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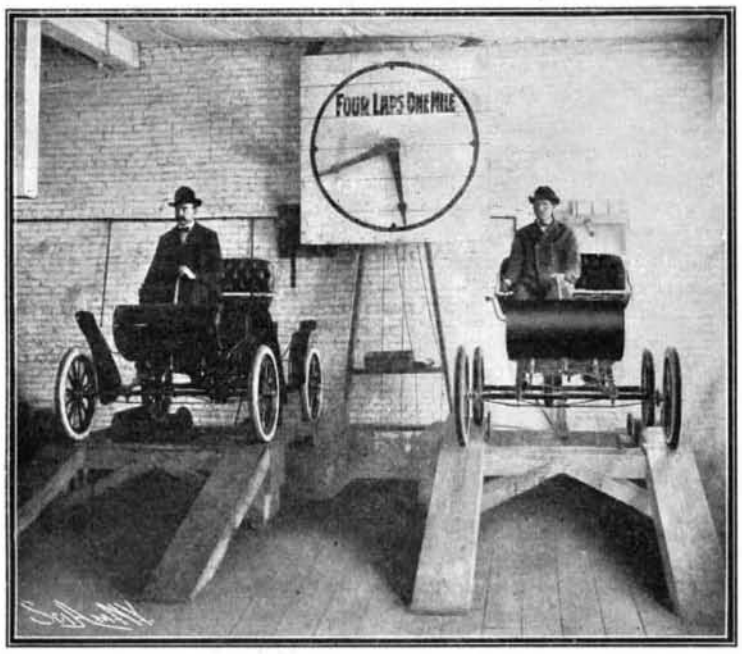
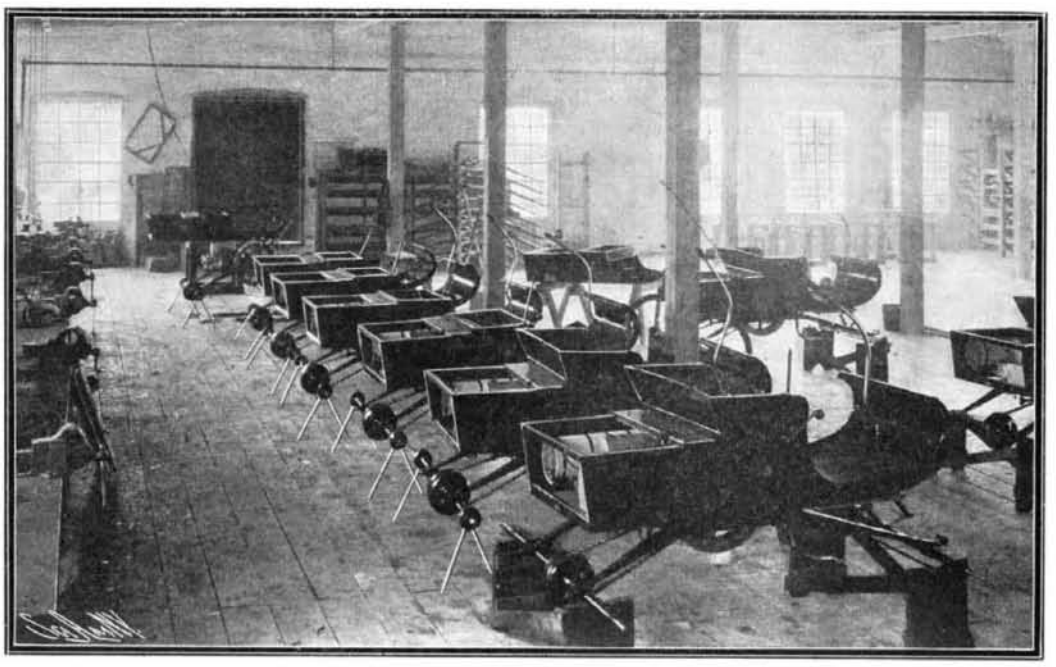
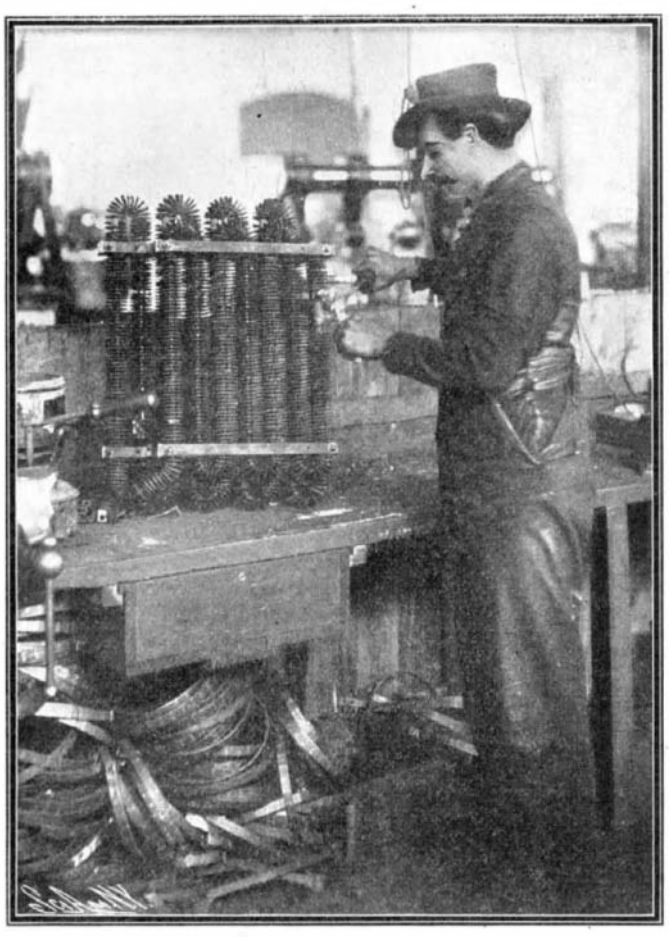


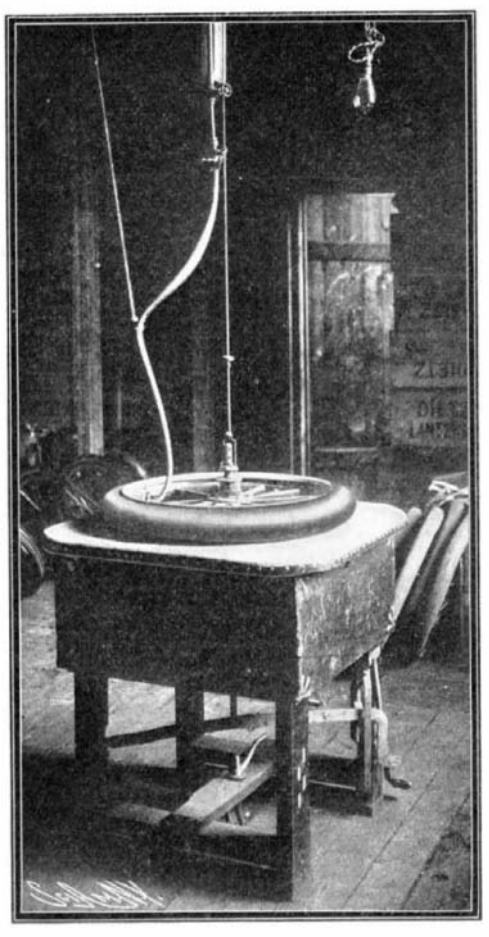
Freeing Up the Machines.



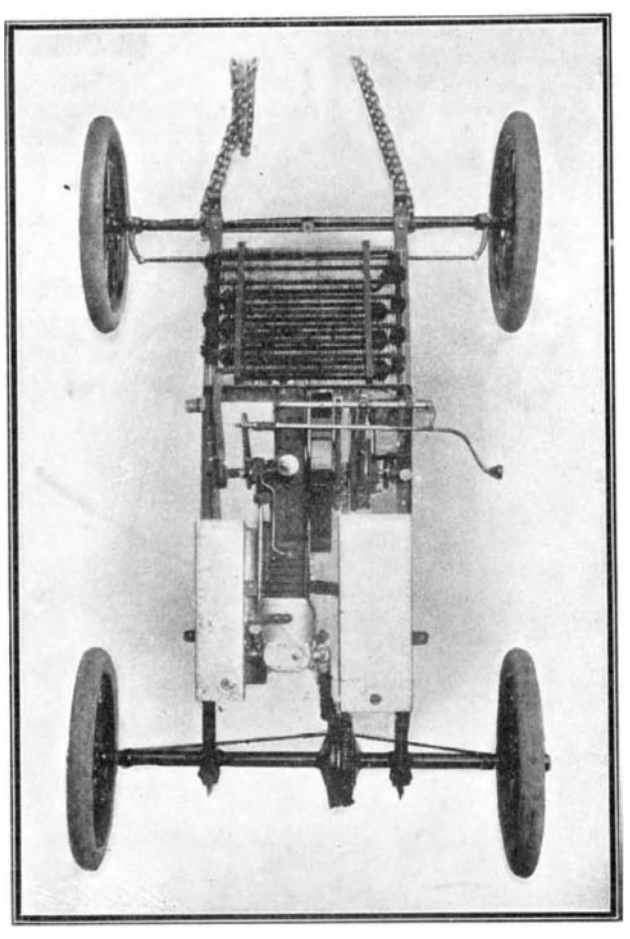
Assembling the Carriages.



Fitting Up Radiator Coils.

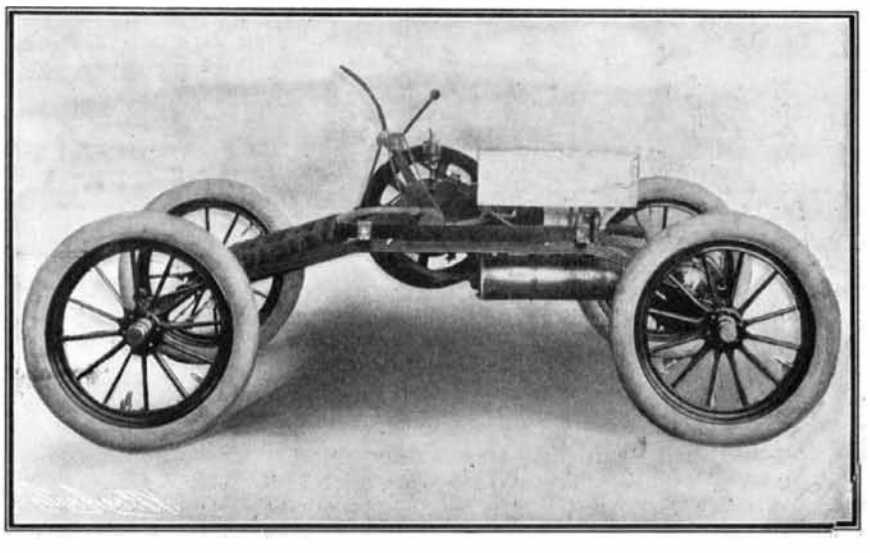


Fitting Up Wheels.



Plan View of the Oldsmobile.

A Difficult Feat.



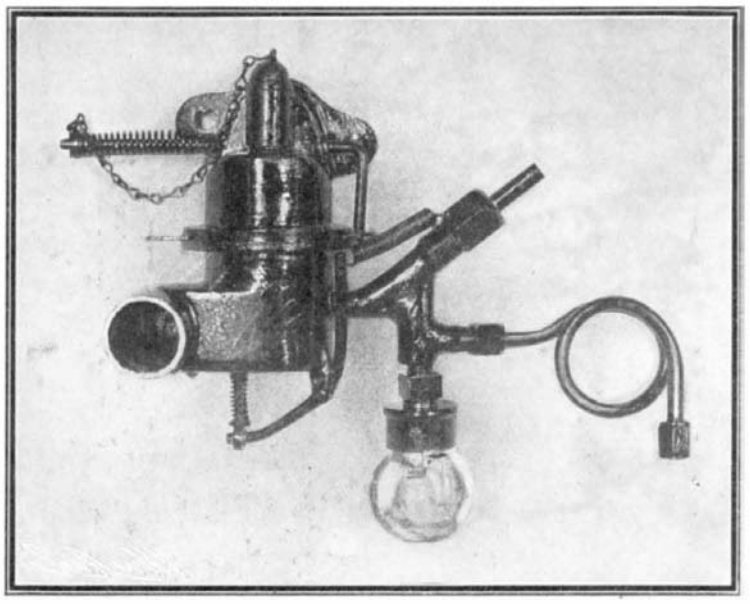
Carriage Body Removed, Showing Running Gear and Motor.

HOW AMERICAN AUTOMOBILES ARE MADE IN LARGE QUANTITIES.—[See page 29.]

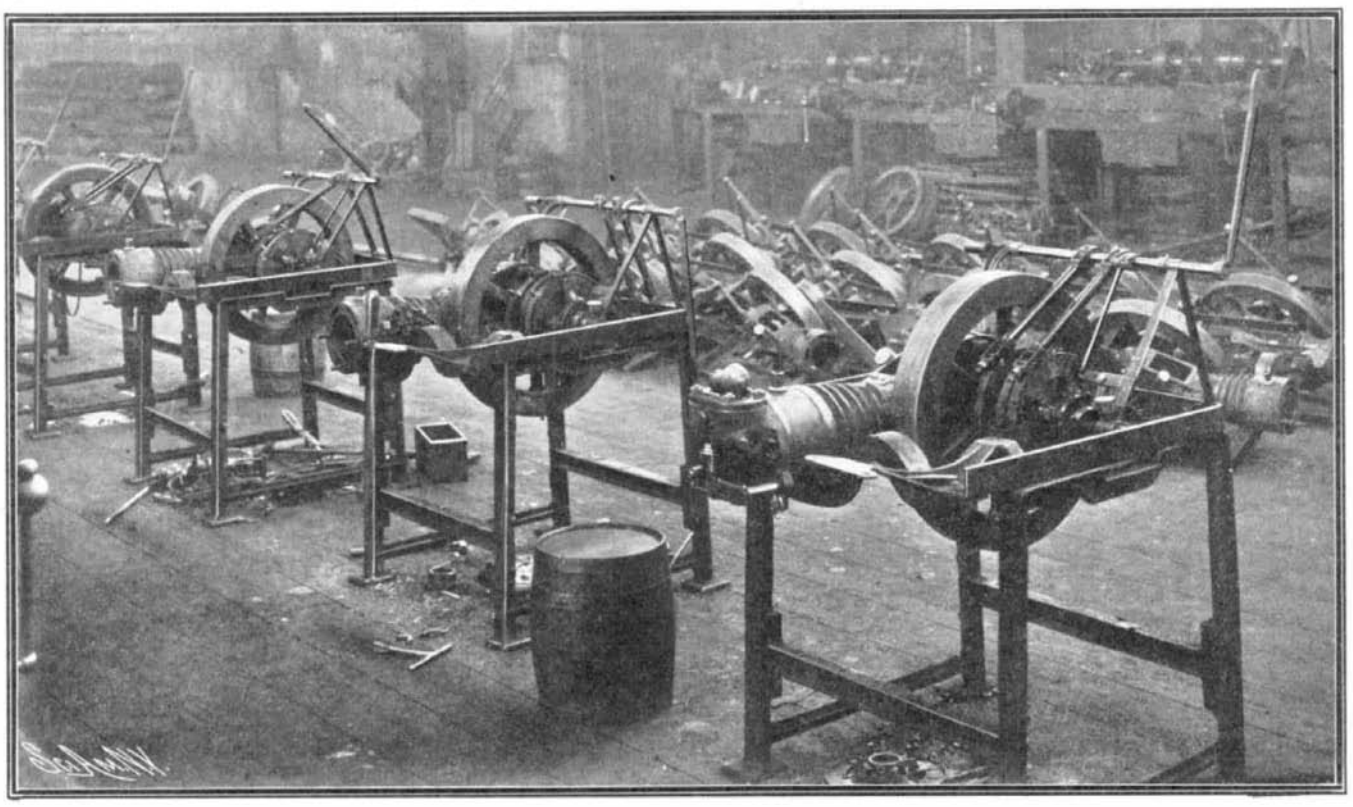
THE MANUFACTURE OF AUTOMOBILES.

A FRENCH ironmaster who made a specialty of sea-coast defense guns was once asked where was his plant. "In my laboratory in Paris," he said; and the same may be said of automobile manufacturing. The bicycle, when first introduced in approximately its present form, immediately became so popular that everyone having any species of plant rushed in to participate in the profits. They soon found, however, that they were at the mercy of those possessing automatic machines and jigs for their "parts," and by the time they themselves were fully equipped for making everything required to produce a high-grade machine at low factory costs, the craze was over, and they found themselves with a well-equipped factory for the production of sewing machines or revolvers. The automobile loomed up at about the same time, and offered an opportunity for idle belts to be set in motion. The results have been interesting, and, on the whole, instructive. Some of the machines were ponderous, some too light; some were admirably designed, but they nearly all tended to produce a new type of mechanic—the automobile repairer. Now it would not be fair to say that an automobile never requires repairs, but some require more than others. Even a locomotive has to be cleaned and inspected daily, but the purchasers of machines who were not possessed of a superfluity of mechanical skill wished to get there and back without undue strandings by the wayside. A few manufacturers came out of the ordeal in good form, and with automobiles which have stood the test of time, and we illustrate the two plants of one of them, located respectively at Detroit and Lansing, Mich. The Olds Motor Works had the accumulated experience of years of successful manufacture of gas and gasoline stationary engines to draw upon when they decided to enter the field, which accounts for their early entrance into the business with a full-fledged plant adapted for the needs of the new industry.

It is our intention to deal with a few of the interesting phases connected with the automobile industry as carried out at their plants. It may be said in general that a large part of the plant of a modern factory for the manufacture of automobiles does not differ materially from that which will be found in any well-equipped machine shop adapted to produce "parts" in large quantities; but there are some points of divergence which differentiate these plants from those of others, and the most important is the inspection of materials. The tests of iron and steel are most rigorous. Borings are analyzed and test pieces are shaped and sent to the testing machines at all stages of manufacture. The tests are both mechanical and chemical. There are drawbar and endurance tests, and no machine leaves the factory without a knowledge that it will perform the work which may reasonably be expected of it. Each machine is tested on the road or a private track, and must be able to climb a thirty per cent grade before being shipped. These tests are of a very scientific nature, those relating to the radiating coils being especially interesting, and being carried on under the direction of a well-known professor of a leading university. When amateurs make their own machines, they usually make an experiment, and the tyro is very apt to buy one. But in the case of the machines to which we refer, the experimental work is all done in a special laboratory, so that the main shops can go ahead and make machines which will run properly after assembling.



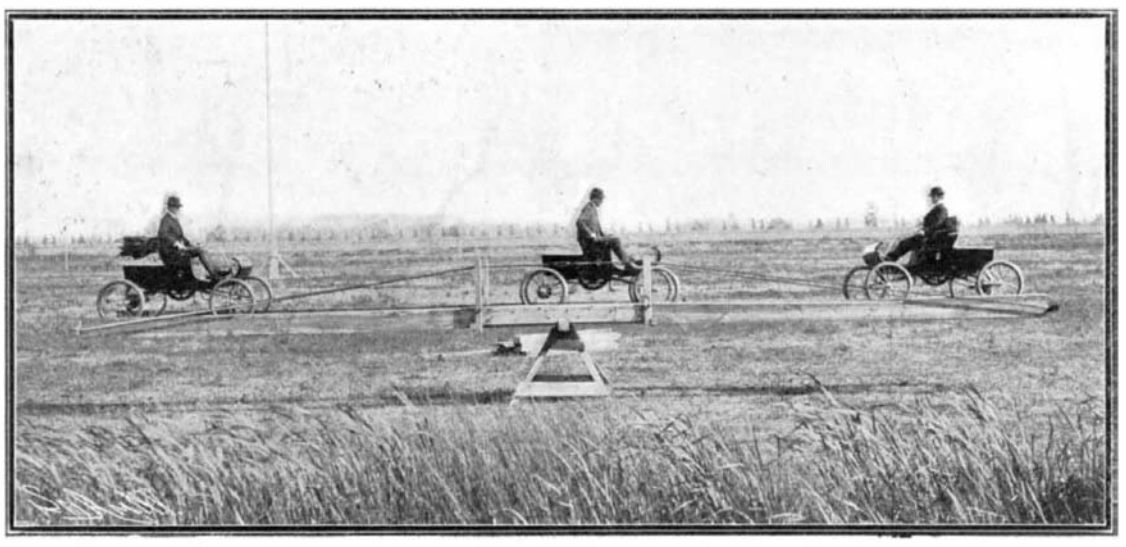
The Carbureter.



Assembling the Motors.

The castings are all made at the Lansing plant, where there is a well-equipped foundry and forge shop. The cylinders are cast in one piece, and, after being tested hydraulically, are bored in pairs by special two-spindle boring machines which do the work accurately and at low cost. From the boring machine, the cylinders then go to the hydraulic testing bench, when, if any defect has been discovered, the machined casting is scrapped. If found perfect as to size by gages, it is sent to the stock room, whence it is taken to the fitting and assembling bench, as wanted. The 4-horsepower engine has only one cylinder, and is of the four-cycle type of explosion-motor. There is only one piston rod, one connecting rod and crank, one balance wheel, and two valves, which are connected direct to the shaft. From this, it will be seen that the heart of the carriage is so simple that the liability of a breakdown is minimized. The shaft is forged from a single billet of steel with the aid of a steam hammer, and is accurately machined. The carbureter is a plungerless device which requires no manipulation of air to get a proper mixture. The testing of carbureters is most rigorous, and one of our illustrations shows a gang of them being adjusted. The gasoline tank holds four gallons, sufficient for a hundred-mile run. The water tank for cooling the cylinder is of the same capacity, and does not require to be refilled except at long intervals unless continuous runs are being made, in which case it will require partial refilling every twenty-five or fifty miles, depending on the condition of the roads and the temperature. The radiating coils under the front of the body will keep the water sufficiently cool even on a hot day. Metal wings are secured at short intervals on the coils, serving to largely increase the radiating surfaces. One of our engravings shows the interesting and scientific tests which are carried on relating to the relative efficiencies of various types of coolers.

The products of combustion are allowed to dissipate in the air with the aid of a muffler. A jump spark igniter is used; it is so placed that the mixture entering the cylinder keeps it free from carbon deposit. The time of ignition, so important in all gasoline engines, is regulated by a small lever at the right side of the seat. Two sets of special batteries are used, the life of which is several months, and renewals are easy. If one set of batteries should give out, the other can be brought into play by turning a switch. The motor and its appendages are run for hours in a special room on testing benches. Here they are under the constant supervision of experts; at least four of whom must file a written statement relating to each machine. Having described the engine proper, the running gear and body are next in order. The body is mounted on 28-inch wooden or steel wheels with 2½-inch pneumatic tires. The wheel base is 5 feet, 6 inches, which helps to make steering easy and assists to do away with jars. The body is hung very low (independent of the motor) on rubber cushions, doing away with vibration and insuring safety in making short turns. No reaches are required, as the long-leaf springs that carry the motor and the body extend from the front axle to the casing that incloses the rear axle, thus making a perfectly flexible gear. The front axle is a very heavy steel tube reinforced and having



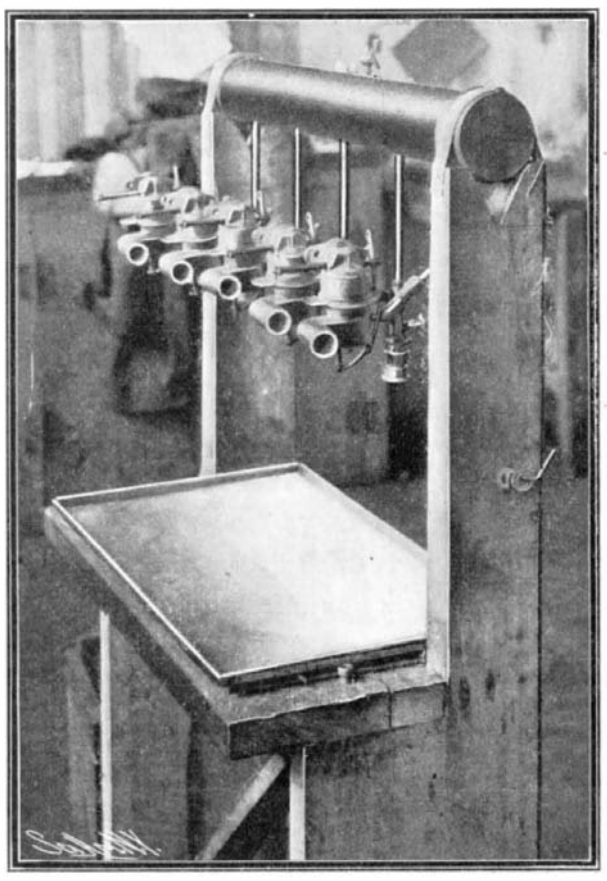
An Automobile See-Saw Showing Capacity for Control.

HOW AMERICAN AUTOMOBILES ARE MADE IN LARGE QUANTITIES.

heavy steering knuckles. The rear or driving axle, with the compensating gear near its center, runs on roller bearings in a casing made of heavy steel tubing, and having two heavy oval flanges that screw together securely and form the gear casing. This construction relieves the driving axle and compensating gear of all strains except the driving of the carriage. The rear wheels are keyed fast to the axle. Both front and rear wheels are given additional strength by steel trusses. The steering lever is attached to the body, which is supported at the front by a double elliptic spring that absorbs all vibration from irregularities of the road without affecting the rigidity of the steering mechanism. The power is transmitted direct from the motor shaft to the rear axle by a chain, tested to 4,000 pounds working strength, which effectively disposes of all chain troubles. The transmission gear is protected by a steel case which is oil-tight, thus permitting the gears to run continually in an oil bath. It has three changes—two forward and one reverse. It is very simple and effective, and for ordinary running all the gearing is locked fast to the motor shaft, there being no gears used except in starting, climbing very steep grades, or in running backward. This avoids friction and noise and the general wear and tear usually found in most transmission gears. The compensating gear and rear sprocket are incased and completely protected from sand and mud. The motor is started easily from the seat by means of a non-detachable crank at the right hand of the driver. A turn of the crank will put the motor in action. The speed of the motor is increased by means of a foot lever acting upon a gate-valve opening which admits more explosive mixture to the igniting chamber, and is further increased by advancing the spark controlled by the lever for change of lead. One lever controls all changes of gear, moving forward to get the two speeds ahead, and backward for the reverse, making a simple as well as effective control.

A very effective band brake operated by the foot is applied by a clutch band to a flange attached to the driving sprocket. It is powerful enough to slide the driving wheels. There is also an emergency brake acting directly on the rear axle and shutting off the power, so that the machine can be stopped on an instant's warning

The range of speed is from three to twenty-five miles an hour, and the net running weight is 870 pounds. When the ease of running and the comfort of traveling in this machine are considered, it is little wonder that they are made in such large quantities as a recent visit to these factories would indicate. The running gear is well adapted to support the covered body of a delivery wagon. We have already illustrated this type of vehicle.



Testing Carbureters.

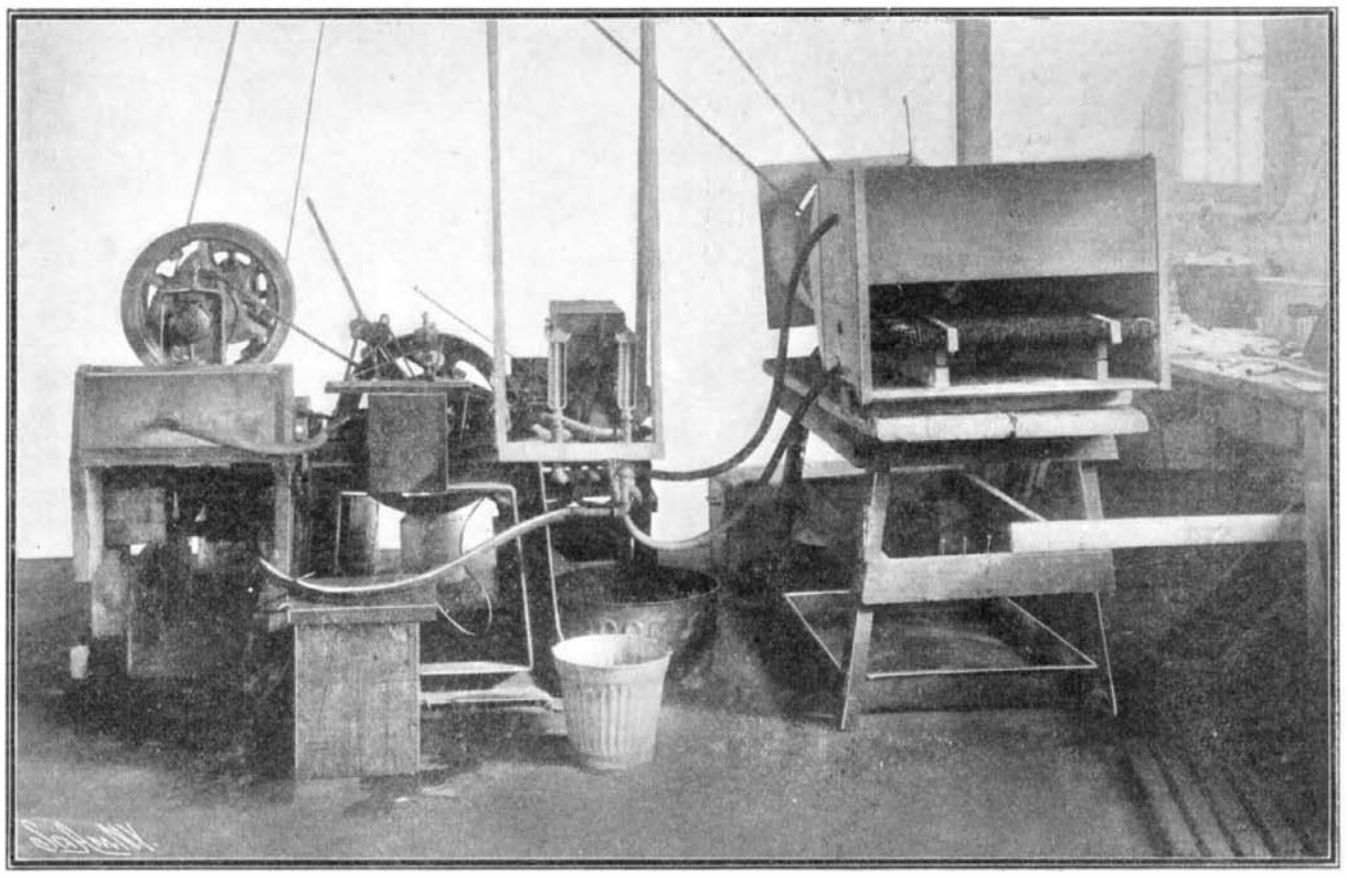
Progress of the United States in Its National Industries.

"The Progress of the United States in its Material Industries" is the title of a statistical statement presented by the Department of Commerce and Labor through the annual report of the Chief of the Bureau of Statistics. The table pictures conditions in the great industries and material interests of the United States in 1903, where such figures are available, and compares those conditions with those of earlier years, running back, where possible, to the year 1800.

Area, population, wealth, public debt and the interest thereon, gold and silver production, money in circulation, savings-bank deposits and depositors, value of money of the country, value of farm products, imports and exports of principal articles and total of imports and exports, railways in operation, number of post offices, receipts of the Post Office Department, and many other subjects indicating in various ways the financial, industrial, and commercial condition of the country are included in the tables, which give opportunity to compare present conditions with those of earlier years. In area, for example, the total in 1903 is 3,025,600 square miles, against 2,980,959 square miles in 1850, and 827,844 square miles in 1800. These figures do not include Alaska or the islands belonging to the United States.

The population in 1903 is stated at 80,372,000, against 23,191,876 in 1850 and 5,308,483 in 1800. The wealth of the country is stated at 94 billions of dollars in 1900, and presumably 100 billions would not be an unreasonable estimate for 1903, while for 1850 the wealth of the country stood at 7 billion dollars, no estimate being given for any year earlier than 1850. The per capita wealth is set down at $1,235 in 1900 and $307 in 1850, having thus more than quadrupled meantime. The interest-bearing debt in 1903 is 914 million dollars, against 1,724 millions in 1880 and 2,046 millions in 1870. The per capita indebtedness of the country in 1903 is $11.51, against $60.46 in 1870, and the interest per capita, 32 cents in 1903, against $3.08 in 1870.

Gold and gold certificates in circulation in 1903 for the first time exceeded one billion dollars, or, to be exact, 1,031 millions, against 810 millions in 1900, 232 millions in 1880, and 25 millions in 1870. The total money in circulation in 1903 is 2,367 million dollars, against 1,429 millions in 1890, 973 millions in 1880, 675 millions in 1870, and 435 millions in 1860. The per capita money in circulation in 1903 is $30.21, against $26.94 in 1900, $19.41 in 1880, and $13.85 in 1860. Deposits in savings banks in 1903 are 2,935 million dollars, against 1,524 millions in 1890, 550 millions in 1870, and 149 millions in 1860. The value of manufactures for the census year 1900 is given at 13 billions of dollars, against 5 1-3 billions in 1880, and less than 2 billions in 1860. Railways in operation in 1902 are 203,132 miles, against 166,703 miles in 1890, 93,262 miles in 1880, 52,922 miles in 1870, 30,626 miles in 1860, and 9,021 miles in 1850.



Testing the Efficiency of Radiating Coils.

DEEP-SEA SUNFISH.

BY PROF. CHARLES F. HOLDER.

So remarkable are many of the large fishes recently discovered that it would be difficult to indicate any individual more singular in shape than another; yet in the entire group the sunfish (*Mola*) stands out as perhaps the most curious and impossible among the forms which attain a large size. It is a shapeless creature and seemingly cut off abruptly behind the fins, and apparently a grotesque head, the ears represented by fins.

The sunfish, or head-fish, belongs to the family *Molidæ*. It is fairly common in the vicinity of Santa Catalina Island, off Los Angeles County, California; that is, I recall no locality on the American coast where the sunfish can be so often observed and examined near at hand. In general appearance the fish is oblong and deep; very thin or compressed; cut off (truncate) behind, so there appears to be no tail, a mere rim of movable flesh taking its place, which has a very limited use in the slow locomotion of this extraordinary fish. The skin is hard and coarse, rough, scaleless, and covered with flat spines; the entire skin in the individuals examined by me was covered with a thick coating of slime, which appears to be a world in itself for numerous parasites which prey upon the fish.

The sunfish is seemingly formed on a reversible plan; that is, the casual observer might conceive it swimming on its back just as well as the reverse, as its dorsal and anal fins are alike, large, long, and conspicuous, the back portion joining more or less with the rim of the "tail." The side or pectoral fins are very small for the size of the fish; the eyes small, but conspicuous; gills small; air bladder absent; color light gray, resembling that of the shark. The mouth of the sunfish is ridiculously small for so large a creature, and is armed with solid white porcelain-like teeth, completely joined in each jaw, forming a powerful beak.

There are three well-known genera of the sunfishes and six species. Comparatively little is known regarding their habits. Their young are strange, spine-clad little creatures bearing at first but slight resemblance to the adult, and when first discovered, were supposed to be different fishes and were so described. The sunfish is one of the few fishes of little or no use to man, though I am of the opinion that the hard skin might be utilized. I once learned that the boys of a certain village in Maine were anxious to secure the muscular envelope of a specimen caught by me to use it as rubber. They cut the hard, elastic substance into round shapes and used them for the interior of home-made baseballs, winding them about with yarn. It was the belief of fishermen and boatmen on the New England coast that the sunfish lived on jelly-fishes, and in many specimens examined by me none contained any solid food or traces of it. The first large sunfish observed by me was off Ogunquit, Maine. It was lying prone upon the water, partially exposed, literally basking in the sun, and I had no difficulty in running alongside and capturing it by inserting a gaff in its mouth, whereupon it began a violent struggle, but in a short time gave up. This fish was about three feet high and was covered with parasites—worms and crustaceans, with a few barnacles of various kinds. A large goose barnacle had found a resting place in its mouth, the long "stem" wav-