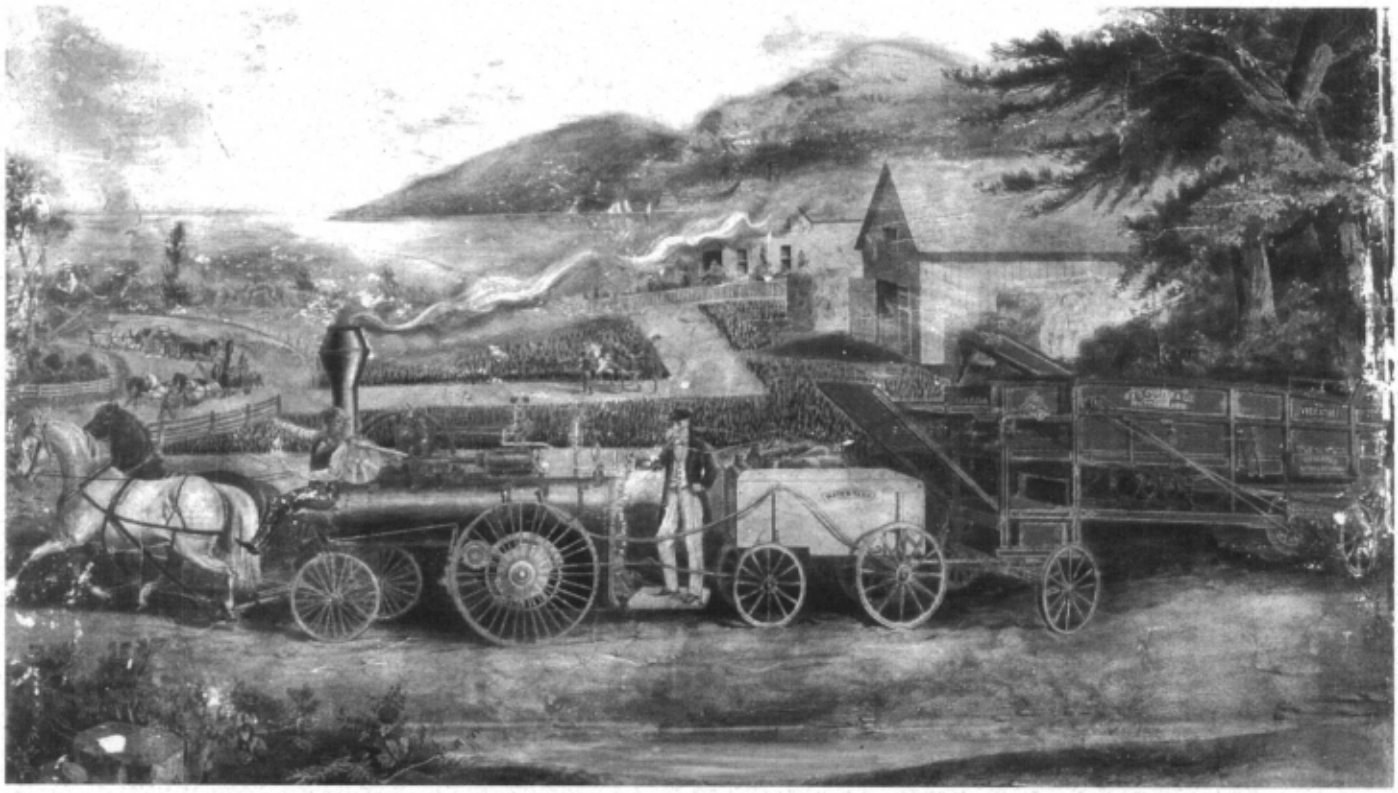
ASME International

COOPER AGRICULTURAL STEAM ENGINES



A

Mechanical Engineering Heritage Collection

Knox County Historical Museum

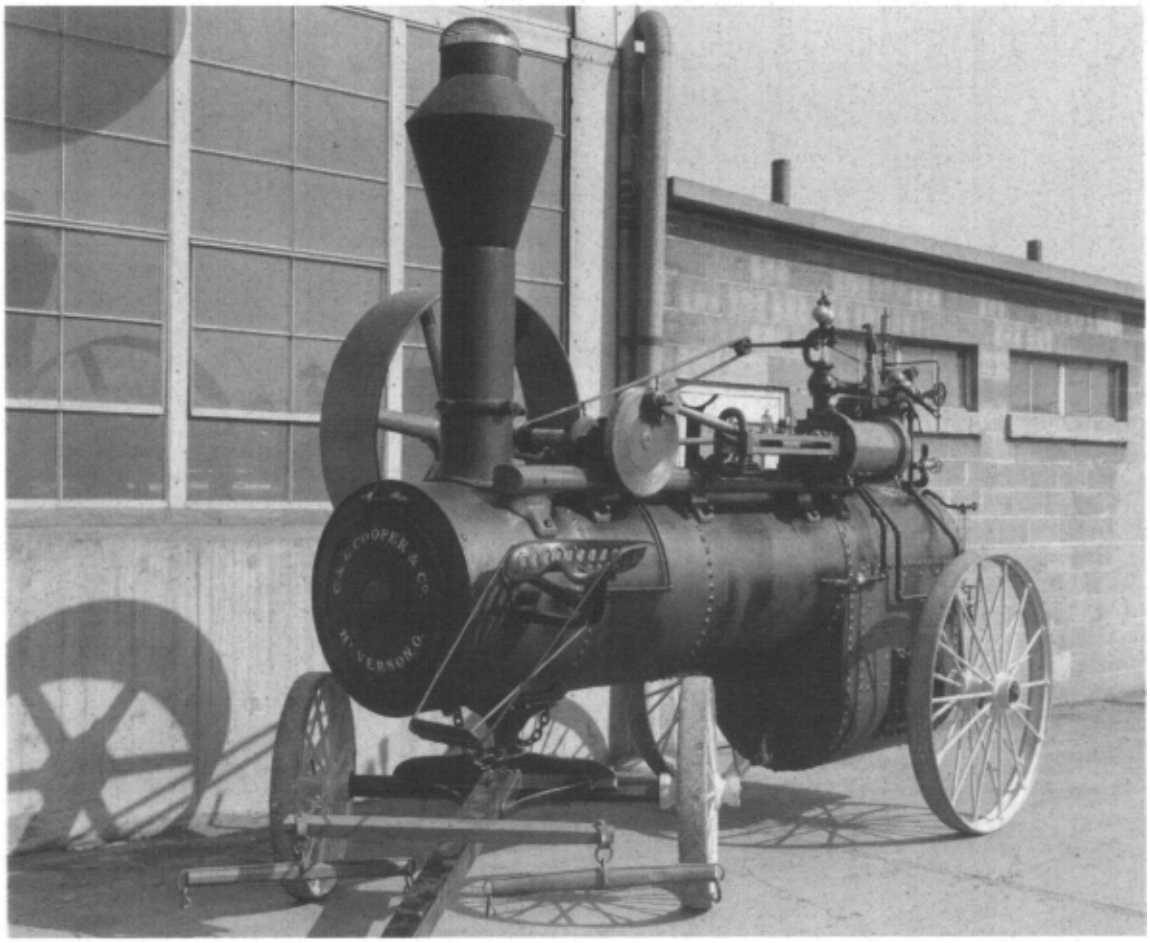
Mount Vernon, Ohio

September 17, 1998

MECHANICAL ENGINEERING HERITAGE COLLECTION
COOPER AGRICULTURAL STEAM ENGINES

THESE ENGINES, BUILT BY COOPER & CO., OF MOUNT VERNON, ARE AMONG THE OLDEST SURVIVING AGRICULTURAL STEAM ENGINES. THEY SHOW THE EVOLUTION FROM THE PORTABLE, SKID-MOUNTED ENGINE (CA. 1860), TO THE HORSE-DRAWN ENGINE (1875), THROUGH THE SELF-PROPELLED, BUT HORSE-GUIDED ENGINE (1875), AND FINALLY TO THE SELF-PROPELLED, SELF-STEERED TRACTION ENGINE (1883). SUCH ENGINES POWERED THE CONVERSION TO MECHANIZED FARMING. COOPER BUILT OVER 5,000 ENGINES BETWEEN 1853 AND 1890, AND OTHER COMPANIES BUILT THOUSANDS MORE BASED ON THE PIONEERING COOPER DESIGNS.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS - 1998



Introduction

In the last half of the Nineteenth Century the C. & G. Cooper Co. of Mount Vernon, Ohio, performed a significant evolutionary development that was to revolutionize farming. Beginning with the design of portable steam engines, which were horse drawn on wagons to the field, they produced steam engines on wheels that were still horse drawn, the first self-propelled engine and finally a traction engine incorporating self-steering. This development, in effect, produced the first farm tractor.

The "steam plow" or traction engine, was the first step of importance in mechanical power farming. In addition to the demand for steam power for plowing, new farm machines invented in the first half of the 19th century stimulated a need for mechanical power.

Importance of Agricultural Steam Power

The great hallmark of the Industrial Revolution is the application of heat engine power to tasks formerly done for countless centuries by muscle power of humans and animals. By the mid-nineteenth century the steam engine was bringing the Industrial Revolution to mine, mill, and transportation, but agriculture was lagging behind.

One of the most laborious tasks in agriculture was that of harvesting grain. The application of artificial power to the task of harvesting grain was particularly dramatic in its effect. Before the advent of the agricultural steam engine, separation of wheat from its straw required hand flailing of the gathered sheaves with awkward special sticks called flails on the threshing floor of the barn. The secondary task of separating the chaff from the heads of grain required a laborious hand operation called winnowing, which consisted of throwing small quantities of grain into the air on a windy day to drive the light weight chaff from the heavier edible wheat. The famous McCormick reaper, invented in 1831, had reduced the labor of cutting the grain and gathering it into sheaves by use of a horse drawn mechanism. However, the application of mechanical separators to the tasks of separating wheat from straw and chaff to obtain marketable wheat from the sheaves would require greater blocks of power and shaft speeds than could be conveniently obtained from draft animals.

By 1847, the Pitts pattern threshing machine was being built by many shops from Maine to Mississippi and by 1860 over 50 shops were building threshers under license from Pitts Brothers.

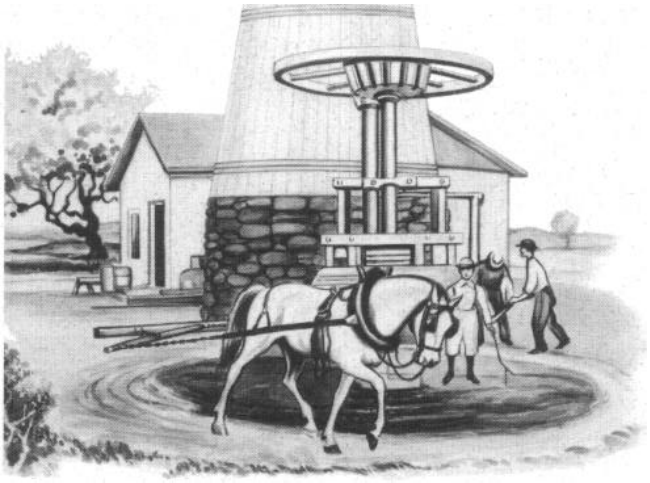
Shortly thereafter, steel plows, mowers, shellers, fodder cutters, and other machines were available to the farmer. With the invention of the reaper and the development of threshers, the flail with its limited threshing capacity, became obsolete. Work animals, through sweeps and tread mills, were inefficient sources of power for operating the threshers and other belt driven machines. Sources of mechanical power greater than the power horses could produce was required.

Early Cooper Company History

The Cooper family moved to Knox County, Ohio in 1808 from Butler County, Pennsylvania. They were a typical frontier family. Charles Cooper was born in 1811 and Elias was born in 1813. The two brothers were reared on a farm three miles south of Mount Vernon, which was purchased by their father in 1810. These two brothers were the founders of the C. & G. Cooper Company.

Seeking a wider field of activity than afforded by the parental farm, the brothers went to Zanesville, Ohio, in 1832, opened a coal mine there, and carried on a small coal business. In 1833, Charles decided that the coal business was not for them and being enamored with the operation of the "Old Davis Foundry" in Zanesville, decided to start one of their own. They sold one of their three horses for $50.00, invested in an iron producing foundry and established their new business in Mount Vernon, Ohio.

The foundry furnace was blown with horse power, (the horse's name was "Bessie"), until 1836, when a small steam engine having a 6 inch (15.24 cm) bore and 24 inch (60.96 cm) stroke was made and installed.



Cooper One Horse Foundry

In 1842, the company's products consisted of carding machines, special power machinery and plows and "hollow-ware". The hollow-ware consisted of vessels having significant depth and volume. During the Mexican War of 1846-48 the company produced slide valve steam engines and war machinery.

In the 1850s the company built blowing engines for blast furnaces and even produced the first steam locomotives built West of the Allegheny Mountains.

In the 1860s, Cooper was determined to build the Corliss type steam engine with its high efficiency due to the use of an oscillating valve mechanism. To achieve this goal Cooper hired Julius C. Debes, an engineer closely associated with the development of the Corliss engine.

Julius Debes became chief engineer, then a partner, extending his genius into many new products.

But emergence of the Corliss did not overshadow manufacture of Cooper's conventional slide valve steam engines immediately. In the 1870s, new Debes' designs also updated standard lines for farms, saw mills, cotton gins, grist mills, and as one Cooper man described, "anything that takes a revolving shaft."

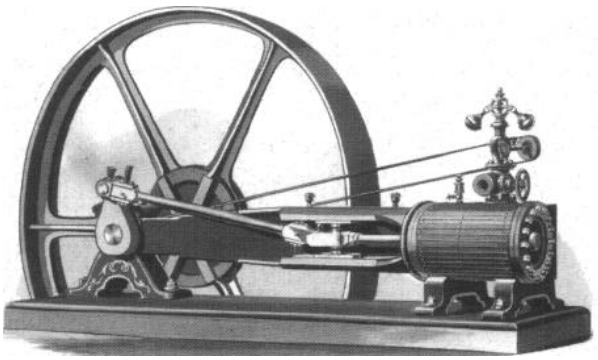
Evolution of the Agricultural Steam Engine

The agricultural steam engine evolved in four distinct steps.

Stationary & Portable Engines

The initial applications involved stationary engines permanently installed in barns where they drove mechanical grain separators and cotton gins. While the stationary steam engine did offer advantages of labor reduction it still had a major disadvantage in that it was stationary. The bulky sheaves containing large quantities of straw and chaff had to be hauled to the barn. Agriculture, by nature a dispersed activity, was unable to take great advantage of the stationary steam engine and thus its use was largely confined to large estates.

The first attempt to transport the engine to the work instead of the work to the engine consisted of portable models that could be pulled by horses into fields or woodlands, on wagons when the ground was hard, or the engine mounted on a heavy set of timber skids when it was soft. The Cooper Improved Portable Steam Engine is of this type.

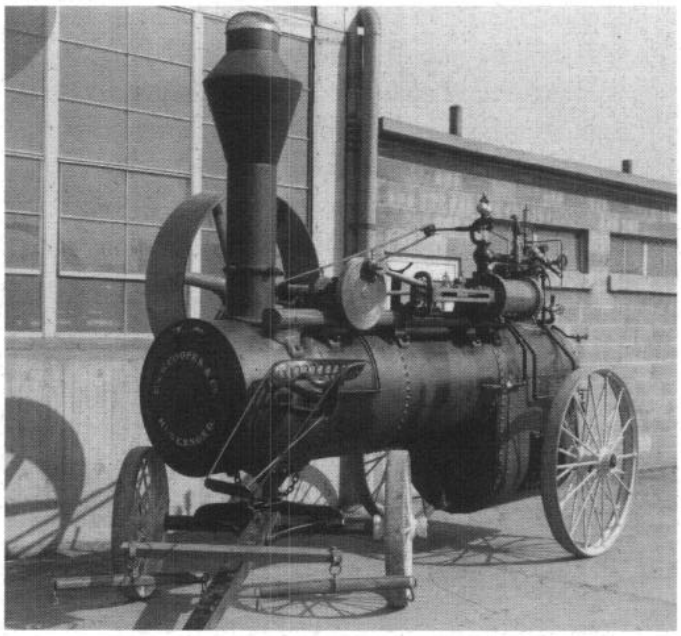


Cooper Improved Portable Steam Engine

So mounted, it could be dragged, with considerable difficulty, by multiple teams of oxen or horses. Moving a skid mounted engine was a major effort and was usually reserved for moves to locations where their power could be utilized for long periods of time, such as sawmills. Moving a skid mounted engine for field work was not the most practical.

Portable Farm Engines

The next improvement was the mounting of the steam engine on a very sturdy set of wagon wheels by which it could be pulled by fewer teams of draft animals than the skidded engine. As long as roads remained firm and dry, the engine could be moved from field to field and farm to farm. This improvement was called the "portable engine." The Cooper Common Farm Engine was of this type.



Cooper Common Farm Engine

Although, more portable than a skid mounted engine, multiple teams of draft animals were still required to pull the portable engine, plus more teams for the water wagon and the separator. The water wagon carried the water necessary for steam engine operation. The movement operation was still difficult enough over the roads of that time that the portable engine did not become widely popular for field work.

Products being produced in by Cooper in 1874 were the Stationary Slide Valve Steam Engine, 40 Models, 5 to 225 horsepower, and selling for $800 to $1,240; Portable Engines, 9 Models, 8 to 30 horsepower, and selling for $975 to $2,300; Corliss Steam Engines, 10 Models, 40 to 300 horsepower, and selling for $2,200 to $12,000.

The 1875 catalog had the following introduction.

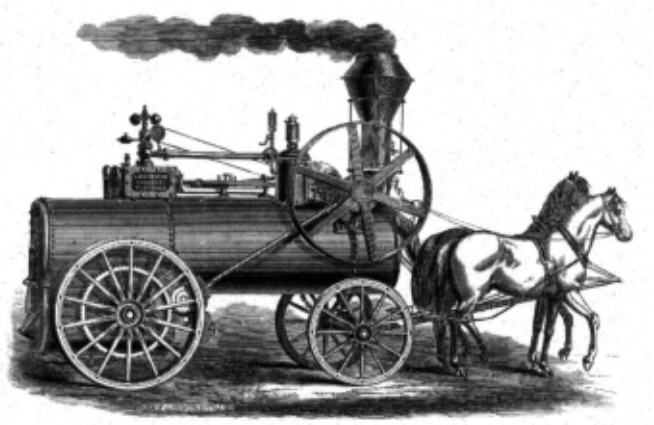
> "When we first introduced farm engines for threshing purposes, some fourteen or fifteen years ago (1860-1861) few persons believed they would eventually come into general use. In the short period since then, however, they have nearly superseded the ordinary *horsepower* in many large sections of the country. The days of the *horsepower* are numbered. Steam power wherever introduced takes all the good jobs."

Traction Engines

The application of a mechanism to transfer power from the engine cylinder to the wheels to propel the engine became the seminal event leading to the popular application of artificial power to the production of food. The concept had many designs, for the need was obvious, but the first commercially successful model was that of Colonel George Rogers of the C. & G. Cooper & Co. of Mount Vernon, Ohio. In 1875 George Rogers patented a bevel gear attachment to transfer power from the engine crank shaft to the rear wheels. This type of engine was called a "traction engine."

Description of the Traction Gearing

The bevel gear and inclined shaft developed by Cooper was a popular method of drive. A bevel wheel at the upper end of the inclined shaft engaged a corresponding bevel wheel on the engine crankshaft, and transmitted the power of the engine to the rear truck wheels, through a cross shaft and gear wheels.



Cooper Traction Engine 1875

The cross-shaft, under the waist of the boiler, carried a bevel wheel, which engaged with a pinion on the inclined shaft. It also carried two spur pinions, one at each end, each of which engaged a large spur wheel on one of the rear axles.

Suitable pawls and ratchets, housed in the hubs of the rear truck wheels and the large spur wheels, engaged these wheels together in such a manner as to permit the truck wheels revolving independently of each other, or one faster than the other, as in turning on the road. They also enabled the engine to be moved from place to place by steam and animal power, used either together or independently, automatically, and interchangeably; that is to say, the engine may be propelled by steam and animal power working together, or by steam power alone (the horses simply guiding), or by the team alone, or the movement may be changed from one power to the other automatically, without requiring any shifting of gearing. If the engine was moving on the road by horse power and it was desired to move by steam, all that was necessary was to let on steam, and if when moving by steam it was desired to move by horse power alone, all that was required was to shut off the steam.

The pawl and ratchet arrangement enabled the rear truck wheels to be driven by the power of the engine or to revolve loosely on their axles as on a common wagon.

The 1881 catalog made the following references to the self-propelled traction engine.

"C. & G. COOPER & CO.'S
IMPROVED TRACTION ENGINES.

As we were the first manufacturers to produce a successful Traction Engine for the American market, a brief account of our experience in this connection will be of interest to our customers.

We built our first Traction Engines in 1875, and of course at first regarded them as an experiment. They were a success, however, from the start, and greatly pleased our customers. For the first two years thereafter we gave many purchasers the option to take off and return the traction gearing at the end of the season, if it did not give satisfaction, or if actual use did not convince the owner that it was worth the extra price charged for the engine. In no case did a purchaser avail himself of this option. We first advertised the engine in our circulars for 1876, and during that year and the year 1877 we made and sold about one hundred of them. In 1878 we built Traction Engines for stock, and the result was we put out over two hundred of them that year, and yet so great was the demand that we were obliged to decline about one-third of our orders during the busy season, more than three-quarters of our farm engine orders being for Traction Engines. Our trade in 1879 and 1880 ran still stronger to Traction Engines, and although we put out about three hundred machines in 1879 and nearly four hundred in 1880 we were obliged to decline a large number of orders both seasons."

Cooper sold the traction engines far and wide. The 1881 circular contained testimonials from customers in twenty-three states; as far west as Utah, as far south as Alabama, as far north as Minnesota, and as far east as New Hampshire.

An Encyclopedia of American Steam Traction Engines by Jack Norbeck, 1976, listed ninety-two manufacturers in the time frame 1871-1920. Twenty-three of these manufacturers were located in Ohio. Three were in Newark, Ohio, which is located twenty-six miles south of Mount Vernon.

According to farm machinery historian, R. Douglas Hurd,

> "By the late 1870s, the C. & G. Cooper Company of Mount Vernon, Ohio had won the reputation of being the first company to manufacture traction steam engines in quantities and market them nationwide. In 1886, more than 1,000 Cooper steam tractors were in use across the country."

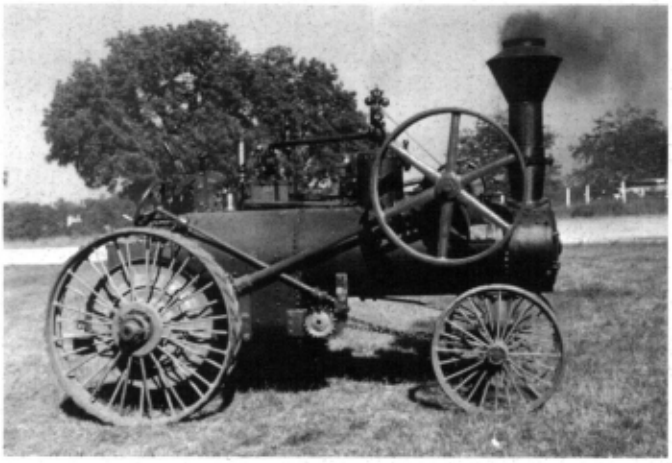
The number of draft animals required to move the engine from field to field was now reduced to a single team of horses which were hitched to a tongue and doubletree attached to a swiveling front axle. The self-propelled traction engine had enough excess power to pull the water wagon, as well as the separator. The C. & G. Cooper Company advertised this feature dramatically via an engraving made by Currier (see Front Cover). In this intriguing portrayal the self-propelled traction engine is running with ease along a muddy road, pulling its full train of water wagon and separator. The horses doing the steering are a high stepping light team more suited for fast buggy trips; there is no tension in their traces because they are only steering. The proud owner at the throttle, attired in dress clothes, is able to handle the engine with one hand. The train of equipment is just leaving a farm with clear evidence of an abundant harvest in the high straw stacks beside the barn.

Contrast this cheery view with the steam engine in the background which is not self-propelled, but being pulled by several teams of horses, and it is bogged down, its owner vainly whipping the stranded animals. More horses are coming out to help, for whose services the engine owner will need to pay. The water wagon and separator require more teams of horses and drivers.

Self-Steering Traction Engine

The adoption of steering to the traction engine did not occur instantly. Many felt that it was safer to guide the machine with a team. Others considered that horses were not frightened when meeting a traction engine preceded by a steering team, and still others felt that the additional horsepower provided by the team was advantageous, both being reasons for horse steering remaining for a while.

The first self-steering traction engine was introduced in 1883. This used a chain drive and worm gear to transfer the motion from a steering wheel to the front axle. This was the first embodiment of the farm tractor, self-propelled and steered.



Cooper Self-Propelled, Self-Steering Traction Engine

The 1883 circular had this to say:

> "C. & G. COOPER & CO.'S SELF-STEERING TRACTION ENGINE
> Aided by our large experience in the construction of traction engines, we have taken particular care to design this engine for hard usage, and claim that for efficiency, compactness, strength, and simplicity, it stands unrivaled in the field, and confidently recommend it to parties desiring a self-steering or road engine. The engine is of the center-crank type, and best adapted to this purpose, as it brings all the driving gears on one side of the boiler, and the balance wheel or driving-belt pulley on the other side, thereby insuring perfect equilibrium and compactness."

America's First Farm Tractor was a reality.

In 1884 Cooper re-introduced their Side Crank Traction Engine incorporating the self-steering feature. In 1885 the rear axle was relocated to redistribute the weight of the engine to prevent the front axle from lifting during rapid starting or when ascending steep grades.

The circular of 1886 introduced a Straw Burning Engine which was unique in that the smoke-stack was located at the fire-box end of the engine over the main driving wheels and near the operator.

In 1887 a Double Speed, Self-Steering Traction Engine was added to the line. It was a fifteen horsepower machine and was stated to be used for saw-mills, etc., and heavy hauling.

An 1889 price list gave the following equipment complement for a standard Self Steering Traction Engine.

> "ENGINE AS FURNISHED: Each engine is furnished complete with Governor, with Regulator and Belt for same, Stop-Valve, Steam-Blower, Steam-Gauge, Water-Gauges, Brass Whistle, Blow-off Valve, Pump and Boiler-Feeder, Safety Valve with Regulator, Globe Oil-Cup for the Cylinder, Self-feeding Oil-Cup for the wearing parts, Steam-Chest, and Cylinder Drain-Cocks, Heater Drain-Pipe with Valve, Oil Can, Wrenches, Flue-Swedge, sixteen feet of rubber Hose, Smoke-stack with Spark-catcher, and a Glass Water-Gauge, and is fired up and thoroughly tested before leaving our works. If self-steering attachment is not wanted, deduct from above prices $25."

The 1889 prices were listed as being $1,150 for the 8 Horse-Power, $1,250 for the 10 Horse-Power, and $1,350 for the 12 Horse-Power machines. The Double Speed Traction Engines, now manufactured in three sizes, 8, 12 and 15 horsepower sold from $1,400 to $1,750.

Cooper built nearly five thousand traction engines during a fifteen year span and received royalties on its patented engine drive from other manufacturers. Despite such success, however, a decision was made to discontinue the product. Ironically, the reason was the company's farmland location. Farmers could not afford to pay cash for traction engines and small Ohio banks were unable to meet credit requirements. By contrast, competing farm implement manufacturers in Chicago arranged for large banking houses there to finance purchases by holding credit papers over long periods of time. Consequently, they captured the market. So the Corliss engine, sold to large mills and manufacturing plants with adequate purchasing power, became the principal product of C. & G. Cooper & Company.

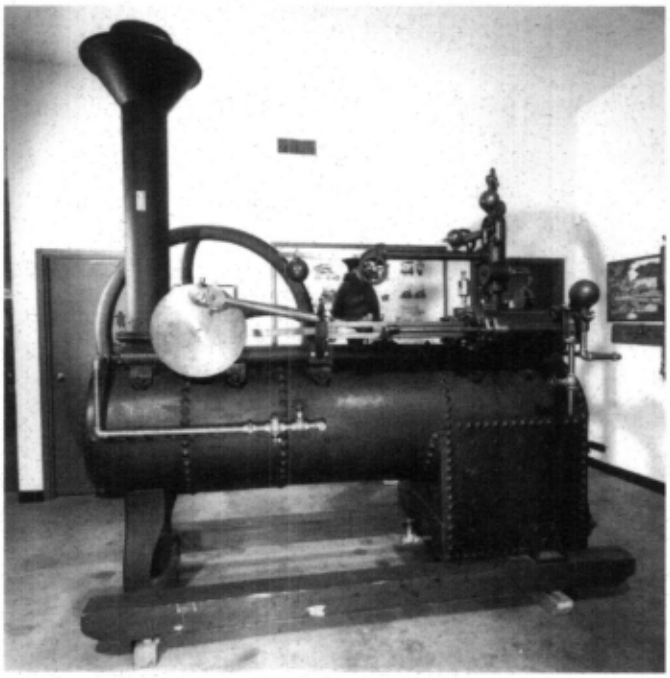
Many other steam traction engine builders produced engines into the 1920s and steam traction engines remained in operation on America's farms until the 1940s.

1875 Photo of Threshing with a Cooper Engine

Description of Cooper Steam Engines at the Museum

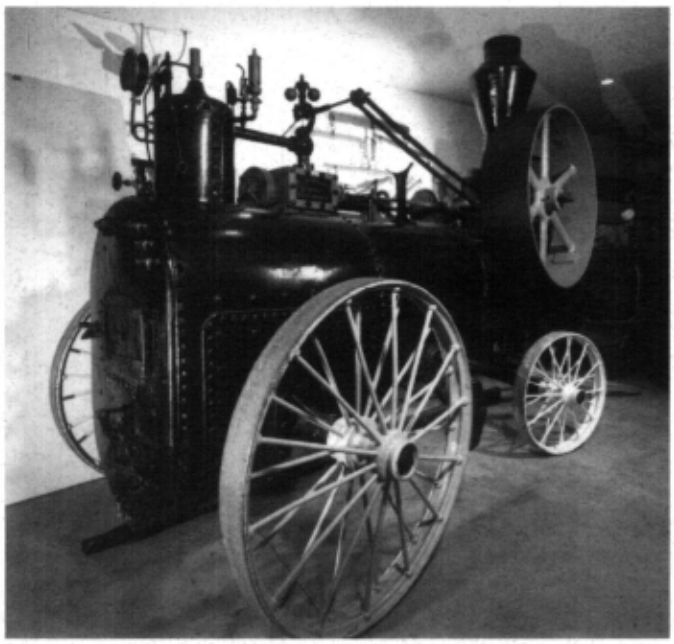
#1 Portable Skid Mounted

This engine was made when the Company was the C. & J. Cooper & Co. This Company existed from 1853 to 1869. Cooper literature in the Museum does not cover C. & J. Cooper Co. products. By comparison with later portable, skid mounted engines, it is probably an 8 horse power machine, with a bore of 6 1/2 inches (16.51cm) and a stroke of 12 inches (30.4cm).



#1 Portable, Skid Mounted

This engine reportedly was acquired by Henry Ford in 1926 from the Geyer Brothers Brewery Works in Frankenmuth, Michigan. The Knox County Museum received the engine from the Ford Museum, Dearborn, Michigan.



#2 Common Farm Engine

#2 Common Farm Engine

This engine is a 15 horsepower Common Farm Engine having an 8 inch (20.32cm) bore and a 12 inch (30.48cm) stroke. The nameplate information signifies this engine was manufactured by the "C. & G. Cooper & Co., Builders, Mt. Vernon, O." The engine was built in 1875. Other particulars identifying this engine are:

Flywheel Diameter:	48 inches	(121.92cm)
Flywheel Face Width:	12 inches	(30.48cm)
Revolutions:	200 rpm	
Boiler Diameter:	32 inches	(81.28cm)
Firebox, Length:	46 inches	(116.84cm)
Number of Flues:	46	
Diameter of Flues:	2 inches	(5.08cm)
Length of Flues:	72 inches	(182.88cm)
Stack Height: (Hinged)	64 inches	(162.56cm)
Wheels: Cast Iron, Spoke		
Rear Wheel Diameter:	50 inches	(127cm)
Rear Wheel Width: (Smooth)	5 inches	(12.7cm)
Front Wheel Diameter:	32 inches	(81.28cm)
Front Wheel Width:	4 inches	(10.16cm)
Weight:	7,000 pounds	(3175.18kg)
Price: (1881)	$1,350	

Other Equipment: Flyball Governor, Whistle, Steam Gage 200 psi (13.78bar), Driver seat on the front, left side, Foot brake with shoes on the rear wheels.

#3 Improved Traction Engine

#3 Improved Traction Engine

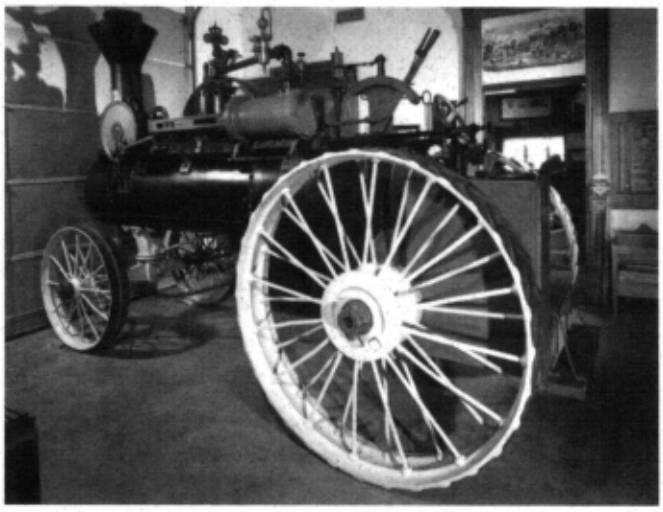
This engine qualifies as a 10 horsepower Improved Traction Engine. It was one of the early engines, probably built in 1875 or 1876. This engine was acquired by Cooper Industries in 1988 from a gentleman in Manhatten, Illinois, for $3,000.

The wheels of this engine have wooden spokes with cast iron tires. The rear tires are 52 inches (132.08cm) in diameter and have a half herringbone pattern to assist traction. The front wheels are 32 inches (81.28cm) in diameter, have a 3 inch (7.62cm) width and are smooth.

This engine has a Patent Plate for the Traction Attachment. The plate bears the following:

PAT,D FEB. 15, 1876

This engine also has a Serial Number, N 5012.



#4 Self-Steering Traction Engine

#4 Self-Steering Traction Engine

This engine was acquired by the Cooper-Bessemer Corporation from the R. M. (Russ) Bell family in Schoolcraft, Michigan (near Kalamazoo). It is a 10 horsepower machine with a 7 inch (17.78cm) bore and 12 inch (30.48cm) stroke.

The wheels on this engine are cast iron and the rear wheels have a chevron pattern cast into the surface for traction. The front wheels have a single center guide cast in the surface to aid steering.

This engine bears Serial Number 5691. It is believed to have been built in 1885 or 1886.

Cooper Cameron Corporation Chronology

The following is a listing of the company names for the manufacturing operation in Mount Vernon, Ohio.

Mount Vernon Iron Works 1883
C. & E. Cooper 1836
C. Cooper
C. Cooper & Co. 1848
Cooper and Clark 1849
Mount Vernon Iron Works
C. & J. Cooper
C. & J. Cooper & Co. 1853
C. & G. Cooper & Co. 1869
Cooper-Bessemer Corp. 1929
Cooper Industries 1965
Cooper Cameron Corporation 1995

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Farm Engines 1875; Forty-Eighth 1881; Forty-Ninth 1882; Fifty-Second 1885; Special Farm Engines 1881, 1883, 1884; Price List 1884, 1885, 1886, 1887, 1888, 1889; Price and Repair List 1882; Repair List 1887.

The Agricultural Tractor 1855-1950
Compiled By R.B. Gray
American Society of Agricultural Engineers
Saint Joseph, Michigan

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THE ASME HISTORY AND HERITAGE PROGRAM

The ASME History and Heritage Program began in September 1971. To implement and achieve its goals, ASME formed the History and Heritage Committee, initially composed of mechanical engineers, historians of technology, and the curator (Emeritus) of mechanical and civil 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.

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

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Mel J. Helmich is retired from Cooper-Bessemer Reciprocating, which grew out of the C. & G. Cooper & Company. He served as Director, Engineering and Technical Director. He has served ASME in many positions; Past Chairman and Secretary of the Internal Combustion Engine Division and is currently a member of the Old Guard Committee. He is a Trustee of the Knox County Historical Society.