on the poop deck, and three 12-pounder Colt howitzers in the tops. During the ship's reconstruction her top side planking and top timbers, her forecastle and poop deck, her stem, stern post, rudder post and rudder were all renewed. A new gun deck and upper deck were given her; her bulkheads, storerooms and magazines are all entirely new, and the fittings throughout the vessel have been renewed and are of modern type. The principal portion of the old ship remaining is that part of her which lies below her light water line.

The new engines of 2,000 indicated horse power are of the horizontal, back-acting, compound type, with cylinders 35 and 66 inches diameter by 48 inches stroke. She is propelled by a single screw. Steam is supplied by four boilers of the Scotch type, which are 11 feet in diameter by 10 feet in length. She is supplied with steam steering gear, electric lighting plant, and artificial ventilation, and her boilers are fitted for the use of forced draught. Her battery is of the rapid-fire type and consists of twelve 5-inch rapid-fire guns mounted in broadside on the gun deck, one 5-inch rapid-fire gun on the forecastle, eight 6-pounders mounted on the rail of the upper deck, two 1-pounder automatics on the poop deck, two 1-pounder Hotchkiss guns on the rail of the upper deck, two 3-inch field guns on carriages and two Colt automatic guns on the bridge. It will thus be seen that the famous old "Hartford" combines the picturesque features of the fighting ship of the sixties with the aggressive powers of the cruiser of the modern type. Although her spars have been cut down, she carries enough sail to give her crew, which will consist largely of recruits, something of that thorough training aloft which characterized the seaman of an earlier date.

In connection with the reconstruction of the "Hartford," the small photograph of the blowing up with guncotton of an old mainmast of the "Hartford" will be of interest. The mainmast was one removed from the ship before she left for the Pacific, and its destruction formed part of the experimental work of the torpedo station at Newport, Rhode Island.

THE "LOCOMOBILE" STEAM CARRIAGE.

In the early days of the present revival of automobilism, the steam engine was regarded with but little favor as a motor, chiefly because of the weight, bulk and general inconvenience accompanying the use of coal as fuel. With the introduction of liquid fuel, however, with its advantages of light weight and ease of storage and manipulation, the way was opened for the construction of a successful steam carriage, and the joint efforts of inventor and builder have produced some light, compact, powerful, easily managed, and eminently successful steam-driven automobiles.

We have selected for illustration, as combining most of the latest developments of the steam-driven type, the steam carriage which is popularly and commercially known as the "Locomobile." It has been sufficiently long on the road and has been tested under such varying and trying conditions as to prove that it is a thoroughly practical design, and representative of the unquestionable advantages and promising future of oil and steam in the field of automobilism.

THE CAR.—The car herewith illustrated carries two persons, and is of neat and decidedly prepossessing appearance. The body, which completely incloses the machinery, is suspended on a frame of 16-gage tubing by means of a transverse laminated plate spring at the front and two longitudinal springs of the same type at the rear. Above the two axles the frame is formed into two small bowstring trusses, to which the springs are securely bolted. Flexibility is secured by providing each of the two longitudinal members which connect these trusses with a slip joint connection (10 and 11), the end of the tube from 10 to 11 fitting snugly but loosely inside a sleeve at 10, and being held in place by an interior bolt which engages a lug brazed into the main longitudinal tube, and is adjusted by a nut at 11, as shown. This affords a strong but perfectly flexible construction, allowing the wheels to ride over obstructions without bringing any wrenching strains upon the frame or the machinery.

THE BOILER.—The shell, *A*, of the boiler consists of a length of 16-gage seamless, drawn, copper tubing, 14 inches in diameter by 14 inches deep. A half-inch flange is formed at top and bottom, to which the tube-sheets are riveted. A steam-tight joint is secured by brazing in the shell flange between the tube-plate and a steel ring on the under side of the flange, and riveting through as shown in the drawing. The boiler is then put in the lathe and two layers of piano wire, *a*, are wound on the shell under a moderate tension. Copper tubes, to the number of 298, are then expanded into the two tube-plates. This little boiler, as thus completed, has a total heating surface of no less than 42 square feet. It is hydraulically tested to 600 pounds pressure and when ready to be put in place it weighs just 105 pounds. It is covered with a thick layer of asbestos lagging, outside of which is an envelope of Russian iron.

THE FUEL.—The gasoline is carried in a copper tank, *O*, capable of holding three gallons, which is stowed beneath the foot board. The tank is kept under a pressure of 35 pounds to the square inch and is connected by the pipe (16) with a reserve air tank, *P*. The air pipe leads in at the top of the tank, *O*, and a branch pipe runs to a pressure gage, *R*. The gasoline is forced out of the supply tank through the pipe, *S*, which leads to the bottom of one of the boiler flues, to which it connects. The oil flows up through the flue, then by means of a pipe across the top of the boiler to another flue, down which it is led until it emerges from the bottom of the boiler to the pipe, *A*, Fig. 1, where it

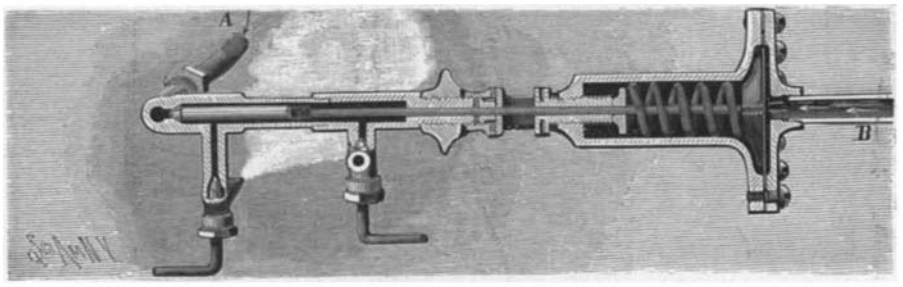

Fig. 1.—SECTIONAL VIEW OF AUTOMATIC REGULATOR.

may be controlled by two hand-operated needle valves, as shown. In passing through the boiler the gasoline is vaporized, and its admission to the burner at (7) is controlled by means of an automatic needle-valve, which is operated by the pressure of the water of the boiler upon the diaphragm, *V*. The diaphragm is so adjusted that when the boiler pressure exceeds 160 pounds, the valve will be closed, shutting off the supply of vapor. The steam pressure is thus automatically controlled through the burner, which, when the boiler has once been started, requires no further attention on the part of the operator. In order to prevent the fire from going out altogether when the vapor is shut off, a bypass of very small cross section is provided on the needle valve, which allows sufficient fuel to pass to keep the burner alight. The operation of the regulator valve is exceedingly prompt, and the device is one of the most pleasing among the many ingenious features of the Locomobile.

THE BURNER.—The burner consists of a sheet-steel cylinder of about the same diameter as the boiler, and is carried, as shown in our illustration, immediately below the latter; within the outer cylinder is a smaller inner one, into which the vaporized gasoline is fed. It is provided with 114 short vertical copper tubes, which extend from the bottom of the burner, where they are open to the air, to the top plate of the inner gasoline vapor cylinder. The air passes in through these tubes, and at the top it meets the gasoline vapor, which issues from the inner cylinder through a large number of small holes around the air tubes, the vapor and the air commingling and burning with the familiar Bunsen flame, immediately below the lower tube-sheet of the boiler. The distance from the base of the burner to the top of the boiler is about 19 inches, which allows it to be placed below the carriage seat and inclosed by the body, as shown.

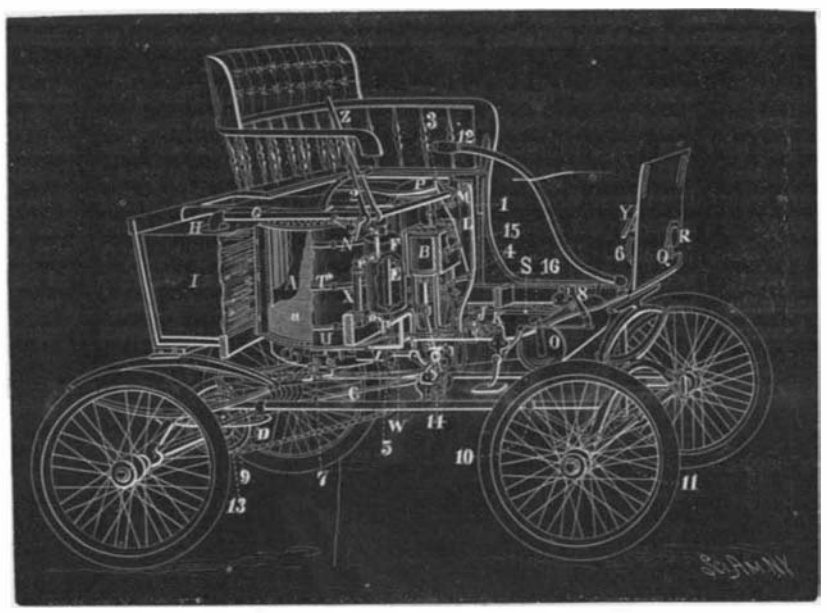

Fig. 2.—OUTLINE DIAGRAM OF THE "LOCOMOBILE."

THE BOILER FEED.—The water for the boiler is carried in a copper tank, *I*, which is placed at the rear of the boiler and partly encircles it. It has a capacity of 15 gallons. The boiler is fed by means of a little feed pump, *J*, which is operated from the cross-head of the engine. The water is led from the tank by means of a rubber pipe, and it may be cut off by a cock, *K*, before the check valve, which is just in front of the pump, is reached. There are three check valves in all between the water tank and boiler, and they all work in the same direction. From the feed-pump the water is forced directly to the boiler. A pipe, *L*, leads from the feed-pump to a by-pass, *M*, which is worked by the lever, *N*, placed conveniently at the hand of the driver. By turning this lever the feed, when the boiler is full, can be thrown back directly into the tank. The boiler is supposed, normally, to carry about 8 inches of water above the tube-sheet, leaving 5 inches of steam space; but an inch or two either way in the water level is not of serious consequence, the boiler steaming satisfactorily even when there is only an inch of water over the lower tube-sheet. A water-glass, *X*, on the outside of the car body shows at a glance the water level. By arranging a mirror, *Y*, on the dash board, the driver can have the water-glass continually under his eye. Check valves are provided above and below the water-glass, so that if the glass should break there would be no rush of steam or water from the boiler.

ENGINE AND DRIVING GEAR.—The engine, *B*, is located in front of the boiler and is secured to the frame of the body. It is shown so clearly in the accompanying engraving as to need no detailed description. It is sufficient to say it is a remarkably well designed and built two-cylinder engine of the locomotive type with Stevenson link motion and ordinary D-valves. The framing is of brass, and a special feature is the fact that the engine has ball-bearings both on the crank pins and the crank-shaft bearings. The engines are bolted to the wooden cross bracing of the body near the cylinders, and the lower part of the engine frame is kept in place by means of a strut, *C*, which extends from the engine frame back to the rear framing of the car. The strut is provided with a right and left hand turnbuckle, which enables the slack of the chain to be taken up when necessary. To allow for the slight movement due to this adjustment, the steam pipe is connected with the top of the steam-chest by means of a U-pipe provided with expansion joints. The driving of the rear axle is effected by means of a twelve-tooth sprocket on the engine shaft and a twenty-four tooth sprocket on the compensating gear-box on the rear axle. The compensating gear is of the usual type and allows of a perfectly independent rotation of the two wheels.

The band brake (9) is operated by a foot pedal (8), which is placed conveniently in front of the driver. The brake is extremely powerful and will bring the car to rest within its own length when it is running at a normal rate of speed. The car may also be brought to a speedy stop by reversing the engines. The reversing lever (2) and the starting lever, *Z*, are both located at the right hand of the driver, the former operating through the crank arms (3 and 4) directly upon the link motion, and the starting lever acting directly upon the throttle valve through the crank arm (1). The pair of cylinders are 2½ inches diameter by 4 inches stroke, with an ordinary cut-off at ⅝ of the stroke. They run at an average speed of 300 to 400 revolutions per minute and develop from 4 to 5 horse power. The cut-off of course can be varied as desired. On a level road, at a speed of 10 or 12 miles per hour, the steam is usually maintained at a pressure of 150 pounds to the square inch. The pop-valve (5) is set at 240 pounds to the square inch. In operating the Locomobile, one is impressed with a sense of the reserve power of the boiler and engines, the car starting from rest with a wonderfully rapid acceleration, jumping up to full speed, if so desired, within a very few lengths. They are remarkably successful as hill climbers, we ourselves having taken one of them up a 12½ per cent grade at a speed of 8 or 9 miles an hour. The same car has on another occasion climbed a grade of from 6 to 7 per cent.

OPERATION.—The boiler may be filled either by attaching a hose to the blow-off valve (14), which is furnished with a coupling for this purpose, or by filling the water tank, from which the boiler will of itself fill by gravity. When the tank is full, the blow-off needle valve is closed. The fire is started by means of a detachable vaporizer and burner, which is inserted into the permanent burner through the orifice (7). As soon as the steam pressure has been raised to 20 pounds or more, the needle valve at (7) to the main burner is opened, and the valve controlling the feed of gasoline to the detachable burner is closed. In about five minutes from the time the detachable burner is inserted, the steam will have risen to 150 pounds, at which point the automatic valve (*V*) will shut down the fire. The carriage is now ready to leave the stable, and beyond the steering, the driver has nothing

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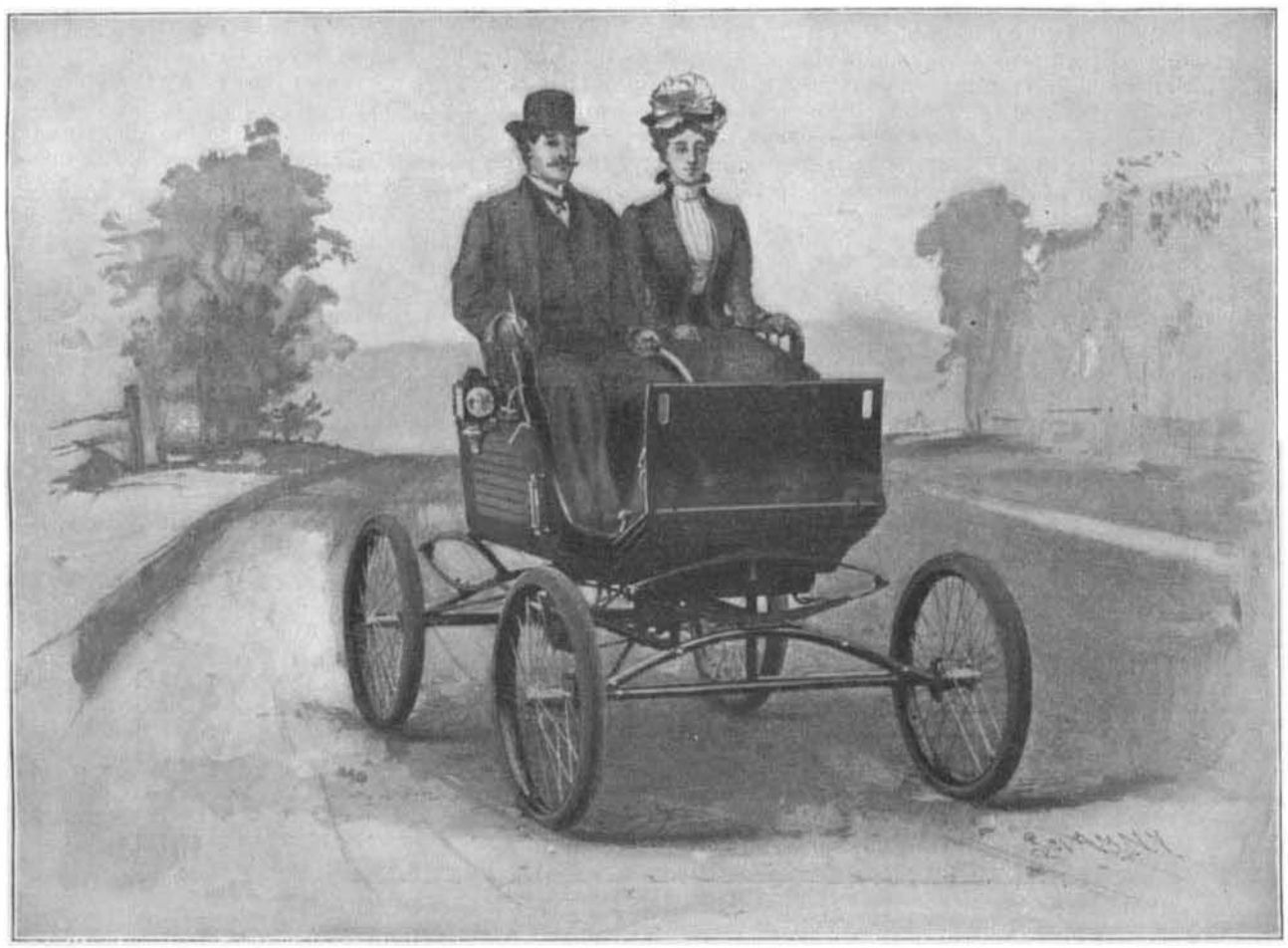
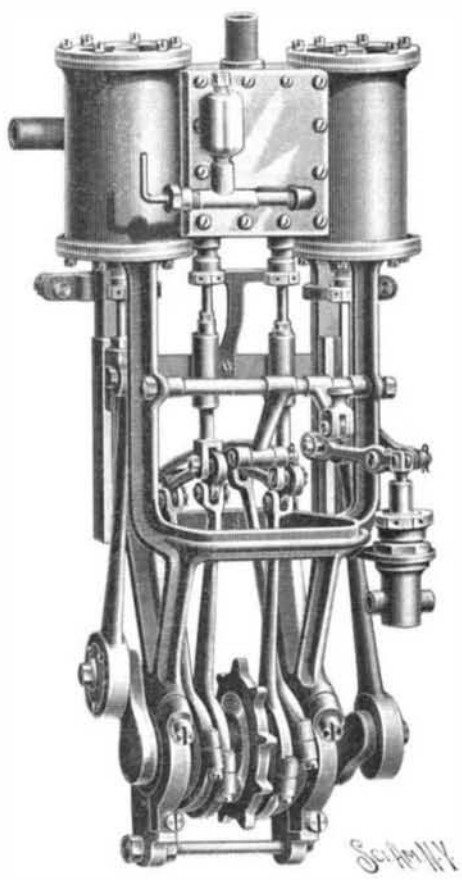
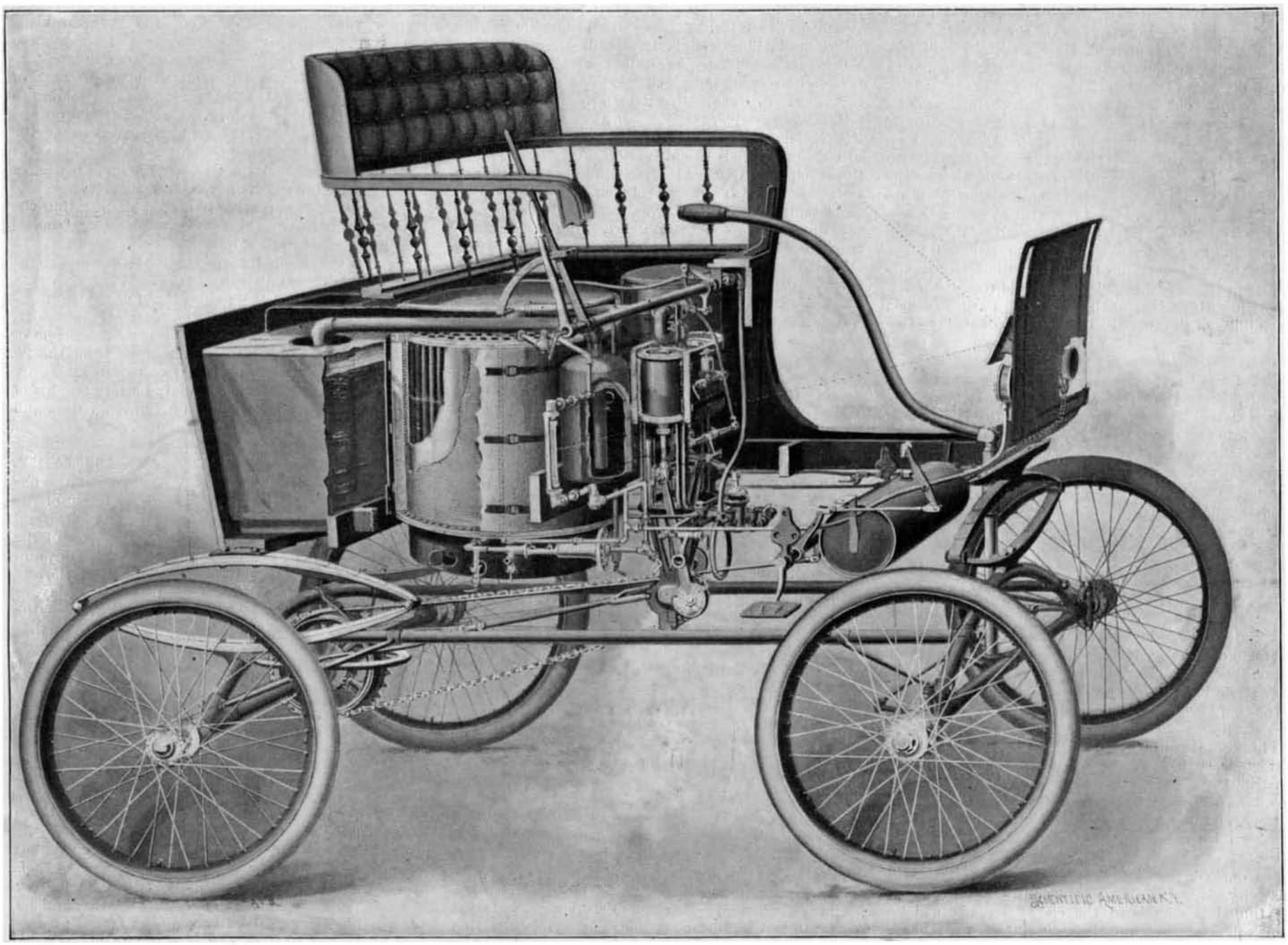


ON THE ROAD.



THE 4-HORSE POWER ENGINE.



THE "LOCOMOBILE"—SECTIONAL VIEW, SHOWING LOCATION OF ENGINE, BOILER, AND TANKS.—[See page 54.]

to occupy his attention in the operation of the Locomobile further than to keep his eye occasionally upon the water-glass. The exhaust steam enters the muffler (*F*) by a pipe (*E*) and leaves it by a pipe (*G*) which extends from near the bottom of the muffler past the boiler and down to a draught chimney (*H*) which passes through the center of the water tank. The gases from the boiler are drawn down ward by the exhausted steam, and both together pass out through the bottom of the body of the car. When complete with water and fuel for a run of twenty-five miles, a Locomobile, such as the one we have illustrated, weighs about 550 pounds. It is carried upon bicycle wheels of the standard pattern, with 2½-inch single-tube tires of a specially heavy construction.

Automobile News.

A motor cab service is about to be introduced in Cologne, Germany.

The traction engines sent to South Africa for the use of the British army have arrived at Frere and have been successfully tested.

St. Vincent's Hospital, of New York city, has an electrical ambulance. It can travel at the rate of ten miles an hour and cost $2,000. It does not differ materially from the ordinary horse-drawn ambulance.

Had motor wagons been used instead of horses, it would have enabled the English gunners to get much nearer the enemy at the Tugela River, and it is probable that they would not have lost so much artillery. Of course the nature of the country must always have some bearing on the use of automobile vehicles.

An automobile hansom cab ran away in New York city January 18 and gave a valuable object lesson regarding the latent power of these vehicles. The accident occurred at Union Square, the cab was turning out to make way for a car; the pavement was slippery, and the cab slid over the Belgian blocks and the rear wheels struck the curb of the sidewalk. The driver's seat was evidently not well secured to the cab, for when the wheel struck the curb, the seat was thrown off the cab and the driver with it, in such a way that the cab ran over him injuring him internally. The cab without its master now began an erratic career. It went straight for the Washington equestrian statue in the southeastern corner of the square. The cab struck the fence around the statue like a snowplow, and the inch and a quarter iron pickets were snapped from the horizontal railing with ease. The railing was also broken and one of the tall hollow iron posts, nearly two feet in diameter, was twisted, broken, and canted over. The base, which was firmly set in the ground, stopped the progress of the cab. The wheels continued to revolve seemingly in impotent rage, the tire of one being partly ground off against the raw edge of the broken base of the pillar. It was some time before any one came along who understood the shutting off of the current. The cab was finally led away by a brother vehicle, and the driver was removed to the hospital. There have been two accidents of this kind in New York city within a short time. It seems as though they might be avoided by some automatic switch which would cut off the current instantly the driver leaves his seat. In case of accidents of any kind the power lever usually seems to be to blame, as it is almost the first thing which the driver seizes to keep himself from falling. A hand wheel would probably be much safer.

A Bullet-proof Shield.

Professor Biles, the well-known ship designer, has suggested that infantry should be provided with bullet-proof shields. Extensive experiments on this line have been made by Cammell & Company, of Sheffield, England. They have been carried out under Major F. Boynton. A shield has been devised which does not weigh more than 7 pounds and gives complete protection to the soldier against the service rifle at 400 yards range. It has been determined that this is the range beyond which protection is advisable, as it is well within that distance that military tactics provide for the bayonet charge. The thickness of the plate is 3-mm. and the area of the cover is about 150 square inches, which gives complete protection to a soldier lying prone upon the ground. A loophole is provided through which the barrel of the rifle projects, the arc of the fire commanded being about ninety degrees. There are three studs attached to the shields, these being provided so that the new shields can be locked into a continuous screen. The shields are built of steel which has special properties enabling it to be bent, punched or drilled, but which yet offers great obstruction to penetration by projectiles. The advantages of such a protection to troops are apparent. The shield is attached to the rifle by a special band and there are no spring catches, the object of the design being to avoid anything which will be liable to get out of order. It is hoped that by the use of this shield trenching operations will be largely avoided and the vexatious delays of pick and shovel work will be often rendered unnecessary.

Science Notes.

An International Congress of Ethnology will be held at Paris in connection with the Exposition from August 26 to September 1, 1900.

The President of the United States, through Secretary of State Hay, has sustained the decision of the United States Board on Geographical Names in regard to the spelling of our new island in the West Indies. It is to be spelled Puerto Rico.

There will be over 7,000 exhibitors at the Paris Exposition, and the United States is in the first rank of the exhibitors. The display will be strictly representative, and will show in an adequate manner the excellence of our productions. In 1873 we had less than a seventh as many exhibitors.

The explanation of a sudden rifle fire which was inexplicably opened from the Boer trenches is given by a newspaper correspondent. He says that the Boers had wires stretched along the ground in front of the trenches connected with lamps, so that if a wire was touched the lamp was extinguished. One night a lamp was put out by a high wind, and the result was that the Boers opened fire, although there was no enemy. The fire ceased when the Boers discovered that the alarm was false.

The expedition of Baron Toll, organized for the exploration of the New Siberia Islands and Sannikoff Land, will set out in June next from a Norwegian port, whence it will proceed to the mouth of the Lena, on the banks of which, at a point above the town of Yakutsk, it will pass the winter. During the summer of 1901 the expedition will begin its explorations toward the north, picking up en route a detachment which will be sent forward from the main body during March, with a sufficient supply of dogs.

The health of the U. S. Navy and Marine Corps is reported upon by the Surgeon-General of the Navy in his annual report, which shows that in the fiscal year 1898, notwithstanding war conditions and prolonged cruising in tropical waters, the ratio of admission to the sick list per 1,000 shows but a slight increase over past years. The ratio for 1898 was 871·69 per 1.000, as compared with 838 per 1,000 in 1895, 777·75 in 1896, and 748·24 in 1897. There were 173 deaths in the year, 118 being from disease and 55 from injury. Excluding the men lost on the "Maine," the death rate was only 7·21 per 1,000.

The annual meeting of the New York Botanical Garden has just been held, and the annual report shows that 165 new members have been added to the roll and that the progress at the garden under the direction of Dr. Britton has been most satisfactory. The number of species and varieties of plants under cultivation and those native to the grounds aggregate collectively over 4,000. The museum building is now essentially completed and needs only a final clearing out, when specimens can be installed. The number of new specimens received through gifts and purchase in the year aggregated 65,837.

A special commission has been appointed to report on the ruins of the cliff dwellers in the vicinity of Mancos and Cortes, Colo., and also near Aztec, Mexico, with the idea of reserving the lands as a national park. This action has been taken as a result of an agitation in Colorado for the protection of these ruins against vandalist relic hunters. Some of the best preserved ruins have been ruthlessly entered by curio hunters, who have broken through walls and roofs and carried away the relics. It would be very wise to have these ruins guarded by the government, and so that they can be investigated by experts. Fortunately, some of the best of them have not been tampered with as yet.

The Trustees of the Boston Museum of Fine Arts have purchased a fine tract of land of about 12 acres at the Huntington Avenue entrance to the Fens. This would give an opportunity for any desired enlargement of the collection. The Museum may be readily reached at this point, although it is not as near the center of the city as its present location at Copley Square, but owing to the fact that the light is deflected by the higher buildings in close proximity to it, the value of the present Museum building is impaired. In its new location the galleries would enjoy excellent light and immunity from fire communicated from other buildings. It may be some years before work is begun on the new site

The twelfth census of the United States in 1900 officially embraces all manner of statistics relating to all industries—except mining. Everything in connection with all trades has official, preliminary statistical notice—except mining; all classes and conditions of men are to be noted—except miners. The great basic industry of the nation, the one business that underlies all else, and on which all else depends, is not represented by any official notification of the intents or purposes of the twelfth census in the closing year of the century. The insane, the deaf, the dumb, are worthy of note, but there is no more mention of the mineral industry in the bill providing for the taking of the twelfth census than if such an industry did not exist.—Mining and Scientific Press.

Engineering Notes.

The French government is perfecting arrangements for the transportation by rail of torpedo boats of small size in the event of war.

The Simplon tunnel is now progressing at the rate of 16 feet per day. It was begun 14 months ago, and must be finished in five years and a half from its commencement.

A firm of rope manufacturers at Mulheim on Rhine manufacture steel wire towing ropes 5½ inches in circumference in one continuous length of nearly 19 miles and weighing 210 tons.

A pay car is to be used at the Homestead Steel Works. It will be run through the various departments, and the men will be paid off, obviating their calling at the pay office.

American ships built in 1899 numbered 954, and they had a gross tonnage of 267,642 tons. This is very close to 1898, when one ship more was built, and the tonnage was only 42 tons less.

There were 231 railroad accidents in the United States in the month of September, including 116 collisions and 110 derailments, causing the death of 93 persons and the injury of 226.

The Louisville & Nashville Railway has created the position of "horticultural agent." The duties of this official will be to encourage horticulture and truck raising along the line by means of information obtained in the same and other sections of the South.

The Hamburg-American line are about to introduce a new kind of fuel on their new freight steamers. It consists of a semi-fluid petroleum which is imported from Borneo in large quantities. It is not liable to become ignited spontaneously at high temperature. The new fuel will permit a reduction of the number of firemen and also a considerable economy of space.

The owner of a half interest in the patented design for "Island Station Platforms" has brought a suit in equity against the city of New York and the Rapid Transit Commissioners to enjoin them from using the patented design in the new underground railway system. The president of the Rapid Transit Commission says these platforms were in use on the London underground railway long before they were patented here.

It is estimated that Great Britain, the United States, and Germany have from two-thirds to three-fourths of the world's business in metals, shipping, finance, imports, exports, etc. These countries produce 77 per cent of the world's make of pig iron; 80·8 per cent of the steel; they take 75·2 per cent of the world's consumption of lead; 73·1 per cent of the copper; 67·5 per cent of the spelter; and 67·2 per cent of the tin.

The following figures, relating to the expansion and contraction of railway rails, 30 feet long, but of different weights, have been obtained by actual experiment in America: Contraction caused by change of temperature from 5 degrees above zero to 20 degrees below zero, 56 pound rail contracted $\frac{3}{16}$ inch, 75 pound rail $\frac{3}{16}$ inch, 85 pound rail $\frac{3}{20}$ inch; expansion caused by change of temperature from 5 degrees above zero to 70 degrees above zero, 56 pound rail $\frac{1}{12}$ inch, 75 pound rail $\frac{1}{16}$ inch, and 85 pound rail $\frac{1}{17}$ inch.

At the occasion of the centennial celebration at the Technical High School, Berlin-Charlottenburg, the Kaiser granted the Prussian technical high schools the right, in recognition of the scientific importance which they have attained in the last decades, besides the fulfillment of their practical labor, to promote their pupils, after passing an examination, to "diploma engineers," and after passing another examination to "doctor engineers." Hence, a "technical doctor" has been added to the number of various doctors in Prussia.

The dam separating the Chicago Drainage Canal and the Desplaines River was lowered on January 17, and the water of the former passed through on its way to the Mississippi and the Gulf of Mexico. The trustees became fearful that action by injunction to prevent them carrying out their plans might be taken by the enemies of the canal, and after a hurried consultation they decided to avoid the risk of further delay, so a permit was obtained from the Governor, and the trustees proceeded to Lockport, Ill., on a special train. The flow over the dam was between 250,000 and 300,000 cubic feet per minute, and when the gates are opened this flow will be increased.

A brick chimney, 160 feet high and 8½ feet square at the base, and 4½ feet diameter at the top, has been overthrown in St. Louis by the use of hydraulic jacks, says The Engineer. The chimney was first undermined on one side, and three 10-ton hydraulic jacks were placed in position under the side. A hawser was then fastened about the chimney, 60 feet from the ground, and ropes led from this hawser to crabs placed at a distance of about 100 feet from the chimney. With eight men at each crab and men at the hydraulic jacks, the chimney was slightly lifted and pulled at the same time; the men at the jacks left their posts at the first warning crack, but those at the crabs continued their work until the chimney fell.