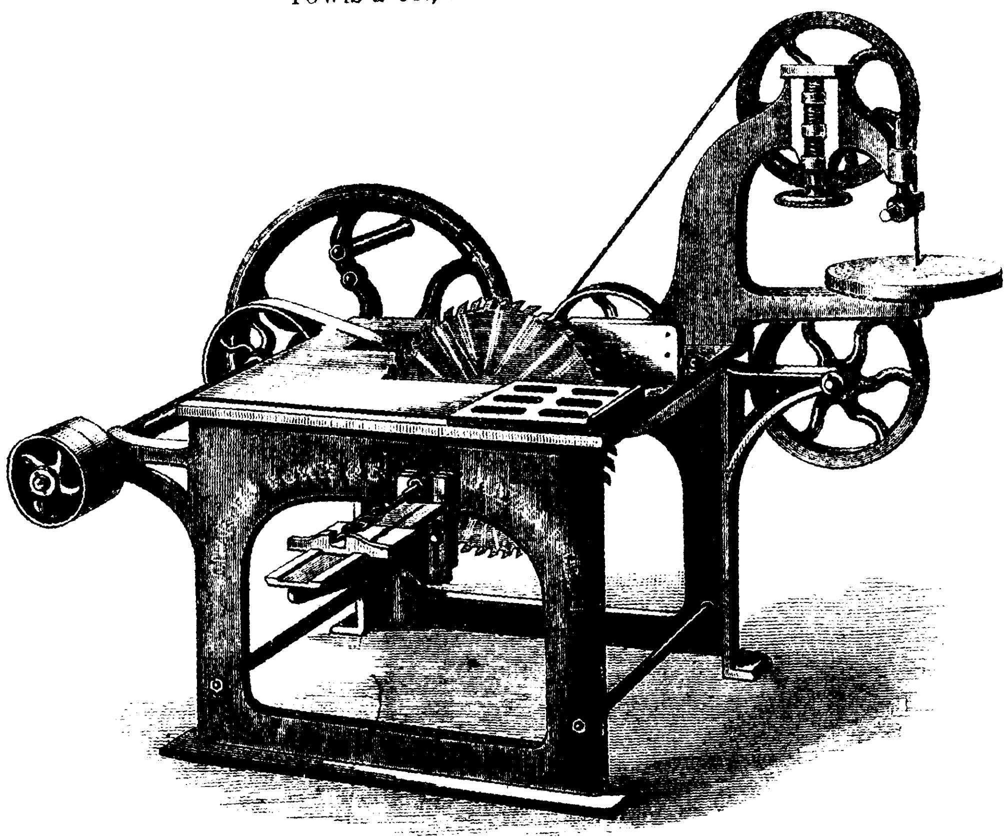


VERTICAL ENGINE.

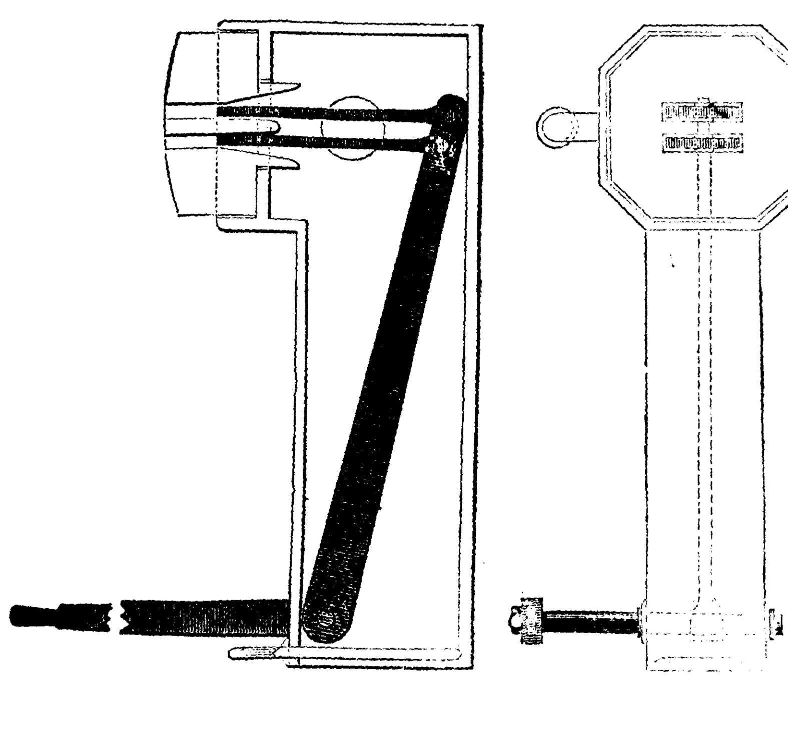


WALLIS & STEVEN'S THRESHING ENGINE.

POWIS & CO., PATENT SAWING MACHINE.



MORGAN'S TUYERE FOR SMITH'S HEARTHS.



LECTURES TO LITTLE FOLKS.

THE PHANTASMASCOPE. — (See page 77.)

Before quitting the subject of our last lecture, we have yet another toy in store for your amusement, it is founded upon the same optical principle which we hope you now thoroughly understand. In the illustration Fig. 1, is shown a disk with figures drawn therein in different attitudes of dancing; near the edges are cut out a series of notches corresponding with the figures delineated on their margins. To exhibit the magical effects of this toy, it must be attached to a spindle and made to revolve rapidly before a looking-glass, and the reflections viewed through the openings, when to your astonishment you will observe the figures in constant motion and exhibiting the most grotesque attitudes; now attend to the explanation. Each figure is seen through the aperture, and as it passes and is succeeded in rapid succession by another and another, differing from the former only in attitude, the eye is cheated into the belief of its being the same object successively changing the position of its body. Consider what takes place in an image on the retina when we actually witness a man in motion; for instance, a man jumping over a gate: in the first moment he appears on the ground, in the next his legs are a few inches above it, in the third they are nearly on the level with the rail, in the fourth he is above it, and then in the successive movements he is seen descending as he had previously risen. A precisely similar effect is produced on the retina by the successive substitution of figures in corresponding attitudes, as seen through the orifices of the revolving disk, each figure remaining on the retina long enough to allow its successor to take its place without an interval that would destroy the illusion. Fig. 2, is an improvement upon its construction in as much as we get rid of the mirror, and enable two persons to witness the deception at the same time: at each end of the spindle a disk is placed and by revolving the spindle you will then perceive that both cards are made to turn with equal velocity, figures will be all dancing or horses prancing, according to the style of figure you choose to delineate upon the card. It is scarcely necessary to observe that the appearances thus produced, may be infinitely varied; heads opening their mouths, and distorting their countenances; creeping serpents, and machinery in active operation are among the subjects that have excited the greatest admiration.

MECHANICAL DRAWING.

For some months past we have given diagrams in Mechanical Drawing taken from the Drawing Books adopted by the Commissioners of National Education in Ireland, but as in every number that we issue there are examples of machinery which if copied accurately by the student will afford him excellent practice, we shall for the future give illustrations of a more varied kind, but on a reduced scale, in order to embrace in each volume as much instruction in this most useful art as possible.

The ability to draw neatly and correctly cannot be too highly estimated by the mechanic, in fact it is an absolute necessity to progress in his trade. The carpenter, the cabinet-maker, the founder, the smith, in fact every artizan who wishes to become master of his craft should have some knowledge of mechanical drawing so as to be able to delineate correctly his ideas upon paper. The frivolous excuses so frequently made of not having taste for drawing, or time to do so, is unworthy of any young mechanic who is in the least desirous of improving his position. Any one can be taught to become sufficiently skilful with his pen and pencil to make good mechanical drawings. This is no gift of nature, it is simply acquired by practice and proper attention to the rules and principles which govern the art, nor is any costly box of mathematical instruments necessary. With a drawing board, square, jointed compasses fitted with pen, pencil, and extension joints; a small pair of compasses with needle points for describing very small circles; a *good ruling pen* parallel ruler, and sliding square, with a few cakes of water colours, such as india ink, sepia, umber, lake, blue, and yellow, he can make almost any kind of mechanical drawing. His instruments, however, should be always good and can be obtained separately of a much superior quality to those sold in boxes, in fact the cheap instruments sold in boxes are absolute trash with which no draftsman, however proficient he may be, can make good work.

The ability to make a good drawing is always a source of pleasure and amusement, and when once the young student acquires the art he begins to feel resources of profitable pleasure within himself, and no longer seeks for frivolous amusements and spending time unprofitably. As regards want of time or want of recreation after the day's work is over, an excuse which is so often made by young men, we can only say, that it is not necessary every evening should be spent in study, other recreations of an enlivening kind, if harmless, are essential to health and happiness, but a few evenings in every month can always be spared for the study of drawing, "where there is a will there is a way."

As a source of pleasure and as an accomplishment, the study of drawing has frequently a great influence over the mind and tends to elevate and refine our ideas; a good picture often conveys more instruction and reaches the heart quicker by the moral which it pourtrays than even a well written book.

Although a knowledge of geometry and perspective is very essential to be a good mechanical draughtsman, yet any one may arrive to great skill in delineating figures and machinery, without having studied the rudiments of either. We shall therefore from time to time furnish such subjects as we hope will prove of value to every one desirous of acquiring the art, whether young or old.

AN OLD INVENTION.

From a paper on the locomotive engine, by Joseph Harrison, Jr., read before the members of the Franklin Institute of Pennsylvania, February 21, 1872, is taken the following paragraph:

"The engineer, noting the curious things in bronze and in copper exhumed at Pompeii and gathered together in the Museum Borbonico at Naples, will linger near a small vessel for heating water, little more than a foot high, in which are combined nearly all the principles involved in the modern vertical steam boiler—fire-box, smoke-box, smoke-flue through the top, and fire-door at the side, all complete; and strange to say, this little thing has a *water-grate* made of small tubes crossing the fire-box at the bottom, an idea that has been patented twenty times over, in one shape or another, within the period of the history of the steam engine."

DOMESTIC.

BUNS.—1 lb. of flour, 6 oz. butter, 2 tea-spoonfuls of baking powder, ¼ lb. sugar, 1 egg, nearly ½ pint of milk, a few drops of essence of lemon. Bake immediately. This receipt will make 24 buns.

AN EXCELLENT CAKE FOR TEA OR LUNCHEON.—1½ lb. flour, ½ lb. butter, 3 tea-spoonful of baking powder rubber in, ½ lb. sugar, ½ lb. currants, ¼ lb. raisins, 1 egg, about a pint of milk. The egg and milk should not be added till just before the cake goes into the oven.

RECEIPT FOR RICE CAKE.—½ lb. rice flour, ½ lb. best flour, ½ lb. pounded loaf sugar, and seven eggs, yolks and whites to be well beaten apart ; the rind of a lemon grated, ¼ lb. of butter; beat all well for ¾ of an hour, butter a pan, and bake for ¾ of an hour. The above receipt has been often tried, and always successfully.

ALMOND CAKES.—Rub 2 oz. of butter into 5 oz. of flour, 5 oz. powdered lump sugar ; beat an egg with half the sugar, then put it to the other ingredients. Add 1 oz. blanched almonds, and a little almond flavour ; roll them in your hand the size of a nutmeg, and sprinkle with fine lump sugar. They should be *lightly* baked.

PIOCAITHLY BANNOCK.—Dry before the fire 1 lb. fine flour; then melt ½ lb. of butter ; then mix with the flour 2 oz. almonds *thinly sliced ;* 2 oz. of orange peel, 2 oz. *sugared* carraways, 2 oz. pounded sugar, then pour on these ingredients the melted butter ; knead altogether well, put the bannock in a slow oven, and bake it an hour.

CARRAWAY SEED BISCUITS. — 2 lbs. of flour, add 2 oz. of butter rubbed in, ½ lb. of sugar, 1 oz. carraway seeds, 1 oz. ground coriander seed, ½ a tea-spoonful of carbonate of soda, and a table-spoonful of arrow-root ; mix the whole well together, and make a stiff paste with warm milk, cut into thin cakes, and prick over with a fork ; bake slowly.

GINGERBREAD CAKE.—½ lb. of fresh butter beaten to cream, 2 lbs. of treacle, 1 oz. of currie seeds, ½ oz. of ground ginger, and a little cayenne pepper ; 1 heaped tea-spoonful of pearlash, ½ lb. of sugar, 2 lbs. of flour, then add 5 or 6 eggs *unbeaten*. Mix well for ½ an hour, and then put it into a papered pan. Fire 2½ hours in a moderate oven. This is considered a very good and economical household cake.

TO PICKLE TWO HAMS.—2 gallons of water ; 1 lb. of bay salt; 2 lb. of common salt ; 2 oz. of saltpetre ; 1 oz. of sal prunella ; 1 lb. of coarse sugar. Boil the whole together, skim it clean, and then pour it boiling hot over the hams ; they must be turned daily for three weeks. This preparation, by being boiled and well skimmed, will cure two more hams by adding a small proportion of each of the salts.

A LEG OF BEEF STEWED.—Cut it into pieces ; put to it a bunch of sweet herbs, two large onions, six or eight cloves, a carrot or two, a turnip, a head of celery, some black pepper, a quart of beer, and water enough to cover the meat, and scum the liquor ; put to it celery ready boiled, and cut it pieces ; also carrots and turnips boiled, and put a little cayenne, thicken some of the liquor with flour, boil a few minutes a little red wine, (not much), pick out the sinews and as much of the meat as it wanted put into the sauce and serve it a deep dish.

EXCELLENT CHEESECAKES, KNOWN AT RICHMOND AS "MAIDS OF HONOUR."—Make some new milk luke-warm, then put a spoonful of rennet, stir it well through a cheese-cloth to get rid of the whey ; then to ½ lb. of curd put 6 oz. of butter, 4 yolks of eggs, and sugar and nutmeg to the taste. Mix all the ingredients well, line patty-pans with a puff paste, fill them with the mixture, and bake in a quick oven. The cheesecakes may be flavoured with lemon for a variety. (The above is an admirable receipt, and has never yet been published that I am aware of.)

TO PRESERVE APPLES IN QUARTERS, IN IMITATION OF GINGER. —The proportions are three pounds of apples to two of pounded loaf sugar. Supposing this to be the quantity, peel, core and quarter the apples ; put a layer of sugar and apples alternately, with a quarter of a pound of the best white ginger into a wide-mouthed jar ; next day, infuse about an ounce of *bruised* ginger in rather less than half a pint of boiling water ; cover it close, and on the day following put the apples (which have now been two days in the sugar) into a preserving pan, with the water strained from the ginger. Boil till the apples look clear, and the syrup rich ; this usually takes place in an hour. A few minutes before the preserve is taken from the fire, throw in the skin of a lemon. In stirring till it begins to boil, great care must be taken to avoid breaking the apples, therefore it is advisable to use a porridge-stick, and when it has commenced boiling take out the stick and put on the lid of the preserving pan, or a plate that may fit the top of it, and let it simmer on a low fire for *about half an hour,* as we found *that time* sufficient. Put it into jars, and let it stand uncovered several days, so as to be perfectly cool, before tying it up with paper and bladder.

EXHAUSTION OF THE SOIL BY APPLE TREES.

The author calculates that, in a life of sixty years, an apple tree removes from the soil 60 lbs. of nitrogen, equal to 11,400 lbs. of farmyard dung. To maintain the soil in condition, therefore, about 175 lbs. of dung ought to be annually given per tree during the fifty years that it is in bearing.—*M. I. Pierre.*

USEFUL RECIPES FOR THE SHOP, THE HOUSEHOLD, AND THE FARM.

A new compound for polishing and cleaning metals is composed of 1 oz. carbonate of ammonia dissolved in 4 ozs. water; with this is mixed 16 ozs. Paris white. A moistened sponge is dipped in the powder, and rubbed lightly over the surface of the metal, after which the powder is dusted off, leaving a fine brilliant luster.

A new alloy for bell metal is proposed, which does not tarnish, is less liable to crack, gives a better sound, and is much lighter in weight than the alloy usually employed for the purpose. It is prepared as follows : Nickel 1 lb. and copper 6 lbs. are melted and cooled. Add zinc 2 lbs., aluminum ½ oz. Melt and cool. Melt again, and finally add ½ oz. quicksilver and 6lbs. melted copper.

A very beautiful application of electro-metallurgy is to apply a coat of silver by electro deposition on natural leaves and flowers. By this means very delicate ornaments are produced, since the precise form and texture of the natural leaf are produced under the thin silver film.

LEMONS can be preserved by varnishing them with a solution of shellac in alcohol. The skin of shellac formed is easily removed by rubbing the fruit in the hands.

THERE is no simpler remedy for preventing cider growing sour than mustard seed. After the cider has fermented and reached the desired palatable condition, put 1 pint mustard seed to a barrel of cider, and bung tight.

WHAT is the real use of the so-called precious stones ? They are not used as money—cannot be made into implements—have no place among medicines—do not ease an aching brow or a gouty finger ; with all their radiance they will not light us in the dark, but will themselves borrow the rays of a tallow candle ? It has pleased God not merely to prepare the word as a convenient and comfortable habitation for man, but also to adorn it—to make it resplendent with the fitting and finishing of a palace.

IN the family of grasses, our botanists include not only the corn tribes of all sorts, but sedges and reeds—the bamboo and the sugar cane—so that a walking-stick is but a straw of a stronger kind, a cane in the tutor's hand is a grass stalk rendered tough and pliable for its peculiar office !

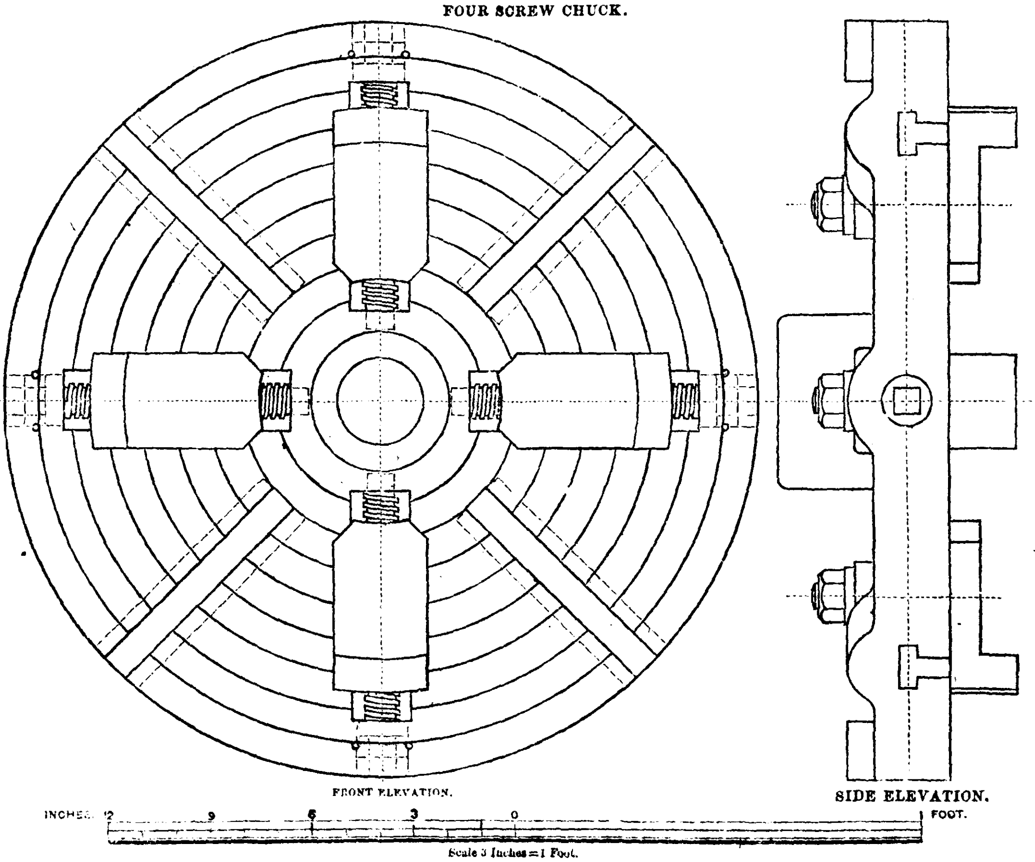
BESIDES food, there is another support which we derive from birds. In health, in sickness, at the point of death, on their soft plumage we repose—some of us, how many hours out of the twenty-four ? There are those who have been known to have slept fourteen hours ! so do not the birds themselves—not even geese !

THE best treatment for slight burns is to apply cotton batting soaked with a liniment made of equal parts of linseed oil and lime water. Be careful not to break the blisters, should any form.

HOW TO GROW FAT.—It is said that a pint of milk, taken every night just before retiring to rest will soon make the thinnest figure plump. Here is a simple and pleasant means by which thin scraggy women may acquire plump rounded figures.

MECHANICAL DRAWING.

FOUR SCREW CHUCK.



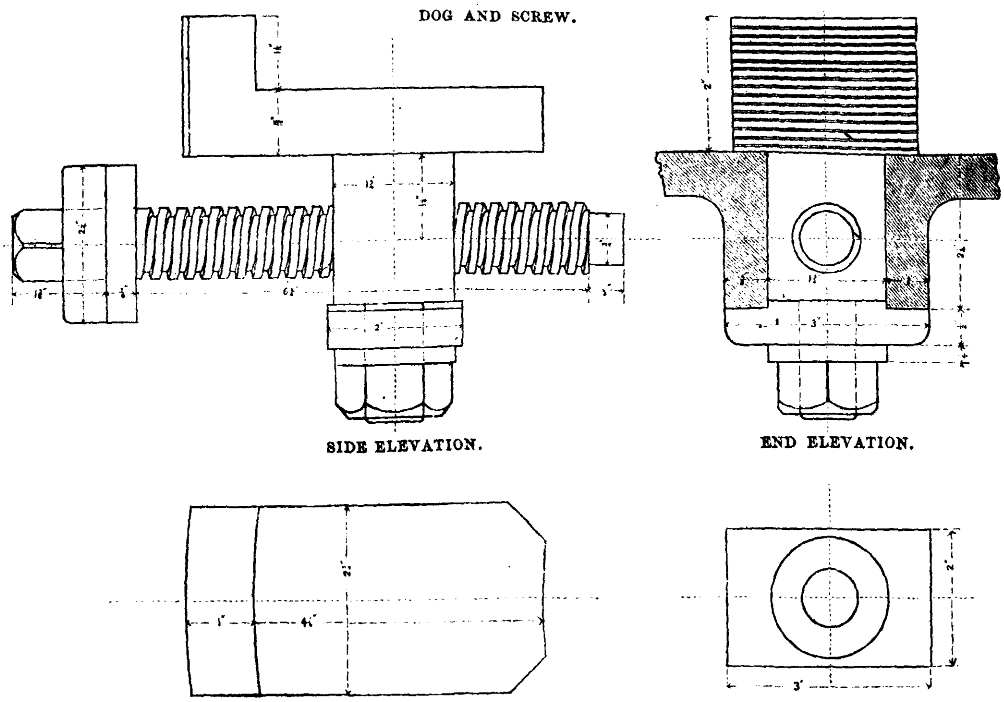
FRONT ELEVATION.

SIDE ELEVATION.

Scale 3 Inches = 1 Foot.

DETAILS OF FOUR SCREW CHUCK.

DOG AND SCREW.



SIDE ELEVATION.

END ELEVATION.

PLAN OF DOG.

PLAN OF WASHER.