and remove scale from the surfaces of the pipe and elongating the pipe in the distorting and restoring operations."

Replies received to letters of inquiry to users have been very favorable concerning the practical use of this pipe.

In consideration of his invention of a method of manufacturing scale free pipe and its successful application, THE FRANKLIN INSTITUTE awards its EDWARD LONGSTRETH MEDAL to DOCTOR FRANK N. SPELLER, of Pittsburgh, Pennsylvania.

THE WORK OF HENRY FORD.

HALL OF THE INSTITUTE,
PHILADELPHIA, March 7, 1928.

No. 2878.

The Franklin Institute of the State of Pennsylvania acting through its Committee on Science and the Arts, investigating the Work of Henry Ford, of Detroit, Michigan, reports as follows:

Henry Ford, the son of William and May Litogot Ford, was born on July 30, 1863, at Greenfield, near Detroit, Michigan. His early life was spent on his father's farm and his education was received at the district school in Greenfield. Living the life of a farmer's boy he became acquainted, in a practical way, with the work to be done on a farm, and later used this knowledge to good advantage in devising machines that have proved of great value in farming operations.

The long and toilsome days of the busy season on the farm did not appeal favorably to young Ford, and since he was interested in all kinds of machinery, he became an apprentice in an engine works where he learned the machinist's trade. Becoming an expert machinist he made rapid progress, and was advanced from one position to another until he became the chief engineer of the Detroit Edison Company.

Mr. Ford made many inventions, and took out many letters patent, in foreign countries as well as in the United States. The first in the United States, No. 686,046, was issued on November 5, 1901, for a Motor Carriage, and was assigned to the Detroit Automobile Company. Many patents

followed in later years, covering many parts of an automobile, and accessories, such as mufflers, chain adjustments, drive gears, steering mechanisms and speed controllers. Perhaps of all Mr. Ford's inventions, that of the planetary drive gear (U. S. Patent No. 787,908, of April 25, 1905) was most significant; for that gear was used on the famous Ford car known as the Model T. These patents of course covered the four cylinder car, known as Model N, of which there were sold in two years a number of cars in excess of the total number of automobiles which all the motor car makers of the world together had been able to produce previously.

The first car was completed in 1892 when Mr. Ford was twenty-nine, but the increase in production was slow for the first few years, it being ten years before the first thousand machines were built. The Ford Motor Company was formed, though, with a small amount of paid in capital, about $28,000, and its progress was necessarily slow. During the early years of automobile production, development was delayed in many cases on account of the Selden patents which were so broad that they covered almost any kind of motor applied to a four wheeled vehicle. Manufacturers were compelled to pay royalties on this patent for some years until after a long series of legal trials the matter was finally settled by a decision in the United States Court of Appeals, in the case of Selden vs. Ford, et al., which declared that the statement "that Selden has solved a great problem and is entitled to the status of a pioneer inventor, is, we think, without foundation."

In all of this litigation Mr. Ford was a leading figure.

In the meantime automobiles were being built abroad by Daimler and Bentz, and in this country by Duryea, Ford, Olds and others and the defeat of the claims of the Selden patent gave such an impetus to automobile construction that the number in use rapidly increased.

The manufacture of machine Model "N" was discontinued and the Ford Machine, Model "T," was standardized in 1908, both as to type of machine and method of manufacture. The output of the Ford automobile manufactory increased from about 10,000 in 1908 to 2,000,000 in 1923 with a falling off during the years of the World War.

The reduction in cost of the Ford car to less than one-

third of the original cost is due to a combination of the following causes: the making of a standard car with parts that are interchangeable; standardization of the manufacture of it; the introduction of moving conveyers by which the work is brought to the workman, each man doing one operation at which he becomes expert, and a determination on the part of Mr. Ford to furnish these cars at prices low enough to permit of their widespread use.

The conveyer system employed in the Ford plants has been an important factor in securing a high rate of production. In this system a continuously moving platform is loaded at the proper intervals with the parts to be used by the workman who stands in one place and makes use of the part as it is brought to him. A careful test is made of the time of each operation and the rate of the moving conveyer regulated accordingly.

The practical result of the introduction of this system has been to increase greatly the speed of manufacture and to facilitate mass production. The last operation in the succession is the assembling of the automobile, which is done on a long moving platform or track, on which the different parts are added in order. When the end of the track is reached, the car can be driven off under its own power.

The conveyer system applied to the assembling of cars, introduced by the Ford Motor Company, and which has been revolutionary in its effect, is now in general use by the automobile and other industries where mass production is required.

On May 26, 1927, the 15,000,000th Ford automobile left the platform driven by Edsel Ford, President of the Company, with his father as passenger. Going to the Museum of the Company, Ford Machine No. 1 was brought out and driven by Henry Ford.

The tremendous increase in the output of the Ford Motor Company is seen in the fact that it operates thirty-five branches in the United States of which thirty-two are assembly plants.

The increased manufacture called for a great amount of raw material and for its preliminary manufacture into the various parts used in an automobile. Believing that these

parts could be manufactured for a lower price by his own plants than that paid for them in the markets, Henry Ford undertook the purchase of raw material and its manufacture as required. This included the acquisition of iron and coal mines and timber lands, and the building of a railroad and line of steamboats. Raw materials are conveyed to the River Rouge plant, which is provided with coke ovens, blast furnaces and saw mills. This plant is equipped with electric furnaces, a cement plant, a glass factory, paper mill, foundry, and machine shops. All these being under the control of a single organization, are highly efficient in producing an economical manufacture of the Ford automobile.

In order to carry out his idea of making machines suitable for farm work, Mr. Ford took up the production of small tractors at the River Rouge plant where the factory for building them has a capacity of 750 "Fordsons," as these tractors are called, each day. These tractors are adapted to many kinds of work and have largely replaced horses.

The extended use of the Ford automobile has resulted from the ability of the company to produce a reliable small car at a low cost. This has been accomplished through Mr. Ford's originality in manufacturing methods, and his genius in building up a large organization, with the economies in buying, manufacture and distribution possible only in large scale operations.

The inexpensive Ford car and truck have materially changed conditions on the farm, enabling a farmer to command better and diversified markets, and to enlarge the social and intellectual contacts of himself and family. The Fordson tractor has increased his efficiency as an agriculturist, and particularly in the Northern States, by dispensing with horses, has enabled him to devote a greater area to crops not consumed on the farm.

To the workman, speedy transportation has opened up a larger field of operation. To the average citizen, the inexpensive car has developed many sources of pleasure heretofore enjoyed only by the wealthy few; and by making possible a more extensive and diversified travel, has created a better knowledge of our country and developed a broader vision.

In consideration of his rare inventive ability and power of

organization, by means of which he was able to effect high speed production of automobiles, revolutionizing the industry; and his outstanding executive powers and industrial leadership, THE FRANKLIN INSTITUTE awards its ELLIOTT CRESSON MEDAL to MR. HENRY FORD, of Detroit, Michigan.

WRIGHT "WHIRLWIND" ENGINE.

HALL OF THE INSTITUTE,
PHILADELPHIA, March 7, 1928.

No. 2890.

THE Franklin Institute of the State of Pennsylvania, acting through its Committee on Science and the Arts, investigating the Wright "Whirlwind" Engine developed by Mr. Charles L. Lawrance, of Long Island, New York, now President and Chief Engineer of the Wright Aëronautical Corporation, of Paterson, New Jersey, reports as follows:

History: At the close of the World War the American aircraft engine industry was concentrated on water cooled engines. This was logical as the water cooled engines had been more successful than the early air cooled type and none of the latter had been developed in the higher powers.

In 1916 Mr. Charles L. Lawrance begun a development of air cooled engines of small power for airplane service in an endeavor to eliminate defects known to exist in previous types of rotary air cooled engines, such as gyroscopic effects, oiling trouble and improper gas distribution, and shortly after produced the three cylinder Lawrance L2 radial air cooled engine. This engine made some notable flights in small planes, but was superseded in a short time by the Wright "Gale" L4 Engine. This was also a three cylinder radial engine and developed 60 horsepower at 1800 r.p.m. It had a bore of 4.25″ and stroke of 5.25″ and weighed 140 pounds.

The success of these low power air cooled engines led to the securing of development contracts from the U. S. Government in 1920 and 1921 for nine cylinder radial air cooled engines of 140 and 200 horsepower. These two engines were developed simultaneously and both passed their fifty