observed to follow the direction of the wind and proceed toward the center of the city. Some affirm that the propelling screw worked well, and others that its action was ineffective. The airship was seen to describe several great circles in the air, under the action of the lateral screws, but afterward went in a straight direction. The aeronauts had thrown out too much ballast, which caused the balloon to mount to a great height. This is no doubt the main cause of the catastrophe. About fifteen minutes after the start a flame was seen to shoot out from the balloon, followed by a white smoke; then came a loud detonation, and the airship was enveloped in flames and burned rapidly. The framework shot down with one end foremost. The great mass fell across the Avenue du Maine, the rear screw breaking in the roof of a small house. The rear part, occupied by M. Severo, fell first. The spectators affirmed that the aeronaut was still alive when he reached the ground; his body was terribly mangled and he expired almost instantly. His aid, M. Saché, who was at the other end of the car, met his death in the air, and his body was half burned. After the bodies had been removed the government aeronauts, Col. Krebs and Commandant Renard, with a squad of 17 men, were occupied in clearing away the debris. The engraving gives an idea of the appearance of the wreck as it lay across the avenue, presenting an inextricable mass of broken poles, steel shafting and wires bent and entangled, and the half-burned remains of the envelope.

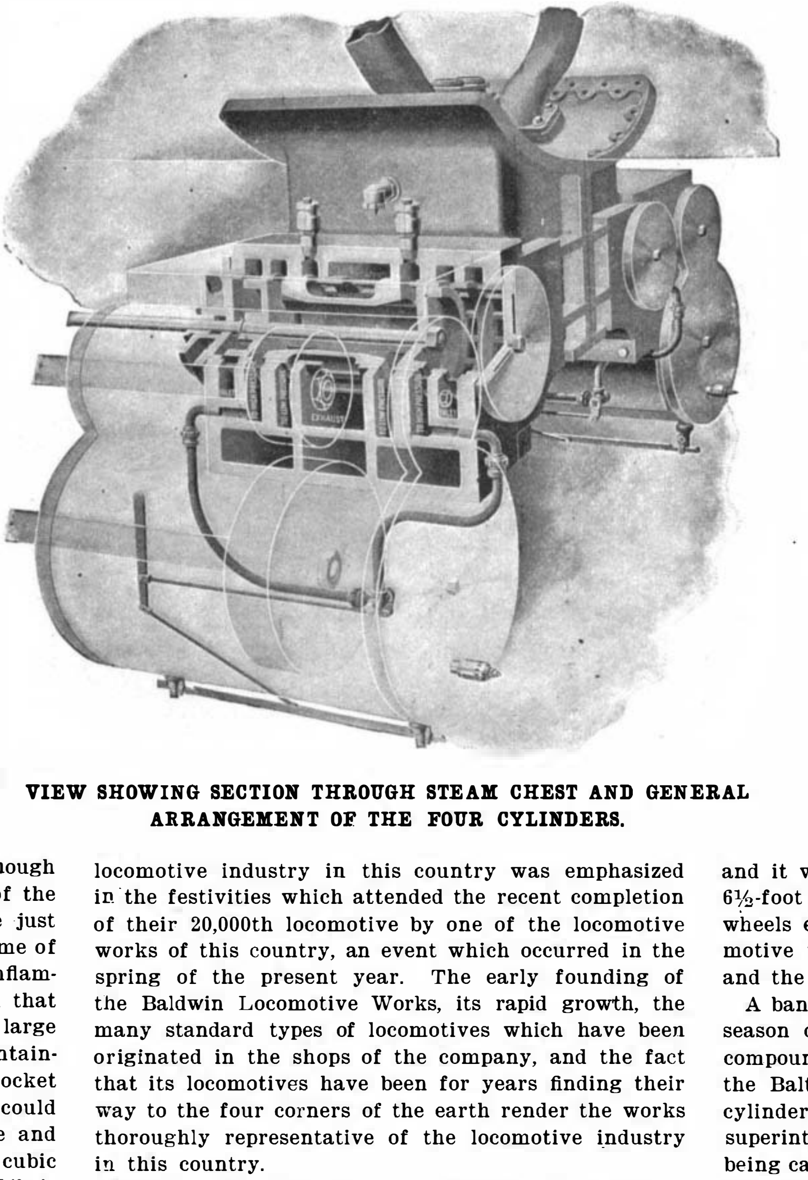
There is a diversity of opinion as to the exact cause of the catastrophe, but all are in accord that the main reasons lie in the balloon's rising too high, with a consequent dilatation of the envelope and escape of gas, and in the proximity of the great inflammable mass of the balloon to the motors and rapidly revolving shafting. It is not certain whence came the flame that ignited the hydrogen. The motor, which is badly burned, may have inflamed the gas or may itself have been burned by the flaming mass. The igniter is almost melted and the carbureter is considerably wrecked, also the gasoline reservoir, which contained seven gallons. There may have been an explosion of gasoline, but this could have been produced either before that of the hydrogen or after the latter had been inflamed. The exhaust pipe of the motor, which must have been brought to a red heat, could have been heated by the gasoline or by the burning hydrogen. Some think that the hydrogen was ignited by the friction of the shafts or gears, which were numerous and ran very near the envelope in some places. The different inflammable materials burned so quickly that it is not easy to say which took fire first. The reason of the escape of the hydrogen is clear. Most of the aeronauts are in accord that M. Severo mounted too quickly. The balloon, which had just been filled with hydrogen in a cool place, soon became very much dilated on reaching such a height. The rays of the morning sun and the difference of atmospheric pressure caused by the elevation to 1,000 feet soon brought about a strong expansion of the hydrogen. The gas may have passed through the silk envelope by rapid endosmose, or its force might have been strong enough to burst the latter; or it may have forced one of the valves which hung at the end of a canvas tube just above the motor. There is no doubt that at the time of the explosion the car was in an atmosphere of inflammable gas, which was all the more dangerous in that it gave no odor to reveal its presence. The large central groove running along the balloon, and containing the upper end of the frame, formed a kind of pocket in which an explosive mixture of gas and air could collect. This would explain the almost complete and immediate destruction of the envelope of 80,000 cubic feet, which came down in a rain of carbonized débris all over the neighborhood.

Santos-Dumont, who is now in Paris, thinks that two explosions of the envelope were produced; the gas burst the envelope by its excess of pressure, and this was immediately followed by the explosion of the hydrogen, which came in contact with the motor. The aeronaut, lacking experience, threw out too much ballast, and the airship mounted very quickly and much higher than was necessary. The fluid dilated, and not finding a sufficient issue, burst the envelope. It will be remembered that the fall was preceded by a detonation, and to form a detonating mixture twelve parts of air are needed for one of gas. The balloon could not, therefore, have contained the explosive mixture at first, or it would not have risen. Santos-Dumont considers, therefore, that the motor was not the primary cause of the explosion. M. Girardot in a conversation with the inventor made several observations on the arrangement of the motor, and both he and Charron insisted that it be provided with escape boxes so that the exhaust gases would not pass out in free air.

M. Severo was born at Rio Grande do Norte in 1864, and his family is one of the wealthiest and most influential in Brazil. After passing his University studies, he devoted himself almost entirely to aerial navigation, as his ample fortune permitted. Besides, he occupied an important position in Brazil, having been elected deputy in 1893 and continuing in the Parliament up to the present. He commenced his experiments about ten years ago, and had some success with his first airship, the "Bartholomeu de Gusmao." The government desired him to build a second airship, and after the success of Santos-Dumont he again took up the matter. The mechanic Saché was one of the most intelligent and skilled employés of the Buchet motor firm, who detailed him to work with M. Severo. The present accident resembles that which took place a few years ago in Germany, resulting in the death of Dr. Woelfert and his aid Knabe. The airship was cigar-shaped and had an explosion motor.

BUILDING OF AMERICAN LOCOMOTIVES.—I.

It would be difficult to find a form of mechanical construction in America which bears more strongly the imprint of our national characteristics than the American locomotive. In its general appearance, constructive details, and unquestionable convenience of operation, it stands entirely distinct as a type among the hundred-and-one styles of locomotives that are manufactured in the shops of the world. This national individuality is seen even more strongly in the great industrial establishments in which our locomotives are made, where labor-saving machinery and carefully-thought-out methods of shop management have enabled us to build at a speed and price which cannot be approached by any other nation. The magnitude of the locomotive industry in this country was emphasized in the festivities which attended the recent completion of their 20,000th locomotive by one of the locomotive works of this country, an event which occurred in the spring of the present year. The early founding of the Baldwin Locomotive Works, its rapid growth, the many standard types of locomotives which have been originated in the shops of the company, and the fact that its locomotives have been for years finding their way to the four corners of the earth render the works thoroughly representative of the locomotive industry in this country.



VIEW SHOWING SECTION THROUGH STEAM CHEST AND GENERAL ARRANGEMENT OF THE FOUR CYLINDERS.

Mathias W. Baldwin, who founded the establishment, started in business as a jeweler in a small shop in Philadelphia in the year 1819. In 1830 the steam railroad was beginning to make its appearance and establishing itself in this country, and to gratify public interest the proprietor of a Philadelphia museum gave an order to Baldwin for the construction of a miniature locomotive for exhibition. In the spring of 1831 the work was completed and the toy was set in motion on a circular railroad track at the museum. The success of the model brought an order to Baldwin for a locomotive from the Philadelphia, Germantown & Norristown Railroad Company. Guided by his experience with the little model, and by some memoranda which he had taken of a locomotive recently imported from England by the Camden & Amboy Railroad Company, Baldwin completed the curious and historical locomotive known as "Old Ironsides," of which we give an illustration on our front page. The engine was tried November 23, 1832, and did duty on the Germantown road and, later, on other roads for a period of over twenty years. The "Ironsides" was a four-wheeled engine, modeled after the English pattern of those days, and it weighed in running order something over five tons. The cylinders were placed beneath the smokebox and connected to a pair of cranks on the rear axle, which was placed in front of the firebox. The driving wheels were 54 inches in diameter, and the front wheels 45 inches in diameter. The cylinders were 9½ inches in diameter by 18 inches stroke, and they were carried beneath the smokebox, as is done to-day with modern inside-connected engines. The wheels had cast-iron hubs, wooden spokes and rims, and wrought-iron tires. The frame was of wood. The boiler was 30 inches in diameter and contained seventy-two copper flues 1½ inches in diameter. The valve motion was given by a single loose eccentric to each cylinder, and the engine was reversed by changing the position of the eccentric on the axle by a lever operated from the firebox. The contract price was $3,000.

The second engine, built in 1834 for the Charleston & Hamburg Railroad Company, was a six-wheeled engine with a single pair of drivers, 4½ feet in diameter, carried behind the firebox, with a half-crank axle of Baldwin's design. The wood and iron wheels used on the "Ironsides" having proved faulty, the driving wheels in this case were cast in solid bell metal. The "Miller" had cylinders 10 inches in diameter by 16 inches stroke, and weighed in working order about 8 tons. The boiler was constructed with a high circular dome over the firebox, a form of construction which was consistently followed for many years afterward. The next engine, the "Lancaster," built in 1834, weighed about 8½ tons, and in that year five locomotives were completed. In the following year, the business having outgrown the works, a location was found on Broad and Hamilton Streets, the site of the present works, then in the suburbs of the city. From that time on the growth of the plant was rapid, fourteen engines being built in 1835 and forty in 1836. Without attempting to go into the details of the progress of the works, it is sufficient to state that several standard American types had their origin in the Baldwin shops, and of these, perhaps the most notable are the "Consolidation," the "Mogul" and the "Atlantic" types. The "Consolidation," from which the type of this name was named, was built in July, 1866, for the Lehigh Valley Railway. She was a remarkably powerful engine for that day, with cylinders 20 by 24; four pairs of drivers connected, and a Bissell pony truck equalized with the front drivers. The engine in working order weighed 90,000 pounds. The "Mogul" class took its rise from an engine built for the Louisville & Nashville Railroad in 1861. The "Mogul" had three pairs of drivers connected, and a swinging pony truck, which was later equalized with the forward drivers. The first "Atlantic" type of locomotive was built in 1895 for the Atlantic Coast Line, which was followed by engines of the same type for the Atlantic City trains of the Philadelphia & Reading Railroad. The 1,000th locomotive was built in 1861. The 5,000th locomotive, built in 1880, was designed for fast passenger service between Philadelphia and New York, and to run with a light train at a speed of 60 miles per hour; its cylinders were 18 by 24, and it was carried on a four-wheel truck, one pair of 6½-foot driving wheels, and a pair of 45-inch trailing wheels equalized with the drivers. The 10,000th locomotive was completed in 1889; the 15,000th in 1896; and the 20,000th in 1902.

A banner year in the history of these works was the season of 1889, when the first of the now celebrated compound locomotives was completed and placed on the Baltimore & Ohio Railroad. It was of the four-cylinder type designed by S. M. Vauclain, the general superintendent, a high and a low-pressure cylinder being carried on either side of the smokebox, the high-pressure above and the low-pressure below, although in some later engines the positions are, for convenience, reversed. The two pistons on either side are connected to a common crosshead, and each pair of cylinders is cast in one piece with the piston, steam-chest and one-half of the saddle. The arrangement is shown very clearly in the accompanying perspective view of the cylinders. The valve, which is double and hollow, controls the steam admission and exhaust of both cylinders. The exhaust steam on the high-pressure cylinder becomes the supply steam for the low-pressure cylinder; and as the steam for the high-pressure cylinder enters the steam-chest at both ends the valve is in practically perfect balance. A by-pass valve is provided to admit live steam to the low-pressure cylinder in starting.

In view of the fact that there is, even to-day, a rather widespread, although mistaken, idea among railroad men that the superiority of the compound to the single-expansion locomotive is doubtful, it is well to draw attention here to two facts: First, that the scientific tests which have been made in experimental engineering laboratories, such as those at Purdue

University and Columbia University, have shown that the compound locomotive is decidedly more economical than the single-expansion; and, second, that where the management, engineers and firemen of a railroad have taken hold of the compound with the determination to give it a perfectly fair trial, it has not proved more costly in repairs and has maintained what we might call its laboratorial reputation for economy. We quote from a paper on the performance of a four-cylinder Baldwin, compound locomotive, by Richard A. Smart, Assistant Professor of Experimental Engineering at Purdue University, in which he draws the following conclusions: First, that there was with an increase of speed an increase of horse power and economy up to 270 revolutions per minute; second, the indications were that the power would increase for speeds considerably above 270 revolutions per minute; third, the increase in economy with increase of speed was chiefly due to a decrease of cylinder condensation; fourth, the average steam consumption of the compound was much lower than the lowest consumption shown by the single-expansion engine; fifth, the saving in steam shown by the compound locomotive would result in a saving in coal of from 18 per cent to 33 per cent.

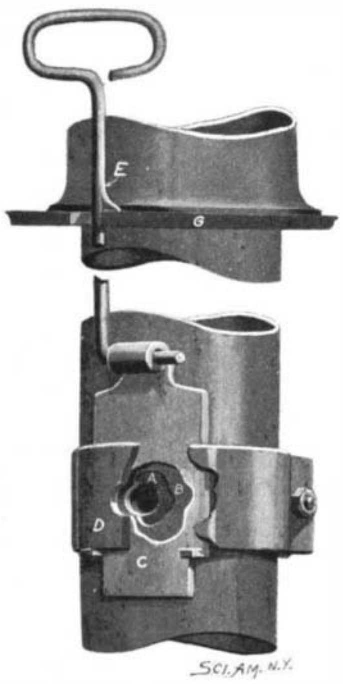
Perhaps the most celebrated locomotives turned out by these works are those which have been built to haul the extremely fast trains which are running between Camden, across the Delaware River from Philadelphia, and Atlantic City. These are of the celebrated "Atlantic" type in which the cylinders drive the rear pair of four-coupled drivers and the weight of the firebox is carried by a pair of trailers. Engine 1027 was built under guarantee to haul a train of eight cars (four coaches and four Pullmans) to Atlantic City, a distance of 55.5 miles, in sixty minutes; or to haul six cars over the same distance in fifty minutes, with a development of an estimated horse power of 1,400. In practice, however, this locomotive exceeded the guarantee by about 10 per cent. Another of the "Atlantic" type was built for the Chicago, Milwaukee & St. Paul Railroad, under contract to haul nine cars between Milwaukee and Chicago in one hour and forty-five minutes, with an estimated development of maximum horse power of 1,600. One of the latter engines exceeded the guarantee by four cars, hauling thirteen cars in the specified time, the train and locomotive together weighing 600 tons. Following on these excellent results the company proceeded to make accurate tests of 1027 to determine just what the locomotive was capable of. It was found that with an experimental train of twelve coaches the horse power increased directly with the speed until it reached 1,450 horse power at 70 miles an hour, and even at this speed the locomotive had a reserve of power to overcome grade resistance or to enable it to accelerate the train to a higher speed.

It is a well-known fact that at the higher speeds the single-expansion locomotive is subject to drawbacks in the shape of wire drawing of the steam, back pressure in the cylinders and overforcing of the fire, which are absent in the compound with its wider range of expansion and its milder exhaust. Careful tests have shown over and over again that there is about 25 per cent economy in a compound as compared with a single-expansion locomotive doing the same work. This is due to the less evaporation required to develop the necessary energy, together with the slower rate of combustion of fuel resulting from exhausting the steam at lower tension. Of course, it is understood that these results are only obtained, as we have before remarked, where the management and operatives of the road are in thorough sympathy with the compound, and are desirous of giving it every facility to show its best results.

The 20,000th locomotive, of which we present an illustration, is a further improvement in which it is sought to secure a more perfect balance of the reciprocating parts than is possible on the ordinary type. The high and low-pressure cylinders, instead of being arranged above one another in a vertical plane, are all carried in one horizontal plane, the high-pressure cylinders within the frames beneath the smokebox and the low-pressure cylinders on the outside of the frames. The low-pressure crossheads are connected with the main driving wheels by outside connecting rods as in ordinary practice. The main driving axle has two cranks, which are set at right angles to each other on each side of the center of the locomotive, and each crank is coupled to the crosshead of one of the high-pressure pistons. The crank on the axle and the crank-pin in the wheel for the corresponding high and low-pressure cylinders are set at an angle of 180 degrees, and the two axle cranks being set at 90 degrees results in the action of each high and low-pressure cylinder on one side of the locomotive quartering with the equivalent cylinders on the opposite side. As a consequence, an almost perfectly balanced engine is secured, and the amount of counterbalance required is reduced to a very low limit. The arrangement is the same as was used by Strong in his locomotive that attracted so much attention a dozen or more years ago, and it has lately been adopted with very good results on two or three of the English roads. Other special features of No. 20,000 are that it carries the Vanderbilt boiler and tender. In the former the firebox is cylindrical and corrugated, and in the tender the water tank is cylindrical, and the coal box is built at the front end of the tender and is, therefore, very conveniently placed for the fireman. The locomotive weighs in working order 176,510 pounds, of which 127,010 pounds are on the driving wheels. The weight of the tender loaded is 99,000 pounds. The driving wheels are 73 inches in diameter and the cylinders are 15 and 25 in diameter by 26 inches stroke. The boiler has a total heating surface of 2,793 square feet, of which 128 square feet are in the firebox.

VENT-CLOSING VALVE FOR PUMPS.

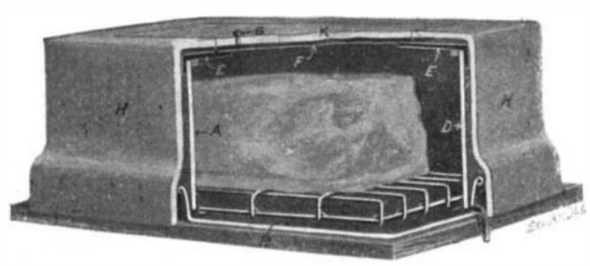
The device here illustrated is designed for use on pumps operated by windmills, and provides a means for closing the vent-hole of the supply-pipe of a pump whenever desired. It is well known that considerably more work is required to pump a given quantity of water when the vent-hole is open than when it is closed, thus prematurely wearing out the pump and windmill. With this device extra wear is entirely avoided, as the vent-hole may be readily closed whenever it is desired to use the pump. In our illustration the vent-hole may be seen at *A*. A metallic strip, *D*, encircles the pipe and is tightly clamped at the rear by a bolt. A portion of this strip directly in front of the vent-hole is off-set or struck-up from the surface of the supply-pipe to permit the insertion of a slide, *C*. To prevent leakage a packing of leather, *B*, is placed between this slide and the pipe, against which it is clamped. After the slide is inserted ears are turned up on its lower portion, and serve as stops to limit its upward movement. A rod passes through the upper end of the slide and serves as a handle to operate the device. This rod passes through a slot in the base, *G*, of the pump and is provided with a small detent or catch at *E*, which hooks over the pump base and serves to hold the slide in its highest position. When the slide is in this upper position the vent-hole is uncovered. If it be desired to close the opening, a forward pull of the handle-rod releases the slide, and it may be lowered to close the vent-hole. The valve, as has been shown, is of very simple construction and may be easily applied to any pump. Mr. J. E. Penner, of Kinbrae, Minn., has just received a patent for this device.



A SIMPLE DEVICE FOR PUMPS.

FOLDING ICE-BOX.

An article which should be of particular value for travelers and also for nurses who have charge of children has been recently invented by Mrs. J. B. Rogers, of Lakewood, New Jersey. The invention relates to an ice-box which may be folded up and packed away in a small space whenever desired. Our engraving shows the ice-box set up in position for use. Side leaves, *A*, and end leaves, *D*, are hinged to the bottom of a waterproof pan, *B*. A flanged top-piece, *E*, serves to hold the leaves in vertical position, their upper edges being wedged between the flanges and blocks on the under surface of the top, *E*. A lid, *F*, covers the opening in the top-piece to which it is hinged, and is provided with a knob, *G*, by which it may be raised. A jacket, *H*, of thick felt covers the ice-box and a flap, *K*, of the same material covers the lid, the felt serving to prevent the entrance of heat from external sources. A grid, *C*, placed in the bottom of the pan, *B*, serves to hold the ice and permit proper drainage of the same. The pan is provided with a drain-pipe to which a rubber hose is attached for drawing off the water. When desired, however, this rubber tube may be removed and the drain pipe closed by a cork or stopper.



A HANDY ICE BOX.

To fold the ice-box, the felt jacket is first removed, then the top, *E*, is taken off, the grid, *C*, lifted out, and the leaves, *A* and *D*, folded over. It will be noticed that the side leaves, *A*, are hinged at a higher point than the end leaves. The purpose of this is to permit the side leaves to fold over and lie flat on the end leaves. The grid is now placed on the folded leaves and is covered by the top-piece, *E*, thus forming a neat and compact parcel. When in position for use there is ample room in the box for bottles or other articles to be kept cool and it is therefore an accommodation which travelers will find indispensable.

Correspondence.

Seismic Disturbances and the Isthmian Canal.

To the Editor of the SCIENTIFIC AMERICAN:

The point urged, in the SCIENTIFIC AMERICAN of this date, in support of the Panama Route for an Inter-oceanic Canal, is hardly a safe one to insist on. Volcanoes are safety valves; the regions where they are are no more to be dreaded than are regions within the seismic belts where volcanoes are absent or remote. You would not advise a friend to select as his home an apartment house where the steam heating boiler had no safety valve, in preference to one where a safety valve was provided. The cases are perfectly analogous. Ometepe, Lago Nicaragua, is a safety valve at any rate. Nicaragua has not such subsidence shocks and surface undulations as has Panama, where there will never be a period of quiescence of sufficient duration to half finish the Bohio dam.

I realize that "geologists" galore have gone to Panama and reported that they did not feel earthquakes. So a man may go to Mississippi in January and say he saw nothing of negro disfranchisement—they don't vote there in January. Visitors of the "eminent scientist," the newspaper posing sort, stay on the Panama Isthmus, as a rule, less than a week. If they will go there, live with the people, camp out in the hills, as have I as an exploring naturalist, they will tell, if truthful, a very different story. Panama does have sudden shocks and quivers that would crack the pyramid of Cheops in twain; no Bohio foundations, on sand and 150, or more, feet below sea level, will ever withstand one such shock. Were there open volcanic vents near by these would be reduced or be wanting. The man who denies this has either never been long on the Isthmus, or—he is in the pay of the Panama people.

Remember Jamaica in the eighteenth century. Not in present geologic times has that island had a volcano in activity. Yet the fates that overtook Port Royal and again Savanna la Mar were far beyond that at St. Pierre in their terrible effects.

Mont Pelee's recent exploit may suffice to prevent the building of the Nicaragua Canal; it is not needed to prevent that at Panama. God himself could not build that and make it "stay put" without transcending His present laws. EUGENE MURRAY-AARON.

Washington, D. C., May 24, 1902.

The Current Supplement.

A very beautifully illustrated paper by Dr. F. A. C. Perrine, D. Sc., on the "Power Plants of the Pacific Coast," opens the current SUPPLEMENT. Messrs. Swinburne and Cooper's paper on the "Problems of Electric Railways" is concluded. Mention has been made in the SCIENTIFIC AMERICAN of the Richards-Archibald method of studying growing crystals by instantaneous photography. Messrs. Richards and Archibald's method is published in full. The famous Berthelot tells something of the radio-activity of matter. Naval affairs have not been neglected. Mr. William Laird Clowes describes recent scientific developments and the future of naval warfare; and S. W. Barnaby discourses on torpedo-boat destroyers.

An Improved Form of Apparatus for Producing Thin Films by Electro-Deposition.

Herr Endruweit, of Berlin, has patented an improved form of apparatus for producing thin films by electro-deposition. An endless metal band is first coated with potassium sulphide, and, after washing, is passed through a nickel bath of the usual composition. The thin film of nickel obtained in this way is backed by copper (by passing through a similar bath containing a copper salt in solution) and by tough paper, before being stripped from its support. A strong sheet or roll of paper faced with bright metallic nickel can be obtained in this manner, and the use of this material after relief-stamping and coloring, for wall-papers and for advertisement show-cards is said to offer many advantages. The electro-deposited "paper" is also reported to be useful for packing the stuffing boxes of high-pressure steam engines, and, if sold at reasonable rates, it is possible that there are many uses for which it may prove suitable.

SCIENTIFIC AMERICAN

[Entered at the Post Office of New York, N. Y., as Second Class Matter. Copyright, 1902, by Munn & Co.]

Vol. LXXXVI.—No. 23.
ESTABLISHED 1845.

NEW YORK, JUNE 7, 1902.

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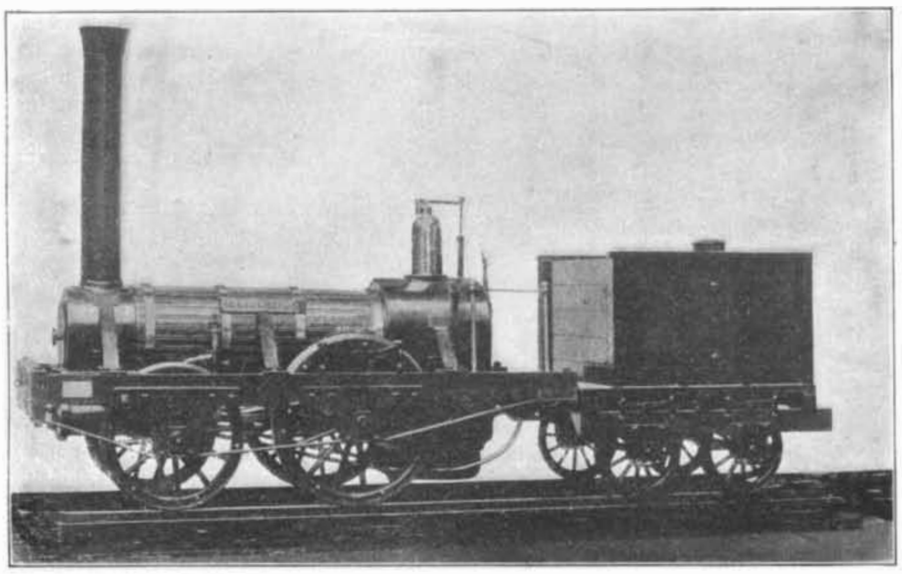
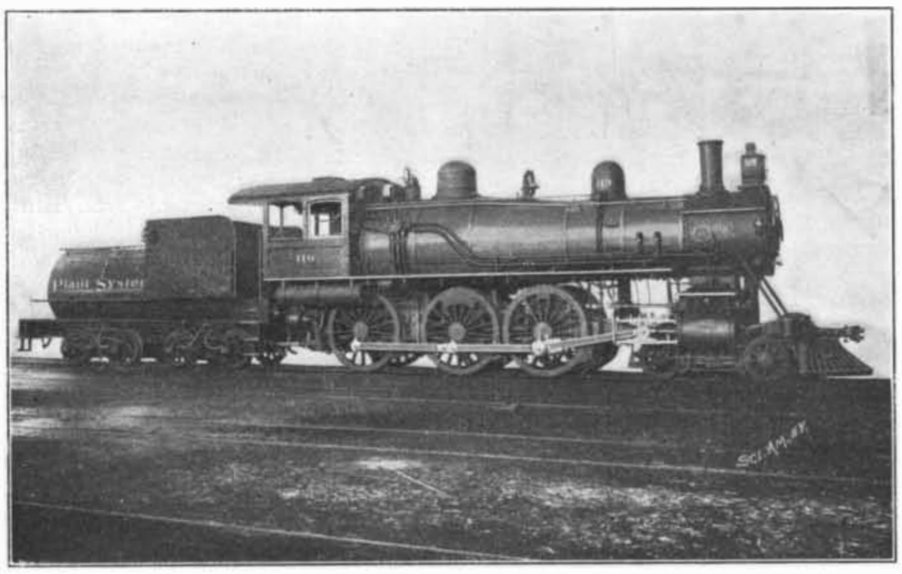
8 CENTS A COPY



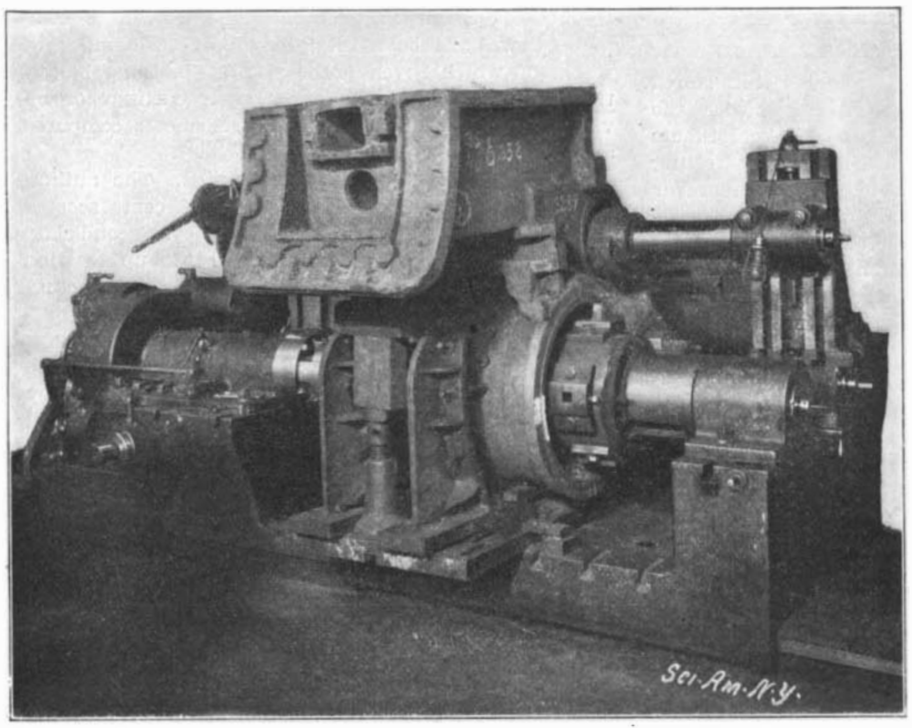
"Old Ironsides," 1832. The First Engine Built by Baldwin.

Two cylinders 9½ inches diameter by 18 inches stroke. Weight, 9 tons.



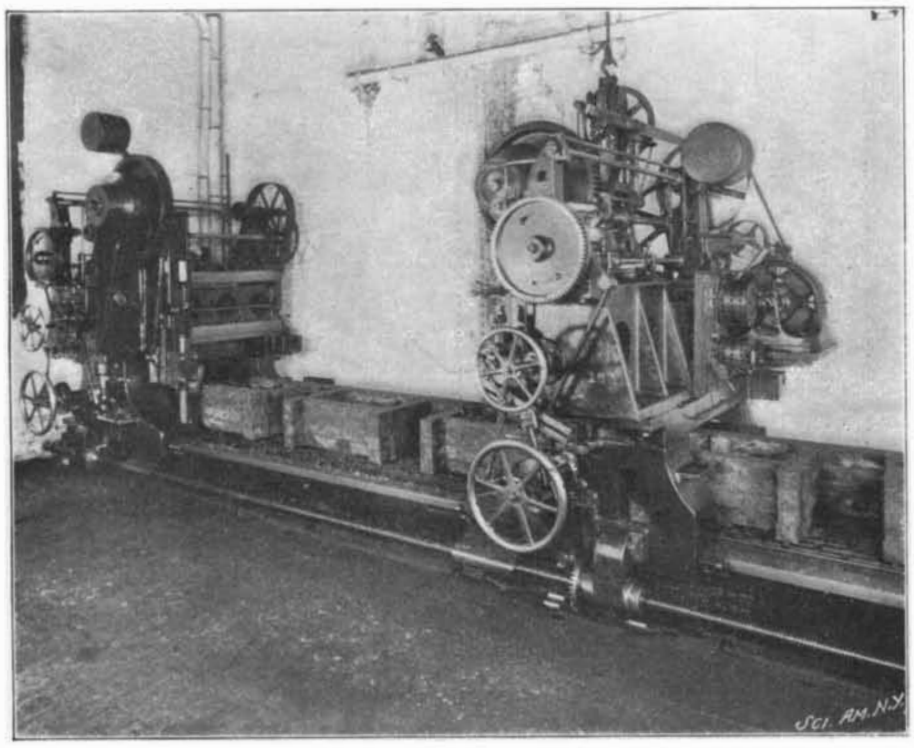
No. 20,000. Four-Cylinder Compound. Built in 1902.

Four cylinders 15 and 25 inches diameter by 26 inches stroke. Weight, 86 tons.



Special Machine for Simultaneously Boring High-Pressure and Low-Pressure Cylinders and Steam Chest.

The Foundry, Showing Flasks for Compound Cylinders.



Double-Head Machine Slotting Two Pairs of Engine Frames.

In the Erecting Shop; Lining up the Cylinders.

THE BUILDING OF AMERICAN LOCOMOTIVES.—[See page 396.]