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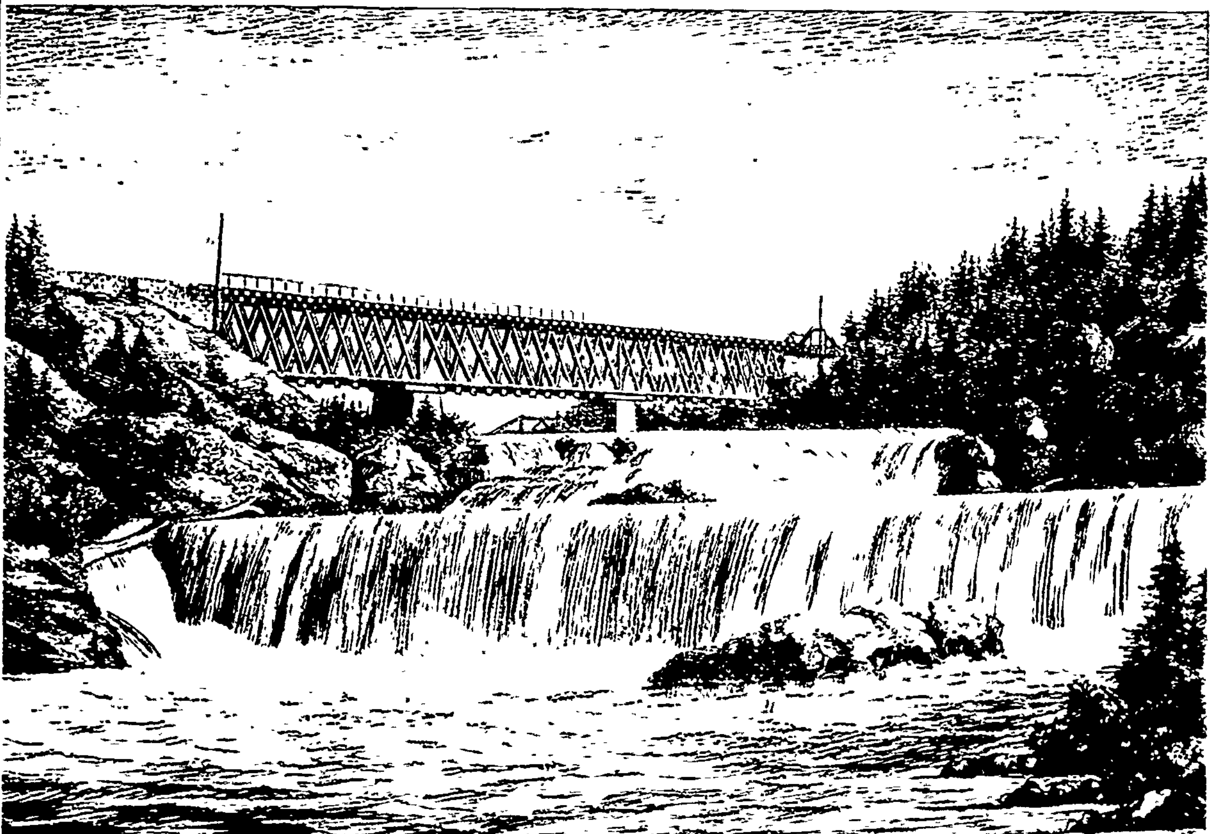


INTERCOLONIAL RAILWAY BRIDGE AT RIVIÈRE DU LOUP.

INTERCOLONIAL RAILWAY BRIDGE AT RIVIÈRE DU LOUP.

We are indebted for the following particulars to Mr. Hazelwood, late engineer of the St. Lawrence District. It is built on the "Howe Truss" principle. It was designed by Mr Sandford Fleming, the chief engineer of the Intercolonial Railway, and is composed of three spans of 100 feet each, with roadway on top. The depth of the truss is 18 feet, and the road-way above the bed of the river 40 feet. This bridge is supposed to be one of the strongest Howe trusses at present in existence. There is a little bridge of 30 feet span on the west side of this one, but connected with it, for the purpose of carrying the railway over the Temiscouata road. The Rivière du Loup and Isle Verte bridges, together with the one over the Eissiquash River, in Nova Scotia, are the only wooden bridges on the entire line of the Intercolonial Railway. They were built before the commissioners consented to comply with the suggestions of the chief engineer to have them all of iron Our illustration is from a photograph by Mr. W. A. Campbell, of Rivière du Loup, *en bas.*

LEONARDO DA VINCI AS AN ENGINEER.

This was the title of a lecture by Mr. A. Hildebrandt, C.E., delivered before the members of the Scientific and Mechanical Society Leonardo da Vinci is generally accepted as a great painter and sculptor, but of his other qualities little or nothing has been known Dr Herman Goathe, of Berlin, has recently published a brochure based upon the study of da Vinci's M.S S, which are deposited in the libraries of Italy, Paris, and London, showing that the man was really a universal genius; and if regard be had to the time in which he lived, he was one of, if not the most wonderful man which our planet ever produced The brochure, which he illustrated with woodcuts copied from Leonardo's sketches, and one lithographed facsimile of a machine with all its details and explanations in Italian, written from right to left—one of his peculiarities—formed the text of the lecture from which we gather the following.

Leonardo da Vinci lived from 1452 to 1519, was born in Florence, where he acquired a knowledge, among other things, of weaving, metal founding, and metal work, such as goldsmithing, which were considered by his master to be necessary preliminaries to painting and sculpture, in which latter he made such rapid progress, that after having painted an angel in one of his master's pictures the latter put down his brush and pallet to take it up no more. We know what a high position Vinci afterwards occupied in the artistic world—that he stood on a level with Michael Angelo, his contemporary. It is not unnatural to assume, with our present-day experience, that to acquire such excellence an absolute specialty must be made of the particular calling, but the contrary fact is one of the most striking features of the old master. To what a state of perfection he brought music may be inferred when we are told that he went victoriously from a competition for the place of first violinist to the Duke Ludwig Mario Sforza, who thereupon called him to Milan in 1484, not without wanting and finding in him the greatest painter and inventor of Italy. He there founded an academy of science, he painted world-famed pictures—such as the ' Last Supper," which still exists (at least in copies)—he modelled the equestrian statue of the Duke's father (which, unfortunately, has got destroyed), he was the Duke's military engineer, and the part he took in architectural work cannot have been a small one, when it is due to his influence that the then prevailing style of late Gothic gave way to Roman and Greek. He wrote several works on painting, light and shade, and other tracts, and designed improved machines and implements, studied anatomy—which he considered indispensable to the painter—and experimented and studied nature generally, which resulted in his philosophical reasonings and tracts exposing him at the same as a free-thinker, to which he really aspired in reference to the then prevailing dogma of the Church relative to the form of the earth. He adapted, about this time, the Martesana canal for navigation, and constructed two others for irrigation. Having left and returned to Milan several times after the removal of the Duke Ludwig Sforza, occupied in various capacities as retired philosopher, private painter and sculptor, painter to the king of France, as engineer-general of fortifications in Florence, Sienna and France, he designed in the last two years of his life the canal of Ramorantin, which was carried out after his death. He was buried in Amboise: Napoléon III, in 1863, caused a memorial to be erected to him after his grave had been again discovered, and a monument was also erected to his memory in Milan.

As a philosopher, no doubt is entertained that all or most of the various discoveries recorded in his MSS. are his original ideas, as they entirely differ from the theories of Aristotle, who lived long before him, and conform very closely with the notions accepted in modern times, which are almost invariably accredited to the period of Galileo, who lived much later (from 1602) His knowledge of the laws in natural science is mostly evident from his application of the same to his every day practice He was an acute mathematician, the invention of the signs + and — is assigned to him, as being one of the first to make use of them. He attempted to square the circle, but gave up the attempt, as it was "impossible to do it with absolute accuracy." He studied and wrote much of perspective, and laid down rules, which hold good at the present day He was well acquainted with the laws of the lever, and made familiar use of them, this applies also to the inclined plane, and his pulley blocks were in continual use. He had also a very clear notion of the weight of bodies and of the law of gravitation His laws of motion do him credit, and the *perpetuum mobile* is studied and condemned in no doubtful terms He studied the strength of materials, and seems to have been conversant with the laws of friction. In hydraulics he was particularly at home, as may be inferred from his practical works of mills' construction, his water-wheels and turbines are admirable, and the laws upon which the hydraulic press is based were perfectly clear to him. He also investigated the waves of fluids and sound, he bored artesian wells and constructed pumps. How well he understood the laws of combustion will be understood when we are told that he was the first to make use of lamp chimneys, and several sketches of candle flames prove that he had hold of the right principle He occupied himself, also, with diving and attempts at flying, and devised apparatus for these purposes. It is, further, more than probable that Leonardo was the inventor of the camera obscura, and his knowledge of astronomy deserves no less attention especially with regard to the sun, the moon, and the earth, and his ideas, although not as definitely expressed as in modern times, are not at variance with what is now known Nor was botany neglected by him; he also made the first attempt to cut figures in wood, *i. e.* wood engraving.

It is not presumed to credit him with the invention of all the various machines of which sketches are found in his MSS., but to say that he made himself acquainted with the same to such an extent as the records show, is almost more than the first engineers of the present day can be expected to attain, to say nothing of the fact that he did design some of them and improve others, and his studies of the various mechanism are of the most interesting kind, and embrace almost all devices known at the present day That he was well acquainted with the properties of iron is certain, for in his MSS. is preserved a drawing which is, in all probability, an original design to stretch it, in fact, a rolling mill, to make the segmental sectioned bars from which he made his cannons. He was undoubtedly an eminent metallurgist of his time. Among his other machines are a boring machine for wooden pipes, such as were and are still used for waterworks, an attempt to construct a planing machine, a file-cutting machine (beyond which, says the author, we have not yet got much), a saw for stone and wood, and a very perfect spindle arrangement for spinning, machines to make ropes, not differing materially from those in use at present, cloth-shearing machines, looms, hammers, draw benches, lifting apparatus and cranes, chains, dynamometers, and many others Primitive though many of them be, some compare favourably with those in use at the present day.

WATERPROOFING CLOTH.—Tweed cloth can be made waterprof by the following method: Into a bucket of soft water put ½lb. sugar of lead and ½lb. powdered alum, stir this frequently until it becomes clear; pour off the clear liquor into another bucket, into which put the garment, and let it stand therein for twenty-four hours, and then hang up to dry, without wringing it, when it will be found to be completely waterproof (proved.) This is preferable to the ordinary Macintosh waterproof, as it does not impede the perspiration.

NEW STREET CAR

In the history of locomotion upon wheels, one of the most important epochs must have been the invention of the common perch-bolt. The old Egyptians, and the Assyrians, seem to have been content to travel upon two wheels, though it may be questioned whether we can, therefore, conclude that they were ignorant of the art of constructing four-wheeled vehicles. But however convenient the two-wheeled chariot may have been deemed for purposes of war, and perchance also for a morning drive in the avenues at Thebes or Memphis, yet the "four-wheeler" was an inevitable necessity, and it is only natural to suppose that in the first attempt to build such vehicles, the second axle would be fixed to the body in the same way as the single axle had always been fixed heretofore. The excessive unhandiness of this rigid "four-wheeler" must have quickly made itself felt. The obstinate tendency of the machine to move in a straight line through space, and its unconquerable aversion to turning a corner, would soon disgust the whips of the period, and the new-fangled drag would be relegated to the slower use of the farmer and country carrier. We have seen it somewhere suggested that the uncompromising straightness of the old Roman roads was dictated by the use of this rigid four wheeler.

But however this may have been, it came in time to be perceived that a pair of wheels will roll in one direction only, *i.e.*, in a direction at right-angles to the line of its axle, and that if the four-wheeler is to be got round a corner, the leading axle must be turned in another direction, and, finally, that if the vehicle is to follow the horse in any direction, the leading axle must be capable of turning in any direction, and the perch-bolt would thus be evolved. Once tried, it would survive under the category of the fittest; and we should to-day think any coach builder insane who should build a carriage without one. Nevertheless, history repeats itself, and in the railway carriages of modern times we have exactly reverted to the old rigid four-wheeler.

No doubt the conditions are essentially different, but cannot the same facility of turning a corner be given to a vehicle running upon rails, without sacrificing its steadiness, or any other essential condition?

This question has been answered in the affirmative by the invention of a tram car of novel design, which has been for some time on trial upon the London Tramway Company's line to Greenwich. The chief peculiarity of the car consists in the mode in which its wheels are mounted. There are three pairs, which are not fitted directly to the under frame, but are so connected by an arrangement of simple construction that they mutually control each other's position, and in such manner that each axle is always held in the right position for rolling along the rail, whether the rail be straight or curved, and whatever the sharpness of the curvature. Thus, when the car is traversing a straight line, the axles are held firmly in a parallel position, and when the car enters a curve the axles are automatically shifted into a radial position—like the wheels of a turntable—and traverse the curve with ease.

The car has now been running for some time in the regular daily service between Westminster and Greenwich, and has been subjected to every test under the varying conditions of weather, state of rails, and abnormal loading, with results which are eminently satisfactory. Although the length of the wheel-base is more than double that of the ordinary cars, yet curves of 30ft. radius are traversed with the same ease and smoothness as a straight line. Owing to the fact that this car was built for use upon a steam tramway, its construction is somewhat heavier than it would be for ordinary work, and it carries a larger number of passengers than usual, yet such is the reduction in tractive resistance obtained by this system that the car runs lighter and distresses the horses less than those in ordinary use. The long wheel-base, beside imparting great steadiness, affords a good support for the under-frame of the car, and prevents that "hogging" effect which is noticeable in ordinary tram-cars, and which is due to their excessive overhang. Experience has entirely dissipated many doubts which were expressed as to its behaviour in passing the open points, and in being put on and off the track, the facility with which the car is handled being in every way superior to that of the rigid four-wheeler.

FEMALE telegraph operators in Berlin are peremptorily forbidden to "paint their faces, or to let their "real, or false, hair wallow' over their backs."

IMPROVED DIAMOND STONE SAW.

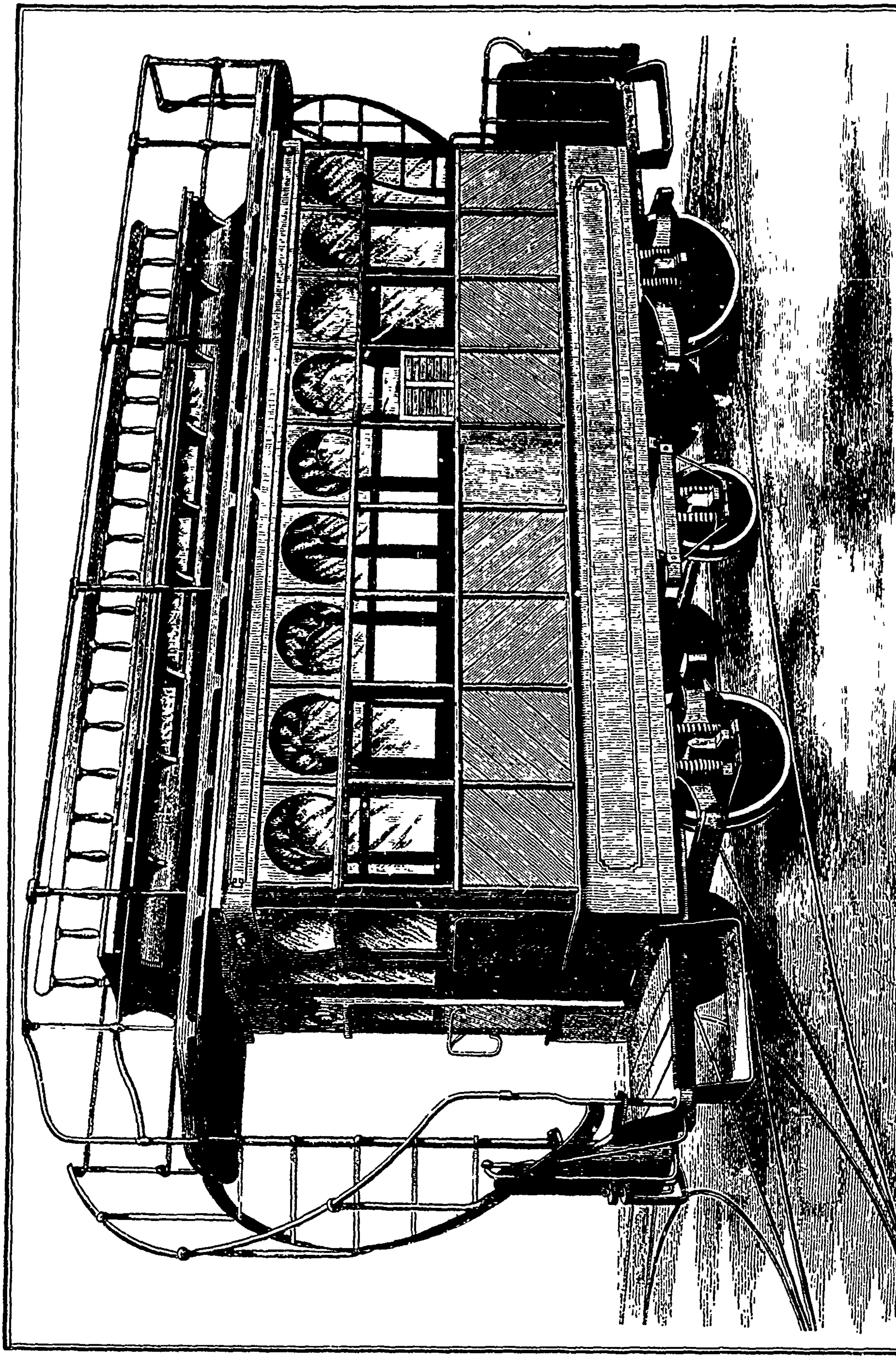
It is only necessary to recall the fact, that of all the trades, that of the stone cutter was practically the most lacking in labor-saving inventions, to appreciate the vast progress accomplished therein by the utilization of the diamond as a cutting tool. Days of slow grinding by the sand saw are giving place literally to minutes of swift penetration by the diamond blade. Numerous ingenious applications of the carbon to industrial uses have already appeared in these columns, and it is presumed that the reader is tolerably familiar with the effect of the diamond tool upon materials far more refractory than the metals. In proceeding to examine, therefore, another machine based upon a similar utilization, the questions of adaptation of the diamond to its work, so as to secure the best results, and that of the construction of apparatus to conduce to such an end, are the matters which present themselves most prominently to our investigation. So far as certain points of construction are concerned, to which reference will be made as we proceed, the invention we are about to describe is new, with regard to its essential features, however, the test of experience has been applied, and successful operation over some two years has well demonstrated their efficiency. The machine is a single blade stone saw. Its uses are to divide blocks into slabs, bed ashlar, edge coping, sills, and the like, square up blocks, and all but finish moldings, accomplishing all this with a remarkable rapidity of execution. Its essential feature is that the diamonds are made to act upon the stone in such a manner as to receive pressure or blow in one direction only. Without this provision, it is found by experience that no amount of ingenuity or care in the setting of the diamonds can prevent their being displaced from the sockets by the alternate reverse action of the blade.

It is first necessary to glance at the mode of securing the carbons in the teeth, as the square bits of steel which are inserted in recesses in the blade, and there held by soft rivets, may be termed. At proper points along the lower edge of the teeth, indentations are made to receive the diamonds, these, inserted, are firmly bound in place with wire, and while thus temporarily secured are brazed in in the usual way, the wire being afterwards removed. This operation, we are assured, fastens the borts or carbons in with certainty, so that no trouble is experienced through their working loose and falling out, so long as the saw is caused to cut, as above noted, in but one direction.

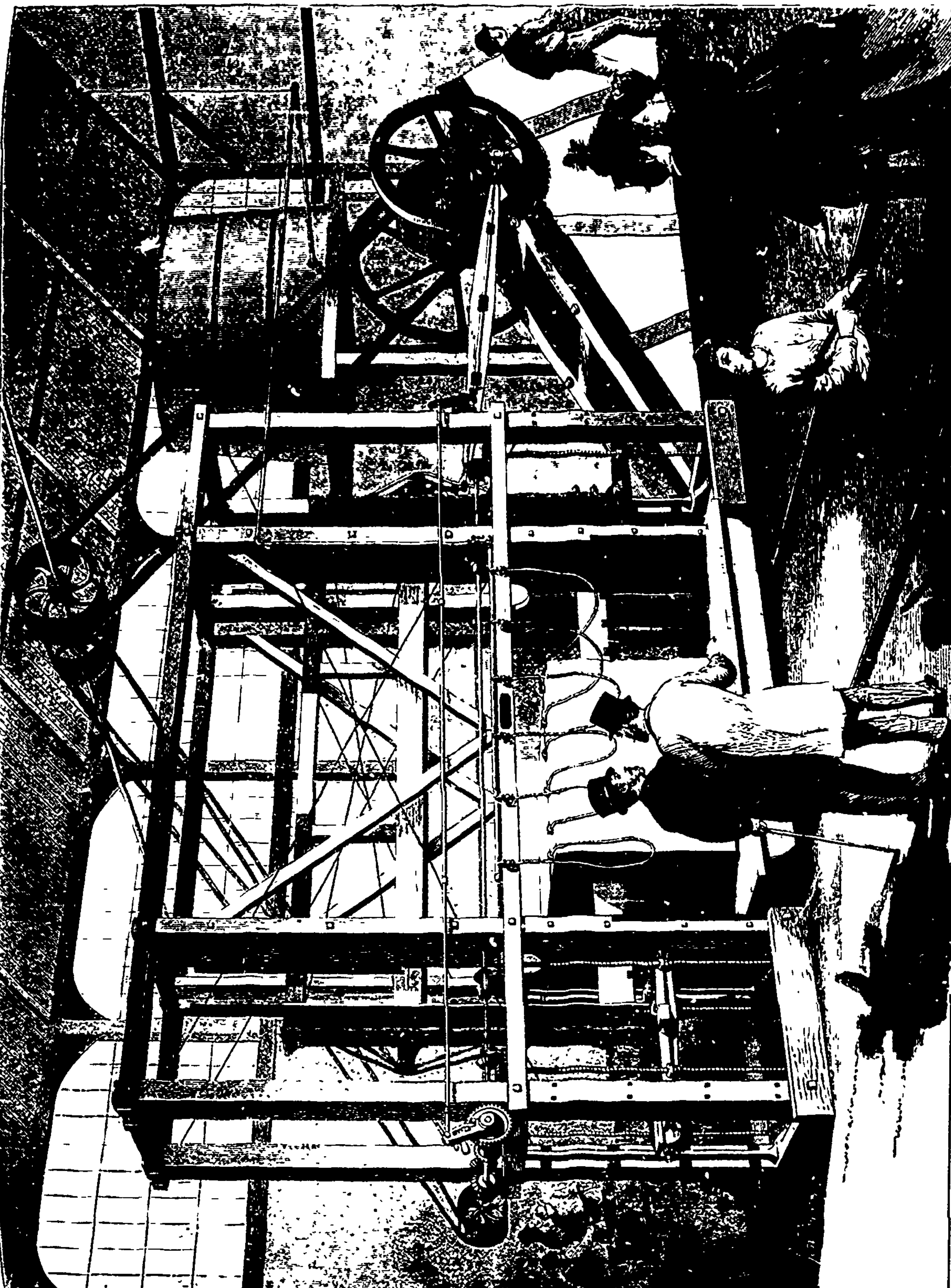
In the machine represented in the engraving on page 37, there is a timber frame formed of eight posts, planted in a concrete foundation and strengthened with the necessary horizontal and transverse bracing. The sash frame is carried by horizontal slides between the posts, and supported on the nuts of eight screws, all of which screws are connected together by gearing to which motion is given by a separate pulley and belt. The effect of turning the screws in one direction is to lower the horizontal slides, and so feed the saw down to its work, the reverse action of course producing the opposite result. The gearing may all be moved, by hand or by belt, when it is desired to adjust the blade vertically, but when the mechanism is feeding, its operation is automatic through suitable arrangements whereby it is moved with the proper degree of rapidity. The horizontal slides above referred to are provided for the sash frame to travel upon, the blade, being mounted in the latter and tightly held by buckles, receives its reciprocating motion from the pitman connecting the crank with the sash.

We have stated that the blade cuts in one direction only. This important point is gained through depressing the saw when it begins its forward motion and then raising it on the return stroke. The mechanism for this purpose is extremely simple, and consist of an eccentric on the crank pin of the pitman, which, through a connecting rod extending along the latter, actuates certain levers and cams, the effect of which is to push the saw down against its own natural spring at the beginning of the stroke, and so to hold it at a given point of depression until the end. The resilience of the metal of course, when the pressure is removed, carries the blade back to its normal position, and so lifts it clear of the bottom of the kerf, during the return stroke.

The above, though general as regards details, is sufficient for the comprehension of the device, to the performances of which attention may next be directed. From those using the machines, we gather the following statement of its average downward feed per hour in various kinds of stone, the figures presented having, in many instances, been borne out by trials un-



NEW STREET CAR



YOUNG'S DIAMOND STONE SAWING MACHINE

der our own examination. Connecticut brown stone, from 2 to 3 feet; Dorcester, N. B, stone, 2 feet 6 inches to 3 feet 6 inches, Amherst, O., 3 feet 6 inches to 4 feet 6 inches; Lockport limestone, 14 to 18 inches; Marblehead, O., limestone, 2 to 3 feet; Canaan, Conn., Westchester, N. Y., or Lee, Mass., marbles, 13 to 16 inches. In the harder kinds of slate, with quartz veins, the saw cuts from 2 feet 6 inches to 4 feet per hour, and so on in proportion to the hardness and impenetrability of the rock. Red Scotch granite we have seen cut at the rate of 3 inches per hour. The kerf made is from $\frac{5}{32}$ to $\frac{3}{16}$ of an inch, leaving a perfectly smooth surface. Slabs to almost any desired degree of thickness may be sawn. The work generally, it is claimed, is accomplished at a speed from ten to thirty times faster than the best apparatus hitherto employed. It is also asserted, by those using the saws, that the cost for the diamonds and setting is less than for the sand and iron required to do the same quantity of work by the old method. The machine is coming largely into use in this city and vicinity, and meeting, wherever employed, with the highest commendation.—*Scientific American.*

AN IMPROVED SYSTEM OF RAILWAY SWITCHES.

In the drawings on page 40, we represent a system of railway switches now frequently used by continental railway companies and advocated by their engineers on account of its solid arrangement, and if not quite simple in construction, offering many points which cannot fail to attract the attention of engineers in this country. A great many railway accidents occur through a faulty construction of the switches, and as long as a new and safer means have not been discovered to convey a train from one line of rails to another, a description of a switch by which, to some extent, a safer mode of conveyance is secured must be of enough interest to draw the attention of railway companies and of those connected with permanent railway construction.

One of the main features of the switches we are describing is that, whereas in the usual mode of construction the stock-rail, or the rail against which the switch or tongue works, is cut out to receive the point of the switch, in this system the stock-rail remains altogether untouched. This not only adds to the strength of the whole, but secures also a more smooth and equal motion of the carriage wheels. As the drawing shows, the stock-rail is the ordinary flange-rail; the switch-rail is, however, of the bridge-rail section, and is rolled of soft Bessemer steel, in the set of switches we are describing the stock-rail weighs 75 lb., the steel switch-rail 105 lb. per yard The rails vary 2 in in depth, which causes a peculiar construction of the slide and heel chairs. In the usual arrangement the stock-rail is fastened to the sliding chair by means of a cotter pin, in this arrangement, however, the stock-rail is not fastened to the chair, but is simply held down by the projecting part of the chair, as shown in Fig. 2. The great advantage gained by the difference in depth of the two rails is that very little or no opportunity exists for dirt or dust to settle between the touching surfaces of the two rails, and thereby a better closin of the points is secured. We will now proceed to give a detailed description of the parts of which such a set is composed, and thereby enumerate all the parts as figured in the drawings. A, two bottom plates of wrought iron 12 in. wide, $\frac{1}{2}$ in. thick, and 6 ft 6 in. in length; to each of these plates are riveted seven wedges $\frac{6}{8}$ in. in width and $\frac{5}{16}$ in. in thickness, tapered so as to give the stock-rails which rest upon them an incline of one in twenty; the length of the stock-rails is 20 ft.; they are fastened to the bottom plates by means of thirteen cast iron clips D, and countersunk bolts with check nuts; at the back end the rail is held down by the projecting part of the heel chair E, and opposite each of the outside clips D, by the projecting parts of the sliding chairs F. Between every two slide chairs on the inside of the stock-rail it is held down by another clip; these latter are fastened by countersunk bolts which have no check nuts to allow for clearance of the steel switch. The bottom plates are fastened to the sleepers in the usual manner, by means of dogspikes.

The two plates of one set are connected by means of flat bars 2 in. x $\frac{3}{8}$ in., bent underneath the plates, as shown in Fig. 2, and fastened to them by two $\frac{1}{2}$ in. bolts; the switches are connected by means of 1 in. rods H, Fig. 4, provided with double eyes and fastened by counterpins to corresponding eyes fixed to the steel rails, as shown, by $\frac{7}{16}$ in tap bolts, these eyes carry the rods to which are fastened the connecting rods and levers of the switch-boxes. The heel chairs E, are fastened to the bottom plate by means of three bolts with countersunk heads, two of which are $\frac{3}{4}$ in. in diameter; the third one is $1\frac{1}{4}$ in. round and swaged at the end to $\frac{7}{8}$ in. diameter; this part serves as a pivot for the switch, as will be seen in Figs. 1, 3, and 10; the thick part of this bolt carries a nut and keeps the chair in its position, as shown. The chair itself is of a peculiar construction: the way the steel switch-rail is fastened to it is as follows: The chair is provided with two projecting parts, one of which holds the two rails K, K, down; the other part projects over the flange of the steel rail; the other flange of this rail, just opposite the place where this part J, of the chair projects over it, is drilled out, and a round washer L, half projecting over this drilled part, and with the other half over the chair, fastens both together by means of the bolt M, to the bottom plate.

At about 3 ft. from the back part of the rails, or where they rest in the heel chairs, is fastened to each stock-rail a distance piece N, Fig 2; this part is carefully turned and firmly fixed to the stock-rail. Its aim is to prevent the points from opening when a train is passing over the switch, and which, without this provision, might occur in the following manner. The steel rails are to a high degree elastic, and the side pressure against the rails of a train passing over the curve would have a tendency to bend the rail between the two points of support formed by the heel chair and the point where the two tops of the rail meet; this bending of the steel switch between these points would of course thrown the points back, thereby causing the wheels to run off the metals. These so called distance pieces have been found very efficient to prevent the said disaster. The other distance pieces marked O, Fig. 10, in the sketch, serve to keep the iron rails at a proper distance apart; they are formed of short lengths of gas piping, through which the fish-bolts P, pass.

Of the two switches one is, of course, straight, the other bent to a radius of 623 ft; the straight part of the rail which closes against the stock-rail is 12 ft. $9\frac{1}{2}$ in long; sections of the point can be seen in Fig. 8, showing in dotted lines the different sections of the tongue at the various distances from the point; the straight switch-rail has a planed part which is set to a radius of 713 ft., being that to which the stock-rail, against which it works, is bent In manufacturing these switches, as this is the most essential part of their construction the planing offers one of the greatest difficulties When the rail comes from the mill it has to be freed most carefully from all bends and twists, and for the curved switch it has to be set to the required radius The rail being extremely elastic, this bending requires the most careful attention, and none but experienced hands will do this work properly It is, moreover, done in screw presses especially adapted for the purpose. The straight switch, which, as we have stated, has a hollow planed part, offers more difficulties. With a specially adapted tool no doubt the rail might be planed hollow, but on the ordinary planing machine this cannot be effected The part of the rail that has to be planed is set to the required curvature, the rail is then cut to the sections shown in Figs 9 and 12, and afterwards bent straight again, and the straight planed part takes the curvature required. It is obvious that the greatest care and attention have to be paid to the manipulation of these rails, as a proper fit is a first requirement. Fig. 3, shows how the steel and iron rails are fastened in the heel chair; the stock-rail and outside rail have been left out in the drawing, in order to show the back of the heel chair; the half round hole receives the head of the fish-bolt, as shown in Fig. 1 Fig. 4, shows how the connecting rods are fastened by means of the eyes J, and the tap-bolt Q, to the steel point; the rod I, of course, passes through the body of the stock-rail. Fig. 10, is a plan showing how the four rails meet at the heel chair, and how they are kept in position, Fig 3, is side elevation of same; Fig. 11, is a plan of the curved switch-rail; Fig. 13, side elevation of same; Fig 12, is plan of the straight rail, and Fig. 15, its side elevation.

We cannot conclude without making a few remarks on the cost of these switches compared to that of the ordinary system. On the whole there is a great deal of expense attending the labour in manufacturing these switches. It is evident that the manipulation for instance of a rail weighing $5\frac{1}{2}$ cwt. is no slight matter, when in the ordinary sets the greatest weight of the switch rail amounts to 3 cwt Besides, the quantity of the material to be cut out of the steel switches is enormous, compared to that of the ordinary switch-rail, and the sections offer a great deal more trouble than the flat planed surfaces of the latter.

As regards the chairs, the weight in the ordinary sets is greatly in excess of that of the new system, but these being of a peculiar make they require difficult patterns, and the castings thereof will increase the price, and in a great measure do away with the benefit of the smaller weight; the price for ordinary chairs being seven pounds per ton, these cannot be made under ten or eleven pounds per ton, exclusive of the price of the patterns. Besides, the bottom plates, in themselves an additional cost to the ordinary system, have all to be punched most exactly, and the holes to be countersunk, whilst the riveting of the wedges to the plates, and the make of these wedges themselves, require much care and labour. It will, therefore, be found that the price of the new system is greatly in excess of that of the old one; but taking into consideration the advantages gained by the cheap maintenance and long duration, we cannot do otherwise than recommend them to the attention of railway companies in this country. Moreover, when anything diminishing the risk of life and limb of passengers and railway officials suggests itself, we consider it our duty to draw the attention of the public to it, and this last-named feature the system we have been describing certainly possesses.—*Engineer.*

NEED OF BETTER TOOLS AND IMPLEMENTS.

A correspondent of the *Germantown Telegraph* makes some good and pertinent inquiries respecting better tools and implements. He says, why can't we have tools and vehicles that will wear alike all over? Why do not manufacturers improve and strengthen the weak points in their wares? Take spades, shovels, and hoes, for instance; three-fourths of them at least fail in the shank, or where the handle joins the blade. If you want one stronger in the shank you must buy one that is heavier all over and may be no stronger in the shank than the others. This ought to be remedied.

If we look over tools in common use we may find that most of them show a weak point or two where the majority of all breaks occur. These ought to be made stronger in new ones. Such, however, does not seem to be the fact concerning a large number of staple articles. Indeed, many things seem to show more weak points than formerly, and needlessly so too. Implement makers may plead that competition is so sharp and that certain articles are already known in the market as standard, that to compete successfully, an article must sell as cheaply as the standard one, and the profits are too small for improvement. This is not wholly true, as inferior articles are often sold for a superior price, when neatly painted, or polished and systematically advertised, and there is no rule of business that forbids the appreciation of merit when properly set forth.

Of course the bulk of manufacturing tools is now done in factories, to the exclusion of home workmanship. Country mechanics complain that they cannot compete with factory prices, and the result is that users of tools buy of dealers who cheat both the maker and the purchaser, thus covering the weak points of his merchandise on the one hand, and preventing the more general diffusion of tool and implement making on the other.

The bent of inventive ingenuity seems to be adjustability more than practicability; more of polish than of use. Now, we plead for the useful, insist that we pay enough now for articles that ought to be more durable. Give us an ounce or two more of metal in the weak points of tools, rather than gaudy paint, and we shall be better satisfied. Let us insist that the weak points be strengthened in tools, implements, vehicles, and machines; and, above all, let us have simplicity of construction. Lastly, we assert without the fear of contradiction by fact, that the maker who will apply the remedy for this state things, and continue the practice of honest tool and implement making, will, with care, make a business which shall become the pride of his country and the envy of his sham rivals.

The British Government have accepted the invitation of the United States to send an English commission to the great Centenary Exhibition at Philadelphia in 1876.

ENGINES OF THE LAKE PROPELLER V. H. KETCHAM.

The engravings which we publish on pages 43, 44 and 45 of the engines of the lake barge, V. H. Ketchum, show the type of steam machinery in use in vessels navigating the great inland waters of this continent. We are indebted for the engravings to the *Engineer*. It will be observed that the engines are of the simplest kind, and so arranged that every part is easily accessible. The valves and other parts requiring frequent renewal and attention are so situated that they can be reached without taking down any part of the engines. The cylinders are 36in. diameter by 2ft. 8in. stroke, with a steam chest between them common to both cylinders. The slide valves are double ported, with an independent cut-off valve on the back of each. The cut-off valves are worked by an arm operated by an eccentric, so arranged that the steam can be cut off at 8in. of the stroke or any other point up to full stroke. Each engine is provided with an air pump 20in. diameter by 16in. stroke, of the trunk type, worked by wrought iron levers connected to the crosshead. The crank shaft is forged in one solid piece, weighing [illegible] tons; the journals, four in number, are 11in. diameter, and 18in. and 16½in long, the two feed pumps have their suctions connected to the hot well; the condenser is supplied with injection water through a 5in. pipe, at the end of which is a trumpet-shaped nozzle for spreading the water. The bilge pump is worked from the pinch wheel at the forward end of the engines, and is located on the starboard side, the cold water pump being on the port side; the propeller is 10ft diameter, with a pitch of 15ft., making 77 revolutions per minute. Steam is supplied by one boiler of the return tubular kind, the shell is 10ft. 6in. diameter, the flues are seven in number—three being 22in. diameter, two 21in. diameter and two 15in. diameter, the return tubes are 4in. diameter, and 166 in number.

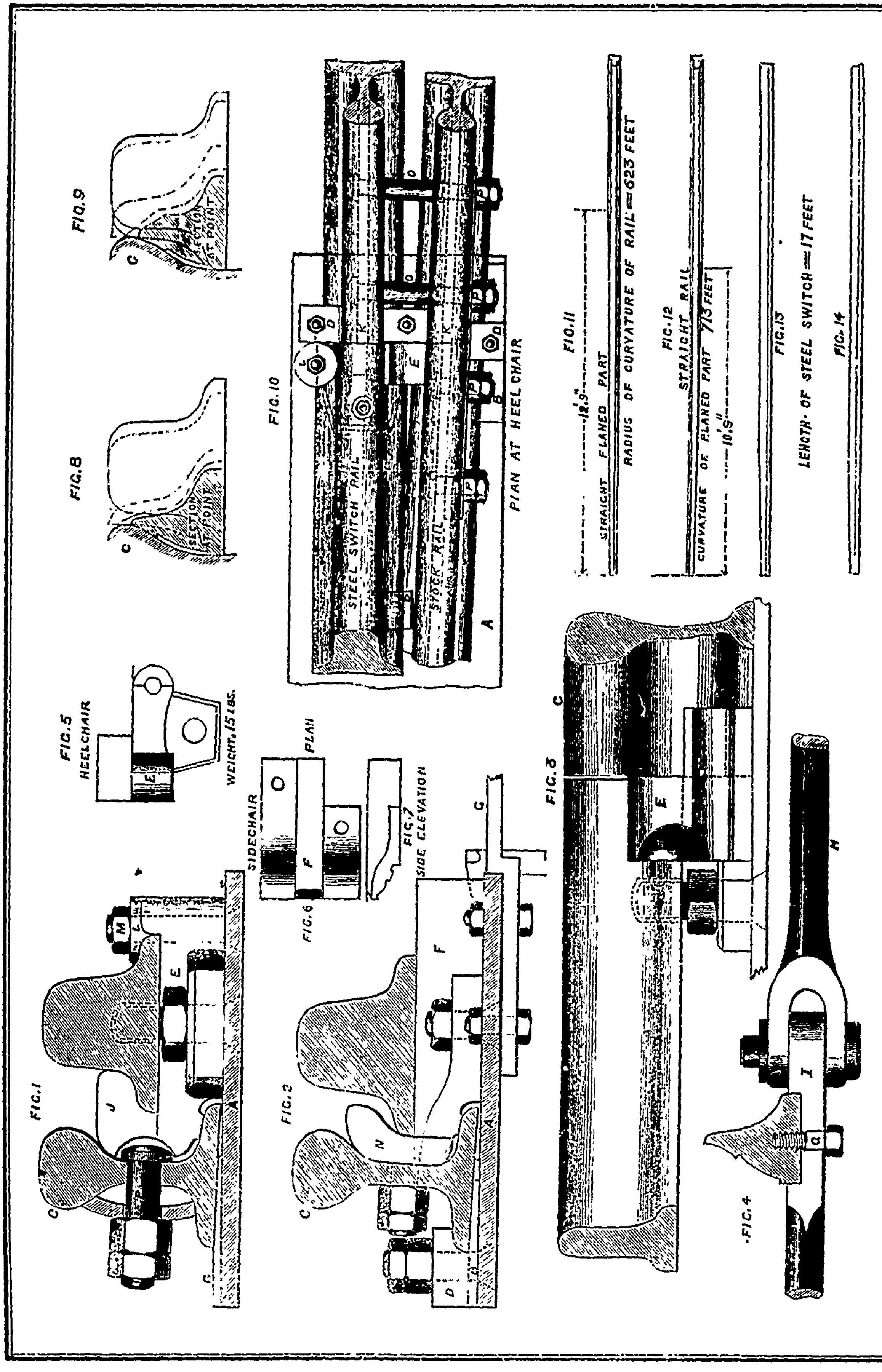
The Ketcham has attained a speed of 10½ miles per hour when running without a sailing barge in tow. With her barge, with a carrying capacity nearly equal to her own, she has made 8 miles loaded, and 8½ miles light. The average steam-pressure carried is 35lb. cut off at one quarter, with a consumption of 1250lb of coal per hour. The vacuum maintained is 25in. She is supplied with a double-cylinder steam winch for hoisting cargo and working the sails, the winch has an attachment for operating two bilge pumps of 7in. diameter, she has also one 3in. steam bilge ejector.

The dimensions of the hull are as follow:—Length between perpendiculars, 231ft., beam, 40ft. 8in., hold, 16ft., light draught, 6½ft., loaded, 14½ft. She is built of oak. Frames, 20in. centres, planking, 5in. thick, ceiling, 5in. edge-bolted. She has four arches on each side with a gangway in each arch, and was salted with 450 barrels of salt. She has two full decks and boiler deck, is square fastened throughout with ⅞in. round iron, and is provided with a centre board. She will carry 2000 tons on 14½ft. of water, steers and handles well under canvas or steam, or both combined, and tows a sailing barge which carries 1800 tons.

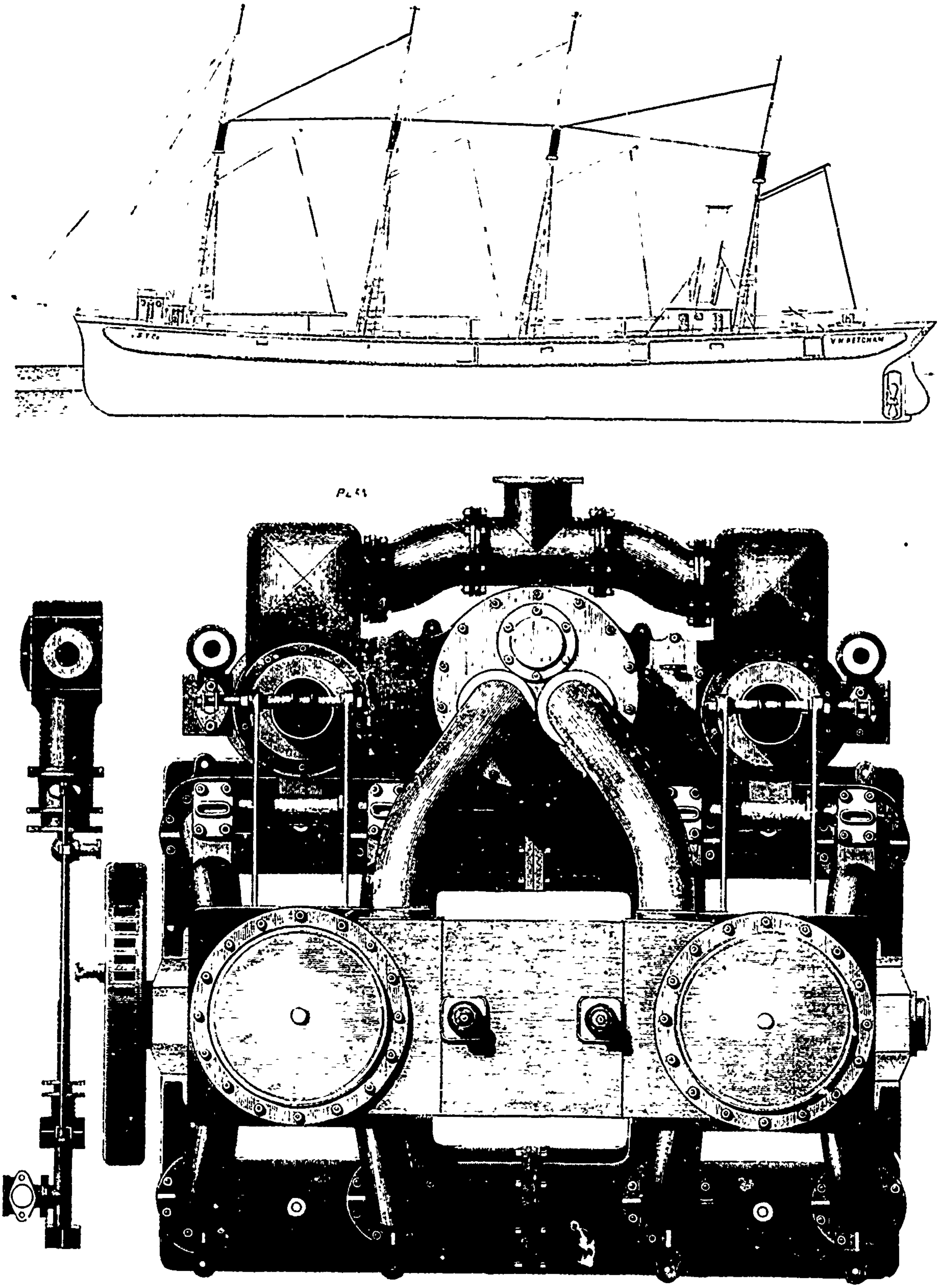
The following is a description of the rigging of the V. H. Ketcham:—Four masts, the foremast, mainmast and mizzen have four shrouds a side of 3in galvanised iron wires. The jigger has three shrouds a side of three galvanised wires. The sails are staysail and a fore and aft sail on each of the masts, with gaffs and booms. Foremast, 83ft. from step to the cap, 26in. diameter; mainmast, 84ft. from step to the cap, 27in. diameter, mizzen, 82ft. from step to the cap, 25in. diameter, jigger, 75ft. from step to the cap, 22in. diameter; top masts 42ft., except jigger, 36ft. Rigging set up with turnbuckles.

The engines were completed in June, 1874, and since that date have been running continuously and giving the utmost satisfaction. We regret that we are not able to say what the indicated horse-power is, but the consumption of fuel is obviously very small, considering the size and speed of the vessel.

The St. Lawrence *Advance* says:—The surveying party which started about a fortnight since on a preliminary surveying expedition for the Richibucto Railway, have returned, and it is said that the prospects of a good location for the road are first rate.



AN IMPROVED SYSTEM OF RAILWAY SWITCHES.



ENGINES OF THE LAKE PROPELLER, V. H. KETCHAM.

SALTING A MINE.

On the last day of the inquiry into the "California Diamond Swindle," in the Court of Exchequer, some evidence, curious and not a little interesting, was read, showing the unskilful manner in which the salting was performed, and the skilful way in which the fraud was laid bare by a United States Government geologist. The story of the original discovery is contained in the following statement, which appeared in the *San Francisco Chronicle*:—"Mr Rubury, a very intelligent young Englishman, who has made two trips to the field, the first with M. Janin, and this last with Roberts, told the reporter a marvellous tale about an ant-hill built of jewels. He had stepped accidentally on the side of the mound, and the busy little insects came angrily forth to wreak vengeance on the intruder. Stooping down to look closer at the ants, Mr. Rubury noticed a great number of red and white stones, of uniform size. A closer examination showed that nearly the entire mound was composed of diamonds and rubies. He shovelled the whole ant-hill into a sack, and brought it along with him."

M. Clarence King, the scientist in command of the geological exploration of the fortieth parallel, having learnt of the asserted discoveries of Arnold, Janin, and party, and fearing that, if there were any truth in the statements, his superiors might blame him for overlooking such a valuable deposit, started to verify the report. Janin had mentioned that the discoveries had been made on a mesa, or table-land, near pine timber. Mr King, who seems a clear-headed and competent phisicist, and to possess scouting capabilities which would do no discredit to the keenest of Cooper's famous Indians describes his progress and success as follows:—From a knowledge of the country, I was certain that there was only one place in that country which answered the description, and, as that place lay within the limits of the fortieth parallel survey, I determined to go there. The main reason why I went was that, if it was good or bad, it would be a blight on my geological survey not to have known of its existence within its area, and I had to do it as a matter of self-defence. I waited until the field-work of the survey was completed for that year, and late in October I left here, accompanied by two assistants, proceeded to Fort Bridger, in Wyoming territory, and organised the camp outfit. We left Fort Bridger on Oct 27th, and marched directly to the spot, reaching there Nov. 2nd, 1872. I camped at about two or three o'clock in the afternoon, on a small stream in a canon at the western end of the mesa. I started to ride down the canon, and within fifteen minutes I found upon a tree a water notice, claiming the water right of the stream, in the handwriting of Henry Janin, signed by him. We then began the search for diamonds in a side ravine leading up to the mesa, finding none. In half an-hour, arriving upon the edge of the mesa, we found a survey stake, with a paper notice, claiming either ten or twenty acre claims. I do not know which they were laid off into; I think they were twenty. Riding around the mesa for a short time, I saw that the lines of tracks radiated from a common centre, and I followed those tracks to that centre, which was the celebrated table rock—a sandstone rock, on which the diamonds had been found. We immediately found rubies scattered on the surface and in the sand, and before dark, which came on very soon, we picked up three diamonds. We then returned to camp. The next morning we went back to this table rock, lay down upon our faces, and got out our magnifying glasses and went to work, systematically examining the position of the stones and their relation to the natural gravels. The first point which excited my suspicion was the finding of a diamond on a small point, or knob of rock, rising about two inches above the surface. The diamond lay directly on top, in a position from which one heavy wind, or the storms of a single winter, must inevitably have dislodged it, and I at once called my two assistants together and pointed out the diamond to them, and told them I thought it was a fraud. I then determined upon a plan of testing the whole question, which consisted of a system of outside prospects conducted over the whole mesa, carried out by digging a bushel or two of earth, averaging it, sifting it in sieves, and then washing both the saved gravel and the refuse dirt at the stream; of an examination of the trails, and tracks of all the party; following their work from beginning to end; a careful examination of the ant-hills, a scrutiny of the rock itself, and of the so-called Ruby Gulch, leading down from the sandstone table to Arnold Creek. The result of the outside prospectings, carried on by four of us through nearly a whole day, was that we found no single ruby or diamond anywhere off the neighbourhood of the rock or off the line of the original Arnold survey. We trailed the surveying parties and the prospecting parties. I fixed upon the trail of Arnold and Janin, recognising Mr. Janin by his slender foot, and followed it from their wanderings around the original 160 acres, finding the spots where Janin dismounted, and determining those in which Mr. Arnold did all the work, following their return tracks to the stream where they had washed out the gravel. Along the line of their outward march, here and there in the vicinity of survey stakes, or upon conspicuous ant-hills, we found an occasional ruby, but 10 feet off their line of travel never one. Returning to the examination of the central table rock, which was made by myself and two assistants, I found that a nearly uniform numerical ratio existed between the so-called rubies and diamonds. In other words, that to about every single diamond there would be from half-a-dozen to eight rubies thrown in as if they had been previously mixed, or as if extreme care was taken that they should bear about that proportion. In nine cases out of ten the gems lay directly upon the bare surface of rock, or upon an indurated crust of pebbles and soil where the rock dipped beneath the surface. This table rock was broken and seamed across its surface and down its sides with deep cracks, varying from a few inches to 18 inches or 2 feet in depth. Many of these cracks had been disturbed by the two parties, those which had been worked by the earliest party, by the hardened surface of the gravel and sand, showing very differently from the more recently disturbed cracks. In every one of the disturbed cracks I found more or less rubies and diamonds; but a considerable proportion of the cracks were filled with untouched earth, and overgrown with grass, cactus plants, and sage brush. With the diamonds and rubies occured small, angular, and partly-rounded quartz pebbles of various sizes, and concretions of iron oxide containing particles of crystallised, quartz, both of which are found freely mingled with the soil from surface to bed rock. Hence, if the gems were a natural deposit, being of a specific gravity, intermediate between quartz and iron concretions, they must have also settled through the earth to the bed rock. I, therefore, selected ground overlying and about the table rock where the top was more or less strewn with so-called rubies, carefully shovelled off the surface inch of ground and gravel, and examined, by means of siever and pan washing, all the material down to the bed rock. About thirty of these tests were made, encircling the table rock, and in no instance was a ruby or diamond found. Ruby Gulch, leading directly from the table rock to Arnold Creek, and by necessity receiving the wash of the gem-bearing surface of sandstone, was found to be extremely rich in rubies at its head; but this richness, instead of continuing down the bed, as, if genuine, it inevitably must, proved to exist only in the ground directly at the foot of the table rock, where the soil was clearly disturbed, mixed and smoothed. I sank a series of four pits to the bed rock, down the gulch, at intervals, excavating probably a couple of tons of material, and although as in every other instance, quartz and iron concretions were distributed throughout the gulch soil, not a ruby or diamond was found. Upon the raised dome-like portions of the table rock rubies and diamonds lay upon the summits and inclined sides in positions where any storms must inevitably have dislodged them, and where, moreover, they were always unaccompanied by quartz or iron. An examination, continued through several hours, of the rock material itself with a field miscroscope, showed no trace of microscopic diamonds or rubies. In the ravines, and upon the mesa near by, are numerous ant-hills, built of small pebbles, mined by the ants, which we found bearing rubies on their surfaces. A still closer examination showed artificial holes broken horizontally with some stick or small implement through the natural crust of the mound, holes easily distinguished from the natural avenues made by the insects themselves, when traced to the end each artificial hole held one or two rubies. Moreover, about the salted ant-hills were the old storm-worn footprints of a man. Many outside ant-hills were studied, but there were neither artificial holes piercing them, rubies within or without, nor human tracks. I discovered on the table three small emeralds. Summing up the minerals, this rock has produced four distinct types of diamonds, a few Oriental rubies, garnets, spinels, sapphires, emeralds, and amethysts—an association of minerals of impossible occurrence in nature.

Next, proceeding to San Francisco, Mr. King sought an interview with the executive committee of the Diamond Company, and accompanied the general manager and party back to the alleged diamond mines. During this last visit with the Colton party to the fields Mr. Janin showed him the places from which, during his previous and first expedition, he and his party had taken gems, and in every instance but one they coincided with the places where upon his first expedition he found the ground in the condition in which he had described it. On the occasion of his visit to the fields with the Colton party he found no diamonds, but found so called rubies strewed upon the surface of the sandstone, and occupying positions where the rain or wind must necessarily have dislodged them. Where the rubies and diamonds came from was pretty accurately indicated by Mr. L. Keller, a diamond merchant, in Hatton Garden, from whom, and whose partner in Paris, in July, 1871, two of the speculators purchased a number of rough diamonds and rubies, perhaps about 3000 rubies and under a thousand diamonds, one or two of the latter of considerable size.

SCIENTIFIC NEWS.

The Way in which Coal is Formed.—"Les Mondes," of Sept. 24th, states that M. Hirschwald, on visiting a gallery in the Claustha mines, abandoned for 300 to 350 years, found some wood which had been left there. It had absorbed the waters which flowed in the interstices of the schists, and had become of a brown colour and coriaceous texture. On exposure to the open air it quickly hardened, and was completely transformed into brown coal (lignite) with a conchoidal fracture. Its percentage of carbon was very similar to that found in the best Saxon lignites. This observation shows that the circumstances favourable to the natural carbonisation of wood are—(1) Situation among fragments of rocks among which circulate freely subterranean waters impregnated with metallic salts. (2) A constant and relatively elevated temperature, such as prevails in deep excavations. (3) Continuous pressure.

Gossamer Spiders, their Work.—Dr. G. Lincecum has read a paper of much interest before the Smithsonian Institute. From this we extract the following passage: "I once observed one of these spiders at work on the upper corner of an open, outside door-shutter. She was spinning gossamer, of which she was forming a balloon; and clinging to her thorax was a little cluster of minute young spiders. She finished up the body of the balloon, threw out the long bow lines which were flapping and fluttering on the now gently increasing breeze, several minutes before she got all ready for the ascension. She seemed to be fixing the bottom and widening her hammock-shaped balloon. And now the breeze being suitable, she moved to the cable in the stern, severed it, and her craft bounded upwards, and, soaring away northwards, was soon beyond the scope of my observation. I was standing near when she was preparing to cast loose the cable, and had thought I would arrest its flight, but it bounded away with such a sudden hop that I missed and it was gone."

The Veins of Beech and Hornbeam Leaves.—Mr. Thomas Meehan, in a paper lately read before the Academy of Science of Philadelphia, said that De Candolle had noticed some years since a difference in the venation between the *Fagus ferruginea* and *Fagus sylvatica*, the common American and European beeches. In the American beech the lateral veins were said to terminate in the apex of the serratures—in the European they terminate at the base of the sinus. He had not read the original paper of De Candolle, but abstracts in the scientific serials. As the statement stood, it conveyed the idea that there was a marked difference in structure between these two allied species which did not, however, exist, as growing in this country the leaves of the European beech are almost entire, the lateral veins, in approaching the margin of the leaves, curve upwards, and connect with the lateral above them, forming a sort of marginal vein near the outer edge of the leaf. The veins of the American beech curve upwards in the same way, but are early arrested, and this sudden cessation of growth produces the serra, which are slightly curved upwards. An early arrestation of growth in the veins makes the serratures, and constitutes the only difference between the two species. The structural plan is the same in both—the European, curving its lateral vein into the apex, reached the upper one—the American terminating abruptly.

Experiments have lately been made (we learn from a German gas journal) in the streets of Heidelberg, with the gas lighting and extinguishing apparatus of M. Flurscheim, in which the flow of gas to the (principal) burner, is produced or stopped by a change of pressure in the mains. The gas coming out of the principal burner is lit by a small adjoining flame (which is preserved from extinction). This auxiliary flame goes out whenever the principal burner is lit, and is lit again by the principal flame, when this goes out in the morning. The experiments made with 28 such apparatuses, have led to a further order for 72.

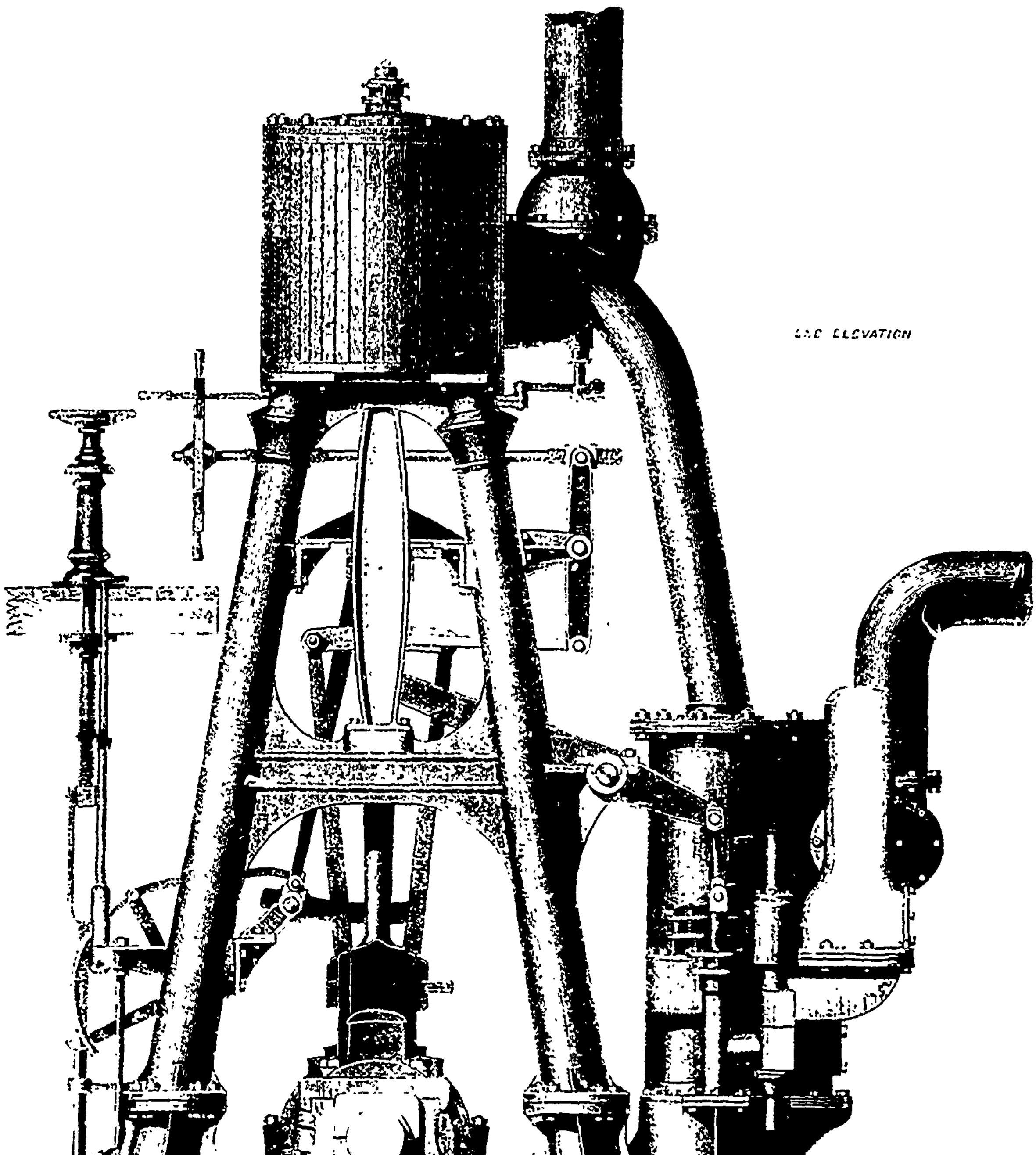
Professor F. W. Putnam, of the Peabody Academy of Sciences, Salem, Mass., has recently explored the Mammoth Cave in Kentucky, and has visited several caverns never before entered. His investigations have resulted in finding coloured fish without eyes, thus exploding the theory hitherto held that all eyeless fish are colourless. White fish with eyes, and crayfish, both with and without those organs, were obtained, presenting many new features of great interest to naturalists. Skeletons of human beings, mounds, and a large variety of valuable archæological relics were found in the new chambers.

Dr. Harkness has discovered, in Plumas County California, a body of water, probably the most elevated in the United States, the barometer registering a height of 7330ft. above the sea level. The lake is of triangular shape, having its longest diameter about one mile and three-quarters in length. The water during last August was intensely cold and of a deep blue colour. The outlet is into Warner Valley, over a declivity of some 2300ft. The California Academy of Sciences has named the lake, after its discoverer, Lake Harkness.

The Statement that plants absorb ammonia from the atmosphere has, it is said, been experimentally demonstrated. Two tobacco-plants were grown under bell-glasses in soil of the same kind, both being supplied with fresh air. But in one case M. Schloesing placed a dilute solution of the sesquicarbonate of ammonia within the bell-glass every day. At the end of six weeks nearly 2 grammes of ammonia had been volatilised in the atmosphere of the one glass, and on analysis the plant subjected to ammonia fumes was found to contain 45 per cent. more nitrogen than the other, which had less than the normal quantity. The nitrogen was diffused throughout the plant.

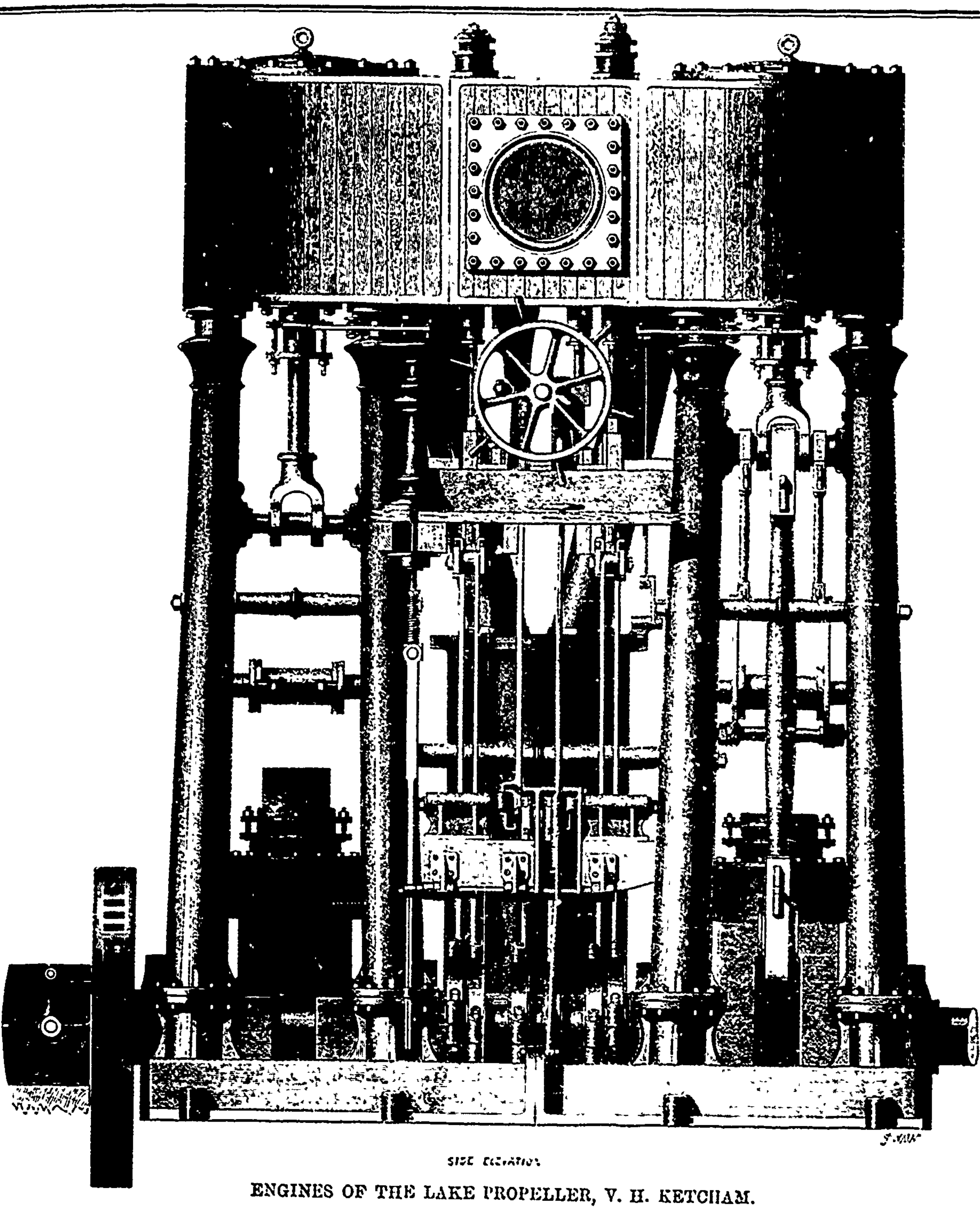
Permanent Ice in a Mine in the Rocky Mountains.—Mr. R. Weiser, of Georgetown, Colorado, states that geologists have been not a little perplexed with the frozen rocks found in some of our silver mines in Clear Creek Co., Colorado. There is a silver mine high up on McClellan Mountain, called the "Stevens Mine." The altitude of this mine is 12,500 feet. At the depth of from 60 to 200 feet the crevice matter, consisting of silica, calcite, and ore, together with the surrounding wall-rocks, is found to be in a solid frozen mass. McClellan Mountain is one of the highest eastern spurs of the snowy range, it has the form of a horse-shoe, with a bold escarpment of feldspathic rock near 2,000 feet high, which in some places is nearly perpendicular. The Stevens Mine is situated in the southwestern bend of the great horse-shoe; it opens from the northwestern. A tunnel is driven into the mountain on the lode, where the rock is almost perpendicular. Nothing unusual occurred until a distance of some 80 or 90 feet was made; and then the frozen territory was reached, and it has continued for over two hundred feet. There are no indications of a thaw summer or winter, the whole frozen territory is surrounded by hard massive rock, and the lode itself is as hard and solid as the rock. The miners being unable to excavate the frozen material by pick or drill to get out the ore (for it is a rich lode, running argentiferous galena from 500 to 1,200 ounces to the ton), found the only way was to kindle a large wood fire at night against the back end of the tunnel and thus thaw the frozen material, and in the morning take out the disintegrated ore. This has been the mode of mining for more than two years. The tunnel is over two hundred feet deep, and there is no diminution of the frost, it seems to be rather increasing.

A Snow Melter.—A model of a patent snow melter has been presented to the city of Paris. It consists of a cylinder revolving round a central furnace, which gives out sufficient heat not only to melt the snow but also to assist in drying the soil underneath.



ENGINES OF THE LAKE PROPELLER, V. H. KETCHAM.

As is well known, the black bulb vacuum thermometers employed for observing the solar radiation give very discordant results, even in the hands of the best observers, and the origin of this has recently been studied by Mr Hicks. of London, who states that, in his opinion, the discordances are in a great measure due to the imperfect vacuum that exists within the inclosing bulb. Having made a large number of instruments with special care, in which the vacuum has been reduced to the lowest attainable limit, Mr Hicks finds that it is possible with proper care to always construct instruments that shall be perfectly comparable with each other In order that the meteorologist may at any time test the perfection of the vacuum within his tube, Mr. Hicks has very ingeniously inserted two wires into the side of the bulb in such a way that a galvanic current applied to the wires will, by the nature of the light that is spread through the vacuum bulb, show with considerable accuracy what proportion of gas, and especially of watery vapor, is there present A pressure within the vacuum bulb exceeding one-tenth of an inch of mercury is not admissible if an accurate instrument is desired, and the vacuum can be easily brought to within one-fiftieth of an inch, in which condition the radiation solar thermometers will prove strickly comparable. Especially it is important that the bulb should be filled



ENGINES OF THE LAKE PROPELLER, V. H. KETCHAM.

with dry gas, and that not the slightest trace of moisture should exist. Mr. Hicks said that although he had made hundreds of tubes with Torricellian vacua, he never knew one to fail showing stratification and white light when the tube was thoroughly clean and free from moisture.

The latest feat recorded of the electric telegraph. A gentleman at the Western Union telegraph office, at 145, Broadway, New York, was sitting in the cable room when a telegram from Philadelphia, destined for Paris, came over the wires. This message, like all others for France, was to go over the cable *via* Duxbury, Mass. The operator called Duxbury a few times, and then said, "That fellow is asleep, evidently, but the cable men are always awake—I'll have to get one of them to go in and wake him up." So he stepped to another desk, called Plaister Cove, in Newfoundland, and sent the following message: "To cable operator, Duxbury.—Please go in and wake up my own true love." This message Plaister Cove hastened to send across the ocean to Valentia, Ireland, who in turn rushed to London · thence it was hurried to Paris, and still on to the European end of the French cable at St. Pierre, the operator there flashed it back to Duxbury. In less than two minutes by the clock the message had accomplished its journey of eight thousand miles by land and sea, as was evidenced by the clicking of the instrument on the Duxbury desk, which ticked out, "That is a nice way to do; go ahead.—Your own true love."

Mechanics' Magazine.

MONTREAL, FEBRUARY, 1875.

ILLUSTRATIONS:

CONTENTS:

ROOFS IN CANADA.

One of the many pleasures of travelling is to notice the different ways in which the different structures of various countries are adapted to their several requirements in accordance with the geographical and other peculiarities of the districts through which one passes. On a first voyage up the Gulf and River St. Lawrence, the traveller is always struck with and pleased by the tin roofs of the churches which glisten from afar and mark the nucleus of a settlement long ere it would otherwise be observed. The unusually steep pitch of the old style roofs is another feature; not confined to Canada, however, but common to most countries where the snow-fall is above the average. Many of these peculiarities, however, are rapidly passing away before our nearer connection by travelling facilities with the rest of the world, and the rapid approach we are making to that great leveller, a high condition of civilization. The change, however, is not altogether for the better in every case, and, especially so, not in the case of our roofs. The old, pretty steeply pitched roof, with its tin covering is giving way to various styles of modern roofs, the flat and the partly flat, for the most part. Whatever may be said in favour of these roofs on the score of cheapness, it seems to us that they are for the most part utterly unsuitable to our climate. The flat gravelled roof is a source of never-ending trouble here. In summer it is almost impossible to exist in the upper storeys of houses thus covered; in winter unless constantly attended to, and shovelled clear of snow they are liable to cave in or to leak in the most frightful manner. A rim of ice forms on the lower edge, backs up the melting snow, and nothing, not even a new roof will keep the water from finding an outlet somewhere to the damage of the house and the injury of the inhabitants. This, however, is not the only evil. Roofs are now being built so slightly that they are liable to fall in by their own weight, or if not so to yield at once to any pressure that may be brought upon them. The fall of the roof of the St. Patrick's Hall will long be remembered as one of the narrowest escapes from a serious calamity on record. Had the hall not been vacated in consequence of warning cracks in the roof, a horrible scene must have occurred with the account of which the whole civilized world would have rung. Then there is the Drill Shed, once a useful and almost necessary building, and one of which our volunteers were justly somewhat proud as large, convenient and well situated. Now it is a ruin, a standing proof of mistake somewhere, and a constant reminder of something still wanted. We do not advocate a return, absolutely, to the old steeply-pitched roofs but we imagine that a good roof, strong and sound under the trying circumstances of this climate might with no great difficulty be devised, which would cost much less than the metal-covered steep roof and yet serve every purpose. With regard to our public buildings it really seems as though the inspection not only of roofs but of walls, &c., is sadly defective. We have already mentioned two accidents and while we write there are people suffering from a third which was all but fatal in its results. A wall falls and crashes through the roof of a dancing hall in which are about a hundred people. Some of them are precipitated through the broken floor twenty feet to the ground and buried in the *débris*. That the result was not more serious may be well regarded as an accident; but to those acquainted with the stringent building inspection regulations of some cities it will by no means appear that the fall of an exposed wall is not within the scope of prevention which should do away with the possibility of such accidents Nothing but careful, constant and stringent inspection will prevent the frequent recurrence of these approaches to catastrophes; and it seems as if a real catastrophe was needed to bring about that carefulness which in this matter as in other matters seems so deficient in Montreal.

THE CENTENNIAL AT PHILADELPHIA

Preparations for the main feature of this celebration, the International Exhibition, are now making such progress as ensures the timely completion of the building and other conveniences on the ground. The Commissioners of Fairmount Park have set apart for the uses of the Exhibition 450 acres of land admirably suited for the purpose. Building began in July last and is rapidly progressing, railway communication having already been established from all parts of the country The art Gallery and Memorial hall especially are in a forward state, and with the main building will be completed before the opening in 1876. An engraving of the Art Gallery will be found on page 197 of our last volume. The apportionment of the space in the main Exhibition building among the various nations to be represented has now been made, the plan adopted being that of the Paris Exposition of 1867.

The main building has 485,090 square feet of available space, and this is divided as follows:—Siam, 3,946 square feet; Persia, Egypt, and Turkey, each 7,776; Russia, 10,044, Sweden and Norway, 10,044; Austria, 23,328; the German Empire, 27,264; Denmark and the Netherlands, 7,776; Switzerland, 6,156; Italy, 11,664; Spain and her colonies, 15,552, France, Algeria, and other colonies, 27,264; Great Britain, India, Canada, Australia, and other British colonies, 46,748; the United States, 123,160; Mexico, 11,664; Honduras, 3,888; Guatemela and Venezuela, each 5,508; San Salvador and Nicaragua, each 4,536; Ecuador, Hayti, and the Sandwich

Islands, each 3,888, the United States of Columbia, 7,776; Peru, 11,664; Chili, 9,744; Brazil, 17,529; the Argentine Republic, 15,552; Liberia, 2,268; Japan and China, each 7,290 square feet. Thirty-four nations and their colonies are thus provided for, and there is a space of 21,408 square feet reserved for contingencies. Although it is yet nearly seventeen months to the opening of the Exhibition there are already applications from American exhibitors for 180,000 feet, although the space allotted to this country is but 123,160 square feet. The applications for space in the portions allotted to other nations go directly to the Commissioners appointed by those nations, so that the officials here have no direct knowledge of the amount asked for.

WOODEN HOSPITALS.

The question of hospitals has been one of considerable interest lately, especially in Montreal. There is no doubt but that when such contagious diseases as small-pox rage, wooden pavilion hospitals, removed as far as may be convenient from other dwellings, are the best for many reasons. Our American neighbours who have a very wholesome dread of small-pox almost invariably adopt this plan when a village or small town is attacked. It seems, moreover, than even for permanent hospitals wood has great advantages over other materials of construction. An interesting paper on this subject, by Mr. John Gay, appeared in a recent number of the "Proceedings of the Medical Society of Victoria, N. S. W." The conclusions arrived at are as follow: 1. That, instead of requiring constant purifying and disinfecting as other hospitals do, they purify and disinfect themselves. 2. That peroxide of hydrogen, the disinfecting agent they generate, contains oxygen—Nature's disinfectant—in a highly condensed and active form, which, moreover, is intensified in the presence of either blood or pus —a property which renders it pre-eminently adapted for hospital disinfection; for it is beyond doubt that pus-cells, in combination with other organic matter, are largely concerned in the causation of those septic diseases which are so destructive to life in ordinary hospitals. 3. That, in consequence of the above-named conditions, the inmates of wooden hospitals enjoy almost, if not perfect, immunity from hospital gangrene, erysipelas, and puerperal fever.

THE PARIS GRAND OPERA HOUSE.

We have already illustrated and described for our readers some parts of this magnificent structure, which has at length been completed In the present number we illustrate the exterior and interior as completed. The entrance is by the Rue Halevy and the door which leads directly into the *Salle d'attente*. This entrance and all the adjacent accommodation, is reserved exclusively for *abonnés*, or holders of subscription boxes, whose carriages here drive close up to the doors of the waiting room. The latter is a vast circular hall, completely free from draught and similar inconveniences, and leading to the grand staircase, which fronts the chief facade of the Place de l'Opera, by a spacious and commodious corridor. Nothing can be more admirable than the whole of this arrangement. It is on emerging from this corridor that the grand staircase bursts upon one in all the magnificence of its present unrivalled decorations. It is literally one mass of gold and bronze and marble and onyx combined with the richest draperies, statuary, and everything that the most lavish expenditure and elaborate ornamentation can bestow upon it. The sight of it is absolutely overpowering, and the impression certainly is that the decorative part is overdone, and yet it is impossible to deny, or not to feel, how very effective and striking it is as a whole. The dimensions, in fact, are so vast that it seems capable of bearing almost all that has been put upon it. The view from the foot of the staircase up to the first grand gallery above is one of the most gorgeous, perhaps, to be found in the inside of any building. The gallery itself is a change of style, for its ornamentation is entirely Italian. Its roof glitters with the most brilliant glass enamel and mosaic work of Byzantine character, while the floor is inlaid with marble mosaics of the same country and period. No less than five hundred millions of these mosaics have been employed either on the roofs or walls or floorings of the galleries and corridors. From the first gallery we proceed to the grand *foyer* or saloon, which runs along the whole breadth of the facade, and immediately behind the gallery and its *loggie*, as the Italians call them, which faces the Place de l'Opera. Here, new sources of amazement await the eye; for nothing can exceed the stupendous grandeur of this gigantic gallery. Its sides are lined with columns of part Indian, part Byzantine, part classical composition—all these styles and periods being more or less combined in the decoration of their bases, which ascend as high as one-third of the shaft, and in their not less elaborate capitals. The effect is gorgeous in the extreme, and baffles all verbal description. The lofty roof is adorned with the paintings of Baudry and other French artists, and the walls are adorned with antique masks, exquisitely carved, with marble pannellings, gold and glittering enamels and mosaics in lavish profusion. And now repassing again the first circle, we enter the theatre proper itself. The dimensions of the parts already visited are so gigantic that the *Salle* itself seems hardly proportionate, and it is only after a longer survey that you discover it to be equal to, if not beyond, the utmost limits of which the human voice is capable of making itself heard effectively. Its form is an elliptical semicircle of great elegance, the centre of the arch being deeply depressed, so as to give a frontage which is at once imposing in its wide sweep and commodious and roomy in its arrangements. The angles of the house are broken by double ranges of columns, between which tiers of boxes are placed.

STRANGE CARD HANDS AND THE LAWS OF PROBABILITY.

A very interesting paper on the above subject appears in a recent number of the *English Mechanic*, by Mr. R. A. Proctor, the celebrated astronomer. Two cases are mentioned, in which the dealer at whist held all the trumps. The first case is thus described in a letter to the Editor of *Westminster Papers*.

"Dear Sir,—One of the most extraordinary incidents in connection with whist I dare say you ever heard of occurred here this week. Four gentlemen, of the highest respectability, with whom I am well acquainted, were playing at whist last Wednesday evening; they had been playing about a couple of hours, when one of them, after having dealt, found his hand to consist of the whole 13 trumps. Two packs of cards were used alternately all the time, and this occurred with one of them after being shuffled and cut in the usual manner. Can you or any of your correspondents give another instance of this ever having taken place?

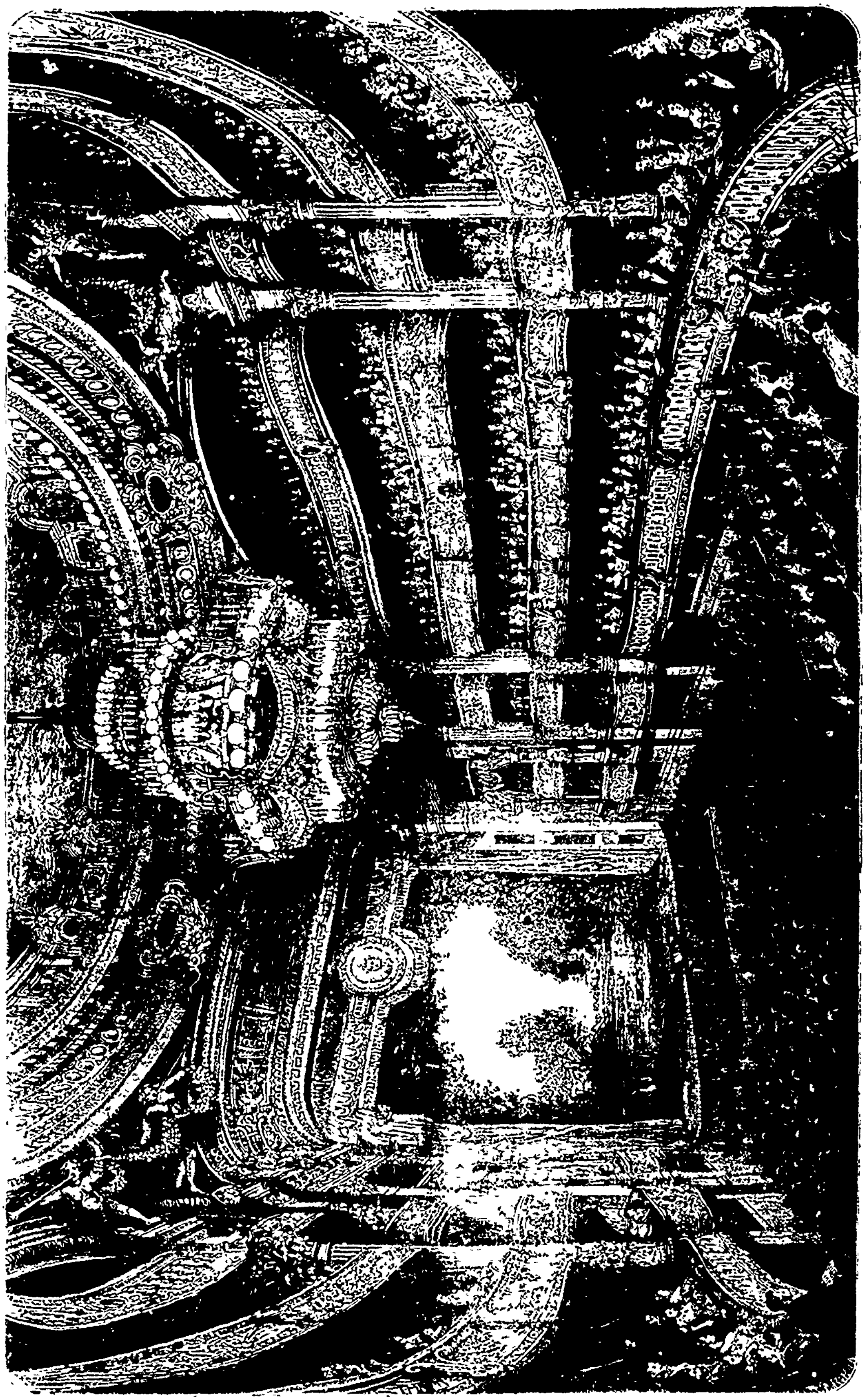
"Yours, &c.,

"Charles Baxter.

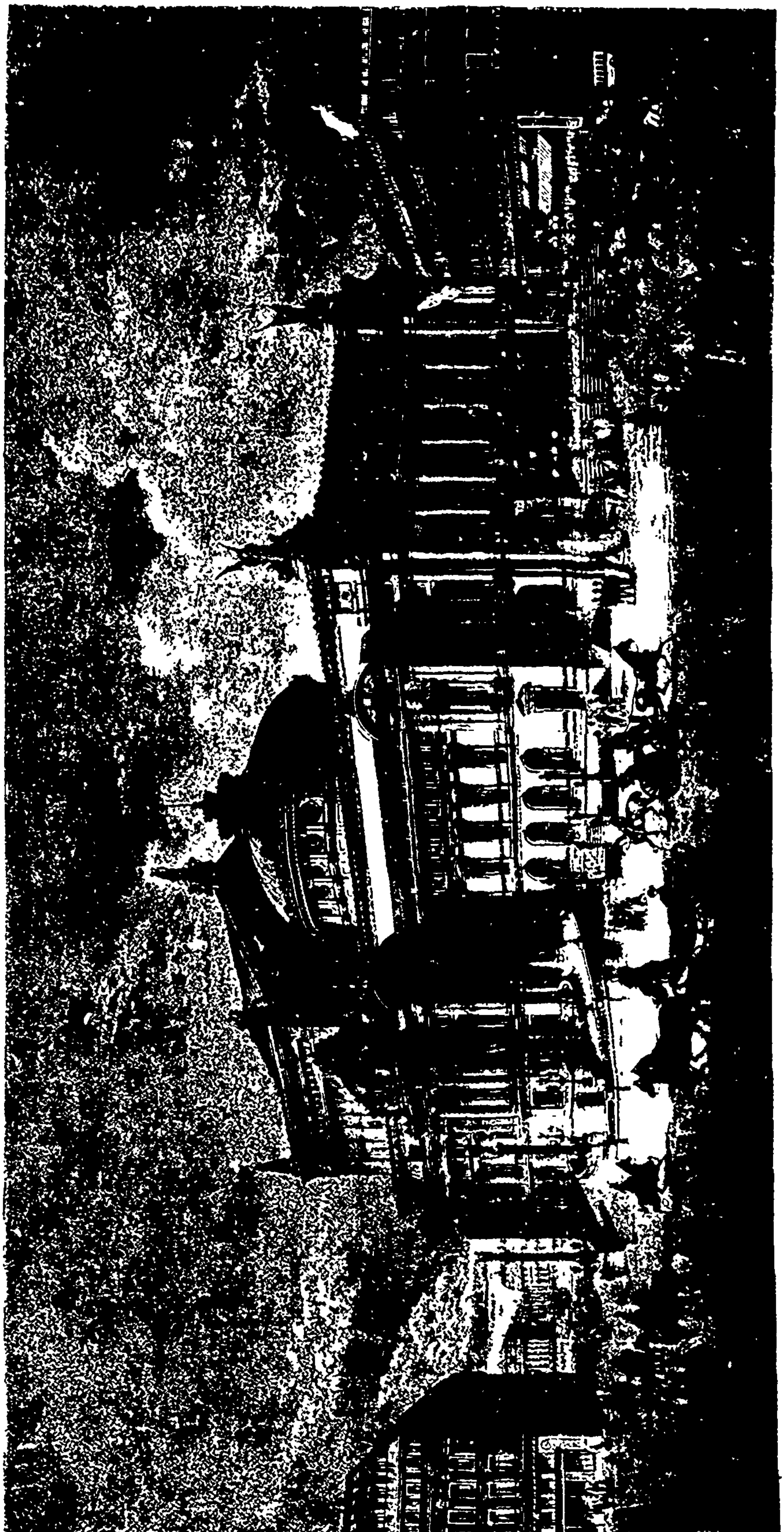
"Magdalen-place, Dundee, Oct. 31st, 1873."

The editor of the *Westminster Gazette* remarks on this as follows:

"An apparently well-authenticated case of the dealer holding 13 trumps, supplemented by three other hands as extraordinary, was published some ten years ago in *Bell's Life*.



INTERIOR OF THE NEW OPERA HOUSE, PARIS



EXTERIOR OF THE NEW OPERA HOUSE, PARIS.

As it may be now to many, and is certain to interest all card-players, we reproduce it here:—

'We have received the following dated Jubbulpore, February, 1863:—

'There sat down to whist the undermentioned officers of the 91st Regiment. The cards, which had been played with before, were shuffled and dealt as usual, and the hands were as follows:—

* Captain H. Wood (dealer), 13 spades; ace turned up.
Ensign H. R. Rolfe, 12 hearts, 1 club.
* Ensign W. C. Hinton, 11 clubs, 1 heart, 1 diamond.
Lieut.-Col. W. T. L. Patterson, 12 diamonds, 1 club.
* Partners.

'Witnesses to the above having happened, without any packing of cards, or any other way of accounting for the occurrence:

(Signed)
W. T. L. Patterson, Lieut.-Col. 91st Regiment.
H. Wood, Captain, 91st Regiment.
H. R. Rolfe, Ensign, 91st Regiment.
W. C. Hinton, Ensign, 91st Regiment.
Extra witness:
A. C. Bruce, Captain, 91st Regiment.'

'Our correspondents inquire whether any of our readers can instance any equally remarkable circumstance, and also ask what are the odds against its happening again. This is a job for Mr. Babbage, or any other man.—Ed. *Bell's Life.*'"

Mr. Proctor goes into lengthy calculations over the subject and corrects the calculations of the editor of the *Westminster Papers*. The latter says that the mind is incapable of grasping the enormous number of possible ways in which 52 cards can be dealt equally between four players. It has been calculated that if the entire population of the earth, taken at one thousand millions of persons, were to deal the cards incessantly day and night for one hundred millions of years at the rate of a deal by each person a minute, they would not have exhausted the one hundred thousandth part of the number of essentially different ways in which the cards can be so distributed.

Mr. Proctor's conclusion is "that instead of the 1,000,000,000 inhabitants of the earth in the supposed case having to deal that enormous number of ages, they would only have to deal each once a minute for one hour and fifty minutes for an even chance of giving all the trumps to dealer. It is probable that there are scarcely 1 000 millions of whist players in the world, but not unlikely that as many as 10 million rubbers are played each day all over the world, say 30 million deals per night, or roughly (and omitting Sundays) about 9 millions of deals per annum. This would give in about twelve years an even chance of a case of all the trumps to dealer. And just as there would be nothing very surprising if two sixes were thrown in four trials; so there is nothing very surprising in two cases of the card hand in eleven or twelve years of card-play. Indeed, there would be nothing very surprising in ten or twelve such cases, at the imagined rate of play. I do not know whether that rate is reasonable or not, having no whist statistics by me. I suppose ten million rubbers would imply, taking the average, about half a million sittings, or two million players each day in the whole world

Mr. Proctor says that he should perhaps apologise for taking up space with reference to card hands, but they serve to illustrate laws of probability, and the laws of probability are not only, as Paley hath it, the guide of life, but are also the safest guide in scientific research; and familiarity in dealing with problems in probability is very useful.

It is really very interesting to see so able a scientific man take up this question of the doctrine of chances, since not only as to card hands, but also in the case of many ordinary recurrent matters, we hear so much nonsense talked and such widely different opinions stated with the gravest air of knowing all about it.

THE CARPENTER, JOINER AND HAND RAILER

Some time ago we reviewed this valuable work, the following extracts from which on the Mansard, or French roof will, however, give our readers a better idea of the scope and nature of the work.

The Mansard or French Roof.

Recently adopted and employed in this country for many of our public edifices and private residences This peculiar and ingenious style of roof having all those striking advantages and prominent features that recommend it to general adoption for every class of buildings, the simplicity of construction, and the elegant effect it produces, must attract the attention and interest of all who are favourable to improvement and good taste. It is not our intention to enter into details, the scope and aim of this work being to show and explain the best and most simple modes of mechanical execution.

We may, however, state that the Mansard Roof has been known and adopted in France for more than two hundred years, during which it has undergone many modifications, especially so in the French capital, where, latterly, the rapid and modern improvements made have changed the entire character of almost everything in building, the Mansard particularly having attained a degree of elegance and finish which we can but only hope to imitate. Yet it is quite possible we may equal the best efforts of French mechanism in the practical execution of this description of roof; this opinion being founded on the fact of our discovery and invention of an entire new system of lines for finding the lengths of rafters and their cuts.

Fig. 1, page 52, shows the angle of the building, and the seat of the hip indicated by A, C: also, see the position of two jack rafters 2, 3 and 2, 3. Further notice that L, is a plate on which rest the ceiling joists, and supported by the given rafter; its corner C, being cut square with the seat, by which we avoid backing the hip. All this being understood, we now come to the construction in a practical way. Knock a few flooring boards together, and lay them on a couple of trestles and commence at Fig. 2; square over a line for a base, say A, D, C, B, next draw the position of the given rafter and the plate on which rest the ceiling joists; again, at the foot of A, square up a line so as to form a right angle with A, B, bisect this and draw the seat of the hip rafter indicated by A, C, which correspond and answer the same purpose as that given at Fig. 1. Again, from the point of the given rafter and the inside of the plate, drop the two perpendiculars, cutting the seat at B, and C.

We will now fix upon the length of the jack rafter as A, F, its down cut being the line 2F, and the bevel for the side cut seen at E, which is sufficiently plain to be understood. To find the length and cuts of the hip, take any point on the base, say D, and let D, B, C, equal A, B, C, on the seat line; square up C, L, and B'3; join 3'D, and we have the exact length and cuts of the hip rafter. This simple process may be employed for many other practical purposes beside roofing.

We may also add that the upper roof being covered with tin, or other metal, and this brought over the crown moulding, there is no necessity for a gutter.

The Mansard Curved Roof.

The construction of this being precisely the same as that given on the preceding plate, the description will be nearly a repetition. The curved ribs are made out of plank and nailed to the straight rafters. All the cuts and lengths of everything for this roof should be done on the ground, and no attempt made to fix before all is ready.

Fig. 1, page 53, shows the angle of the building, also the position of the seat for the hip rafter, and L, the plate which it supports, the corner being cut off square with the seat.

Fig 2. Let the line that shows the top of the joist be a base to start from; now fix upon and draw the position of the curve and given rafter; set off the position of the upright board that forms a part of the gutter; then from A, square up a line to make a right angle with A, D; this bisect and draw the line A, C. We have now the seat of the hip from which all the lengths and cuts can be readily obtained. Drop lines from the point K, and the plate, the two perpendiculars having cut at B, C; take any point, say D, and make D, 2'B, C, equal A, 2'B, C, on the seat; square up C, L, and B'3; join 3, 2, and we have the length and cuts of the hip rafter. Our next want is the curve standing on the angle, and which must intersect with that given. This also can be readily found by squaring up a few lines from the base—no matter where—say through O, 2, 3, cutting the curve.

Let D, O'2, equal A, O'2; then from the points where the perpendiculars have cut the given curve, draw the dotted lines parallel with A, D, to intersect those from D, O'2, and let the distance B 3, on the upper part, equal B 3, on the seat; then through the points thus obtained, trace the curve. We now want the length and cuts of the small curve that nails against the hip at the lower part. Suppose we fix its position at N, on the seat line. The two perpendicular from its longest and shortest points, cutting the given curve, determine the length, the solid line from N, being the longest point and down cut and the dotted line squared over its edge gives the bevel or side cut.

The curve on the angle should have a backing to receive the boards or covering.

To find this, look at Fig. 1, and notice the thickness of the hip rafter, cutting equally on each side of the corner at L; set the compasses to the distance made by the two lines that are square with this, which transfer to the level lines at Fig. 2, made through the points of intersection on the angle rib B, P; a line traced through those distances gives the backing.

ON THE "KINDERGARTEN," OR DEVELOPING SYSTEM OF DRAWING.

At the last meeting of the Edinburgh Architectural Association, the following paper was read by Mr. Leonard A Wheatley on the above subject:—

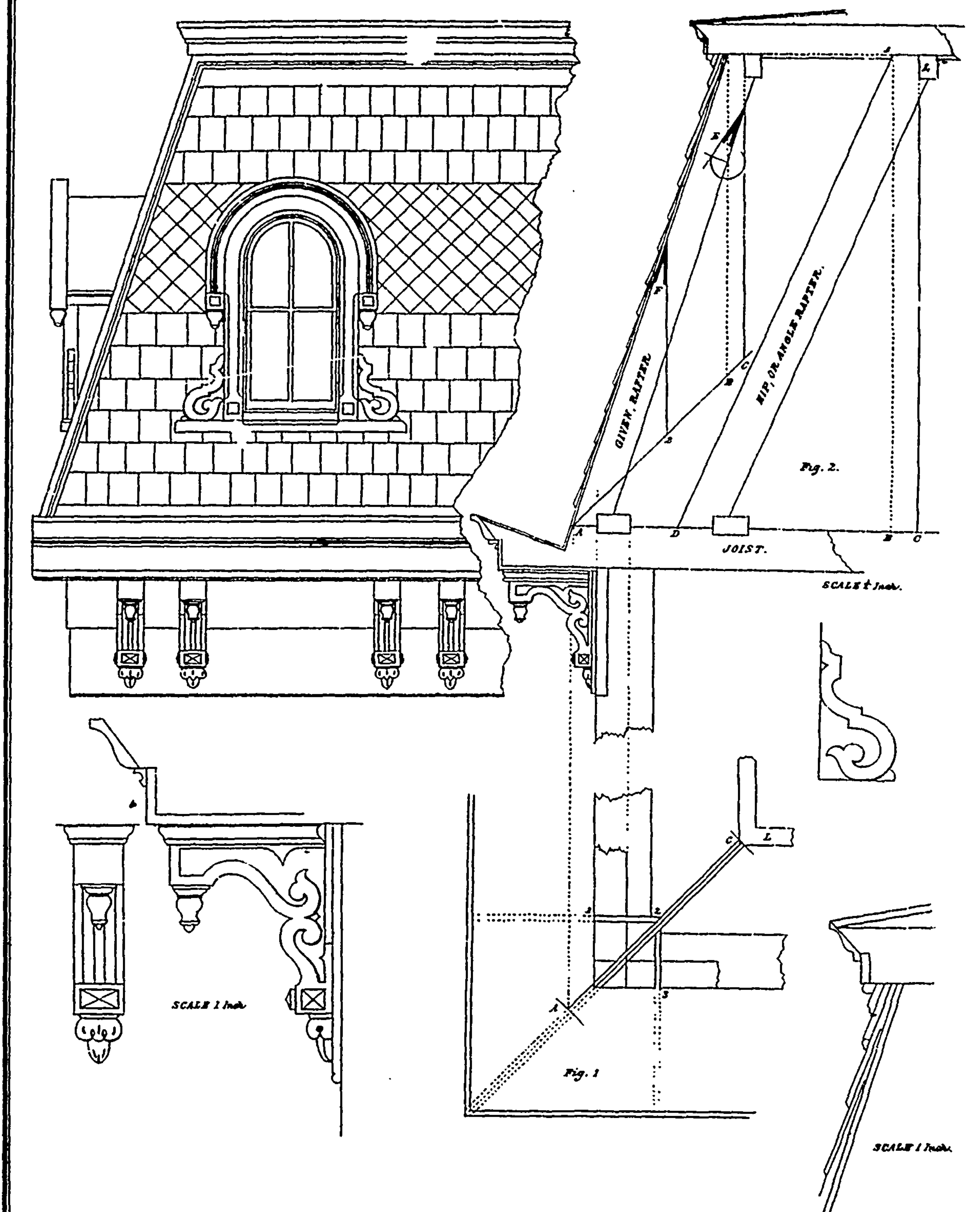
The importance of drawing to the architectural profession is undeniable. This being the case, it is as well to consider what is the best method to follow in order to attain proficiency in this art. As a nation, we do not excel in drawing, and many of our best artists would have been the better for a greater knowledge of and a fuller training in it. The French, as a rule, are splendid draughtsmen, and the German artist excels in his drawing more than his colouring. The system to which I wish to call your attention, is not to replace freehand drawing and copying from nature, but simply to train the hand in making lines and curves, and the eye in seeing correct distances and proportions, thus giving a taste for the graceful,—matters which are of vast importance to the architect, who, as a rule, has been too apt to despise drawing, notwithstanding s me splendid masters of the pen and pencil in his ranks. The science of education, or "pædagogics,' is only of recent date. Great credit is due to Jean Jacques Rousseau for, in some measure, introducing, or rather for calling attention to a more reasonable system of education; but his genius was as erratic as his philosophy emotional, and would have had little or no effect even in his own country but for the labours of the philosophers of Germany. Kant and Hegel did not think it beneath their notice, but Herbart and Beneke were the principal writers to develop the science. Pestalozzi was, however, the author to whom education is chiefly indebted. He, like Arnold in our own country, strove to implant (and by his noble character succeeded in doing so) in the minds of his pupils a certain religiosity, or higher tone of morals, even in the most elementary teaching, knowing well the power of morality in elevating the mind, and the higher the mind the more capable is it of receiving true education. Pestalozzi was born at Zurich in 1746, became director of an educational establishment at Yverdun in 1804, and died at Brugg, in Aargau, in 1827. His writings, which were voluminous, have been extensively read, and passed through many editions, several of them having been translated into various languages. His scholars were very numerous, and through them an immense improvement was effected in elementary instruction throughout the whole of Europe, and his name was held in such estimation that the centenary of his birth was kept with great éclat in 1846. Among his pupils was Friedrich Frobel, the founder of the "Kindergarten" system, and to one of the results of whose labours I wish to call your attention. F. Frobel was born in 1782 at Oberweizbach, in Schwarzburg-Rudolstadt. As it was intended that he should be a farmer, he studied the natural sciences at the University of Jena, after which he became the secretary on an estate in Mecklenburg; but he felt called to a higher destiny, and went to Frankfort as a humble teacher in 1803, and from henceforth remained faithful to his vocation, he passed three years in tuition at Pestalozzi's Institute at Yverdun, and his mind was thereby decided in favour of Pestalozzian ideas. He now went to the Universities of Gottingen and Berlin for the purposes of study; but then came the time when, Europe being overrun by the armies of Napoleon, he felt called upon, like Fichte and other noble minds to take up arms in the war of liberation, and joined the celebrated rifle brigade commanded by General Lutzow, and immortalised by the poet Korner,—

> "From sire to son the tale shall go,
> 'Twas Lutzow's wild Jager that routed the foe"

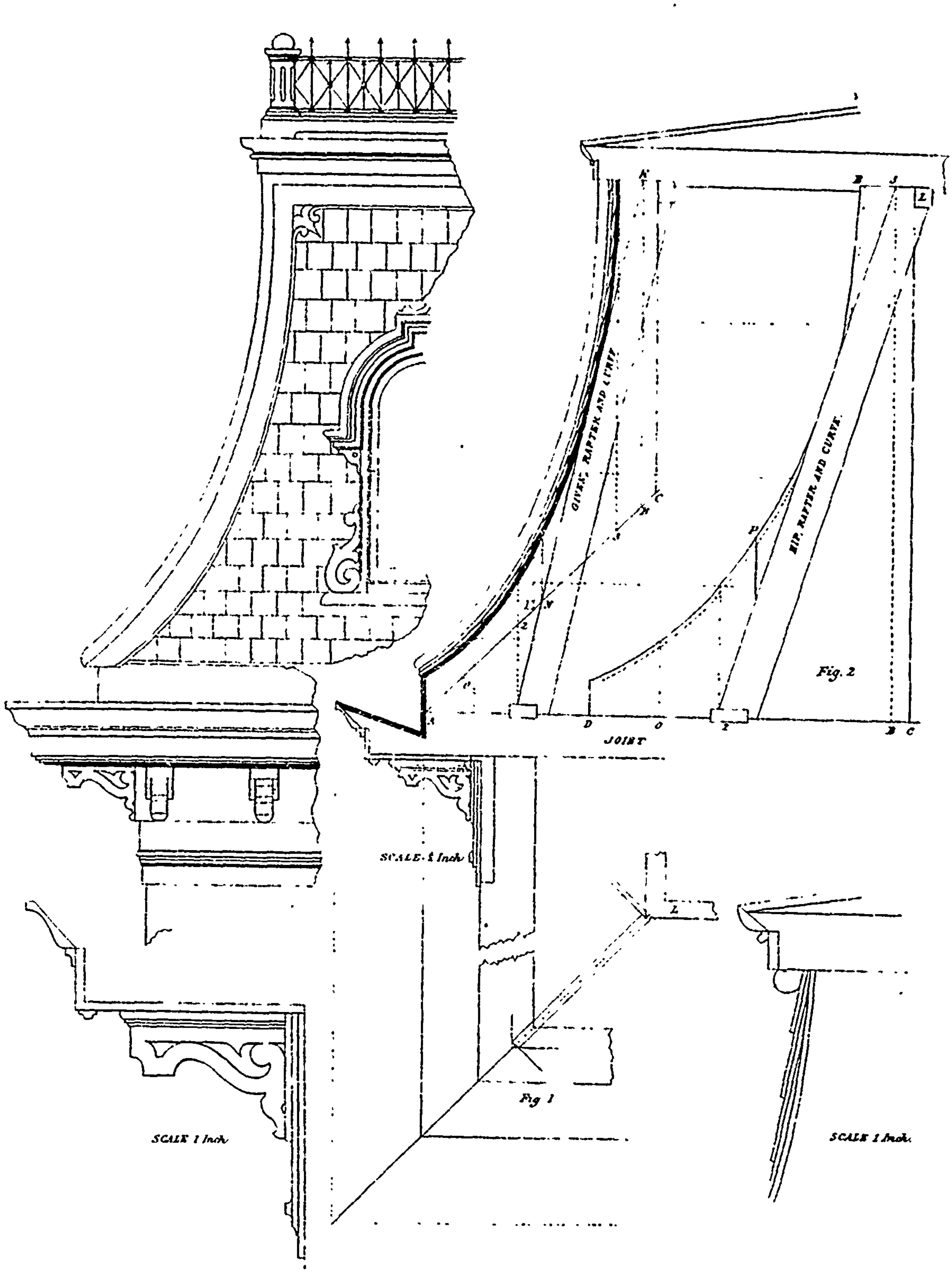
On the restoration of peace, he founded in 1819, an educational institute at Griesheim, removed a year later to Keilhau, near Rudolstadt, an establishment which still flourishes. He left it to be carried on by other men in order to found fresh ones in Switzerland. It was not until his return to Germany in 1837, that his ideas were matured on what he felt his real mission to propagate, and what resulted in the "Kindergarten" with which his name will ever be connected. He wished to propose something to employ children before the legal age for school. He had already founded a Kindergarten at Blankenburg for the purpose, and now on his return to his native country, he was enabled, notwithstandi. g many hostile attacks, to carry out successfully, and with general approbation, his system of teaching by means of ga... He died in 1852, at Marienthal, where he was about to ... an establishment for the training of Kindergartnerinnen, or female teachers of his system. The idea is that children should be led to gain knowledge, and what is better, be made to think, even in their games. Children attend to their games, and if these are superintended, attention is readily given to those directing them; the toys are very simple, those first used are small pieces of wood like lucifer matches (Stabchen), which are laid in various directions, and joined so as to form figures and outlines of familiar objects, the children being made acquainted with the meaning of straight lines, horizontal, perpendicular, and diagonal, then angles (right, acute, and obtuse). As a gift they have bricks when they learn the meaning of square, cube, &c. Peas are used to join the little sticks, in order to make various pretty objects. Plaiting, sewing, and drawing, are all employed in turn, but the chief end of the system is to direct the children to think; they also learn to be exact, attentive, and industrious. All sorts of knowledge are acquired, not only by exhibition of natural objects, such as flowers, &c., in a garden, but pictures are extensively used in conveying instruction. Children are treated as reasonable beings, and are led, not driven, and may obey the poet's admonition:—

> "Be not like dumb driven cattle:
> Be a hero in the strife."

In teaching drawing, books and slates are used which have been ruled in small squares (chequers). The pupil commences by marking over the lines the length of one space in a perpendicular direction, then two, then three, then four spaces; afterwards alternately, 1, 2, 3, 4; 4, 3, 2, 1. When this is accomplished, the pupil is encouraged to invent designs from the strokes he has learnt to make. After which, he proceeds in the same manner with horizontal lines, and in his subsequent composition uses both perpendicular and horizontal lines. He is now in a position to be shown the junction of these two lines so as to form right angles, and make squares of different dimensions, disconnected, joined, and interlaced, the parallelograms of 2, 3, and 4 spaces, as well as other figures formed of similar lines The square is then divided, the acute angle thus formed being explained; diagonal lines, called of the 1st, 2nd and 3rd order, according the slope, are now practised singly and then in unison with those previous learnt. After copying these in the book, drawing from memory should be done on the ruled slate, one of the chief benefits being the use of the inventive faculty; the pupil's compositions should be drawn first on the slate, when any faults can be pointed out by the teachers and when corrected copied into the book. I am enabled by the kindness of Mr Frobel, the nephew of the inventor, and who carries on the system to Edinburgh, to show some of the drawings he executed when a young man at the establishment at Keilhau, as well as some by his daughter at ages of eight, nine and thirteen. He says the inventive faculty is stronger in boys, by whom some very beautiful designs have been made. After the pupil is proficient in the use of straight lines, having formed all manner of angles and



CONSTRUCTION OF MANSARD ROOF.



CONSTRUCTION OF MANSARD ROOF.

many-sided figures, with every variety of angles, he is prepared for the circle, which is drawn first small and single then in various combinations, and united by lines, then larger, afterward arcs of circles, the angles at the points of junction of the arcs being explained, thus preparing the pupil, by geometrical drawing and by the use of geometrical terms, to the higher study of geometry itself You will now see why the system deserves the name of "developing." As all true art must be on this principle, it will not do for the architect to commence at once to form his buildings in geometric fashion, as has been done in this city, but as all good architecture has gradually been developed, we must use the inventive faculty in us by improving our present style, or rather want of style, and seeking to form harmonious and truthful combinations with the materials which are now placed in our reach, nor shirking the difficulty by hiding them up, not leaving them to engineers to carry out, but by improving our own taste and that of the public; and this is what I claim for this system, which, however, is not itself even developed to its full extent, but when the drawing has met with the success it deserves it will be followed by other subjects, such as colouring, &c, but it has not as yet met with sufficient encouragement in this country. In Switzerland, one of the countries most forward in education, the Kindergarten is general, as also in Austria, where it has lately been ruled that no school shall be without a garden, gardening being used as a means of training. Work, such as requires the use of tools, is imployed with great success in a similar manner; and if this were better carried out we might more often meet with that intelligent master workman so much spoken of, but so seldom met with. Something must be used as a means of training: in our country we generally used Latin and Greek, as at Oxford, — sometimes mathematics, as at Cambridge,—of late years some have proposed modern languages, and others science. The advantage of drawing, however, is that it can be commenced earlier, and after-training gradually acquired by it, knowledge of mathematics follows as a natural result; and the acquisition of languages, modern and ancient, is more easily gained by a mind already advanced in growth and maturity. In the architectural profession, a young man who has had the advantage of this training will be none the less able to use the rule, the T-square, and the compasses, but he will have acquired method, carefulness, and accuracy,—qualities by no means to be despised.

THE VEGETABLE CELL.

By. Alfred W. Bennett, M.A., B.Sc, F.L.S,

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In few departments has science-teaching undergone so great a change in recent years as in the mode in which the botanical student is instructed in the rudiments of his science. It is not many years since botany was thought to consist in a knowledge of the names of plants, and a facility in distinguishing and naming closely-allied species differing from one another in the most minute characters. The real history of the structure of the plant, the mode in which its various tissues are formed, the function which each part is destined to fulfil, were not thought to form any part of the programme. Teachers of botany now recognise that their science has a much wider scope and a far nobler aim He may be a profound botanist who has no knowledge of "critical" species, who would hesitate in assigning the most recent Latin name to half the flowers he might gather in wood or by wayside. To make himself acquainted, as far as Nature will reveal her secrets, with the internal economy of the subjects of his study, is the main object of his observations and of his labours. And for this purpose the microscope must be freely used Indeed it is only since our opticians have produced instruments of such power and comparative perfection that we have been able to gain much insight into the internal structure of plants.

At the foundation of all vegetable anatomy lies a knowledge of the structure of the Vegetable Cell. Though a few earlier writers obtained some insight into the part played by it in the structure of plants, Schleiden was the first, in his "Principles of Scientific Botany," to present the theory of the cell in a connected and complete form, Schleiden's account being confirmed, carried into more minute details, and in some points corrected, by subsequent observers, chiefly belonging to Germany, von Mohl, Nageli, Hofmeister, and others.

It cannot be too clearly understood by the beginner that all vegetable tissues, of whatever kind, are formed originally from cells of the structure we are about to describe, and that all growth is the result of the multiplication, in some way or other, of these cells There are plants of so simple a structure —Unicellular Algæ and Fungi—as to be formed of but a single cell; others, also Algæ and Fungi, consist of but a single filament of cells; but all the higher plants are aggregates of cells, infinite in number, which, in the more complicated forms of tissue, have undergone modifications in a great variety of ways.

The vegetable cell is a sac or vesicle completely closed on all sides; the form of the cells may be easily recognised by placing under a comparatively low power of the microscope thin sections of potato, elder-pith or a similar tissue, or in the semi transparent leaves of *Anacharis* or *Vallisneria*, or those of *Sphagnum*, which consist of only a single layer. The cell represented in fig. 1. C.* is from the tuber of the artichoke. The coating of the sac or cell-wall (*h*) consists of a very fine membrane of cellulose; within which are a variety of substances known as cell-contents Two of these are invariably present in all young growing cells—water, and a mucilaginous more or less granular substance known as protoplasm (*p*); situated within which, but varying in position, generally almost close to one side, is a nearly transparent body consisting of denser, almost solid protoplasm, the nucleus (*k*). The structure and composition of each of these parts must now be examined somewhat more in detail.

The *Cell-Wall* is always of uniform chemical composition, its constitution being $C^6H^{10}O^5$, identical with starch and dextrine Though perfectly continuous and destitute of any pores or orifices that can be detected even by the highest powers of the microscope, the cell-wall is, nevertheless, permeable to fluids, the cell-sap passing into the cell by the process of osmose, that is, the passage through a permeable diaphragm of the less dense of two fluids of different specific gravity, which are separated by the diaphragm The substance of the cell-wall is secreted from the protoplasm which it contains; but, according to Nageli, Sachs, and other competent authorities, its growth in thickness does not depend, as was at one time supposed, on the formation of new consecutive layers, each within those already in existence, but on the "intussusception" or interposition of fresh particles or molecules of cellulose, which penetrate into every part of the cell-wall from the protoplasm. The cell-wall is perfectly colourless, and when thin transparent, so as to reveal the internal structure of the cell.

The *Protoplasm* is the essential life-giving portion of the cell. It is not homogeneous in its consistency; the layer nearest the cell-wall is somewhat denser, and forms a kind of skin or bladder enveloping the interior portion, and was termed by Mohl the "Primordial Utricle" (Primordial-schlauch), a term which is still generally applied to it. The *Nucleus* † already described is present in the early stage of the cells of all higher organisms without exception, but that it is not an essential ingredient is shown by its absence from Unicellular Algæ and the cells of some other lowly organisms Very commonly the nucleus contains other smaller bodies of a similar character within it, the Nucleoli. The protoplasm is often absent from one or more cavities in the interior of the cell, termed vacuoles, which are occupied by the cell-sap. The protoplasm may be contracted and separated from the cell-wall by the application of iodine and dilute sulphuric acid, a drop of iodized solution of chloride of zinc causes the cell-wall to assume a beautiful blue colour, the nucleus and the rest of the protoplasm retaining a brownish yellow tint The exact part played by the nucleus in the functions and in the multiplication of cells is a point at present involved in much obscurity. Protoplasm differs in its chemical composition from cellulose in containing nitrogen; but the experiments hitherto made have failed in assigning to it any definite and constant formula.

In addition to water and protoplasm, which are contained in every cell when in a growing condition, other substances are frequently or generally present, of which some of the most important may be here mentioned.

* All the woodcuts in the present article are borrowed, by permission of the English publishers, from the English edition of Sach's "Text Book of Botany," the most complete and trustworthy work on Vegetable Morphology, about to be published by the Clarendon Press, Oxford.

† Called by Schleiden and the older writers, the Cytoblast.

Starch is the first product of assimilation, that is, of the union of the elements of water absorbed by the root with the carbon removed by the leaves from the carbonic acid of the atmosphere Its chemical composition is identical with that of cellulose, but its properties are different. It never enters, moreover, into the constitution of the cell-wall, but is always imbedded in the protoplasm in the form of distinct grains, the form of which is nearly uniform in the same species of plant If a drop of dilute solution of iodine is placed on a thin section of a potato, the grains of starch are beautifully brought out under the microscope by the bright violet colour they assume, the cell-wall remaining colourless The pith of the elder or the bulb-scales of the hyacinth form equally good preparations starch being invariably found in those parts of the plant—as bulbs, tubers, rhizomes, albuminous seeds, &c.—where the food-material is stored up for the nutrition of the young plant, whether it be developed from an embryo or a leaf-bud. Starch-grains generally contain a body which may be defined as the nucleus, and the growth of the grain invariably takes place by intussusception, new particles of the formative material becoming intercalated, according to Sachs, between those already in existence; the new matter assuming the form of concentric layers o greater and less density, that is, containing a smaller and larger admixture of water Grains sometimes become compound by the production of several nuclei in their interior.

Chlorophyll is the substance which gives the green colour to leaves and branches, and may be considered as a peculiar form of protoplasm, the green colour being probably due to the admixture of a very small quantity of iron The constitution of this substance has been very carefully investigated by Mr H C Sorby, who finds it to be composed of different bodies, especially a blue and a yellowish-green one, the mixture of which gives the familiar leaf-green colour The chlorophyll always occurs in the form of minute granules interspersed through the protoplasm, which vary their position in the cell according to the intensity and direction of the light They are formed only in the presence of sunlight, either direct or diffused, and it is only these parts of the plant which possess them that have the power of decomposing the carbonic acid of the atmosphere. Independently of this alteration in position of the chlorophyll-grains, the protoplasm itself has often—perhaps always—a rotating or circulating motion within the cell: this can be easily perceived in the leaves of *Vallisneria*, the stems of *Chara*, the hairs on the filaments of *Tradescantia*, the stinging-hairs of the nettle, &c.

Raphides are minute crystals, generally of oxalate of lime, contained within the cell, their purpose is not known: possibly the fixation of oxalic acid, which might otherwise be injurious to the plant. They abound in many plants, as the stem of the *Cactus*, the leaf-stalk of rhubarb, &c., and may very easily be made out in a section of the leaf of the hyacinth.

Having described the structure of the cell and its contents, we may now follow the various modes in which cells multiply, or by which the different kinds of tissue are formed from the original cell. The various mode of the multiplication of cells may be classed under four heads.—(1) Free cell-formation, (2) Cell-formation by Conjugation, (3) The Renewal or Rejuvenescence of cells: and (4) Cell-division. Of these the last is by far the most common, but the three first are of the utmost importance, as throwing great light on what it is that constitutes the vital principle of the cell

1 *Free Cell-formation* is of comparatively rare occurrence It consists in a portion of the protoplasm within the primordial utricle of a cell becoming separated, and secreting a membrane of cellulose in which it becomes envelo, ed, one or more cells being thus formed within the parent-cell. In this way are formed the "embryonic" or "germinal vesicles" within the embryo sac, as well as the first cells of the endosperm or "albumen" in the ovules of Angiosperms; and the spores within the asci of some species of Ascomycetous Fungi, as *Peziza*.

2 *Cell-formation by Conjugation* is also an exceptional phenomenon being exhibited only in the reproduction of some of the lower classes of Algæ—the Palmellaceæ, Desmidiaceæ, Diatomaceæ, and Zygnemaceæ (sometimes collected together into the single group of "Conjugatæ"), and in a few genera of Fungi, as *Syzygites* and *Mucor*. A very good instance of the phenomenon is presented by an abundant and well-known fresh-water Alga, *Spyrogira longata*, which forms a most beautiful object under the microscope, from its chlorophyll-grains being combined in each cell into a spiral band visible through the transparent cell-wall. Figs. 3, 4 represent the mode in which this process takes place. The filaments of this Alga consist of a row of cylindrical cells, each of which contains a mass of protoplasm, and the conjugation takes place between the adjacent cells of two more or less parallel filaments Protuberances (fig 3 *a*) first of all make their appearance at opposite points of these adjacent cells, which at length meet (*b*) The cell-wall then gives way between them (fig. 4 *a*), and the two masses of protoplasm coalesce, the whole finally passing over into one of the cells (*b*), and the resulting mass at length becomes coated with a cell-wall of cellulose (*c*), forming the reproductive body known as a "Zygospore." In the unicellular Desmids and Diatoms, and in the Mucorini, the process is similar.

3. *Renewal or Rejuvenescence of Cells.*—This process takes place in the formation of the "Swarmspores" or "Zoospores" of Algæ The whole contents of a cell of a filament contract, and the mass of protoplasm assumes an ovoid form, with a broad green and a narrower hyaline end, provided with cilia or fine threads of protoplasm either at this latter end or surrounding the whole spore. The cell-wall gives way, and, as the swarmspore escapes from it, it moves rapidly forward with its narrower end in front, propelled by the vibratile motion of its cilia, till it at length comes to rest, when its cilia disappear, and it attaches itself by means of rhizoids or root-hairs, and then only the naked ball of protoplasm becomes coated or encysted with a cell-wall secreted out of its own substance, and finally developes into a new filamentous Alga. Fig 5 shows the various stages of this process in the case of an *Œdogonium*. This process, as well as these already described, is relied on as demonstrating a point of cardinal importance in vegetable physiology, viz that the vital portion of the cell is its protoplasmic contents, independent of the cell-wall.

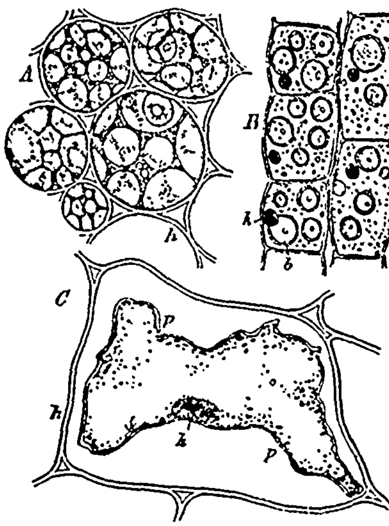
4 *Cell-division* is the process which occurs in all reproduction of cells connected with vegetative growth, i e., it is the sole means by which tissues are produced The following modifications of the process are presented, viz.:—

a. Where the whole of the protoplasm contained within the primordial utricle divides into derivative, or daughter-cells; but these daughter-cells do not secrete cell-walls until they have become completely isolated. This is the mode of formation of the zoospores of *Achlya* and other less highly developed Algæ, as well as the spores of *Equisetum*. If the whole protoplasmic body, in its contraction, were to form only one ball, the process would become one of renewal or rejuvenescence. Two varieties occur of this modification, according as the protoplasmic body contracts during its division, owing to the expulsion of water, or no contraction takes place. The pollen-grains of some Endogens are formed on the latter principle.

b Where the daughter-cells formed by the division of the protoplasm of the mother cell become coated with a cell-wall of cellulose while the division is taking place. This is again subject to two varieties, depending on the contraction or not of the protoplasmic body during division. The ordinary mode of the formation of the pollen of Exogens within the anther belongs to the first of these categories; the second illustrates the mode in which ordinary cellular tissue is formed by the multiplication of cells. Fig. 6 represents this most common form of cell-division in the case of the filamentous Alga *Spyrogyra longata* The protoplasm-sac first begins to fold in at two opposite points, the line connecting which would often pass through the nucleus. The nucleus divides into two, the two halves gradually separating from one another and forming the distinct nuclei of the two new cells which are produced by the folding in of the protoplasm and the simultaneous secretion from the protoplasm of a new dividing-wall of cellulose.

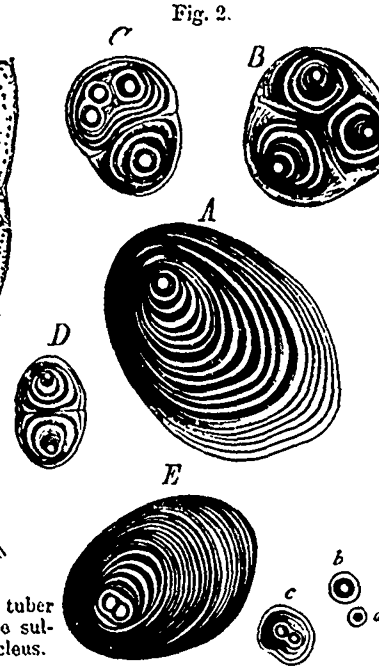
Several apparently anomalous modes of the production of cells are known, to which special terms have sometimes been given, but they may all be referred to one or other of the modes now described. The formation of the "spores" of the Mould-Fungi, and of the "basidiospores" of the higher Fungi, is sometimes described as if it consisted in the "basidium" or basal cell forming several spores in succession, which become detached one after another from the parent-cell. What really takes place is in all cases a bipartition of the cell of the hymenium, but into two very unequal portions; the smaller portion or "basidiospore" becomes detached, the larger portion remains behind, rapidly grows to its original size, and

Fig. 1.



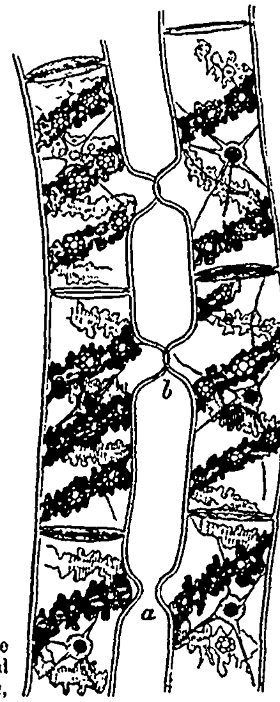
Forms of cells; *A* and *B*, from the maize; *C*, from tuber of artichoke, after action of iodine and dilute sulphuric acid; *h*, cell-wall; *p*, protoplasm; *k*, nucleus.

Fig. 2.



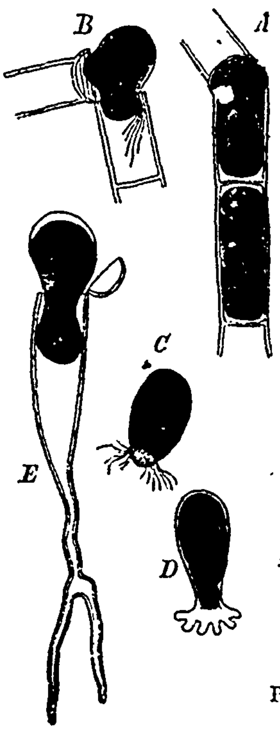
Starch-grains from a potato-tuber (× 800). *A*, an older simple grain; *B*, a partially compound grain; *C*, *D*, perfectly compound grains; *E*, an older grain, the nucleus of which has divided; *a*, a very young grain; *b*, an older grain; *c*, a still older grain with divided nucleus.

Fig. 3.



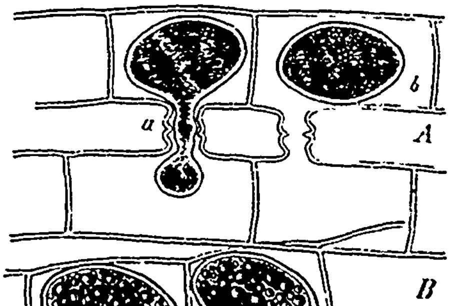
Two filaments of *Spirogyra longata*, showing the commencement of the process of conjugation (× 550).

Fig. 5.



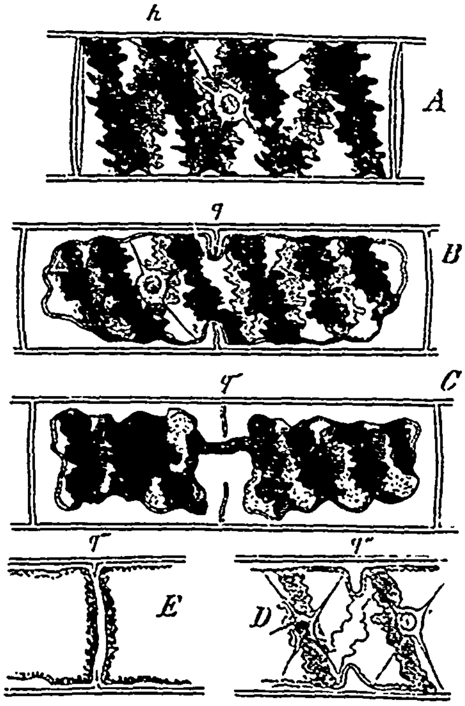
A–D, various stages in the development of the swarm-spore of an *Œdogonium* from the protoplasm of a cell; *E*, escape of the whole of the protoplasm from the single cell of a young *Œdogonium*. (After Pringsheim, × 350.)

Fig. 4.



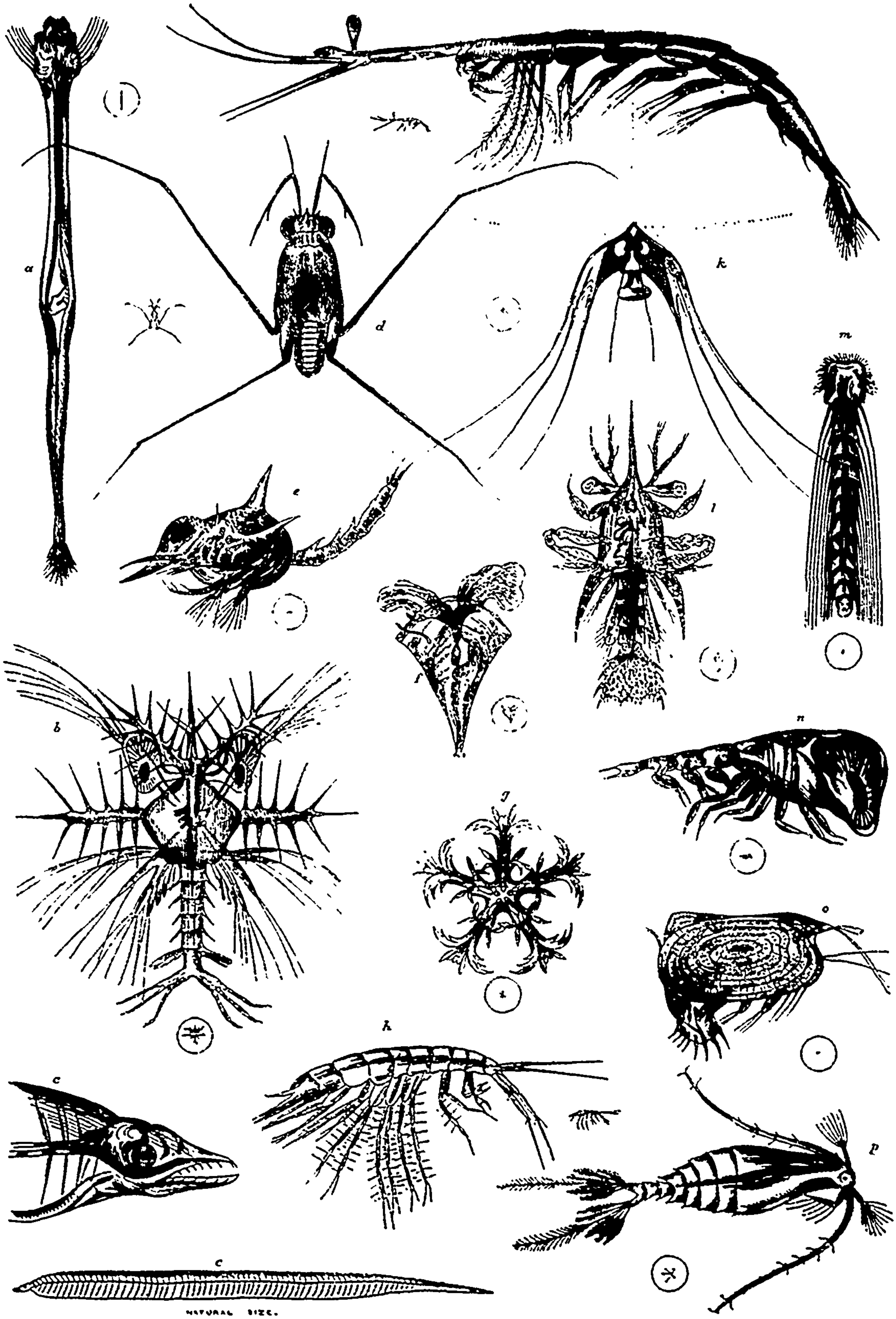
Production of the Zygospore in *Spirogyra longata*; *A*, an earlier: *B*, the final stage.

Fig. 6.



A, *B*, *C*, a cylindrical cell of *Spirogyra longata* in successive stages of division; *D*, *E*, the central portion of the same cell; *q*, the new wall of cellulose in the process of formation.

THE VEGETABLE CELL.



OCEAN SURFACE LIFE.

again and again repeats the same process. The process described in some text-books as the "Gemmation" or "Budding" of cells, characteristic of the yeast-plant and other very lowly organised Fungi, is a simple process of cell-division. The protoplasm-sac of the cell swells on one side, carrying the cell-wall along with it; the papilla thus formed becomes subsequently separated by constriction, secreting an intermediate wall of cellulose, and ultimately becomes detached as an independent cell.

It only remains to describe the mode in which cells develop into tissues. The simplest forms of vegetable life, as the *Palmella cruenta* and *nivalis*, or "Red-snow," among Algæ, consist of single cells, which perform all the functions of life, both vegetative and reproductive. Others again, both Algæ and Fungi, are formed of simple rows of cells. but in all the higher forms of plants the cells are united into tissues, the various forms of which have formerly been distinguished into two classes, Cellular and Vascular Tissue. *Cellular Tissue* is the only form of tissue found in the lower classes of Cryptogams, Algæ, Fungi, Lichens, and Mosses, and in the rapidly growing parts of all plants. It consists of masses of cells which have undergone no material change from their original condition, being still closed sacs without communication with one another except through their permeable cell-walls, and containing protoplasm, since it is only by cells in this condition that the processes of vegetable life and growth can be carried on. The "cambium region," in which is formed the new wood of all woody plants, consists entirely of cellular tissue. When the cells retain nearly their original form, being still roundish or elliptical, the tissue is termed *Parenchyma*; when the cells are greatly elongated in one direction, more or less attenuated and overlapping one another, the term *Prosenchyma* is applied to it. *Vascular Tissue*, on the other hand, consists of cells which have undergone modification in two ways: by the thickening and hardening of the cell-wall, and by the fusion together of a number of cells. The thickening of the cell-wall seldom takes place uniformly, but more often in regular patterns; and thus are produced the forms known as annular, spiral, pitted cells, &c., giving rise to the production of tissues of a similar character.

Prof Sachs, in his "Text-book of Botany," proposes the following classification of tissues:—

1. *The Epidermal Tissue.*—The outer layer of cells of an organ consisting of a mass of tissue becomes distinguished by the thickness and firmness of its cell-walls, and hence usually by the cell-cavity being less. In the lower forms of plants the passage from this to the internal tissue is gradual; in all the higher plants the epidermis is much more strongly differentiated. The hairs which so commonly cover the young parts of plants are invariably developments of particular cells of the epidermis, and the stomata (often erroneously called "breathing-pores," from a mistaken view of their function) are openings through the epidermis to the intercellular spaces that lie beneath. Cork is another form in which the epidermal tissue occasionally develops, and in the majority of our forest-trees it assumes the form known as Bark.

2. *The Fibro-vascular Bundles.*—The tissue of Vascular Cryptogams and Flowering Plants is traversed by separate string-like masses of tissue, which can often be completely isolated from the rest of the plant, and are the Fibro-vascular Bundles. Each separate fibro-vascular bundle consists, when it is sufficiently developed, of several different forms of tissue, and must therefore be considered as a tissue-system. A portion of the bundle always remains for a time in a condition capable of further development, constituting the *Cambium*, which frequently divides the bundles into two distinct portions, called by Nageli the *Phloem* and the *Xylem* portions of the bundle; the former consisting of succulent, generally thin-walled cells, the latter having mostly a strong tendency to thicken its cell-walls. It is not, however, necessary for the fibro-vascular bundle to contain pure woody tissue. Spiral vessels occur always in the veins of the leaves and in the medullary sheath of the stem of Exogens. The fibro-vascular bundles are extremely well seen in a transverse section of a leaf-stalk of any exogenous plant, from the petiole they ramify into the blade of the leaf, forming the veins or nerves.

3. *The Fundamental Tissue* is the term given by Sachs to those masses of tissue of a plant or of an organ which still remain in their original condition after the differentiation of the epidermal tissue and the fibro-vascular bundles. It may consist of various descriptions of tissue, but is always to a large extent parenchymatous. In the leaves of Ferns and Flowering Plants the fundamental tissue forms by far the larger portion, constituting the "mesophyll."

4. *Laticiferous Vessels* and *Intercellular Spaces* may occur in any of the three systems of tissue now described, and sometimes pass into them by insensible gradations. The true Laticiferous Vessels are canals filled with milky sap resulting from the coalescence of rows of cells, and lying in the phloem portion of the fibro-vascular bundles. They occur abundantly in many orders of plants, as the Papaveraceæ, Convolvulaceæ, Cichoriaceæ, Euphorbiaceæ &c. The Intercellular Passages result from the separation from one another of rows of cells, and are also frequently filled with a milky, oily, or resinous fluid, as in Umbelliferæ and Coniferæ.

The different kinds of tissue now described are to be met with only in the more or less mature parts of plants. The parts which are actually in a state of growth as the ends of shoots, leaves, and roots, consist of a uniform tissue, the cells of which are all capable of division, rich in protoplasm, with thin and smooth walls, and containing no coarse granules, to which the term *Primary Meristem* has been given. From this the Epidermal Tissue and Fibro-vascular Bundles are differentiated as the organ develops, the portion which undergoes comparatively little change being distinguished as the Fundamental Tissue. The terminal portion of an organ with permanent apical growth, which consists entirely of primary meristem, is termed the *Punctum Vegetationis*; or when, as is sometimes the case, it projects as a conical elongation, the *Vegetative Cone*. A remarkable difference in the mode of development of the punctum vegetationis occurs almost uniformly between Cryptogams and Phanerogams. In Cryptogams the whole of the cells of the primary meristem almost invariably owe their origin to a single mother-cell lying at the apex of the punctum vegetationis, and called the *Apical Cell*. In Phanerogams, on the other hand, without exception, there is no single apical cell of this character: even when a cell lies at the apex, it is not, as in the former case, distinguished by its greater size, nor can it be recognized as the single original mother-cell of all the cells of the primary meristem.

We have attempted to give here only the merest outline of the constitution of the cell and of tissues. For the further elucidation of the subject we must refer our readers to the more modern text-books of botany, especially Prof. Sachs's "Lehrbuch," an English edition of which is about to be published by the Clarendon Press, Oxford.

OCEAN SURFACE LIFE.

In the College of Physicians, London, hangs, or did hang, a chart twelve feet by eight feet in dimensions, upon which are more than six hundred fine water-colour drawings of marine animals, executed by Mr Francis Ingram Palmer, R. N., navigation sub-lieutenant of H. M. S. Sylvia, who was employed in the admiralty surveys of China and Japan several years ago, and who accompanied the expedition of Consul Swinhoe a thousand miles up the great river Yang-tse-Kiang. These marine animals are such as are found in the Chinese Archipelago, the Indian Ocean and the Atlantic waters. An idea of this curious work of art, which is also a very instructive study in natural history, may be obtained by an inspection of the engravings on page 57. Lieut. Palmer has obtained some fame in other branches of art. His sketches of views on the Yang-tse-Kiang were formerly published in the *Illustrated London News*, and attracted a good deal of attention. The collection of specimens from which the drawings in the College of Physicians and surgeons was made was acquired only by very extensive labour. Mr Palmer dragged the surface of the ocean for more than 12,000 miles, wearing out forty new and many repaired nets. He examined by the aid of powerful glasses, all the animals brought on the deck. His perseverance and skill in conducting his researches are perhaps even more praiseworthy than his artistic faculty of delineation. The engravings are shown greatly magnified. The natural size of each animal is represented by the small figure enclosed in a small circle placed near the magnified figure of the same animal. Although the animals are themselves small, science has bestowed upon them names sufficiently large and high-sounding.

Referring to the engravings, they represent, *a*, a species of sagitta; *b*. the larva of a decapodous crustacean, *c*, the leptocephalus, a remarkable fish, the head of which alone is shown magnified; *d*, the ocean fly, a hemipterous insect, which skims on the surface of the sea, *e* the zoë, a species of young crab, *f*, a pteropodous mollusk, *g*, an asteirdian, or star-fish, *h*, an amphipodous crustacean, *i*, a stomapodous crustacean, *k*, a larva of the echenoderm, or sea-urchin, *l*, alaurina, or larva of Palinurus lobster; *m*, a new annelid, *n*, an amphipod crustacean; *o*, an ostracodous or bivalve crustacean, *p*, a copepodous crustacean, with plume-like hairs. *American Artisan.*

THE PHILOSOPHY OF WELDING.

BY W. MATIEU WILLIAMS, F.R.A.S., F.C.S., IN *Lon.*

In the address of M. Jordan, President of the Société des Ingénieurs, delivered at the annual meeting of that society in Paris, a novel explanation of the welding of iron is offered. M. Jordan says that welding "is a phenomenon exactly similar" to the regelation of water, the phenomena of regelation being these, that if two or more pieces of ice at a temperature not lower than their melting point, or preferably at a temperature much higher than their melting point, be pressed together, the liquid water adhering to their melting surface becomes solid at the places of contact, and thus the two pieces are refrozen into one. M. Jordan very aptly illustrates the phenomena of regelation by the making of a snowball, telling us that this may be done "when snow is at a temperature not lower than 0° Centigrade, *i.e.*, the freezing point of water." Every man who has been a boy will confirm this, and remember that when snow was very dry, and the temperature of the air below the freezing point, the snow-flakes would not cohere without the aid of much pressure and warmth from the hand, but that with sloppy snow during a thaw he could make a hard icy snowball with ease. M. Jordan compares the making of the snowball by the children with the welding of the iron ball by the puddler, maintains that the processes are identical, and applies Sir W. Thompson's rather recondite explanation of regelation to the cases of iron and platinum welding.

It appears to me that this explanation is fallacious as the conditions of solidifications in the two cases are not only by no means alike, but are diametrically opposite, the welding of both iron and platinum being effected at a temperature considerably below their melting point, while the primary condition for the cohesion of two pieces of ice by regelation is that they shall be exposed to a temperature above, or at least not below their melting point. In order that regelation should be analogous to welding, it should take place at a temperature far below the freezing point. Now it is well known that under such circumstances regelation does not and cannot occur, and therefore it differs essentially and primarily from welding.

If it had been discovered that two or more pieces of iron, while in a furnace, raised above their melting point and streaming into fusion, would cohere when passed together, and that this cohesion resulted from the solidification of their liquid surfaces, in spite of the melting heat of the furnace, we should then have an analogy with the regelation of melting ice, and M. Jordan's conclusions would be justified. Regelation means the resolidifying of a liquid, or a special cohesion in spite of liquidity; welding means a special cohesion in spite of solidity. If M. Jordan had described them as examples of curiously opposite actions, the comparison would have been more nearly correct. We might plausibly assume that, while the pressing together of two pieces of wet ice produces a solidification of the surface liquid, the pressing together of two pieces of heated iron has the opposite effect of momentarily liquefying the surfaces of contact, and thereby soldering them together. The plausibility of this explanation is increased by the fact that pressure develops heat, and thus the welding heat might, at the surface of contact, be momentarily raised to the fusing point, and then, on the removal of the pressure this liquid film might solidify and thus produce the welding cohesion. But even this theory is, in my opinion, too learned. A far simpler explanation may be found, and we must never forget that when two or more explanations equally fit a given set of facts, the simplest is the best, and usually the true one.

In order to find a true analogy to welding, we need go no further than the vulgar "sticking together" of two pieces of cobbler's wax, pitch, putty, or clay. These are in a viscous or semi-fluid condition, and they cohere by an action similar to the transfusion or intermingling and uniting of two liquids. Iron and platinum pass through a viscous or pasty stage on their way from the solid to the liquid states, and the temperature at which this pasty condition occurs is the welding heat. Other metals are not weldable, because they pass too suddenly from the solid to the liquid condition. Ice, although it fuses so slowly, in consequence of the great amount of heat rendered latent in the act of fusion, passes at once from the state of a brittle crystalline solid to that of a perfect liquid. It passes through no intermediate pasty stage, and therefore is not weldable, or does not cohere like iron, etc., at a temperature below its fusing point.

It is usual to cite only iron and platinum, or iron, platinum, and gold, as weldable substances, but this, I think, is not correct. Lead should be included as a weldable metal. The two halves of a newly-cut leaden bullet may be made to reunite by pressure, even when quite cold. This is obviously due to the softness or viscosity of this metal.

Outside of the metals there is a multitude of weldable substances. I may take glass as a typical example of these. Its weldability depends upon the viscosity it assumes at a bright red heat, and the glass-maker largely uses this property. When he attaches the handle to a claret-jug, or joins the stem of a wine-glass to its cup, he performs a true welding process.

The chief practical difficulty in welding iron arises from the fact that at the welding heat it is liable to oxidation, and the oxide of iron is not viscous like the metallic iron. To remedy this oxidation the workman uses sand, which combines with the oxide and forms a fusible silicate. If he is a good workman, he does not depend upon the solidification of this film of silicate, as the adhesion thus obtained would be really a soldering with brittle glass, and such work would readily separate when subject to vibratory violence. He, therefore, beats or squeezes the surfaces together with sufficient force to drive, out between them all the liquid silicate, and thus he secures a true annealing or actual union of pure metallic surfaces.

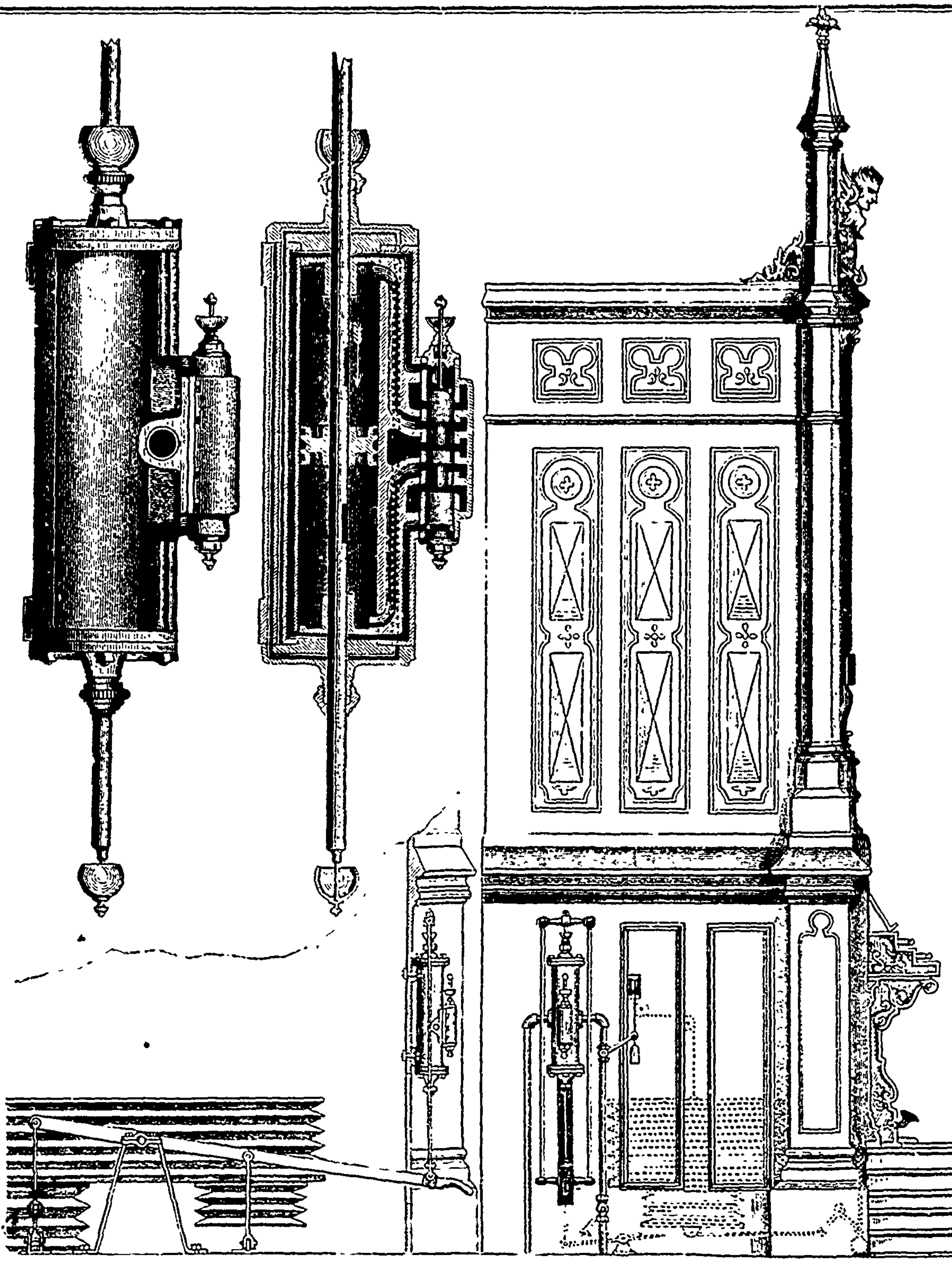
Cast-iron or steel containing more than two per cent. of carbon cannot be welded. Why? I think I may venture to reply to this oft-repeated question by stating that the compound of iron with so much carbon is much more fusible than *pure iron, or than steel with less carbon, and that it runs* more suddenly or directly from the solid state into that of a liquid, and hence presents no workable range of weldable viscosity.

HYDRAULIC ENGINE FOR BLOWING ORGANS.

The accompanying engraving comprises perspective and sectional views of an engine designed for blowing organs, and also diagrams showing the manner of attaching the engine to the case of an organ and its connection with the bellows.

Many of our mechanical readers are aware that the subject of blowing organs by water-power has been carefully studied a long time, and that many costly experiments have missed success from the difficulty in procuring a steady, regular motion. Most of the devices hitherto employed to secure regular motion have involved more or less complicated auxiliary attachments. The manufacturers of this engine claim that a regular motion has been secured for the first time without such complications. The engine is fastened, as will be seen, on the side of the instrument immediately above the hand-lever of the bellows. The appliances for starting and stopping the machine are carried to the front of the organ, and are placed under the control of the organist by a foot-lever beneath his seat. In the induction-pipe is placed a governor-valve controlled by a counterpoise-lever, which acts together with the bellows in regulating the supply of water according to the requirements of the instrument. The connection with the bellows is made by cord and pulleys to the end of the counterpoise lever. As the bellows fills the weight at the end of the counterpoise-lever, it descends, thus closing the valve to a greater or less extent, and, as the bellows empties, the action of the cord and pulleys raises the counterpoise-lever, admitting more water to the engine, and thus increasing its action upon the bellows. The extreme simplicity of this device is its ample recommendation.

The piston-rod performs the function of a valve which admits water to a passage way, through which it enters the valve chest at one or the other end, according to the admission. This passage-way is formed in the walls of the cylinder. Recesses are formed in the piston-rod, which alternately pass through the end of the cylinder sufficiently at the end of the stroke to allow communication between the space in the cylinder and the passage-way which leads to the valve-chest.

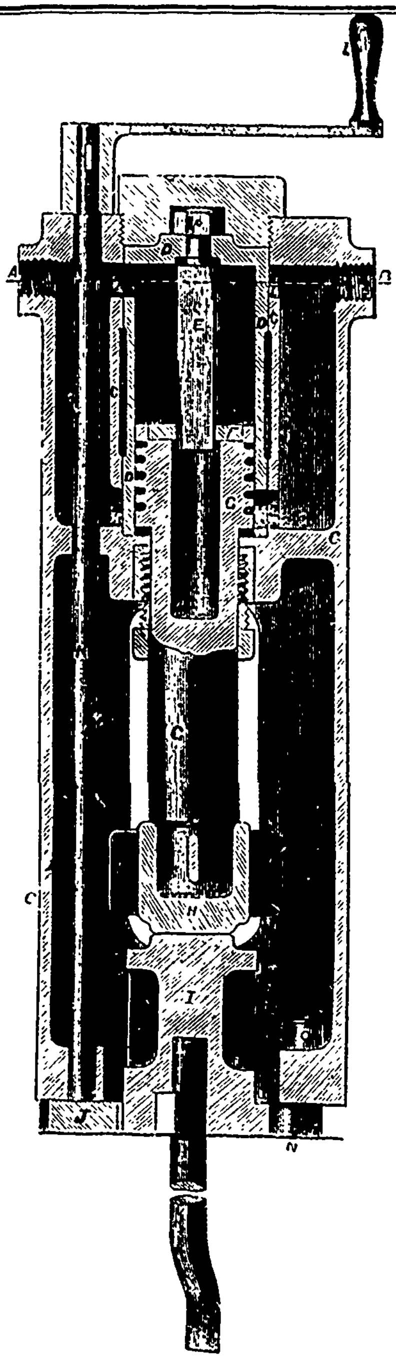


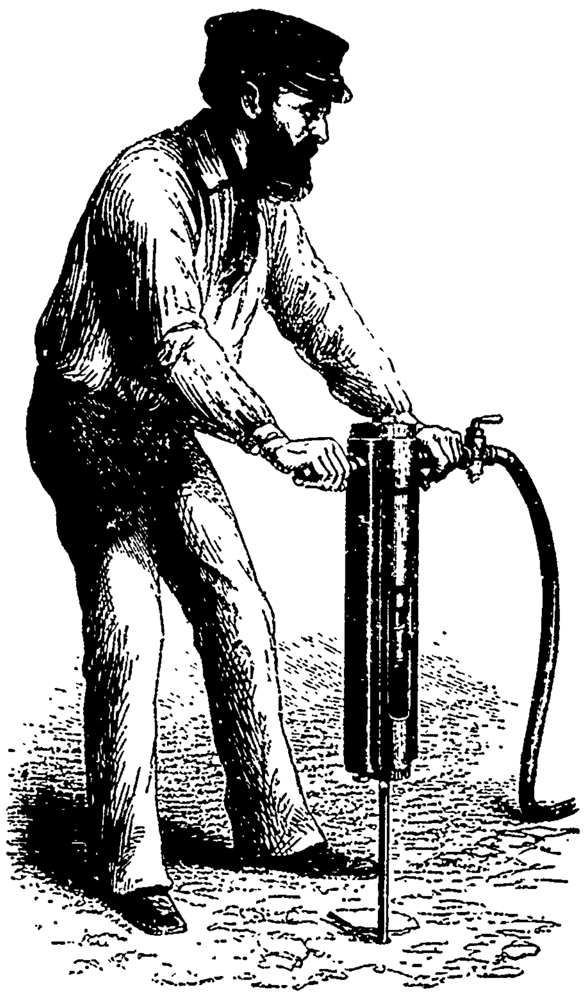
HYDRAULIC ENGINE FOR BLOWING ORGANS.

The valve is simply a cylindrical D valve. Its operation will be at ounce understood by inspecting the sectional engraving. As water-pressure is received on all sides of this valve, it requires but little power to move it. Its operation is, therefore, quiet but certain.

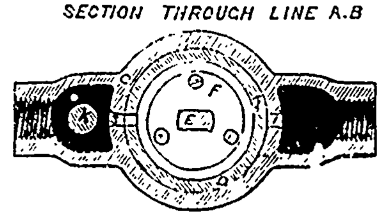
The advantages claimed for this hydraulic engine over all others in the market are, first, that all the working parts for reversing the motion of the piston are operated from the inside, the slots in the piston rod communicating with the auxiliary ports in the cylinder, these ports being designated by dotted lines in the engraving, and which convey the water from the supply-pipe to the valve-chest. In other hydraulic motors there are more or less complicated parts, worked by levers or tapped arms from the outside, and very liable to get out of order. The importance of a machine in which there are no parts that can get out of adjustment in churches, where no one is employed who is familiar with machinery, is apparent.

Under the most unfavorable conditions it is stated that the cost of water to operate the engine is only from ten to twenty cents per hour.—*American Artisan.*





SECTION THROUGH LINE A.B



THE WARSOP ROCK DRILL.

THE WARSOP ROCK DRILL

The illustrations above, represent a novel apparatus for drilling and boring in every description of rock or stone, and is especially suited for sinking mine shafts, or drilling in quarries. In principle it is a close imitation of the ordinary process of hand boring with hammer and chisel, the chisel remaining always at the bottom of the hole, while it is rapidly struck by a small steam or air-propelled hammer. In this respect it differs from all other rock drills or jumpers which have the chisel attached to a reciprocating piston rod. This chisel point, upon which the whole apparatus rests, ressembles a gouge, with a midfeather or projecting rib within it. The curve of the gouge is made to the radius of the hole, and allows the chisel to be turned while the hammer is at work without grinding off the edge. it also insures a perfectly round hole, a great desideratum. The gouge drills are made quite as easily as the ordinary drill point, and are resharpened with equal facility by being heated at the point, and struck in dies cast off a sharpened drill. The method of applying the power to this tool is choosen with strict regard to economy, both of force and material. The weight of the blow on the chisel is decided by the enduring quality of the steel employed for the cutting edge and as the hammer has no other duty than to strike the socket holding the drill, the force of the blow continues constant, and the rate of progress in work varies exactly with the quality of the stone to be bored. The cutting edge of this chisel slides smoothly round its axis while the hammer is in action, and being kept so close to the stone the cutting edge is far less liable to breakage than if it were attached to a piston rod. In addition to this, a smaller piston area is required to produce the blow, as no accidental resistances have to be provided against—as, for example, when the chisel attached to a piston rod is plunging up and down in a hole filled with cuttings and water, or when the frame by reason of vibration has slightly shifted, throwing the chisel against the side of the hole. Besides this, the piston rod of a "jumper" is burdened with the whole weight of the chisel, which increases as the hole becomes deeper, and requires additional power as the work proceeds or else loses in speed, whereas it is claimed that in the Warsop arrangement the moving weight is constant, and the only difference which can take place is a slight absorption, of power by the inertia of a long chisel when boring a deep hole; and that moreover, with a reduced weight of piston or mass in motion, a greater number of blows can be struck in a given time, representing an increase of effective work. In the section, C is the cylinder or main body and frame of the machine. An inner cylinder or casing D, fits accurately into the cylinder C at its upper part, and this casing is free to partially rotate in the outer cylinder. In the top of the casing D is firmly fixed a twisted bar, E, which may be either flat, square, or a round bar rifled with spiral groove cut in it. This bar passes through a disc F of steel firmly fixed in the piston or ram G down the centre of which a hole is bored to receive the full length of twisted bar E. At the opposite end of the piston rod is firmly fixed or cottered a head H having two wings h^1, h^2, fitting grooves cast in the frame C and capable of sliding freely up and down them. The head H is made to rest upon or strike at each blow an anvil or cap I having a recess at its lower part made to receive a drill or chisel. The end of the anvil is formed with a rim around it, against which the end of the main body or frame rests. This base or rim of the anvil I has teeth cut around its periphery, into which gear a smaller toothed wheel J attached to or formed in one piece with the rod K and handle L, in such a manner that by turning the handle L the drill inserted in I will be rotated. The reciprocating action of the piston G is as follow:—In the casing D are formed or cut four narrow longitudinal slots or portways. These slots correspond, one at the top and one at the bottom at the opposite side of the casing, with corresponding portways in the cylinder C, and in such a manner that, when the casing is partially turned round, one port at the top and one at the opposite side are closed, and the other two are open. Compressed air is admitted to the cylinder through the opening B, passes alternately through port 2 or 1 into the casing D, forces the piston G up and down, the steam or air escaping or exhausting alternately through ports 3 and 4, and out at the passage A. The partial rotation of D in the cylinder, and consequent regulation of the air to and exhaustion from the interior is effected by the reciprocating motion of the piston —which is prevented from turning round by the wings h^1, h^2, —causing the bar E to twist, or partially turn backwards and forwards, at each stroke in the hole made to receive it in the disc F, the motion given to the bar and casing being greater or less as the twist in the bar is greater or less. By this means the piston G and tup H are made to give a succession of rapid blows on the anvil I, and consequently to the drill point or cutting edge of the tool inserted in the anvil. The drill is constantly being turned round by the handle L, the machine being prevented from turning round by a sleeve or slide M, which is firmly fixed to a tripod or heading stand. Compressed air enters through one handle, while the other serves as an exhaust pipe. There is no striking action in the valve arrangement, which is designed to eliminate all loss from clearance spaces. This simple little tool may be easily carried about by one man, and may be put to work without even having the hole started by hand, as is not uncommon at present. It has been successfully used, we understand, on the toughest sandstone without sticking fast, even when boring at the rate of 18in. per minute, and it has been equally successful on the Mount Sorrel granite, the hardest in the kingdom, which it pierced with a 1¾in. drill at the rate of 3ft. per hour, a feat which has never before been accomplished, so far as we are aware, by any power drill. The Warsop rock drill will do good work with air or steam at 16 lb. per square inch, the maximum pressure at any time need never exceed 20 lb. Messrs. Tangye Bros and Rake of Newcastle-on-Tyne, the licencees, inform us that they are at present under contract to supply a drill on this principle to bore 6in. holes. The weight of the apparatus, as represented in the woodcut, for boring 1½ in. holes, is only 65 lb.; larger sizes are light in proportion.

RECIPROCITY COUPLINGS FOR RAILWAY CARRIAGES.

The absolute necessity that exists for the introduction of secure and easily-manipulated couplings for railway carriages in place of those at present in use will be understood when it is remembered that, as admitted by the railway companies themselves, over 26,000 railway servants are annually killed or injured, and that these accidents, in a great number of cases occur whilst they are performing the operations of coupling or uncoupling trains. There is no little danger also to the general public from the hurried and consequently often imperfect manner in which this operation is performed, as the history of more than one fatal casualty shows, and the adoption of an improved system or apparatus has been strongly and repeatedly urged upon the railway authorities by the Government Inspector, Captain Tyler, whose extensive experience and special knowledge in railway affairs lends weight to any recommendation he may make.

Still, looking to the extent of the rolling-stock—there being nearly half a million railway waggons and other carriages in England alone—it is important that the desired change should be of such a character as not to necessitate any great displacement, while, at the same time, it is of equal importance that the new apparatus should be of easy application, and so simple that its working should be within the capacity of any railway porter. Farther, vehicles fitted with it must be capable of coupling themselves together automatically, without the intervention of manual labour, of ready disconnection without the necessity of men placing themselves between the carriages, and the couplings must work equally well with spring and block buffers, and do their work exposed to rough usage, dust, dirt, vibration, and exposure to all weathers. All these conditions appear to be fulfilled by the apparatus patented by Mr. Attwood Brockelbank. It possesses, in addition, provision for the effective tightening of the carriages; so that, whether they require to be tightened, loosed, or wholly uncoupled, all necessity for railway servants passing between the carriages is avoided, and each process is performed from any desired part of the vehicle and by one identical action. By its means, Mr Brockelbank says, an engine can couple up any number of trucks or carriages to make up a train by simply running up the buffers together, drivers can take up a train or leave it at will. These are valuable qualities, both as regards economy and safety, for they would effect a very considerable saving of time, labour and expense, in shunting operations, while drivers would be enabled in emergencies, such as in the Merthyr casualty, to follow a running train and secure it and they would be similarly enabled in another class of difficulties, as in the fatal accident at Guildford, to attach or withdraw their engines at discretion. The economical adoption of the new couplings is of prime importance. The first cost would be trifling, they could be readily adapted to existing rolling-stock, for the couplings are fitted to the present draw-bar, the spring-action is maintained, and they can be used in conjunction with, while they allow of the gradual displacement of the present system. The experimental trials already made have been very successful, and the new couplings have been most favourably spoken of by many civil engineers of eminence. Altogether, whether we regard the combined simplicity and ingenuity of its construction, the facility and economy with which it may be adopted, the security it affords against accidents to passengers, and the promise it gives of some diminution of the terrible yearly slaughter of railway servants, we must regard this invention, should it at all fulfil the hopes and promises of its inventor, as one of the very first importance.

As has been already shown, the object of the invention is two-fold—first, to simplify the connecting means for the carriages composing railway trains, and secondly, to obviate the present necessity for railway servants passing between the carriages in coupling or uncoupling them, which is one of the most fertile sources of accident, and often fatal accident, to that useful and hard-worked class. The construction and *modus operandi* is as follows: — On waggons there is a combined hook and loop suspended so as to turn on pivots, and prevented by means of stops from falling below a horizontal line, in such a manner that when the ends of the two waggons are brought together the hook of one will slide over the end and into the loop of the other, and the connection is effected and disconnection accomplished from either side of the waggon by an ordinary lever. For carriages the connecting is effected in exactly the same manner by the coupling.

The engravings on page 64, will more fully explain the structure and indicate the action of the Brockelbank couplings.—*Iron.*

REGULATIONS FOR CONSTRUCTION OF CHIMNEYS.

The Syndical Chambers of Paris, each chamber representing a trade or group of trades, and the whole meeting at certain periods in general assembly and having its officers and a journal of proceedings both of the separate and the United Chambers, do excellent service, especially now that they have the ear of Government and are not regarded with suspicion, under the fear of their being political societies in disguise.

A short time since the Prefect of the Seine issued an order respecting the construction of chimneys in private buildings; the Chambers of Masons, considering that the regulations laid down by the authorities would at times create insurmountable difficulties, appointed a Commission to report upon the subject, which report has been received and adopted unanimously by the Council.

The following are the regulations proposed by the Chamber which cannot fail to have an interest for all engaged in construction :—

1. No chimney-shaft shall be formed in stone walls of less than forty centimètres (16 in.) thick, plaster included, or in brick walls of less than thirty-seven centimetres.

2. Chimney-shafts in the interior of walls shall only be constructed of bricks or of terracotta, which shall key into the materials of the wall itself. The use of the *boisseaux* or *pots* of burnt clay (short quadrangular tubes with a lip now in common use) is absolutely prohibited.

3. The tongues of the pipes engaged in the brickwork of the chimney shall never be less than eight centimètres in length.

4. Between the interior surface of the chimney-shaft, and that of any bays formed in the wall, there shall always be twenty-five centimètres of solid masonry, plastering included.

5. Chimneys built against piers in masonry, walls in ashlar work being at least forty centimètres in thickness, brick walls of at least twenty-two centimètres in thickness, or, in garrets against brick partitions, of eleven centimètres in thickness, may alone be constructed by means of tongue-pieces in plaster, or with burnt clay *boisseaux*, covered with plaster.

6. The tongue-pieces, or the *boisseaux*, covered with plaster, above referred to, shall never be less than 65 millimetres, $2\frac{1}{2}$ in., in thickness, over all.

7. Isolated chimney-shafts, or group of such shafts, must be constructed in the same manner and of the same materials as shafts, constructed within walls.

8. Every chimney-shaft ought to have a section equal to three square décimètres, or three-tenths of a metre. The smallest side of such rectangular shafts not to measure less interiorly than 15 centimetres (6 in.), and the angles to be rounded off with a radius of 2 in.

9. In every new building the necessary arrangements must be made in the roof to afford easy access to the top of the walls against which chimney-shafts are constructed, and, when the chimneys are engaged within the walls, way shall be made near the chimney-shafts themselves, so that the mouths of the chimneys shall be accessible without difficulty.

THE PRACTICAL MAN.

He sat beside us in a street car. He looked over our shoulder at the new copy of the *Scientific American*, which, fresh from the press, was receiving our final scrutiny, and requested the load of the paper for a moment when we had finished. He glanced at the first page, skimmed over the middle, and peeped into the inside.

"I suppose that the paper interests a great many people," he remarked.

We modestly signified our assent, and murmured something about forty odd thousand.

"Wall, it doesn't me," he interrupted sharply. "It doesn't take no books or paper to learn me my business, you know. Never learned nuthin from books in my life. Didn't have but a quarter's schoolin, and then I went into the shop. Served my time with old Pete Reynolds, of Boston. You know'd him, mebbe; dead now. Was his foreman; now I'm boss of my own works in the city. I'm a practical man, I am. All yer hollergeys and hossorphys may do well enough to write about; but they ain't no sort'er use in the shop. They just git intermen's heads, and set'em a thinkin about other things than their work, and then they git inventin', and that's the last of 'em. Why, I had a likely young feller, who used ter buy that paper and read on it, dinner hour. Sometimes he'd stick it up on his lathe, until I stopped that, mighty suden. Wall, one day I caught him scribblin' with a piece of chalk on a bit of board, then I know'd the invention fit had got hold of him, and that he was a goner. A few weeks after he comes to the office, and says he, 'Boss, I've got a little arrangement here that'll make the old lathe do better work,' and he out with one of them leg'lar printed paytents, and showed me a new attachment for making gearings, and sich. 'Wall,' says I, to humour him, like, 'sonny,' says I, 'you can go make yer masheen and set it up on the lathe, if yer want r. But the ungrateful villin began to say something about royalty and shop rights, and I told the book-keeper to pay him right off and let him clear out. Bow me if he did'nt go over to Smith's acrost the street, and rig his affair there, and the first thing I know'd, Smith was turnin' out work at half my prices. Then I had to go find that feller, and pay him his blamed royalty, and a heap it was too.

"Now, there was a good hand just spiled by a-readin', if he'd a let that ere paper of you'rn alone, he might ha been a good, steddy man, gittin' his three dollars a day comfortable and reg'lar. Now they say he's makin stamps by thousands, but he's spiled. Wont be worth nuthin ever for work agin. Where'ud I have been if I'd pegged away at books and noozepapers—eh ?"

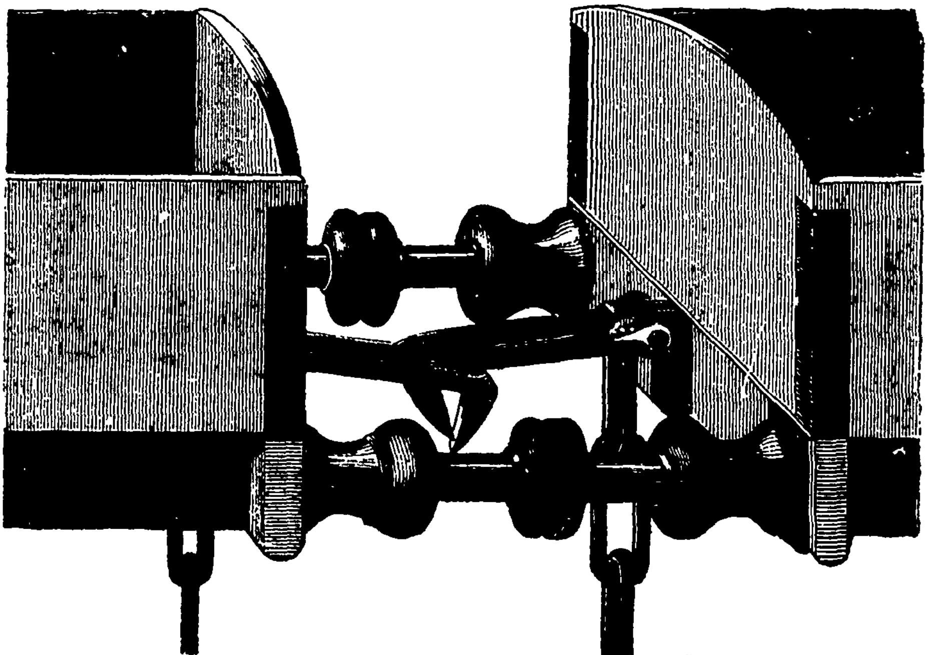
Our practical friend did not wait for an answer, for while we were cogitating a suitable response, he suddenly made a bolt out of the car and rushed down a side street toward a dilapidated looking edifice, which, we conjectured, was none other than the "works.

"We want no theorist, we require a practical man." "Where can I find a practical man to take hold of my invention and push it?" How frequently we have heard these remarks! And how often, when we have turned to the speaker and asked for a definition of the term practical man, has a puzzled expression and a lame attempt at explanation, usually ending with "Oh, I know what I mean," been the sole reply!

Our street car friend is one type of the practical man. He is of the "self-styled" variety the most numerous, probably, existing. He is the least useful as an individual, the least progressive as a brain worker, and the least enlightened as a member of the human race, of any class of civilized mankind. He is a compendium of thumb rules, an epitome of set ideas encircled by the iron barriers of his own mind, which allow of neither the substitution nor admission of better views, nor the expansion of those within. At mere handicraft, he may be skilled, but ask him for a reason, and he is a dumb. He it is who leads the van of the shriekers against free and liberal education, who clings to that sophism which argues that the "world is the best teacher," who turns his son directly from the nursery into the shop, who renounces the inventor and all his works, until compelled, by absolute force of circumstances, to yield to progress, and finally, who, having no knowledge other than his manual skill and set of thumb rules, scorns it in others.

"But we want no longhaired philosophers to run our shops," possibly thinks the reader. True, nor need we have them. "Science," says Lord Brougham in his fine definition of the team, "is knowledge reduced to system." The true scientist is he who not only possesses this systematic knowledge, but, if he be so situated as to require its immediate aid, knows how to put it in practice. He is neither the sage who meditates erudite abstractions, nor the *soi-disant* "practical man" who devotes himself to mere system. He is eminently the man of practice, but of intelligent practice, who is a master of principles, of reasons : to whom the mere application of a truth is nothing as compared with the truth itself : the latter immutable, the former an idea to be changed as occasion may require or judgment suggest. Such is the person we mean when we seek the "practical man," not the blatant individual who thrusts himself forward under that title.

Our acquaintance of the street car carried off our paper. He honestly mailed it back to us the other day. We smiled as we saw the thumb marks on all the pages, and opposite an engraving there was a pencil note of: "I kno a better plan than this.' Perhaps after all a latent idea in his brain has been aroused, or has he taken the invention fit? Should he see this, he will probably scout the idea that our humble efforts have awakened him, for "it doesn't take no papers to learn me my business, you know."—*Scientific American.*



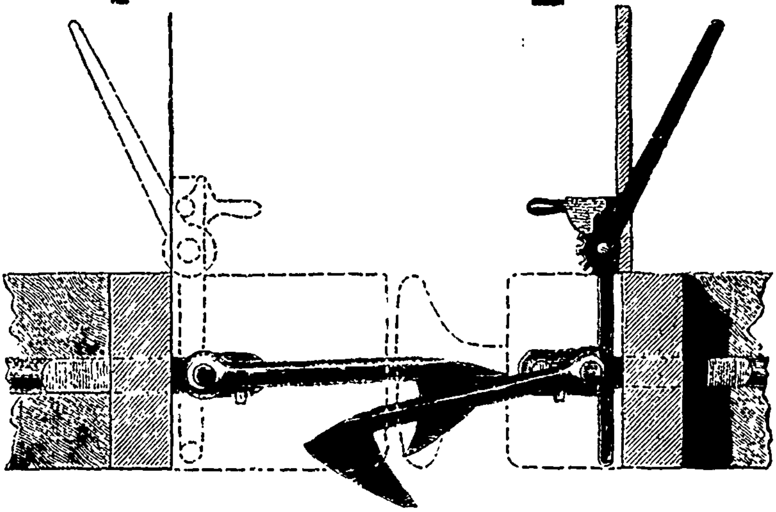


Fig. 2.

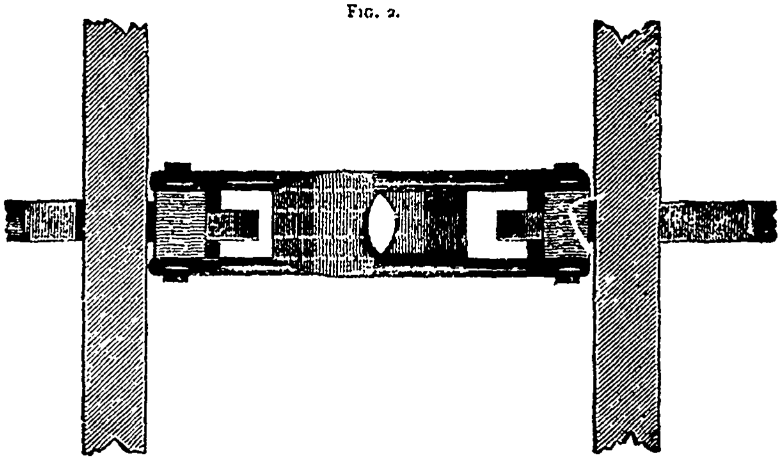


Fig. 3.

RECIPROCITY COUPLINGS FOR RAILWAY CARRIAGES.