Power
in
the Present

The Development of the Tractor

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A farmer in 1910 needed 135 hours to produce 100 bushels of corn, 106 hours for 100 bushels of wheat, and 276 for a bale of cotton.

The average for the United States in 1960 was about 23 man-hours to produce 100 bushels of corn, 17 for 100 bushels of wheat, and 77 for a bale of cotton.

A reason for this big drop in the American farmer's labor requirement was the development of the tractor.

Tractors were perfected because of the need for mechanical power for the new machines that were being invented and produced for farmers.

Cyrus McCormick invented his reaper in 1831. It soon created a demand for belt power with which to thresh the mechanically harvested grain crops. By 1860 more than 50 shops from Maine to California were building threshers under license from the Pitts Brothers, American inventors who patented a thresher in 1837.

Steel plows, mowers, shellers, fodder cutters, and other machines were offered to the farmer soon thereafter.

The reaper and the thresher made obsolete the flail, which had been in common use for centuries in all parts of the world for beating out the grain from the heads. First it was a whip, sometimes with two or more lashes. The later versions consisted of a wood handle with a shorter stick hung at the end so as to swing freely.

Work animals also became obsolete, in a manner of speaking, in time. Used with sweeps and treadmills, they pro-
vided some power, but not enough for operating the thresher and other belt-driven machines. Manufacturers of thresher and other machines undertook therefore the production of movable steam engines.

The early steam engines furnished belt power, but they had to be pulled from place to place by horses or oxen. One of the first to be produced in the United States was the Forty-Niner. It was built in Philadelphia in 1849 by A. L. Archambault in 4-, 10-, and 30-horsepower sizes. The smallest of these weighed 2 tons, or a thousand pounds per horsepower.

The Baker and Hamilton Co. marketed a movable threshing engine in 1880. The boiler had a jacket of 2-inch staves, held in place by brass bands, and could burn wood, coal, or straw. It had an Ames engine and Laufenburg boiler and was built by the Ames Iron Works of Oswego, N.Y. Henry Ames was one of the early builders and advocates of steampower on the farm, and he founded a factory to make movable engines in 1854.

The next step in the evolution of farm power was the conversion of the portable steam engine into a self-propelled steam traction engine.

The first ones were developed primarily for plowing. Obed Hussey of Baltimore invented and put into operation a "steam plow" in 1855. J. S. Fawkes of Christiana, Pa., produced a more successful steam plowing outfit in 1858. Its frame was of iron, 8 feet wide and 12 feet long, and rested on the axle of a roller (driver) 6 feet in diameter and 6 feet wide.

President Abraham Lincoln, in an address before the Wisconsin State Agricultural Society at Milwaukee, in 1859, said:

"The successful application of steam-power to farm work is a desideratum—especially a steam plow. It is not enough that a machine operated by steam will really plow. To be successful, it must, all things considered, plow better than can be done by animal power. It must do all the work as well, and cheaper, or more rapidly, so as to get through more perfectly in season; or in some way afford an advantage over plowing with animals, else it is no success."

Philander Standish built the Standish steam rotary plow, the Mayflower, at Pacheco, Calif., in 1868. It was offered for sale in several sizes, ranging from 10 to 60 horsepower. Operating speed was 1.7 to 3.4 miles an hour, and the plowing rate was up to 5 acres an hour.

Also in 1868 Owen Redmond of Rochester, N.Y., patented a steam plow. A report of the Commissioner of Agriculture in 1870 announced that "a gang of six plows, designed to go with the engine, has since been constructed, intended to be operated by one man, who also might be the fireman."

While the main efforts in providing self-propulsion systems for steam tractors seemed to center largely around the use of wheel propulsion, many inventors were at work devising methods for providing better traction through the application of tracks and other devices. They worked out many unusual ideas.

Gideon Morgan of Calhoun, Tenn., received a patent for a wheel substitute in 1850. The language of his patent was for an improvement in track-type tractor design; the development of the crawler-type tractor in the United States therefore must have begun before 1850.

R. J. Nunn of Savannah, Ga., patented an "improvement in land conveyance" in 1867. It was essentially two or more bands running over a series of grooved rollers that were mounted in a frame and driven through a larger roller powered by a steam engine.

Thomas S. Minnis of Meadville, Pa., in 1867 patented a locomotive for plowing and in 1870 a steam tractor mounted on three tracks—two in the rear and one in front. Each rear track was driven by a steam engine, attached at the rear, through pinion and drive gear.
According to Hal Higgins, an authority on power farming, “Iowa’s first ‘dirt farming tractor’ was this Minnis Crawler from Pennsylvania that came out to the raw prairie within sight of the new Iowa State Agricultural College as the first students started attending classes within sight of its smoke.”

Robert C. Parvin of Illinois in 1873 built a steam tractor propelled by an endless chain of steel plates to which “feet,” shod with 2-inch plank, were attached. It pulled six plows.

Charles H. Stratton, Moscow, Pa., in 1893 produced a steam-powered traction engine designed especially “to travel readily over plowed ground, for cross plowing, and other work.” The front end was supported by wheels on a pivoted axle and the rear by a pair of compactly arranged tracks actuated through gears and pinions from the horizontal engine. Besides driving the tracks, the engine could be used to drive a shaft that could be used to drive threshers or other machines—a so-called power takeoff.

One of the first attempts to manufacture track-type tractors commercially was made by Alvin O. Lombard of Waterville, Me., in the early 1890’s. He patented one of the first practical track-type tractors in 1901. Lombard adopted the ball tread idea of John B. Linn of Cleveland.

Lombard substituted rollers for the balls. He built a workable tractor and sold a number of machines. The unit was “designed specially for transporting lumber and logs over the rough roads and even cross country in the Maine woods.” It embodied half-track construction. The front was supported by runners in winter and wheels in the summer. Two power-driven tracks were in the rear.

Another track tractor was the Centiped Log Hauler manufactured by the Phoenix Manufacturing Co., Eau Claire, Wis. It resembled the Lombard machine, but it used a vertical instead of horizontal engine.

Other early inventors tried to solve the problems of traction by making the driving wheels wider and wider.

Daniel Best sold his first steamer, a three-wheeler with vertical boiler, in 1869. One big-wheel outfit which was made by the Best Manufacturing Co. in 1900 for the Middle River Farming Co., Stockton, Calif., had two wood-covered drive wheels 15 feet wide and 9 feet in diameter. The outfit weighed 41 tons.

The Stockton Wheel Co. (later the Holt Manufacturing Co.) built its first steam traction engine (of a track type) in 1890. Topography, soil, and their large acreages led farmers on the Pacific Coast to accept this type of tractor more readily than farmers in other sections.

Benjamin Holt successfully demonstrated his first track-type tractor near Stockton in 1904 after considerable experimentation, in which he devised a pair of rough wooden tracks that he installed on a steam engine from which the wheels had been removed.

He made use of three clutches—the master clutch, for connecting the power source, and the track clutches. When the track clutch was released on one side, the power applied through the track clutch on the other side caused the tractor to pivot around the declutched track. Application of brakes on the declutched side increased the speed of turning. This method of transmission continues to be used by the Caterpillar Tractor Co. and has been adopted by most other manufacturers of tracklaying tractors.

Only eight of the track-type Holt steamers were built. He had already made experiments to replace steam power by gasoline, and one model tractor of the track type, which burned gasoline, was produced in 1907.

Inventors between 1870 and 1880 devised a suitable gearing for the rear wheels of portable steam engines of the wheel type and also a chain or belt drive from the engine flywheel to a countershaft of this gearing to provide self-propulsion.

The bevel gear and inclined shaft developed by C. and G. Cooper of
Mt. Vernon, Ohio, was also a popular method of drive. It enabled the farmer to convert his portable steam engine into a traction engine in the field.

A United States patent was issued in 1880 for a steering device, although English tractors were fitted with steering gears as early as 1863. There followed the introduction of a clutch and gear train between the engine and rear wheels.

The steering gears on these early steamers were not at first considered reliable by some manufacturers, and operators were cautioned about their use on public highways.

The suggestion was made that it might be safer to guide the machine with a team of horses. Some said horses were not frightened when they met a traction engine preceded by a steering team. Others felt that the additional horsepower provided by the team was advantageous—some of the reasons why horse steering remained for a while.

Many farmers started buying self-propelled steam engines in the late 1870's. About 3 thousand steam tractors and almost that many steam threshers were built in 1890. Several plow manufacturers advertised multiple-bottom steam tractor plows or gangs in 1894. By 1900 more than 30 firms were manufacturing 5 thousand large steam traction engines a year.

These tractors were improvements over earlier models. The gearing, shafting, and other wearing parts were built to withstand the immense strains imposed upon them in pulling large threshers and plowing many furrows at one time. Big wheat farms and ranches in the Dakotas, Colorado, Montana, Nebraska, Kansas, California, and western Canada were using steam traction engines.

About this time the Geiser and Friede companies, both of Waynesboro, Pa., offered steam lifts for engine gangs. This development indicated, even this early, that thought was being given to cutting down labor requirements in plowing and to lighten-
boiler. The flues passed horizontally from the firebox at the rear to the smokebox in front.

The products of combustion in the return-flue boiler traveled first through the main flue to the combustion chamber in the front end of the boiler and then back through the many small flues to the smokebox in the rear.

Little space was provided under the grates of all three types to catch ashes and cinders. Grates were always in danger of burning out. This danger was overcome in the firebox return-flue boiler, in which water surrounded the heated surfaces, the grate area was larger, and the boiler had a larger heating surface.

Boilers of the vertical type had a cylindrical shell with a firebox at the lower end. Fire flues extended vertically from the flue sheet above the fire to the top of the boiler or horizontal water tubes placed in courses, so that each course was at right angles to the course next below and next above. These tubes and circulation plates maintained constant circulation.

Of the two main approaches in constructing the steam traction engine, one was to make the boiler the central structure and attach all other parts—engine, drive gears, steering gear, main truck—to it. The other was to provide a separate framework on which to mount the boiler and attach all the parts.

To spare the engine from damage from heavy shocks and jars on rough roads, heavy coil springs were placed between the boiler and front and rear axles. Springs in the steering gear helped prevent breakage when the front wheels hit an obstruction.

The early engine usually was mounted on the boiler, called top-mounted, and the boiler was mounted on the truck. Sometimes the engines in the locomotive type were mounted under the boiler.

One common method of mounting the boilers, known as side mounting, was to attach stub axles of the drivers to brackets placed at about the middle of the sides of the firebox. In another type, known as rear mounting, one continuous axle was located back of the firebox. A continuous axle was often mounted ahead of the firebox on return-flue boilers. It was known as under mounting.

The power of the steam traction engine was transmitted usually to the traction wheels by a simple train of spur gears made of cast iron. A driving pinion attached to the friction clutch engaged an intermediate gear, which in turn engaged a large compensating gear on the countershaft. Pinions on either end of the countershaft drove large master gears, which were fastened in the drive wheels by rigid or spring connections.

Traction engines first were geared with one forward speed to make 2 or 3 miles an hour on the road. Later some—especially on those used in hilly country—were geared with two forward speeds, one slow and one fast.

The front or steering wheels often were of steel, with the outer ends of the spokes riveted to a flange inside the rim, and the inner ends riveted to arms on the hub. A flange, or collar, around the middle of the outside of the front wheels tended to prevent lateral slippage. Steering was done by guiding the front wheels with a chain, winding shaft (roller), worm gear, and hand wheel. Sometimes power from the engine helped in steering.

The rear traction, or drive, wheels usually had steel tires, round or flat spokes, and a cast-iron hub. Cleats of steel or iron were mounted diagonally on the outside of the rims to increase traction. On rims that were cast, the cleats were part of the cast.

Early attempts to develop gasoline tractors were sparked by the need to reduce the size of the threshing crews. Such crews included two men to operate the steam engine, two to haul coal and water, two to operate the thresher, a waterboy, and several men to haul bundles to the thresher and the grain away by horses and wagons.
Not the least of the problems was to feed them. Days, maybe weeks, before the threshing crew was due at a farm, the farmer’s wife started to plan and prepare the gargantuan meals she was going to serve them—hams, a side of beef, chickens, fried potatoes, gallons of milk, at least three kinds of pie, maybe homemade ice cream. Her reputation as a cook was at stake, she knew, and the feasts she fixed were something to be proud of and marvel at. Still in our language are terms that recall her and them—“a meal fit for a threshing crew” and “eat like a bunch of threshers.”

Most of the first attempts to develop liquid-fuel tractors consisted of mounting a stationary gasoline engine on a chassis patterned after that of the steam traction engine. This combination became the self-propelled gas engine.

Experimenters even built a gasoline tractor that looked like a steam traction engine with the rather strange idea that thereby they would not scare the horses so much. Also with horses in mind (why, we do not know), some put a whistle on the rig.

Before a tractor could be fully realized, there had to be a promising internal-combustion engine. The early experimenters used gunpowder, turpentine, and natural and artificial gas for fuel.

The discovery of petroleum fuel in quantity speeded the development of the gasoline engine. In 1859, at Titusville, Pa., Edwin L. Drake drilled his first oil well and got the petroleum product that paved the way for the creation of a great industry. The internal-combustion engine made rapid strides when petroleum fuel was available.

About the first internal-combustion engine on record was the one credited to Abbe Hautefeuille, a French physicist, who in 1678 conceived the idea of burning a small amount of gunpowder in a chamber. While he continued experimenting, other French, Dutch, English, and American engineers developed many and various ideas for producing power.

Finally Nicholas Otto, a German, devised a practical power unit of the internal-combustion type. It had one cylinder. Counting the movement of the piston in one direction as one stroke, his engine made four piston strokes per explosion in the same manner as the four-cycle (“Otto cycle”) engines used today in all American-made automobiles. Those in the cars have more cylinders, but they are four cycle.

This development did not begin to assume importance until 1876, when it reached a reasonably satisfactory stage. The patents of the Otto cycle engine, however, were so basic in character that not until they expired in 1890 did other companies start to work on similar engines.

One hundred firms in the United States were making internal-combustion engines by 1899.

Another early and important development was the compression-ignition engine. It was the work of Rudolph Diesel, a German scientist, who patented his first engine in 1892. Before inventing the engine that bears his name, he had considerable experience with air compressors and with internal-combustion engines with spark ignition. He used coal dust, a useless byproduct in mining, which was blown into the cylinder with compressed air. He found out that it was not feasible to use coal dust as a fuel.

Before long Diesel came out with an oil-burning, compression-ignition engine that proved successful. His idea was adopted quickly as a source of power. In the diesel engine, the fuel is injected after compression is practically completed, and is ignited by the heat of compression of the air supplied for combustion.

Probably the first gasoline tractor that was an operating success was the one built in 1892 by John Froelich. A good businessman, he ran a grain elevator, a well-drilling outfit, and a
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threshing outfit powered with a steam traction engine. He wanted to build a smaller tractor—one that would run on gasoline.

He mounted a single-cylinder, vertical-type gasoline engine, made by the Van Duzen Gas and Gasoline Engine Co. of Cincinnati, on a Robinson running gear equipped with a traction arrangement of his own manufacture. It completed a 50-day threshing run belted to a Case 40 x 58 thresher, pulled the thresher over rough ground, and operated in temperatures of -3° to 100° F. The Froelich was the forerunner of the John Deere tractors.

Some of the other tractors of this period were the Patterson, 1892; the Hockett (Sterling), 1893; the Van Duzen, the Otto, and the Lambert, in 1894; the Huber, 1898; and the Morton in 1899. The Patterson became the foundation for the Case line of tractors, and Morton became the forerunner of the International Harvester line.

C. W. Hart and C. H. Parr built their first tractor model in 1902. Their second model a year later was considerably improved. Their 30-60 "Old Reliable" appeared in 1907; in 1909 came the Hart-Parr 15-30, a tricycle type. Even their early models were designed for pulling (drawbar work) rather than for belt work—they made their transmissions rugged to withstand the heavy strains of plowing.

Hart and Parr formed a company that was to become a part of the Oliver Corp. They established in 1905 the first business in the United States devoted exclusively to making tractors.

Other tractors were the Electric Wheel, 1904; the Dissinger, 1904; the Eason-Wysong Auto-Tractor, 1905; and the Ohio, 1905.

The Ohio Manufacturing Co. later bought the patent rights for the Morton and in 1905 built a few tractors for the International Harvester Co., which in 1907 built its first tractor. Like the Ohio tractor, it was friction drive for both forward and reverse.

Other models were the Waterous in 1906, the Transit and the Ford in 1907, and the Russell, Olds, Joy-McVicker, and the Geiser in 1909. The Ford tractor of 1907, an experimental machine made by the Ford Motor Co. of Detroit, used parts of a Ford car and a binder. The front wheels and axle and steering were from the car. The rear wheels were binder bullwheels.

The origin of the word "tractor" was originally credited to the Hart-Parr Co. in 1906 to replace the longer expression "gasoline traction engine," which W. H. Williams, the company's sales manager, who wrote the advertisements, considered too cumbersome. The word actually was coined previously and was used in 1890 in patent No. 425,600, issued on a tractor invented by George H. Edwards of Chicago.

Although tractors powered with internal-combustion engines had been manufactured for about 20 years, people generally had no chance to compare field operations of steam and gasoline tractors until the first Winnipeg trial in 1908, conducted under the auspices of the Winnipeg Industrial Exhibition in Canada. In that and in tests in 1909-1912, representatives of many countries witnessed the competition of gasoline tractors plowing in the same fields with steam tractors.

The first Winnipeg trials were mainly contests of hauling and plowing for comparison of such factors as the thousand foot-pounds hauled per pint of fuel and the pints of fuel used per acre. The trials became more comprehensive with the years, until in 1912 the score sheet included an economy brake test, maximum brake test, plowing test, and a rating on design and construction. The contests showed, even at that early stage, the possibilities of the gasoline tractor. The interest created by the trials encouraged experimenters and manufacturers to continue their pioneer efforts.

Most of the gasoline tractors before 1910 had automatic intake valves, hit-and-miss governors, and make-and-break ignition systems. Electric current
The frames of the wheel tractors were built up of channel iron, to which the engine and other parts were bolted. Most large drive gears were of cast iron, exposed to the dust and dirt, and wore rapidly. The built-up drive-wheels, often 6 feet and sometimes 8 feet in diameter, turned on a one-piece "dead," or floating, axle. Selective-type transmission, where there were any gears to select (many had only one speed forward), was common, although friction drive and planetary-gear transmissions were not uncommon. Clutches varied.

Makers of steam tractors and makers of gasoline tractors competed strongly during 1910-1920, when the number of tractor manufacturing companies increased from 15 to more than 160 and existing companies began to present more than one model. The president of a gasoline tractor company said that when he first went into business the manufacturers of steam tractors refused to load their machines on the same freight cars with gasoline tractors.

The International Harvester Co. in 1910 produced its 45-horsepower Mogul, which had a two-cylinder horizontal opposed engine, with gear drive forward and friction reverse; in 1911, the 45-horsepower Titan, with a two-cylinder twin horizontal engine, with gear drive forward and reverse; in 1912, the 15-30 single-cylinder Mogul; in 1914, the 10-20 Titan with a twin horizontal-cylinder engine, and the 8-16 Mogul with a one-cylinder horizontal engine and planetary-gear drive forward and reverse; and in 1915, the 15-30 Titan, with four-cylinder horizontal engine. The 8-16 International, with a four-cylinder vertical engine, the first to bear the company's name, appeared in 1918. It was one of the early attempts to design a machine suitable for smaller farms.

The International Harvester Co. introduced a practical power takeoff for its tractors in 1918. It permitted direct transmission power from the engine to such equipment as mowers, small combines, and sprayers. That was an important development. Most tractor manufacturers soon had their tractors so equipped, and they started to fit many of their field machines for power takeoff drive.

Deere & Co. brought out the Waterloo Boy in 1916 and a twin horizontal-cylinder kerosene-burning engine and 180-degree crankshaft, and so inaugurated a basic engine design that is to be found in most of its current models. The machine performed well at the National Tractor Demonstration in 1918 at Wichita, Kans.

The Bear, produced by the Wallis Tractor Co. in 1912, proved to be the advance guard of the Massey-Harris line. It had one front steering wheel, a directional vane, and two rear driving wheels.

The Wallis Cub appeared in 1913. It also was a three-wheeler, but it had a more compact design and introduced a revolutionary development—a frameless-type construction. The one-piece, U-shaped crankcase and transmission housing of boiler-plate steel was the backbone of the machine. The industry liked it, and soon designs by various manufacturers were introduced.

The Ford Motor Co., after considerable experimentation, in 1917 started production of the Fordson. It also was of unit-frame construction but of cast iron instead of boiler-plate steel. The tractor was light for its power and relatively low in price. This unit-frame type was practicable. Most manufacturers soon adopted the idea.

This Fordson development came at an opportune time—the year the United States became involved in the First World War. Boatloads of horses were being shipped abroad. Labor was
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becoming scarce. Materials were restricted. Power became more vital than ever. The manufacture of more than 34 thousand Fordsons in 1918 and 100 thousand by 1925 (25 and 75 percent, respectively, of the tractors produced by all companies) helped greatly to meet difficulties caused by the war. After 1925, with returning normalcy and the increasing interest in the general-purpose tractor, production of the Fordson dropped, and its manufacture was discontinued in this country in 1928.

The J. I. Case Co., which had built its first machine in 1892, resumed building tractors in 1911, when the Case 30–60 appeared. It produced in 1912 the Case 20–40, which performed exceedingly well at the Winnipeg Trials that year. Case built its first tractor with a four-cylinder vertical engine in 1915. It had three wheels—a single front steering wheel, the right rear a driver, and the left rear an idler. Case produced the 9–18 model in 1918 and in 1919 the 15–27, both of one-piece frame, or unit, construction.

The Allis-Chalmers Co. built its first tractor in 1914. It had three wheels and 10–18 horsepower. In 1916 Allis-Chalmers introduced a cultivating tractor of 6–12 horsepower, which also could pull a plow. The company soon became an active contender in the business.

A significant development in 1913 was the introduction of the Bull tractor by the Bull Tractor Co. of Minneapolis. It was powered by a small engine of 12 horsepower. It started a trend toward smaller units, which practically all manufacturers followed. Several hundred machines were sold in its first year; within a year Bull ranked first among all tractor manufacturers in the number produced. Its relative position declined from year to year, though, and in 1918 it ceased production. This tractor had one drive wheel, making a differential unnecessary, and an idler wheel mounted on a crank axle on the left side for leveling.

The Minneapolis Steel & Machinery Co. and the Minneapolis Threshing Machine Co. started producing tractors in 1911. In 1914 the Moline Plow Co. started production of the Moline-Universal, which was one of the earliest practical approaches to a general-purpose tractor. A later edition of the Moline-Universal, the Model D in 1917, probably was the first tractor to make use of a storage battery for ignition, starting, and lighting. The three companies merged in 1929 into the Minneapolis-Moline Power Implement Co., which later became the Minneapolis-Moline Co.

The large tractor, seemingly the predominant type in 1910–1920, could not accomplish the many tasks necessary to mechanize the farm—it could only plow, drive threshers, and pull large headers. Much thought had been given to the problem. Manufacturers began experimenting with light tractors suitable only for cultivating, and some eight or ten companies produced them.

Light tractors did not fill the need, however, for two tractors thus were necessary on the farm, and that was beyond the farmer's needs and pocketbook.

A machine was needed that would plow and thresh and with proper attachments would also cultivate, sow, and perform other field operations—an all-purpose tractor.

Experimentation continued meanwhile on track-type tractors. Various models appeared: The Bullock Creeping Grip (1910) by the Bullock Tractor Co. of Chicago; the Yuba (1912) by the Yuba Manufacturing Co., Marysville, Calif., with the tracks mounted on "balls that rolled in a race"; an improved model (1912) by Holt; the Killen-Strait (1914) by the Killen-Strait Manufacturing Co., Appleton, Wis., with two track drivers in the rear and one front steering track; the Bates Steel Mule C (1916) by the Bates Machinery and Tractor Co., Joliet, Ill., with a single track in the rear for driving and two widely spaced front steer-
ing wheels; the Trundaar (1916) by the Buckeye Manufacturing Co., Anderson, Ind.; the Leader (1917) by the Dayton-Dowd Co.; the Bear (1918) by the Bear Tractor Co., N.Y.; the Cleveland H (1918), later to be made by the Oliver Corp.; the Monarch (1918) by the Monarch Tractor Co., Watertown, Wis., later to merge with the Allis-Chalmers Manufacturing Co.; and the Best (1913) by the C. L. Best Gas Traction Co., San Leandro, Calif., which in 1925 combined with the Holt Manufacturing Co. to form the Caterpillar Tractor Co.

It is of interest that during the First World War the Holt Caterpillar tractor was important as an artillery and supply tractor and also was the inspiration of Gen. E. D. Swinton, a Briton, who invented the tank, which worked havoc among enemy troops and installations. This tank consisted of two large motor-driven tracks, one on each side, between which was mounted an armor-plated housing, which protected the crew, turret, and guns.

Tractors in 1920, considered collectively, embodied fundamental principles of engineering and design that exist, perhaps in more refined form, in today's tractors.

The one-piece cast-iron frame, replaceable wearing parts, force-feed and pressure-gun lubrication, enclosed transmission, carburetor manifolding, air cleaner, electric lighting and starting, high-tension magneto ignition with impulse starter, enclosed cooling system, antifriction bearings, alloy and heat-treated steels, and the power take-off had all been introduced. Some experiments had been made with rubber tires. The light-weight, low-price tractor had been designed and widely accepted. Several fairly successful motor cultivator-type units were on the market.

The advantages of the tractor as a farm power unit had been well established. More than 160 companies produced 200 thousand units. (Fifteen companies made 4 thousand tractors in 1910. The number of manufacturers reached a peak of 186 in 1921.)

Many makes and types of tractors were on the market. Many turned out to be impracticable, and often the farmers were the scapegoats—many fence corners harbored so-called tractors, abandoned as useless, often even before they were fully paid for.

The farm equipment industry and others began to work for a standardized rating of tractors. Nebraska in 1919 passed a bill that in effect required that all makes and models of tractors to be sold in Nebraska pass certain tests.

The Nebraska Tractor Law specifies: "... Each and every tractor presented for testing, shall be a stock model and shall not be equipped with any special appliance or apparatus not regularly supplied to the trade. ..."

"Such tests shall consist of endurance, official rating of horsepower for continuous load, and consumption of fuel per hour or per acre of farm operations. The results of such tests shall be open at all times to public inspection. ..."

The tests began in 1920. With modifications, they have continued since, except during the war. The test codes used in Nebraska were developed by engineers in the University of Nebraska, the Society of Automotive Engineers, and the American Society of Agricultural Engineers.

The tests, which have been used all over this country and in many other countries, have provided standards for rating tractors, have speeded up improvements on many of them, and have eliminated many that were inferior in design and performance.

A drop in production of tractors occurred during the postwar depression. Manufacturers, instead of just marking time, took this chance to incorporate new features. In the keen competition that followed, the tractor was improved steadily, although a number of companies had to discontinue business.

The depression brought a big drop in prices: Fordson tractors sold for 395
dollars in 1932—a 35-percent drop from the price in 1921. The Moline tractor, which sold for 1,325 dollars in 1920, was reduced to 650 dollars. One result was that many farmers who otherwise would not have been able to take advantage of power farming got good equipment.

Attention had to be given to air cleaners used on the engines. Dust that enters the engine from the intake can damage the working parts—particularly the pistons, rings, and cylinders.

Many makes and types of air cleaners appeared. They differed in ability to remove dust, the degree to which their use imposed vacuum or choking on the carburetor intake, and their effect on the maximum power to be obtained from the engine.

To determine the dust separation efficiency, vacuum imposition, and effect on power, tests were made at the University of California at Davis. The dust-separating efficiency of the 26 cleaners tested in 1922 varied between 42.7 percent and 99.8 percent. Fifteen cleaners had more than 95 percent efficiency.

The International Harvester Co. in 1924 produced the Farmall, probably the first successful attempt to build a real all-purpose tractor. It could plow (two-plow size), cultivate four rows, and, as attachments were developed, do other jobs. It probably did more than any other to broaden the usefulness of the tractor and thus to further mechanization on the farm.

The Farmall had high rear-axle clearance; small, closely spaced front wheels to run between rows for cultivation; and a hitch for attaching a cultivator or other equipment. Industry accepted it readily. Soon similar machines appeared, designated as General-Purpose, Universal, All-Around, Row-Crop, Ro-Trac, Do-All, and so on.

Deere & Co. in 1923 offered the rugged Model D tractor, which became one of the company's standbys. It produced in 1928 its first general-purpose tractor, the 10-20, with arched front axle and high-clearance rear axle and three-row planting and cultivating equipment. Deere in 1929 put on the market its GP tricycle tractor, equipped with a mechanical power lift for lifting integrally mounted implements. It was the first tractor so equipped.

Several companies developed refinements: The Oliver tricycle row-crop tractor, with tiptoe wheels; the Massey-Harris FWD (four-wheel drive); the Allis-Chalmers all-crop, and the Case.

Mechanical power farming slowed down in 1931, but even in that depression year several more companies offered row-crop machines, among them Huber, Caterpillar (a high-clearance, track-type machine), and Sears, Roebuck and Co.

Another advance in 1931 was Caterpillar's Diesel 65, the first diesel-powered tractor in the United States to be put on the market. It was an important step, and several companies, after experiments, put out diesel-powered tractors in 1934. Most of the tractor companies now have diesel-powered tractors in their lines.

The wheel tractor was rough to ride. A farmer, after a day on one, was well shaken up; he had had it.

Relief came in pneumatic tires, which made riding easier and reduced vibration. They also meant less wear on tractor parts, permitted higher speeds in the fields and on roads, and reduced rolling resistance—all in all, more efficient operation.

Citrus growers in Florida, having noted that the tractors damaged the roots of the trees, in 1928 or so started putting discarded casings (without inner tubes) on steel wheels. That seemed to help.

Tiremakers watched this development, and in 1931 the B. F. Goodrich Co. developed a zero-pressure tire. It consisted of a rubber arch built on a perforated steel base for attachment.
CHANGING SOURCES OF FARM POWER
TRACTORS, HORSES, AND MULES

Tractors
(exclusive of farm and garden)

Horses and mules
(all ages)

Among the tools developed for use with the motor lift were two- and four-row corn and cotton cultivators, two-row potato cultivators, ten-row truck crop seeders and cultivators, six-row beet planters and cultivators, four-row corn and cotton planters, three-row middlebusters, two-row listers, and 7-foot mower attachments.

Allis-Chalmers in 1938 made a one-plow, general-purpose tractor, Model B, that weighed less than 2 thousand pounds. It sold for 495 dollars at the factory—the first small farm tractor, mounted on rubber, to sell for less than 500 dollars.

Another development that improved the usefulness of tractors was the three-point hydraulic hitch developed by Harry Ferguson in Ireland and brought to this country in 1939 after many tests. It was a revolution in implement control. It strongly influenced the whole trend of design of tractors and equipment.

After a demonstration before Henry Ford, a working agreement was established between Mr. Ford and Mr. Ferguson for mass production of a tractor incorporating the Ferguson system.

Hydraulic systems have become
standard or optional equipment on practically all models of tractors. The hydraulic system includes an oil receptacle, pump, valves, and a control lever within reach of the driver, connected by means of high-pressure hose to a power cylinder (a piston within a cylinder), which can be located on any part of the tractor or trailed implement where a control is desired. The hydraulic systems can control mounted and drawn implements, govern the depth of tillage implements, operate loaders, and activate power steering. Sometimes they can be used to increase the traction of the rear wheels by transferring a part of the weight of the implement to the rear wheels of the tractor.

The Minneapolis-Moline Co. in 1941 introduced the first standard tractor fitted at the factory for burning another type of fuel for tractors—LP (liquefied petroleum) gas. Some companies previously had offered kits for converting the tractors in the field from gasoline or kerosene to LP gas.

This LP gas, a light end of the crude oil, had been largely a waste product until means had been developed to liquefy it by compression. When the cost of the two fuels is similar per unit of work, LP gas has advantages in that it burns cleaner and causes less oil dilution. Gasoline is usually more readily available, and the engine is easier to start with it on cold days.

All major manufacturers of wheel tractors produced one or more LP gas-burning models in 1960.

Experimental work on tractors was again curtailed during the Second World War. Few new models appeared. Many tractor plants were converted to make war materials. Tractor production increased rapidly after the war; 793,497 tractors were made for farm use in 1951.

A marked improvement in the extremely important power takeoff, which we mentioned, was offered by the Cockshutt Plow Co., Brantford, Ontario, in 1947.

It was a continuous-running power takeoff (direct engine-driven power takeoff), which continued to operate even when the clutch was released. Heretofore, machinery operated by the regular power takeoff, such as sprayers, drawn cornpickers, and combines, would stop when the clutch was released. The continuous-running power takeoff allows one to stop the travel of the tractor without stopping the power takeoff. The same can be done with the independent power takeoff, which was developed later.

All major manufacturers of farm tractors now furnish one or more models of their tractors with either continuous-running or independent power takeoff.

Another use of hydraulic control came in 1947, when Allis-Chalmers offered its Model WD tractor, fitted with a device for power adjusting the rear wheel tread. It permitted the operator to use the engine power for changing the spacing of the rear wheels while sitting on the tractor seat. He was spared the strenuous and time-costly job of making tread alterations by the hand-and-jack method.

All but one of the major American manufacturers of tractors offered models with power-adjusted rear wheel tread as standard or optional equipment in 1959.

The International Harvester Co. in 1954 announced a new source of farm electrical power, the Electrall, that can be mounted on its tractors. It is an electric generator driven by the tractor engine. Besides supplying electric power for tractor-drawn machinery, such as hay balers, and for farming operations where the utility companies' wires did not reach, it can also serve as a standby unit in case of failure of electric service.

It is provided with outlets that supply three types of current: 220-volt, three-phase 60-cycle alternating current, mainly for driving electric motors; 120-volt, single-phase current to attach to house wiring circuits; and
TRACTORS MANUFACTURED IN THE UNITED STATES, 1909-1958
(Exclusive of steam and garden) for agricultural, industrial, and military use

220-volt single-phase current for such heavy requirements as the electric range.

Later a trailing model of the Elec-trall was announced, mounted on a two-wheeled trailer and driven from the power takeoff of the tractor.

Among the major improvements in the transmission systems since 1954 are those that permit “on-the-go” shifts, a greater range of travel speeds, and automatic adjustment of speed to draft requirements.

International Harvester put a new torque amplifier on the Farmall Super M-TA. A lever near the driver allows the operator instantly to reduce the travel speed 33 percent when the going gets difficult and at the same time increase the drawbar pull in any selected gear without stopping, or declutching, or shifting and without touching the governor control or throttle setting.

Another example of a new power transmission is the one announced in 1958 by the J. I. Case Co. A direct-drive clutch, a torque converter, and a master clutch give the tractor operator the option of the hydraulic torque converter or mechanical direct drive.

Still another example of new transmission is the “Select-O-Speed” announced by Ford in 1959. The transmission is a 10-speed, fully selective power shift unit. It is controlled by one small hand lever. There is no clutch pedal, and yet shifting can be made with the tractor in motion with almost no interruption.

We feel we should mention self-propelled machines although they are not tractors—they take the place of tractors where they are used. Their propelling power unit is an integral part of the implement.

The self-propelled combine—harvester-thresher—appeared in commercial production in 1944. About one-fifth of the million combines on farms in the United States were of this type in 1958.

The Massey-Harris Co. received special authority in 1944 from Government war agencies to make and distribute 500 self-propelled combines to experienced operators. This Harvest Brigade began operations early in May in Texas and California and worked north. By the end of the season they had harvested more than a million acres, or an average of more than 2 thousand acres for each combine.

Self-propelled units are easier to operate and have faster working speeds...
than trailed machines. They lose less time in opening fields and moving between jobs. Because they cost more, single-purpose self-propelled machines must have a relatively larger annual use to be comparable to the trailed units in cost.

Self-propelled machines, sprayers, cornpickers, hay balers, windrowers, and forage harvesters also were made in 1960.

Another machine is the self-propelled chassis, on which various harvesting units can be mounted interchangeably.

The Minneapolis-Moline Co. in 1945 presented details for the Uni-Farmor system, which provided a chassis or Uni-Tractor equipped with a power unit upon which several types of machines could be mounted. The company had four separate and interchangeable harvesting machines ready in 1954 for use with the Uni-Tractor: A combine, cornpicker, cornpicker-sheller, and forage harvester. Several other manufacturers started to make units that could be used with the Uni-Tractor, including forage harvesters, a sugar beet harvester, and an applicator of anhydrous ammonia.

Attachments of several types have been developed to make the operation of the tractor more automatic.

One kind of tractor guide uses the last plow furrow of the previous round as a guide to steer the tractor. The guides are most successful in large, level fields.

A Department of Agriculture engineer in the Texas High Plains reported: “Some farmers in the Amarillo and Lubbock area use guides for flat breaking and planting. For flat breaking, the operator makes the first few rounds driving the tractor. Then he plows 24 hours a day, and comes back to the field only to refuel. This is accomplished with disks mounted ahead of the front wheels and running in the furrow. If the guide or tractor gets out of the furrow, the ignition is automatically cut off. For planting, the disks are mounted in front of the front wheels of the row-crop tractor and stay in the lister furrow. The operator watches his cotton boxes while going down the row and gets back on the tractor seat to turn it around at the end of the row.”

Tractor guides of the furrow type have been commercially available from manufacturers of tractor accessories for many years. Five were listed in a 1959 directory of farm machinery manufacturers.

The International Harvester Co. in 1931 equipped one of their Farmall 30 tractors so that it could be controlled by radio. The tractor was demonstrated to thousands of people at the Century of Progress exposition in Chicago in 1933.

A member of the staff of the Department of Agricultural Engineering in the University of Nebraska in 1958 equipped a farm tractor with radio controls, by means of which the tractor could be started, stopped, and steered and its gears shifted. The operator was some distance away.

Another development for guiding tractors is an automatic pilot. It is actuated by lightweight feelers that can sense the position of the crop row to be cultivated, the windrow to be baled, or the distance to any other row to be followed. This pilot was not intended to replace the operator but to be an aid to make his work better and easier.

Two research engineers who had worked independently announced in 1958 that they had developed an automatic tractor pilot—L. A. Liljedahl, of the Department of Agriculture, and C. B. Richey, of the Ford Motor Co.

The Ford Motor Co. demonstrated a self-steering tractor at its testing center at Birmingham, Mich., in 1958. The sensing antenna for the steering controls is between the front wheels of the tractor and picks up its signals from a small wire buried under the test track. A second antenna receives start and stop signals over the same wire to control the clutch and brake.
Engineers of the University of Reading, England, in 1959 demonstrated a tractor controlled by a wire laid along the ground or just under the surface. Controls were available for steering, starting and stopping, operating the clutch, power takeoff, horn, and other mechanisms.

These and similar controls, which depend on a wire for guidance, may be useful on a test track or for performing certain operations that are repeated frequently in the barnyard or other fixed course. We question their value for work in the fields.

The efficiency of tractors has been improved greatly over the years. One measure of that is the amount of fuel used.

Tests at the University of Nebraska showed that in 1920 the average wheel-type tractor tested delivered 5 drawbar horsepower-hours per gallon of gasoline or distillate. The average wheel tractor tested in 1959 delivered 10 horsepower-hours to the gallon. The average wheel-type tractor with diesel engine delivered 10 drawbar horsepower-hours per gallon in 1935 and 13.3 horsepower-hours per gallon in 1959.

A reason for the greater efficiency has been the use of higher compression ratios in many of the gasoline-burning engines and the increased use of diesel engines. (The compression ratio is the relation of the volume within the cylinder when the piston is at its bottom dead center to the volume when at the top.)

The compression ratios of spark-ignition engines in 1941 varied from about 4 to 6; in 1959 the compression ratios of spark-ignition engines varied from about 4 to 8.5. Compression ratios of current diesel tractor engines vary from about 15.5 to about 22. (American automobile engines in 1960 had compression ratios from about 8 to 10.5.)

Many other improvements have been made in tractors.

Valves have been improved by the use of better alloys, and their life has been lengthened by the use of rotators and valve seat inserts.

Valve guides and spark plugs have been improved.

Bearings are precision manufactured to carry greater loads with less susceptibility to fatigue and greater resistance to corrosion.

Better oils and methods of lubrication have been provided, as have improved ignition and cooling systems.

Such improvements give the farmer more power from his tractor with little or no increase in cost or weight.

The electric starter, rubber tires, motor lift, hydraulic controls, and easily attached hitches are among the pieces of equipment that have made operation easier.

Many improvements contribute to the operator's comfort. Deere & Co. came out in 1946 with a Powr-Trol unit to be attached to trailing implements so that they could be lifted and lowered by hydraulic power from the tractor. Hydraulic remote controls were common enough by 1949 so that standards on them were adopted by the American Society of Agricultural Engineers and the Society of Automotive Engineers.

Power steering in automobiles inspired power steering in tractors. Allis-Chalmers put power steering attachments on the WD-45 (wheel type) tractor in 1956. All major American manufacturers offered at least one model with power steering as standard or optional equipment in 1960.

Seats on tractors used to be simple things of steel which soon became quite uncomfortable to the driver. Now they are of foam rubber or are equipped with springs, some of which are adjustable to the operator's weight. Some tractors are equipped with umbrellas, windshields, air-conditioned cabs, and radios. They are a matter not only of comfort, although that is important when days are from sunup to sundown, the thermometer stays at 100°, and clouds of dust fill eyes, nose, and mouth.
They increase efficiency and safety and are a matter of common sense, for a valuable crop, expensive machinery, and a man's life may be involved.

Safety is more important than comfort. In a great number of farm accidents, tractors have been a factor. The National Safety Council, professional engineering societies, manufacturers, and individuals have worked constantly for greater safety.

An important step was the adoption of standards for the location of the tractor hitch to help prevent the rearing of the tractor when under load. Design standards have been adopted also for the power takeoff and for safety lighting for combinations of farm tractors and implements. The improvements in hitches and the wide adoption of hydraulic power also have done much toward making the tractor safer to operate.

Nevertheless, every farmer should pay more attention to safety. The tractor replaces the horse, but the use of some horsesense would help prevent accidents. Only a fool works in front of the cutterbar of a mower, binder, or combine when the tractor engine is running, drives too close to a ditch, or hitches a load to the rear axle and jumps into it with the full power of the tractor. The load should be hitched to the drawbar, and the clutch should be eased in.

The manufacturers put protective guards on machines for a purpose—they should be kept there.

Professional engineering societies and industry groups have contributed greatly to the development of the tractor. Among them are the American Society of Agricultural Engineers; the Society of Automotive Engineers; the Farm Equipment Institute, which has a membership of more than 100 manufacturers of tractors, bearings, pistons, steel, aluminum, and tires; and the Tire and Rim Association, Inc., whose members are makers of tires, rims, wheels, and related parts.

Manufacturers of tractors have found it highly desirable to adopt certain standards to provide for the interchangeability of various brands of implements between tractors.

One example: It would not be hard to imagine the confusion that would be created if the tractor power takeoffs were not uniform in speed, location, and drive shaft. The adoption of these standards in manufacture is voluntary on the manufacturers' part, but they cooperate with the professional societies and other organizations that strive to achieve uniformity of many of the components of their units. Hydraulic control, power takeoff, lighting, and wheels are examples of components covered by standards and recommendations sponsored by joint action of the American Society of Agricultural Engineers and the Society of Automotive Engineers.

To develop some of the recommendations for standardization is not always a simple task. One, for example, recommended preferred drive wheel tire and rim sizes for general-purpose farm tractors. The recommendation was developed chiefly by four groups, the American Society of Agricultural Engineers, the Society of Automotive Engineers, the Farm Equipment Institute, and the Tire and Rim Association. Besides adopting certain standards that pertain to their own industry, tractor manufacturers also adopt some of the standards developed for automobile and other manufacturers so that there is general uniformity in certain components, such as pistons, antifriction bearings, oil filters, spark plugs, bolts, and screws.

The usual channel of distribution of farm tractors and repair parts involves manufacturer, branch, dealer, and farmer.

The manufacturer owns the branch. It is in an important regional center and carries a large stock of the equipment and repair parts that may be needed in the territory.

The local dealer, selected or approved by the manufacturer, usually
sells and services the full line of farm machinery of the manufacturer for which there is a demand in his community. He is an important link in the distribution of tractors and other farm machines. He must be a good merchant and he must also know the functions of each implement he sells and the size and type of equipment required. He has to be able to furnish good service to keep them running. His repair shop is much more than the old type of blacksmith shop. It is equipped to service and repair gasoline and diesel engines, combines, and others of the more complicated, precision-built implements that have become commonplace in farm operation.

Prompt service is so important in connection with tractors and other important farm machinery that many successful dealers have service shops at their retail stores and provide specially equipped trucks whose drivers can make repairs and adjustments in the field. In emergency, repair parts are delivered by air from the factory or branch.

All of the large manufacturers of tractors have grown to their present stature by developing new and improved types of tractors and other farm equipment and by acquiring other companies engaged in the manufacture of items which they wished to add to their lines. Expansion enabled them to increase their volume and provide complete lines to offer to distributors and dealers.

One 1960 Directory of American manufacturers of farm machinery listed 13 manufacturers of crawler tractors and 35 builders of wheel-type tractors. Nine full-line companies made a large percentage of the machines. We give a few details about each of them.

The International Harvester Co., Chicago, the largest manufacturer of agricultural machinery in the United States in 1960, was incorporated originally in 1902 and began producing tractors in 1906. Several large firms were merged to form it. The company maintains a dozen or more factories in this country and several in Canada and other countries. Tractors are manufactured at plants in Chicago, Louisville, and Rock Island.

Deere & Co., Moline, Ill., the largest manufacturer of steel plows and our second largest manufacturer of agricultural machinery, bought the Waterloo Gasoline Engine Co. in 1918 and began to build tractors. The name of the gasoline engine company was changed to John Deere Tractor Co. in 1926 and later to Deere & Co. Back of this tractor company was an organization originally established by John Deere in 1837.

The J. I. Case Co., Racine, Wis., the third largest, was incorporated in 1880 as the J. I. Case Threshing Machine Co. The business was originally established by Jerome I. Case in 1842. The J. I. Case Threshing Machine Co. was actively engaged in the building of steam tractors in the 1890's and was among the first to turn to the gasoline tractor. The plant at Racine was enlarged in 1912 to permit the production of tractors. Engines were bought from the Davis Motor Co., Milwaukee. In 1913 they started building their own engines. In 1919 it merged with the Grand Detour Plow Co. It purchased the implement plant of the Emerson-Brantingham Corp. at Rockford, Ill., in 1928, when the J. I. Case Plow Co. of Racine was taken over by the Massey-Harris Co. of Toronto. The J. I. Case Plow Co. of Racine was taken over by the Massey-Harris Co. of Toronto. The J. I. Case Plow Co. sold the rights to use of the name “Case” and “J. I. Case” to the J. I. Case Threshing Machine Co. of Racine. Thus an end came to years of confusion caused to these two concerns that had the same name but were not connected with each other.

The Massey-Harris Co., an amalgamation in 1891 of the Massey and Harris companies, Canadian manufacturers of agricultural machinery and tractors, extended its holdings in this country through the purchase of the
THE DEVELOPMENT OF THE TRACTOR

J. I. Case Plow Co. at Racine in 1928. The J. I. Case Plow Co., incorporated in 1919, was a consolidation of the J. I. Case Plow Works Co. and the Wallis Tractor Co., both of Racine. The plow company, established in 1876, engaged primarily in the manufacture of plows and tillage equipment. The Wallis Tractor Co. was organized in 1912 to manufacture farm tractors. Harry Ferguson, Inc., merged with the Massey-Harris Co. in 1953, and the resulting company became Massey-Harris-Ferguson, Inc. “Harris” was dropped from the name in 1958, and the firm became Massey-Ferguson, Inc., with United States headquarters in Racine.

The Oliver Farm Equipment Co., incorporated in 1929, acquired the business and property of six manufacturers to become a full-line agricultural implement company. Chief among these were the Oliver Chilled Plow Works of South Bend, Ind., the Nichols and Shepard Co. of Battle Creek, Mich., the Hart-Parr Co. of Charles City, Iowa, and the American Seeding Machine Co. of Springfield, Ohio. When this consolidation was effected, efforts were concentrated on the well-known Hart-Parr tractor, and the Nichols and Shepard factory was converted into one building harvesting and threshing machines. The tractors were produced under the name of Oliver Hart-Parr. The Cleveland Tractor Co., which had been making a tracklaying tractor under the name of “Cletrac,” in 1944 combined with the Oliver Farm Equipment Co. to form the Oliver Corp., and all of the equipment and tractors are produced under the name of Oliver.

Formation of the Minneapolis-Moline Power Implement Co., incorporated in 1929, was the result of a merger of the Minneapolis Steel and Machinery Co., the Minneapolis Threshing Co., the Moline Implement Co. The Minneapolis Steel and Machinery Co., organized in 1902, had been building Twin City tractors since 1908, and at the time of merger was engaged in the manufacture of threshing machines and tractors. The principal products of the other two companies included tillage implements, which, combined with the tractor and threshing machine companies, gave another full-line agricultural implement company. The Allis-Chalmers Manufacturing Co. was incorporated in 1913. Its expansion through the acquisition of eight manufacturing concerns widened its scope to embrace a diversified line of power machinery. It began to manufacture farm tractors shortly after the beginning of the First World War. In 1928 it took over the Monarch Tractor Co. (incorporated in 1918) and has since manufactured tracklaying tractors under the name Allis-Chalmers. The Advance-Rumely Co., makers of threshing machines and farm tractors, was acquired in 1931.

The Caterpillar Tractor Co., Peoria, Ill., was formed by a merger of the C. L. Best Tractor Co. of San Leandro, Calif., and the Holt Manufacturing Co., which had plants at Stockton and Peoria. The latter firm was the originator and holder of the Caterpillar trademark. The Best Co. was organized in 1910 and the Holt Co. in 1892, a successor to earlier Holt firms dating from 1869. Benjamin Holt built the first practical crawler tractor in 1904 at Stockton. The Holt Manufacturing Co. purchased the interests of Daniel Best in 1908, and the latter retired from business. C. L. Best, a son of Daniel Best, formed his company in 1910 and in 1913 started producing tracklayers in his father’s old plant at San Leandro. stiff competition ensued between the two interests until the merger. In 1928 the Caterpillar Tractor Co. acquired the Russell Grader Manufacturing Co. of Minneapolis, a manufacturer of roadbuilding machines for more than 20 years. The products of the Caterpillar Tractor Co. then included tracklaying tractors, combined harvesters, stationary engines, and a varied line of roadbuilding equipment.

The Ford Motor Co., Tractor
and Implement Division, Birmingham, Mich., was one of the major producers of wheel-type farm tractors in 1960. The Ford Motor Co. produced its first tractor for the trade in 1917 under the name Fordson. The name Ford could not then be used because it had already been given to a tractor manufactured by a group that included a young man by the name of Ford. The production of Fordson tractors increased rapidly to a yearly peak in 1925. Thereafter production declined, and the production of Fordsons in the United States ceased in 1928.

The Ford Motor Co. again started the mass production of tractors in 1939. Henry Ford made a working agreement with Harry Ferguson of Ireland, whereby Ford tractors were made which used the Ferguson system of a combined linkage and hydraulic control. The oral agreement between Mr. Ford and Mr. Ferguson was terminated late in 1946. Thereafter Ford continued to manufacture tractors, making use of the three-point suspension and hydraulic system. Harry Ferguson, Inc., also continued to manufacture tractors with a three-point suspension and hydraulic system, making use of engines from another manufacturer.

Never before has such a wide selection of sizes and types of tractors been available to the American farmer as in 1960.

Among the wheel tractors are sizes that pull a 12-inch plow and sizes that can pull eight 16-inch plows. Speeds of only 1 mile an hour are available for special jobs.

Most of the wheel tractors made in this country use gasoline or distillate as fuel, but each major manufacturer makes at least one model with a diesel engine and at least one model that burns liquid petroleum. Nearly all of the track-type tractors use diesel engines, but one manufacturer, the Oliver Corp., makes three models in the smaller sizes that burn gasoline.

Every major line includes all-purpose tractors—those to which cultivators, planters, and other field equipment can be attached readily. These models are designated in various ways by the manufacturers with such names as General Purpose, Farmall, and Universal. All-purpose tractors usually have three wheels, the front wheels of the others are adjustable as to tread. Other models are available that have higher crop clearance than usual and are sometimes listed under such designs as Hi-Crop.

Small four-wheel tractors of the riding type usually are of less than one 12-inch plow capacity. Many have appeared on the market since the war, and are popular with part-time farmers and others who have occasional need for a small tractor. Most of them have a single-cylinder, air-cooled engine.

Power is usually transmitted from the engine to the drive wheels by combinations of belt, chain, and gears, although some have gear and worm transmission. Many attachments are available—plows, rotary tillers, harrows, seeders, cultivators, sprayers, sickle bars, rotary mowers, and snowplows.

A variety of garden tractors and motor tillers also are available. They are of the walking type. They usually have one or two wheels, but motor tillers may have no wheels that touch the ground.

Many farmers use garden tractors for odd jobs for which larger tractors are too cumbersome and uneconomical. Commercial vegetable growers also use garden tractors, but most are bought by suburban homeowners.

Nearly 40 thousand garden tractors of the walking type were shipped by American manufacturers in 1958. Nearly 3 thousand had 2 horsepower or less, and more than 37 thousand had more than 2 horsepower. Of the 174 thousand motor tillers shipped by the manufacturers in 1958, more than 152 thousand had more than 2 horsepower.

All of these garden tractors have a single-cylinder, air-cooled engine,
which usually is started by a rope. Most of those with an engine of up to 2 or 3 horsepower do not have a clutch for releasing the engine; instead, the engine is released from the drive wheels by loosening the belt, either by means of an idler pulley or by tilting the engine. Many attachments are available for garden tractors—rotary tiller, harrow, cultivator, seeder, mower, hay rake, cart, grader, fertilizer spreader, and snowplow.

Ordinarily it would be advisable to select a make that is available locally. Then one could see and maybe operate the machine before purchasing it. A 1- to 2-horsepower engine will be large enough for light work, such as cultivation, but for plowing with a conventional plow and extensive land preparation, a tractor with an engine of at least 3 to 4 horsepower will be required.

As to the future, we expect more widespread adoption of many of the improvements now limited to particular models.

The trend in automobiles leads us to expect the development of fuels and engines that will use higher octane gasoline.

There may be radical changes in engine design. Ford, for example, began work in 1954 on a free-piston engine that uses heated gases to drive a turbine and does not require many of the parts of a conventional engine. It shows promise of fuel economy, and it is adaptable to a wide range of fuels.

Nuclear power is an intriguing possibility. A small unit suitable for powering tractors may be in the offing using the principles in use in large installations. With nuclear power, it may be necessary to refuel only once a year.

Another possibility is a tractor with hydraulic drive, which would be driven by two hydraulic motors, one in each drive wheel. The National Institute of Agricultural Engineering in England has developed an experimental model of such a tractor.

Perhaps the self-propelled chassis, with its own power unit, will become more competitive with the conventional tractors of today.

Electric tractors are mentioned sometimes. Storage batteries for power have not been satisfactory, nor has electricity from powerlines through cables. Future development of an electric tractor will probably depend on efficient transmission of current without wires or the development of an efficient long-life battery much superior to those now available.

Tractors of the future will be easier to use. More of them will have power steering, scientifically designed seating, and an automatic pilot to guide the tractor along the crop or other row to be followed.

Using Wheels To Move Farm Loads

Jordan H. Levin

Wheels we tend to take for granted, as we do some other things that are common, useful, and old.

The story of wheels, though, is almost the story of civilization and surely the story of agriculture.

The importance of wheels is that a man can use them to multiply the work of his arms, legs, back, and even his brain.

Wheels move materials, animals, and people slowly or fast and up and down from where they are to where they