ASME International

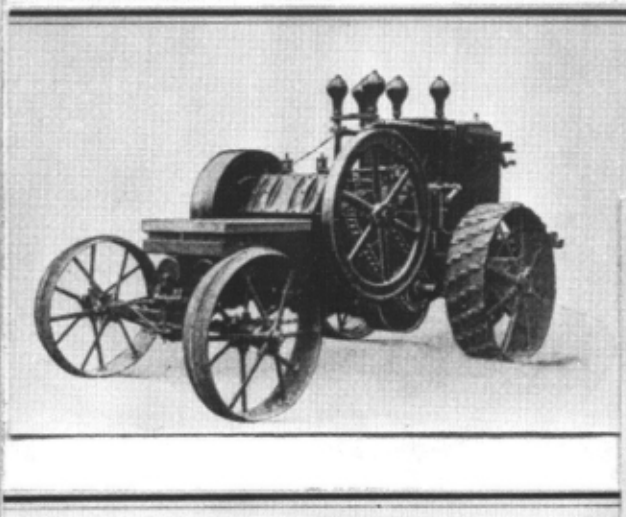
THE HART-PARR TRACTOR

INTRODUCED IN 1901

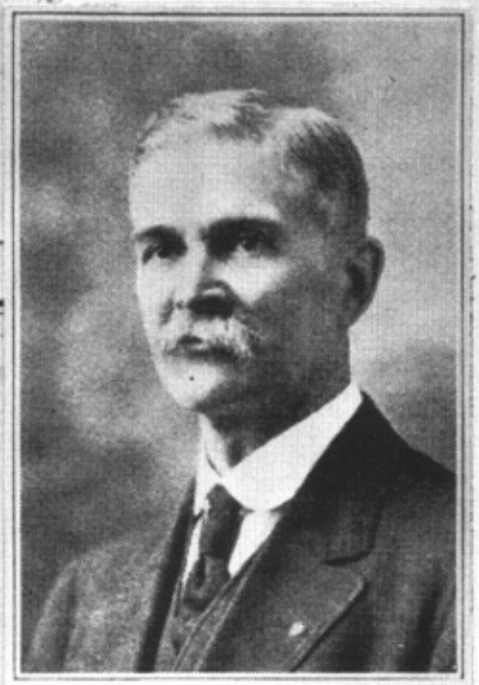
A NATIONAL HISTORIC MECHANICAL ENGINEERING LANDMARK

C.W. HART

(1872-1937)



(1868-1941)



C.H. PARR

The first home of the Hart-Parr Company, 1900, and old Hari-parr Number 1. First successful gasoline tractor ever built. Built in 1901 sold in 1902. Operated successfully by its farmer owner for 17 years.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
MAY 18, 1996
CHARLES CITY, IOWA

HART-PARR TRACTOR'S CONTRIBUTION TO THE ADVANCEMENT OF AGRICULTURE

By

JOHN E. JANSSEN

INTRODUCTION

Steam engines were introduced to farming following the Civil War. By 1900 there were 30 companies manufacturing 5,000 steam engines per year. The boiler and water supply made the engines big and heavy. Roads and bridges were often unable to support the weight of these engines. Suitable fuel was scarce on the western prairies. Soft coal produced soot that fouled the fire-tube boilers. Soft wood had a low heating value and hard wood slabs were awkward to handle. The fire box was a source of hot embers that sometimes set grain fields on fire. Water was a problem also; it required another man and a team of horses to haul water from sometimes distant locations. Thus, it was widely recognized that a successful internal combustion engine would be a great advantage.

Charles W. Hart and Charles H. Parr met as mechanical engineering students in 1892 at the University of Wisconsin in Madison, Wisconsin. Their mutual interest in the development of the internal combustion engine led them to a joint, extra credit project to produce an internal combustion engine. In fact, they produced five engines and graduated with honors. They found some financial backing, incorporated and built a small factory in Madison to produce stationary engines. These were designed to run on gasoline. According to Hart-Parr records, about 1,200 stationary engines were built at their Madison factory.

By 1900, production had exceeded their factory space and Hart wanted to build a traction engine that could pull a plow. They needed more capital and a larger factory. This they found in Charles City, Iowa, Hart's birthplace. Charles Hart's father interested local business men in backing a new factory located in Charles City. It was incorporated June 12, 1901. Construction of a factory in Charles City exclusively for producing "Gasoline Traction Engines" began July 5, 1901. This was the first factory for producing farm tractors exclusively.

AGRICULTURAL MACHINERY DEVELOPMENT

To fully appreciate the contribution that Hart and Parr made to the advancement of agriculture, it is necessary to follow the development of the internal combustion engine from its ftrst inception and the development of farm machinery during the 19th century.

John Deere developed the polished steel, mold-board plow to plow the heavy black soil of northern Illinois in 1837. Cyrus McCormic invented the reaper in the 1840's. Following the Civil War and the opening of the Mid-Western United States to farming, there was a general movement to mechanize agriculture. Coupled with this was the need for mechanical power sources to replace horses. Steam power had been exploited during the Civil War, and efforts were made to use steam engines on farms. These were only partially successful. Steam traction engines were big, heavy, and awkward to maneuver considering the power they could develop.

Steam engines were used with some success to power threshing machines in the 1870's, and they continued until the 1930's. They had several draw backs, however. The fuel, coal or wood, was usually in short supply on mid-western farms. The use of these fuels in the boilers presented a fire hazard. More than one grain field and straw stack was set afire by embers from the stack or fire box on the engine. Thus, there was an urgent need for an engine that was more compact, more maneuverable, that did not require a water supply and could operate on a fuel that did not pose the fire hazard of coal or wood.

I C ENGINE DEVELOPMENT

In 1678, Abbie Hautefeuille proposed a gunpowder engine to raise water. Huygens and Papin improved on this principle. John Barber, 1791, and Robert Street, 1794, patented gas engines. Phillipe Lebon, Samuel Brown, L. W. Wright, and William Barnett made advances in the early 1800's. Saudi Carnot, 1824, put the analysis of heat engines on logical footing and devised the ideal cycle for a heat engine. Unfortunately, no one to this day has been able to construct an engine based on Camot's cycle. J. J. E. Lenoir of France made a successful gas engine in the 1860's. Beau de Roachs devised a cycle on which N. A. Otto based his four stroke gas engine. Otto obtained a U. S. patent in 1876. His coverage was

very broad, and he put a high price on the royalty for his patent. This stifled development until the European courts limited his monopoly in 1890. Otto died in 1891 and his U. S. patent expired in 1894. Julius Hock of Vienna is reported to have developed a gasoline engine in 1874, but Otto received a patent. In 1889, Franz Burger and the Charter Co., developed an engine on wheels that could be moved about for belt work. Other inventors began to experiment in 1890's. By 1901 there were twelve examples of IC engines mounted on wheels, some of which could be called tractors:

Prototype Tractors

1889	Charter	1894	Lambert
1892	Froelich	1896	Daniel Best
1892	Paterson	1898	Huber
1893	Hockett/Sterling	1899	Morton
1894	Van Duzen	1901	Kinnard-Hanes
1894	Otto	1901	Hart-Parr

TRACTOR DEVELOPMENT

John Froelich was a custom thresher operating in South Dakota. He experienced the problems of steam power with his J. I. Case steam engine. He obtained a Van Duzen single cylinder gas engine and mounted it on a Robinson steam engine chassis. He devised a reversing gear so that it could back up. Steam engines can rotate in either direction by adjusting the valve timing with a Stephenson valve lever. Four cycle IC engines rotate in only one direction. Froelich used his engine during the 1892 threshing season. He formed the Waterloo (Iowa) Gasoline Traction Engine Co. Between 1893 and 1896 he produced four machines. Two were sold but subsequently returned because they did not meet the buyer's expectations. The Waterloo Co. made a corporate decision to concentrate on stationary engines, and they did not re-enter the tractor business until 1913. Froelich left the company which was reorganized as the Waterloo Gas Engine Co. There is speculation that he may have worked for Hart-Parr after 1901, but this has not been documented.

Benjamin Holt of Stockton, California produced his first horse drawn combine in 1886. It required 20 horses to pull it. Daniel Best built a steam powered, straw burning combine a few years later. His combine had wheels each 9 feet wide to support the weight of the machine on the soft, sandy soil of the Sacramento River delta, where it was used. Best incorporated to produce steam engines in 1892. He demonstrated an internal combustion engine tractor in 1896, but he did not put it into production. Holt demonstrated his crawler tractor powered with an IC engine in December of 1904, but he did not form a company to start producing crawler tractors until 1908. By then Hart-Parr was selling tractors worldwide. Best sued Holt for patent infringement in 1908. The suit was settled when Holt bought out the Daniel Best Co. Best died in 1908. His sons formed the C. L. Best Co. in 1910 to produce internal combustion (IC) engine tractors. The C. L. Best and Holt Companies merged in 1928 to form the Caterpillar Co.

J.I. Case is said to have experimented with an IC engine machine in 1902, but steam engine business was good and they concentrated on that for another 20 years.

HART-PARR FOUNDED

Hart-Parr's Charles City factory built in 1901 was the birth of the farm tractor industry. Their first gasoline traction engine, No. 1, Serial No. 1205 was built in late 1901 and sold in July of 1902 to David Jennings of Clear Lake, Iowa. (See D. Strawser's comments attached.) This machine used a two-cylinder engine of 9-inch bore and 13-inch stroke developed for their stationary engine line. It was rated at 17-drawbar horsepower and 30-pulley horsepower. The first production run of 13 tractors was in the fall, winter and spring of 1902-03. These were rated at 17-30 horsepower. The drawbar horsepower was always significantly lower than the pulley because of friction in the large gear reduction needed--about 50:1, slippage between the wheels and ground, and the energy needed to move the tractor. Tractor Serial No. 1207 of this style is the oldest Hart-Parr in existence, and is in the Smithsonian collection.

Also, in 1903 they increased the engine bore to 10 inches and the stroke to 15 inches. This increased the horsepower to 22-40 on the drawbar and pulley. Serial No. 1341 of this model was sold to the grandfather of William Peterson Jr. of Lowell, Indiana in 1904. Peterson still has the tractor and it is in running condition.

HART-PARR ENGINE

The first engine used a push-rod operated exhaust valve and a spring loaded intake valve. Speed was controlled by holding the exhaust valve open when the engine reached its Upper limit. The engine would then miss-fire. This was call the “hit or miss” system.

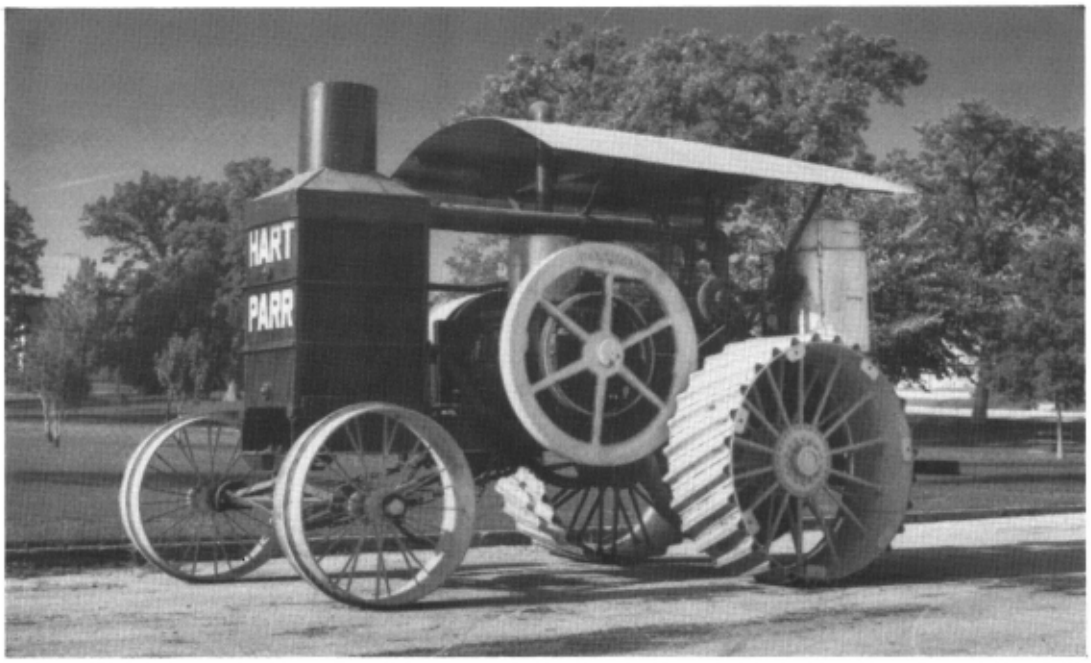


Fig. 1. The Old Reliable 30-60

Hart and Parr had introduced the valve-in-head design with overhead cam in their 1896 stationary engine. During the 1901-04 period they used both push-rod and overhead cam operated valves. They referred to the overhead cam operated valve as a rotary valve. After the 1905 the overhead cam was used exclusively. This is standard in almost all IC engines manufactured today.

Hart-Parr introduced the heavier drive gear design in 1904, called a plow gear. The standard gear used a bevel gear differential. A spur gear differential was used for the plow gear. This could transmit more torque. The same tractor models could be ordered with either differential. Hart-Parr tractors were known for their rugged construction.

THE KEROSENE ENGINE

Until 1904 Hart-Parr engines were designed to run on gasoline. They originally used a fuel pump system, but because of a lack of gasket and packing materials that would tolerate gasoline without leaking, they substituted a gravity fuel feed system. They had designed their own carburetor. Gasoline supplies were becoming less reliable by 1904 because of competition from the rapidly developing automobile market. Prices for gasoline were increasing, and there was speculation that it might be rationed. Kerosene was cheaper, more plentiful, and the energy content per gallon was higher because kerosene is more dense. Consequently, in 1904 Hart and Parr invented a double carburetor that metered kerosene through one side and water through the other side. An engine running on plain kerosene had a very serious combustion knock problem. Hart and Parr found they could ameliorate this problem by adding water to the combustion air. In practice the engine was started on gasoline. When thoroughly warmed up, the operator changed a valve that switched the fuel from gasoline to kerosene. Then, when the engine began to knock, the operator opened a water valve that provided water injection to the engine. This controlled the knock. Since the engine speed was controlled by the hit or miss method, water was consumed only when the engine was under load. It was said that water consumption was about equal to fuel consumption. This was the first known use of water injection in an IC engine to control combustion knock. The principle has been used in high-performance engines since then; World War II fighter aircraft used water injection for emergency power. Although Hart and Parr failed to take the trouble to caver many of their inventions with patents, they did apply for coverage on the double carburetor in 1908 when Rumley copied much Hart-Parr technology. The patent issued in 1915.

Ignition was also at an early stage of development. Hart-Parr used a dry-cell battery system for starting the sengine. In 1904 they introduced a low-tension

magneto for running. This was the first use of a magneto ignition system on tractor engines.

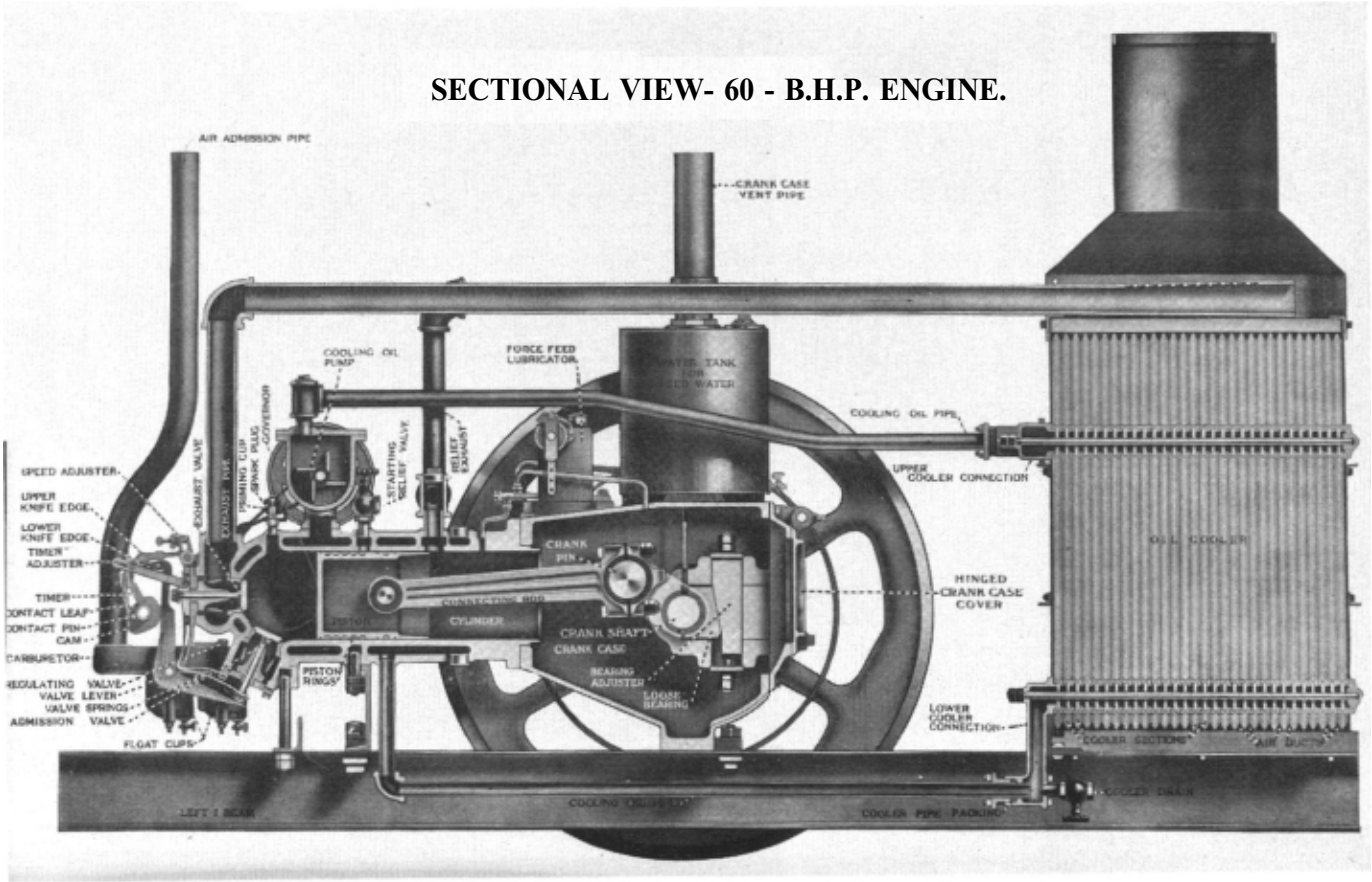
A forced feed lubrication system was introduced in 1905. Oil from a central reservoir was pumped to all of the bearings. As the oil leaked out of the bearings it collected in the crankcase. From here it was piped out of the engine to drip on the external drive gears. The flow of oil through the bearings and onto the drive gears kept them clean, but it produced a large oil/dirt collection on the inside rim of the rear wheels. The machines were called gas or gasoline traction engines by the industry until Hart-Parr started using the term "Tractor" in their advertising literature in 1907. Other producers rapidly followed the Hart-Parr lead.

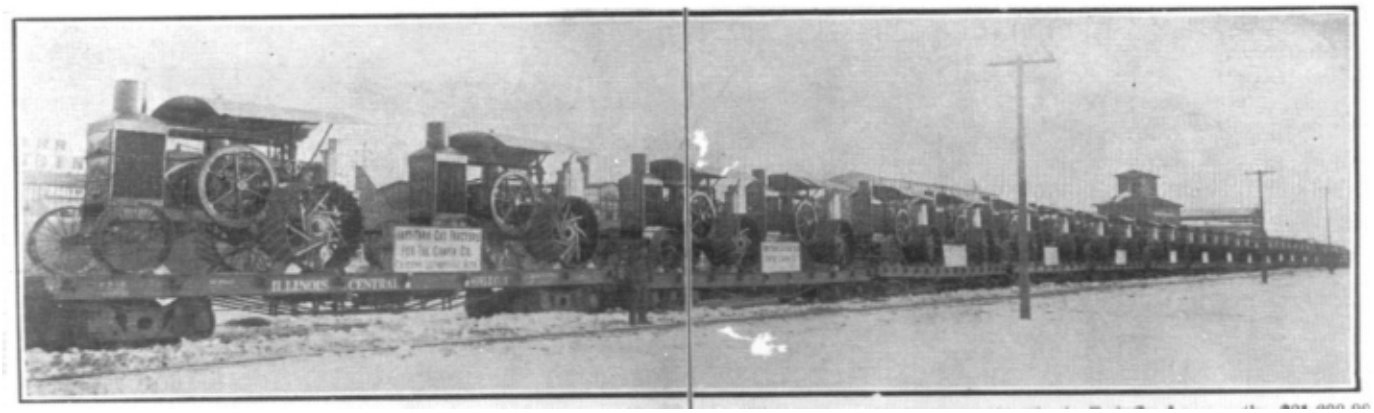
The 1908 22-45 tractor had the centerline of the cylinder offset to one side of the centerline of the crankshaft. The centerline of the connecting rod was then more nearly normal to the crank pin during the power stroke of the engine. This increased torque, reduced piston slap and reduced vibration. This feature has been used in other engines. Chevrolet accomplished the same effect in some of their engines by locating the wrist pin in the piston slightly to one side of the centerline.

RUMLEY CONNECTION

Meinard Rumley, a blacksmith in LaPorte, Indiana began building steam engines to power threshing machines in 1861. By the early 1900's he could see the future of an IC engine for this purpose. He died in 1904, but his sons carried on his business. After Charles Hart died in 1938, most of his personal records were destroyed. Ben Hart, C. W. Hart's nephew, has reconstructed stories from his personal knowledge, that of his aunt's, C.W.'s widow, and other family members. Mrs. Hart said that a Rumley had worked for Hart-Parr as an employee. Antagonism between Hart-Parr and Rumley grew to a point where, about 1908 or 1909, Rumley commandeered or hired away Hart-Parr's chief engineer, who's name is not known. On January 15, 1909 O. B. Zimmerman, Hart-Parr's chief draftsman left Hart-Parr for Rumley. Zimmerman may have been the "chief engineer" referred to by Mrs. Hart. Also a salesman, P. B. McIntrye, left for Rumley.

There was another story that Charles Hart went to LaPorte to help Rumley develop the first Oil Pull Kerosene Annie tractor. Chuck Hart, C. W.'s son, could not verify this and doubted its truth. In any





Train load of 34 Hart-Parr Tractor Engines Leaving Charles City, IOWA, for Canada, Jan. 25, 1910. These sold for 2,400.00 each, the Train Load representing $81,600.00

event, Rumley introduced the Oil Pull in 1909. It was almost a copy of the Hart-Parr 30-60. Charles Hart did not take time to file patent applications on many of his inventions. He was apparently angered by Rumley's free use of Hart-Parr technology and did file an application for his vaporizing, water/fuel carburetor in 1909. The patent was not issued until 1915, but it must have persuaded Rumley to adopt a Secor atomizing carburetor which permitted the fuel/air mixture to be throttled with a valve. Thus, the Rumley abandoned the hit or miss method of speed control. By 1910, carburetor technology had advanced considerably. Rumley went through bankruptcy in 1915 as a result of a crop failure in 1912 and the war in Europe in 1914.

The Rumley Company was reorganized as the Advance Rumley Co. which also absorbed Altman-Taylor. Both Advance and Altman-Taylor were old steam engine manufacturers that had turned to IC engines. Rumley had previously (1911) acquired Garr-Scott who in tum had acquired another company a year earlier. Thus by 1910 a great deal of consolidation was going on in the industry that Hart-Parr had started in 1901.

FOREIGN MARKET EXPANSION

In 1908 Hart-Parr opened offices in Wichita, Kansas and Aberdeen, South Dakota. Branch houses were erected in Grand Forks, North Dakota, Portage La Prairie, Manitoba, and Great Falls, Montana. Trade contracts were entered into with firms in Buenos Aires, Argentina, in Austria and in Russia. Shipments of Hart-Parr tractors were made to Cuba, Chile, and the Philippine Islands. Hart-Parr was an international company in 1908 at a time when most of its competitors were just entering the U. S. Market.

The opening of the Great Plains region to agriculture following the Civil War had been the great incentive to mechanize American agriculture. Breaking the prairie sod was largely beyond the capability of horses. Steam engines were tried at first, but the problems already discussed proved to be more than steam traction engines could handle. It was the internal combustion engine tractor that solved the problem, and Hart-Parr was the leader.

Europe already had an established agriculture based on horses. Thus, there was less incentive for developing IC engine powered tractors. Nayler & Co. Ltd. of Hereford, England developed steam powered tractors, trucks, and wagons in the late 1800's. They were producing, "Lampless Oil Engines, Petrol Engines, and Machinery" by 1913. The outbreak of World War I in 1914 stalled the development of the IC engine tractors for Nayler and other European manufacturers. Europe did not begin to catch up with the United States until the 1920's.

SUMMARY

All of the tractors produced around 1910 were similar in appearance to the Hart-Parr. The two-cylinder engine with cylinders mounted horizontally and the crankshaft parallel to the axle was common. Exposed spur gears were used with a friction clutch for a forward and a planetary gear for reverse. Kerosene or distillate was the common fuel. Some used water cooling, however. This was the state of the art by 1910. The Hart-Parr No. 1 tractor, Serial No. 1205 was used by the original owner for 5 years. It passed through several other owners the next 12 years and was finally scrapped shortly after World War I. A few model 2's still exist in private hands. Serial No. 1341, owned by William Peterson of Lowell, Indiana may be in the best condition. There are no examples of Model No. 2 in museums for public display, however.

Model No. 3, designated the 17-30, used a 2 cylinder engine with a 9 inch bore and 13 inch stroke. It

developed 17 horsepower on the drawbar and 30 on the pulley. In 1907 the engine bore was increased to 10 inches and the stroke to 15 inches. Introduction of the overhead cam and valves in the head brought the horsepower up to 30 and 60 on the drawbar and pulley respectively. Designated the 30-60, it became known as the "Old Reliable" and it was produced until 1918. Four additional units were built on special order in 1924. A total of 3,798 units were built. The Charles City tractor is one of these.

Hart-Parr's major accomplishments in the development of a successful farm tractor included the oil cooled engine, the valve in head principle with overhead cam, the magneto ignition system, the plow gear, the vaporizing carburetor with water injection, and forced fed lubrication. (See the attached list for their claimed firsts.) They offered various wheel types for use on different soils. One four-cylinder model of 100 horsepower was developed, but it was decided that this was too big. They were concerned about the ability of users to safely operate and maintain such a large machine. In 1912 they developed a course to train users in the operation and maintenance of their tractors. Courses were taught at some of the branches, and a correspondence school course was developed.

It should be noted that both the Encyclopedias Brittanica and Americana recognize the Hart-Parr No. 1 as the first commercially successful farm tractor and Charles City, Iowa as the birthplace of the industry. All historians agree.

Tractor Show - Dallas Texas about 1910 - 12

HART-PARR TRACTOR BEGINNING

by Doug Strawser

The first Hart-Parr traction engine was assembled during the winter of 1901. A type L (30 hp) 9-inch bore stationary engine was mounted on a pipe frame chassis, using steam engine wheels. It was sold to David Jennings of Clear Lake, Iowa, being delivered on July 19-26, 1902.

The second Hart-Parr traction engine consisted of a type L (30 hp) 9-inch bore stationary engine (cylinders inverted with exhaust downward), mounted on a chassis completely designed by the Hart-Parr Co. Their I-beam frame and planetary clutch unit assemblies were introduced on this tractor. It was assembled during the summer of 1902 and sold on July 15, 1903 to P. Wendeloe of Ethan, South Dakota for $1,800.00

The fall of 1902 and spring of 1903 saw the first production run of Hart-Parr traction engines numbers 1206 - 1218. These 13 units used 30 hp type L engines having cylinders mounted so that the exhaust exited upward through the canopies. This was the first successful group of tractors produced in the United States.

HART-PARR FIRSTS

Hart and Parr were never content or so full of confidence that they had a lead on the competition. They never let up on their efforts to better their products. They kept a keen edge and were compulsive tinkerers and experimenters, racking up improvement upon improvement. Their accomplishments--"firsts" in the tractor industry--read like a list of historical events:

1900	First oil cooled engine produced
1901	First successful tractor brought out
1902	Developed valve-in-head principle for tractor engines
1903	First standardized type of tractors completed on the 22-45 size
1904	First successful method of burning kerosene for fuel brought out
1904	First magneto ignition on tractor engines
1905	First force-fed lubrication on tractor engines
1907	Developed famous Hart-Parr "60" line
1908	Developed first foreign tractor business
1910-1914	Developed early types of small tractors
1912	Brought out the world's largest tractor -- 100 horsepower
1914	Standardized tractor production on four wheel construction
1917	Developed modem Hart-Parr "30" tractors
1918	Perfected principle of outside counterweights on tractor engines
1918	Brought out first kerosene fuelizer
1920	Alemite system of force-fed lubrication adapted to tractors
1925	Set world's non-stop drawbar record

The series is impressive and Hart-Parr advertised their "firsts" throughout the world.

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THE HISTORY AND HERITAGE PROGRAM OF THE ASME

The ASME History and Heritage Recognition Program began in September 1971. To implement and achieve its goals, ASME formed a History and Heritage Committee, initially composed of mechanical engineers, historians of technology, and curator (emeritus) of mechanical engineering at the Smithsonian Institution. The Committee provides a public service by examining, noting, recording, and acknowledging mechanical engineering achievements of particular significance. The History and Heritage Committee is part of the ASME Council on Public Affairs and Board on Public Information. For further information please contact Public Information, American Society of Mechanical Engineers, 345 East 47 Street, New York, NY 10017-2392,212-705-7740.

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The ASME Historic Mechanical engineering Recognition Program illuminates our technological heritage and serves to encourage the preservation of the physical remains of historically important works. It provides an annotated roster for engineers, students, educators, historians, and travelers. It helps establish persistent reminders of where we have been and where we are going along the divergent paths of discovery.