ing of the center shaft, *D*. From the annular trough the water flows through a number of vertical pipes, *N*, into the collecting basin, *M*, from which it is conducted by an outflow pipe.

The great capacity of this machine, both for cooling and humidifying, is due to the large amount of evaporating surface provided in the nest of cylinders, combined with the large volume of air which is drawn through the cylinders by the fan. The air, with its temperature raised or lowered and its humidity increased or decreased, passes out into the room through the annular opening between the cylinder and the collecting basin, as indicated by the arrow.

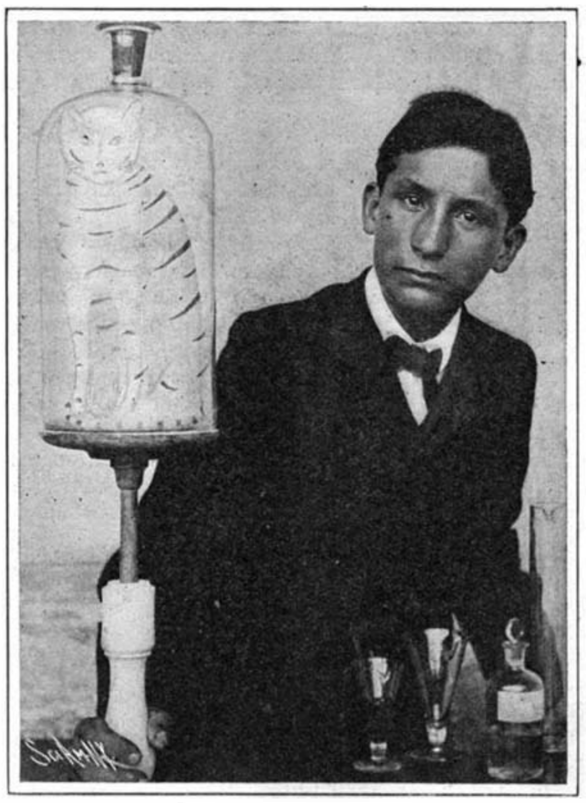
The accompanying table gives the results of an hour and fifteen minutes' test conducted for a representative of this paper, with the 24-inch machine, which forms the subject of one of the engravings. The test was conducted in a machine shop containing 105,000 cubic feet of air. The generator is suspended from the roof by rods, which pass through the base. The fan is driven by a motor which will be seen mounted upon the base, from the bottom of which will be seen the water discharge pipe, which leads down to connect with one or other of two adjoining water tanks. Connecting with each of the tanks is a series of feed pipes, provided with the necessary valves, etc., and leading to a three-throw circulating pump, which will be seen adjoining the tanks. The connections are so arranged that the water may be drawn from one tank, forced over the cooling surfaces of the machine, and discharged into the other tank, or *vice versa*. There are also steam pipe connections, by which the water in the tanks may be raised to the desired degree of temperature.

TEST OF 24-INCH AIR REGENERATOR.

Time.	Thermometer in Room.		Relative Humidity	Water.		Air Delivered by Machine.		
	Dry.	Wet.		Feed.	Return.	Dry.	Wet.	Relative Humidity
	Deg.	Deg.	Per Cent.	Deg.	Deg.	Deg.	Deg.	Per Cent.
12.25	78	67	57	105	93	87	82	80
12.40	79	72	72	110	96	87	82	80
1.10	81	75	75	110	96	88	85	88
1.10	81	75	75	67	96	88	85	88
1.25	81	74	72	71	72	77	72	78
1.40	81	73	68	71	72	76	70	74

Although the air regenerator is designed primarily for cooling the air and reducing humidity, its range of application is much wider than its name would indicate. It is capable not only of decreasing the humidity and lowering the temperature in a room, but, if desired, as in the case of a room in a textile factory, it can increase the humidity and raise the temperature. Furthermore, it can be used to increase or decrease the humidity while maintaining the temperature the same. The method of securing these results is as follows: When it is predetermined to increase the humidity and raise the temperature, the water in the feed tank is heated by steam to a certain desired temperature. This hot water is fed to the machine and distributed over the evaporating surface, where its heat and vapor are imparted to the air, as the latter is drawn through. Conversely, when it is desired to decrease the humidity of a room and lower the temperature, the flow of water is reversed, the cold tank being used as the feed and the hot tank as the return. The resultant effect upon the air is that its moisture is condensed on the cold water which is flowing over the plates, and its temperature lowered.

At the beginning of the test of one hour and fifteeen minutes, above referred to, the dry-bulb thermometer, placed about 50 feet distant from the machine, showed a temperature inside the room of 78 deg.; the relative humidity was 57 per cent; and the outside temperature was 81 deg. As the first half of the test was designed to increase the temperature and humidity, the feed water had been raised by means of a steam jet to 105 deg. The air was taken in from the outside of the building at a temperature of 81 deg., and drawn over the evaporating surfaces. The test started at 12:25, and forty-five minutes later the dry thermometer inside the room showed 81 deg., and the relative humidity had risen to 75 per cent. At 1:10 the operation of the machine was reversed, and the process of cooling and reduction of humidity commenced, the



A CHEMICAL TRICK.

feed water being passed into the machine at 67 deg., and the feed of air being drawn from the interior of the building. Half an hour later, the temperature inside was 81 deg., the relative humidity had fallen to 68 deg., the outside temperature at the time being 82 deg., and the relative humidity of the outside air being 74 per cent.

It should be mentioned in conclusion that inlet air ducts are provided in each regenerator, by which the air may be fed either directly from the atmosphere or taken from the upper strata of air in the room itself. The manipulation of these air dampers, the control of the temperature of the feed water, and the further control of the speed of the fan, render it possible to secure a very delicate regulation of the interior atmosphere of any room in which they are installed. Furthermore, the introduction of large volumes of pure air from the outside, its passage over running water where the dust is caught and removed, and its thorough circulation through the room or building, is in itself a potent safeguard to the health of the inmates.

The American Society of Civil Engineers has admitted a woman to membership in one of its lower grades.

A CHEMICAL TRICK.

BY GUSTAVE MICHAUD, D.SC.

When we happen to witness a phenomenon which seems to violate natural laws, we are not likely to forget its cause if it be explained to us. The following experiment, which I devised for my students, helped them to understand as well as to remember some chemical data.

A white cat, made of flexible pasteboard and imprisoned in a glass jar, is shown to the audience. The lecturer announces that, without opening the jar or even touching it, he will cause the cat to undergo a zoological as well as a chemical transformation. He takes the support of the jar, and pushes it forward in full view of the students. The change occurs almost instantaneously. The cat takes a rich orange color on which black transversal stripes rapidly paint themselves. The cat has become a tiger.

The whole transformation is produced by emanations of hydrogen sulphide, which is generated in the jar itself without any visible apparatus. The cat has been previously coated with a solution of chloride of antimony wherever the orange hue was to be produced, and with a solution of basic acetate of lead wherever the black stripes were to appear. Both solutions are colorless. After the coated cat has been introduced in his glass cage, a small piece of pasteboard is placed under the wooden support so as slightly to incline the jar forward. A few decigrammes of pulverized sulphide of iron folded in a piece of blotting paper are deposited behind the cat, on the elevated side of the bottom of the jar. Two or three cubic centimeters of diluted sulphuric acid are dropped with a pipette on the opposite side. When the performer wishes the transformation to take place, he takes the wooden support and pushes it forward as if he wanted to enable everybody to see better what is going to happen. By so doing he suppresses the slight inclination which kept the iron sulphide beyond the reach of the sulphuric acid. The gas is evolved, and the formation of the orange sulphide of antimony and black sulphide of lead takes place in a few seconds.

THE ART OF INVENTING.

BY EDWIN J. PRINDLE, OF THE NEW YORK BAR.

It seems to be popularly believed that the inventor must be born to his work, and that such people are born only occasionally. This is true, to a certain extent, but I am convinced there are many people who, without suspecting it, have latent inventive abilities, which could be put to work if they only knew how to go about it. The large percentage of inventors in this country compared with all other countries, shows that the inventive faculty is one which can be cultivated to some extent. The difference in ingenuity is not wholly a matter of race, for substantially the same blood exists in some other countries, but it is the encouragement of our patent laws that has stimulated the cultivation of this faculty.

The popular idea seems to be that an invention is produced by its inventor at a single effort of the imagination. It is, undoubtedly, true that every inventor must have some imagination or creative faculty, but, as I shall seek to show, this faculty may be greatly assisted by method. While reasoning does not constitute the whole of an inventive act, it can, so to speak, clear the way and render the inventive act easier of accomplishment.

In the making of all inventions which do not consist in the discovery of the adaptability of some means to an end not intentionally being sought after, the first step is the selection of a problem. The inventor should first make certain that the problem is based upon a real need. Much time and money is sometimes spent in an effort to invent something that is not really needed. What already exists is good enough or is so good that no additional cost or complication would justify anything better. The new invention might be objec-

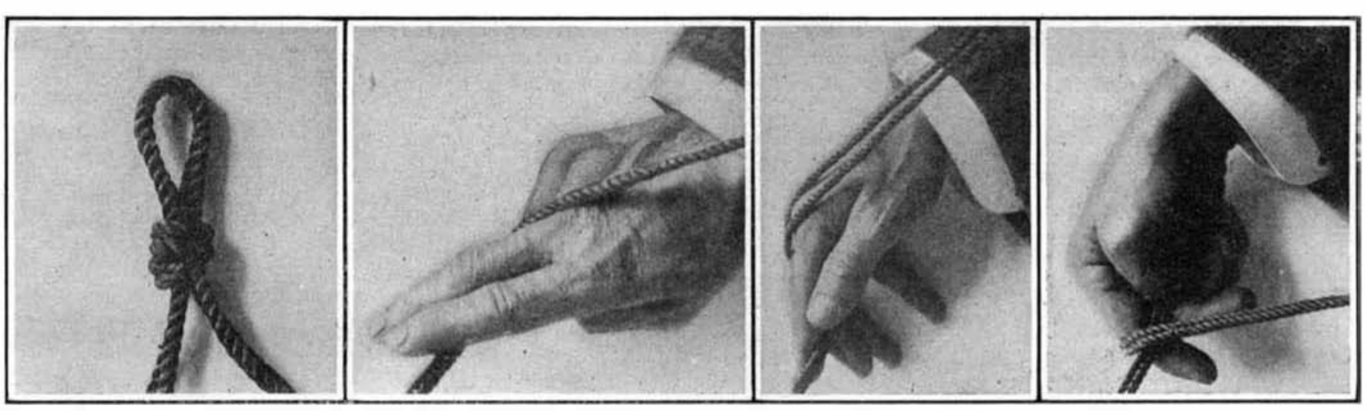


Fig. 1. Fig. 2. Fig. 3. Fig. 4.

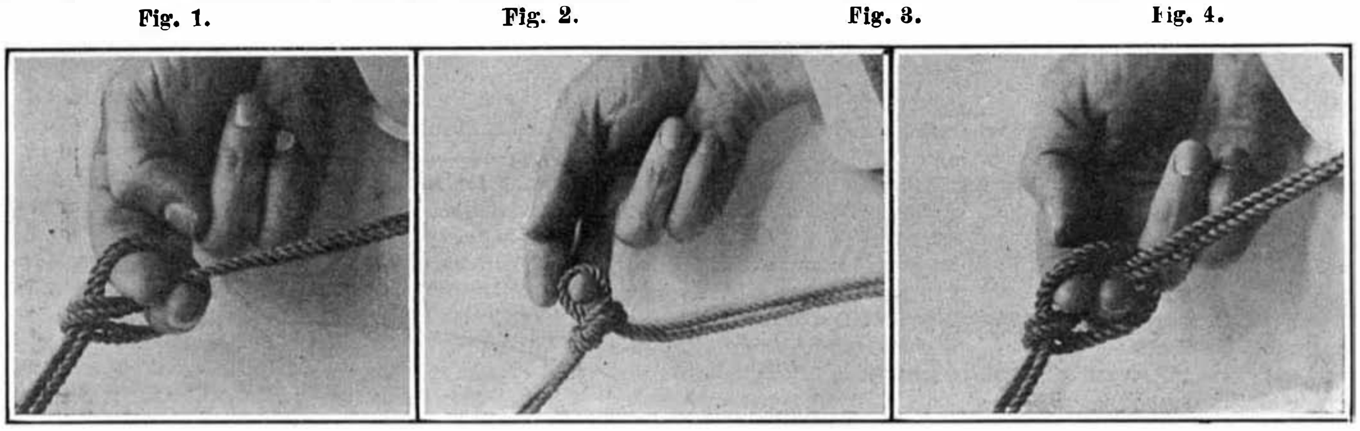


Fig. 5. Fig. 7. Fig. 6.

HOW THE CORD KNOTTER OF THE SELF-BINDING HARVESTER WAS INVENTED.

tionable because it would involve counter disadvantages more important than its own advantages, so that a really desirable object is the first thing to be sure of.

Having selected a problem, the next step should be a thorough analysis of the old situation, getting at the reasons for the faults which exist, and in fact discovering the presence of faults which are not obvious to others, because of the tendency to believe that whatever is, is right.

Then the qualities of the material, and the laws of action under which one must operate should be exhaustively considered. It should be considered whether these laws are really or only apparently inflexible. It should be carefully considered whether further improvement is possible in the same direction, and such consideration will often suggest the direction in which further improvement must go, if a change of direction is necessary. Sometimes the only possible improvement is in an opposite direction. A glance at the accounts of how James Watt invented the condensing steam-engine will show what a large part profound study of the old engine and of the laws of steam played in his invention, and how strongly they suggested the directions of the solutions of his difficulties.

We now come to the constructive part of inventing, in order to illustrate which, I will seek to explain how several inventions were, or could have been, produced.

The way in which the first automatic steam engine was produced was undoubtedly this—and it shows how comparatively easily a really great invention may sometimes be made. It was the duty of Humphrey Potter, a boy, to turn a stop-cock to let the steam into the cylinder and one to let in water to condense it at certain periods of each stroke of the engine, and if this were not done at the right time, the engine would stop. He noticed that these movements of the stop-cock handles took place in unison with the movements of certain portions of the beam of the engine. He simply connected the valve handles with the proper portions of the beam by strings, and the engine became automatic—a most eventful result.

A most interesting example of the evolution of an invention is that of the cord-knotter of the self-binding harvester. The problem here was to devise a mechanism which would take the place of the human hands in tying a knot in a cord whose ends had mechanically been brought together around a bundle of grain.

The first step was to select the knot which could be tied by the simplest motions. The knot which the inventor selected is that shown in Fig. 1, and is a form of bow-knot.

The problem was to find how this knot could be tied with the smallest number of fingers, making the smallest number of simple movements. As anyone would ordinarily tie even this simple knot, the movements would be so numerous and complex as to seem impossible of performance by mechanism. The inventor, by study of his problem, found that this knot could be tied by the use of only two fingers of one hand, and by very simple movements. The knot will best be understood by following the motions of these fingers in tying the knot. Using the first and second fingers of the right hand, they are first swept outward and backward in a circular path against the two strands of the cord to be tied, as shown in Fig. 2.

The fingers continue in their circular motion backward, so that the strands of the cord are wrapped around these fingers, as shown in Fig. 3.

Continuing their circular motion, the fingers approach the strands of the cord between the twisted portion and a part of the machine which holds the ends of the cord, and the fingers spread apart as shown in Fig. 4, so that they can pass over and grasp the strands thus approached, as shown in Fig. 5. The fingers then draw back through the loop which has been formed about them, the fingers holding the grasped portion of the strands, as shown in Fig. 6.

The knot is finished by the completion of the retracting movement of the fingers through the loop, thus forming the bow of the knot as shown in Fig. 7.

The inventor found that one finger could have a purely rotary movement, as if it were fixed on the arm and unable to move independently of the arm, and the movement being as if the arm rotated like a shaft, but the second finger must be further capable of moving toward and from the first finger to perform the opening movement of Fig. 4, and the closing movement of Fig. 5, by which it grasps the cord. The inventor accordingly, from his exhaustive analysis of his problem, and his invention or discovery of the proper finger motions, had further only to devise the very simple mechanical device illustrated in Fig. 8 to replace his fingers.

The index finger of the hand is represented by the finger *S*, which is integral with the shaft *V*. The second finger of the hand is represented by the finger, *U*, which is pivoted to the first finger by the pin, *s*. The grasping movement of the finger, *U*, is accomplished by a spring, *V'*, bearing on the shank, *U'*, and its opening movement is caused by the travel of an anti-friction roll, *U''*, on the rear end of the pivoted finger, over a cam, *V''*, on the bearing of the shaft. The shaft is rotated by the turning of a bevel pinion, *W*, on the shaft through the action of an intermittent gear. The necessity of drawing the fingers backward to accomplish the movement between Figs. 5 and 7 was avoided by causing the tied bundle to have a motion away from the fingers as it is expelled from the machine, the relative motion between the fingers and the knot being the same as if the fingers drew back.

Thus the accomplishment of a seemingly almost impossible function was rendered mechanically simple by an evolution from the human hand, after an exhaustive and ingenious analysis of the conditions involved.

It will be seen from the example I have given that the constructive part of inventing consists of evolution, and it is the association of previously known elements in new relations (using the term elements in its broadest sense). The results of such new association may, themselves, be treated as elements of the next stage of development, but in the last analysis nothing is invented or created absolutely out of nothing.

It must also be apparent, that pure reason and method, while not taking the place of the inventive faculty, can clear the way for the exercise of that faculty and very greatly reduce the demands upon it.

Where it is desired to make a broadly new invention on fundamentally different lines from those before—

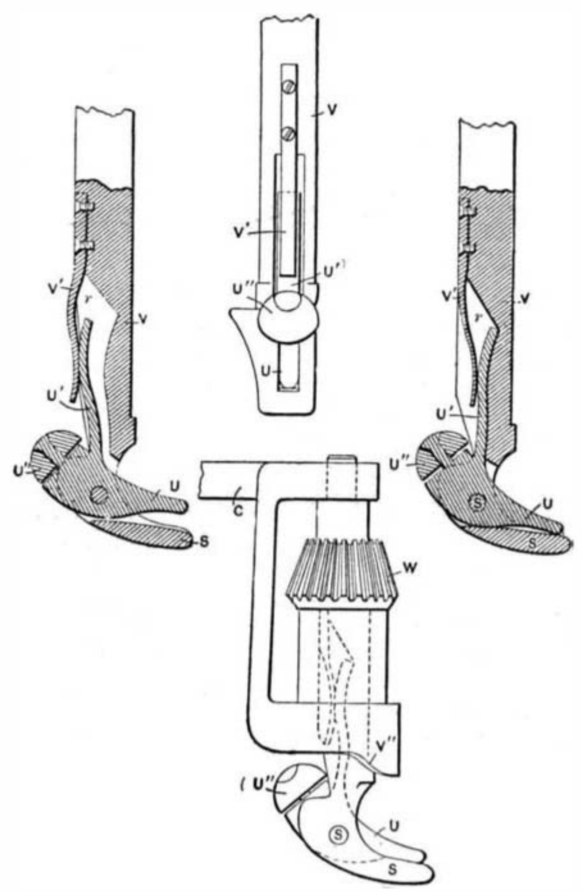


Fig. 8.

THE MECHANICAL FINGERS OF THE CORD KNOTTER.

having first studied the art to find the results needed, the qualities of the material or other absolutely controlling conditions should be exhaustively considered; but at the time of making the inventive effort, the details should be dismissed from the mind of how results already obtained in the art were gotten. One should endeavor to conceive how he would accomplish the desired result if he were attempting the problem before any one else had ever solved it. In other words, he should endeavor to provide himself with the idea elements on which the imagination will operate, but to dismiss from his mind as much as possible the old ways in which these elements have been associated, and thus leave his imagination free to associate them in original and, as to be hoped, better relations than before. He should invent all the means he can possibly invent to accomplish the desired result, and should then, before experimenting, go to the art to see whether or not these means have before been invented. He would probably find that some of the elements, at least, have been better worked out than he has worked them out. Of course, mechanical dictionaries, and other sources of mechanical elements and movements will be found useful in arriving at means for accomplishing certain of the motions, if the invention be a machine. Many important inventions have been made by persons whose occupation is wholly disconnected with the art in which they are inventing, because their minds were not prejudiced by what had already been done. While such an effort is likely to possess more originality than that on the part of a person in the art, there is, of course, less probability of its being thoroughly practical. The mind well stored with the old ways of solving the problem will be less likely to repeat any of the mistakes of the earlier inventors, but it will also not be as apt to strike out on distinctly original lines. It is so full, already, of the old forms of association of the elements as to be less likely to think of associating them in broadly new relations.

Nothing should be considered impossible until it has been conclusively worked out or tried by experiments which leave no room for doubt. It is no sufficient reason for believing a thing won't work because immemorial tradition, or those skilled in the art, say it will not work.

In inventing a machine to operate upon any given material, the logical way is to work from the tool to the power. The tool or tools should first be invented, and the motions determined which are to be given to them. The proper gearing or parts to produce from the power each motion for each tool should then be invented. It should then be considered if parts of each train of gearing cannot be combined, so as to make one part do the work of a part in each train; in short, to reduce the machine to its lowest terms. Occasionally a mechanism will be invented which is exceedingly ingenious, but which it is afterward seen how to simplify, greatly at the expense of its apparent ingenuity. This simplification will be at the sacrifice of the pride of the inventor, but such considerations as cheapness, durability, and certainty of action leave no choice in the matter. It will sometimes be found that a single part can be made to actuate several parts, by the interposition of elements which reverse the motion taken from such part, or which take only a component of the motion of such part, or the resultant of the motion of such part and some other part. Where a machine involves the conjoint action of several forces, it can be more thoroughly studied, if it is found there are positions of the machine in which one force or motion only is in operation, the effect of the others in such position being eliminated, and thus the elements making up the resultant effect can be intelligently controlled.

The drawing board can be made a great source of economy in producing inventions. If the three principal views of all the essentially different positions of the parts of a machine are drawn, it will often be found that defects will be brought to light which would not otherwise have been observed until the machine was put into the metal.

It is desirable to see the whole invention clearly in the mind before beginning to draw, but if that cannot be done, it is often of great assistance to draw what can be seen, and the clearer perception given by the study of the parts already drawn, assists the mind in the conception of the remaining parts.—Abstract of a paper read before the American Institute of Electrical Engineers.

Start of the Wellman Polar Airship Expedition from Paris.

On Friday, the 15th instant, Walter Wellman, the intrepid explorer who is about to attempt the 1,200-mile journey from Tromsoe, Norway, to the North Pole and back in the largest dirigible balloon that has ever been built, started from Paris. A special freight train was employed to transport the airship, its appurtenances, and supplies to Norway. Mr. Wellman will be accompanied on his journey of exploration by an appointee of the United States Weather Bureau, an expert aeronaut, and a mechanic. Notwithstanding that a recent test of the two motors of the airship is said to have shown the development of 100 horsepower as against the 75 contracted for, Wellman expressed himself as much better satisfied with the balloon part of his airship than with its mechanical features. He expects to get the latter perfected, however, and to make a number of trial tests before starting on the actual journey about the first of August. In case of an accident to the airship, the explorers expect to make their way back over the ice on sledges drawn by the motor ski-supported bicycle illustrated in our last issue.

The principal producing centers of coke in Germany are on the Ruhr, on the Sorre, at Aix-la-Chapelle, in Silesia, in the environs of Obernkirchen, and near Zwickau in Saxony. The basin of the Ruhr produces, according to the German statistics, about 65,000,000 tons of coal and about 11,000,000 tons of coke annually. This is the firmest of the German cokes and the most valuable with reference to its chemical constitution. The following figures are compiled from late sources and show that Germany is at the head of the European countries in this branch of industry, and is second only to the United States:

Germany, 14,004 tons; Great Britain, 10,000; Belgium, 2,048; Russia, 2,000; France, 1,850; Austria-Hungary, 1,300; Spain, 405; Sweden, 60; Denmark, 19; Italy, 18. Total for Europe, 31,704 tons.

United States, 23,039 (this figure is not the latest return, but will answer for comparison); Canada, 342; Japan, 70; Australia, 127; add Europe, 31,704. Total for the entire world, 55,282 tons.—Revue des Eclairages.

A ONE-HUNDRED-TON DERRICK CRANE FOR FITTING OUT VESSELS.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

An interesting electric crane of the derrick type is now in operation at the Greenock dockyards of the Scott Shipbuilding and Engineering Company, on the River Clyde, for facilitating and expediting fitting-out operations on large vessels. The crane has been designed and constructed by Messrs. George Russell & Co., of Motherwell near Glasgow, to whose courtesy we are indebted for the accompanying illustration. The crane is erected on the west bank of a new fitting-out basin that has recently been completed. Owing to the design of the crane, it has been possible to place its center extremely close to the edge of the quay wall.

As will be observed from the illustration, the crane itself is carried on three masonry pedestals or piers, the advantage accruing from which is that it is possible to get clearance for the sides of vessels. The piers supporting the center mast and diagonal legs are continued to a height of twenty-five feet above the level of the quay. The piers are built upon concrete foundations of a great depth. In the case of the pedestal carrying the vertical mast of the crane, the center of the pier is only seven feet from the edge of the quay. This enables the crane to deal with its maximum load of one hundred tons at an effective reach of sixty-three feet from the edge of the quay.

The mast of the crane is built up of steel plates and angles well braced together, and connected at the bottom by a massive steel box girder, which transmits the vertical pressure to the center pin. This vertical pressure is distributed over the surface of the concrete by a large base, which insures the imposition of a small pressure on each square foot of concrete. At the top of the mast is a heavy forged steel post, in which the upper end of the mast terminates, and to which also the diagonal legs are fixed by means of trunnion rings. To overcome the liability of bending stresses upon the diagonal stays, the connecting arrangement at this upper end is such that the center line of each diagonal intersects the center line of the mast. To the concrete base is bolted a heavy steel plate, which carries the cast-steel slewing rim of the crane, and also a cast-steel socket in which the center pin is fitted.

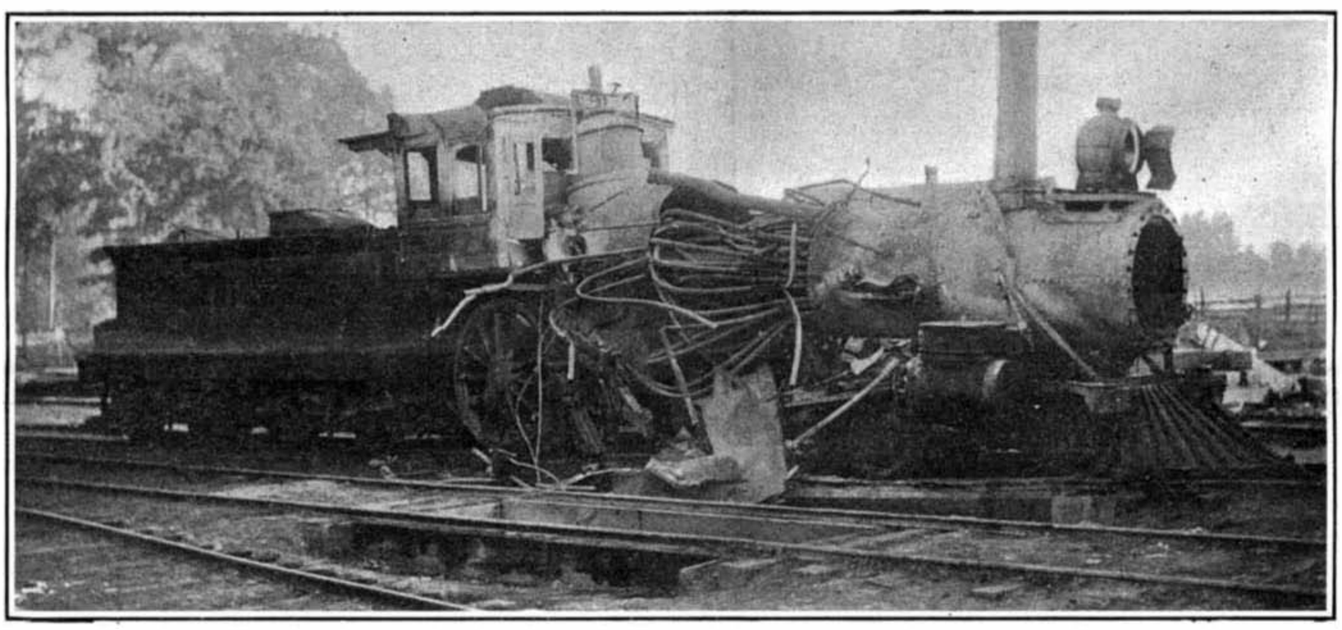
The tapered diagonal legs are connected at their bases with the central pier by horizontal stays built of steel plate and angles. In order to resist any compressive strains to which they might be subjected, they are stiffened by a lattice construction. The diagonal legs rise at an angle of forty-five degrees, while the base horizontal girders similarly form an angle of forty-five degrees with the edge of the wharf in the ground plan, thereby leaving ample space on either side of the crane for the accommodation of material. The railroad tracks are laid parallel with the edge of the wharf.

The electrical equipment comprises four motors and gearing. For derricking the jib, there is one motor of fifty horse-power running at 290 revolutions per minute; one of similar horse-power for the main purchase hoisting, and two of thirty-five brake horse-power for light purchase hoisting and slewing respectively, representing an aggregate of 170 brake horse-power. Each motor and its attendant gearing are independent, and all are controlled from a cabin carried on the side of the mast at a height of fifty-six feet above the level of the quay, so that the operator has a clear and uninterrupted view of the whole field of operations. The equipment in the cabin comprises the main switchboard and four controllers, as well as the hand wheels for applying the auxiliary braking arrangements. Each motion is fitted with automatic electric brakes, and for the hoisting and derricking gears powerful hand brakes are provided. All the main spur wheels are of cast steel, while the smaller wheels and pinions have machine-cut teeth. In the cases of the slewing and derricking gearing the worm-wheels are of gun metal, with the worms of forged steel. The main barrels for hoisting and derricking are of seven foot diameter, right and left screw grooved in the lathe. The design of these barrels constitutes an important feature, since the spur gears are placed in the center of the barrels, with the two sections of the barrel on either side grooved right and left hand, so that the ropes can coil on both ends simultaneously, thereby dividing the stresses equally between the two sides of the mast. Four hundred feet of cable can be wound on each section.

In order to clear the gunwales of a vessel when the crane is working at its maximum radius of seventy feet, there is allowed a clear height of thirty-five feet between the edge of the wharf and the under side of the jib. The main hoisting block has a vertical range of one hundred feet, and the load is carried on eight parts of rope, thereby giving a duplicate quadruple purchase. The load-carrying device is ingenious. There is a cylinder containing oil on which the load is carried, and the latter is able to revolve with very little resistance by means of a lifting ring with a piston at its upper end. In order to overcome oil leaking from the cylinder, which is made of steel, there is a gun-metal liner three-eighths inch in thickness.

The crane has been tested to one hundred and twenty tons with complete success, though the maximum working load is one hundred tons at any radius between a maximum of seventy feet and twenty-five feet, at a lifting speed of five feet per minute. Ninety tons can be raised at seventy-five-foot, eighty tons at eighty-foot, seventy tons at eighty-five-foot, and sixty tons at ninety-foot radii. With loads from ten to fifty tons the lifting speed is ten feet per minute, and for loads less than ten tons, forty feet per minute. With the independent light purchase gear a weight of ten tons can be lifted at any radius up to one hundred feet. The slewing speed with the full load of one hundred tons is one hundred feet per minute.

With this appliance the operations of fitting out a vessel can be expeditiously carried out. The radius of the crane enables the whole beam of the ship to be commanded; and for lifting and lowering into position the heavier sections of the vessel's machinery installations, it has proved to be especially advantageous.



Forward Driving Wheel Blown Away; Bar Frame Broken; and One Section of Barrel Entirely Destroyed.

DISRUPTIVE FORCE OF A LOCOMOTIVE BOILER EXPLOSION.

The Current Supplement.

The current SUPPLEMENT, No. 1590, is opened with an illustrated article on the rotary converter sub-stations of the Long Island Railroad. A very practical article is that on Tinning. Mr. J. E. Thornycroft concludes his articles on gas-engines for ship propulsion. The second installment on "Canals, Ancient and Modern," is published. Mr. Nelson P. Hulst concludes his treatise on the Metals in Human Progress. Some statistics are published on the foreign commerce of the United States. Mr. Robert Grimshaw writes instructively on Gypsum, a much-misunderstood material. Some devices for determining the energy losses in sheets of iron are described by Dr. Alfred Gradenwitz. Perhaps the most important paper in the current SUPPLEMENT is that by Marconi on the control of the direction of electric waves. The paper relates to results observed when, for the usual vertical antenna employed as receiver or absorber in a wireless telegraph station, there is substituted a straight, horizontal conductor placed at a comparatively small distance above the surface of the ground or water. Major Ormond M. Lissak's paper on Primers and Fuzes for Cannon is concluded. The preliminary report of the State Earthquake Investigation Commission is presented.

Since 1898 there have been completed for the French navy thirteen armored cruisers, which may be divided into five types: Three units of 7,700 tons, three of 9,500 tons, five of 10,000 tons, one of 11,300 tons, and one of 12,500 tons. In addition to these, there are under construction three additional cruisers of 12,500 tons, and three of 13,600 tons.

A LOCOMOTIVE BOILER EXPLOSION.

It is seldom surely that the ubiquitous camera has recorded a more picturesque view of an exploded locomotive boiler than that shown in the accompanying illustration. The accident happened at the town of Daleville, Ark., on a road known as the Ultima Thule, Arkadelphia and Mississippi Railroad. The engine had been in the shop undergoing repairs, which had just been completed. After washing out the boiler, sufficient steam was raised to run the engine out of the shop and over the cinder pit, where the explosion occurred. The injectors on both sides had just been tested and found in good condition, and by the use of the blower the steam had been raised to the desired pressure of about 145 pounds to the square inch, when the boiler gave way. We are indebted for the photograph to Mr. A. A. Peters, master mechanic of the A. S. W. R. R., of Gurdon, Ark., who informs us that it was impossible to determine the age of the boiler, the name and number plate both having been removed. It was built of $\frac{3}{8}$-inch iron, and the seam on the bottom of the barrel was reinforced with an additional $\frac{3}{8}$-inch sheet, making with the covering strip a total thickness of $1\frac{1}{8}$ inches. The explosion tore the sheet off through the line of the rivet holes, tearing into the connection sheet near the firebox. The barrel was entirely carried away between the firebox and the front rings of the boiler. Twenty of the flues collapsed, and were split open as though they had been cut through with a chisel, for a length of from 10 to 24 inches. The front flue sheet was broken in pieces and the nozzle and front end were blown entirely away. At the time of the accident a man was oiling the driving box of the front right-hand driver. The explosion tore the frame apart at this point, blew this driving wheel off its axle and entirely away from the engine, and, of course, killed the oiler. Subsequently to the accident, Mr. Peters, who was called in to investigate, and, if possible, explain the explosion, took off the pop valve, tested it with water pressure, and found that it went off at 140 pounds. The engine had been carrying 145 to 150 pounds previous to its visit to the shops. One fact to be noted was that some time previously a new firebox had been put in the boiler, and there was a smaller number of flue holes in the firebox flue sheet than in the front flue sheet. These surplus holes were closed with pocket-flues, nearly all of which blew out of the sheet at the time of the explosion, and crashed into different places in the machine shop. Some idea of the enormous energy of the explosion is given by the fact that these pocket flues had been rolled into the flue sheet and beaded.

As to the cause of the disaster, we can only suggest that in putting on the reinforcing strip along the bottom seam of the barrel, fresh rivet holes may have been drilled intermediate of those already there, and the available sectional area along the seam so greatly reduced, that it was actually weaker rather than stronger for the third plate. The fact that the sheet parted, in spite of its total thickness of $1\frac{1}{8}$ inches, along the line of the rivet holes, would seem to suggest this as the cause of the disaster.

The Armament of the "Dreadnought."

As a result of prolonged trials and experiments by the British Admiralty, it has been decided that the main armament of the "Dreadnought," which is rapidly approaching completion, is to comprise ten of the new 12-inch Mark X wire-wound, breech-loading, quick-firing guns. The weapon is the most powerful that has yet been designed for naval purposes. It is 45 calibers and weighs 58 tons. The weight of the projectile is still, however, the same as in the former weapon, that is, 850 pounds, but its penetration is much greater, being through 51 inches of wrought iron at the muzzle, while its velocity is 2,900 foot-seconds. The powder charge will be 325 pounds of modified cordite. The firing capacity of this weapon is two rounds per minute. The "Dreadnought" will be ready for steam and gunnery trials in October, by which time construction will have occupied a little more than one year.