THE FRANKLIN INSTITUTE
COMMITTEE ON SCIENCE AND THE ARTS

No. 2405

Subject Contributions to the Evolution of the American Locomotive

Applicant Baldwin Locom. Wks.

Address

Date of Application

Inventor

Address

COMMITTEE:

Chas. E. Ronaldson Chairman

T. Carpenter Smith

Arthur Falkenau

Strickland L. Kneass

Report presented to General Committee:

Award

To

MEETINGS:

Final Action:

Report, Medal, and Certificate presented forwarded to Inventor
commanding the respect and admiration of the World.
From their first locomotive which continued over a year to complete, they are to-day turning out nearly fifty-two (52) completed Engines every week. While it is hard to presume that even this great number may increase in the near future, the problems of maintenance, production and management, intricate and perplexing, have all been satisfactorily solved and to-day, these vast Works operate systematically and smoothly without apparent friction of any sort whatever.

During the seventy-five years of their existence, they have kept ahead of its rapidly increasing requirements of its Rail Roads throughout the civilized world, while in later years,
when the demand for Electrical Engines developed, we find these works turning out a product fully equal to and second to none everywhere. And also, when the Compound Locomotive came into vogue, these works were quick to take hold of and produce their own type of this class of engine.

In the process of Evolution, from the first crudely constructed types of locomotive, the American type developed, having four (4) driving wheels and a four (4) wheeled frame; then followed the "illegal" pattern, then the "Consolidation", the "Hastings", the "Decapod", "Atlantic", "Mikado" and "Prairie" besides "Pacific" types and a great variety of locomotives of different gauges and for different kinds of service, representing current requirements.
The Better-Palmer owned and controlled by this Company in "region" in point of number so that it is impossible to all this to resurrect these your sub-committee confining themselves to those that were essential to the high efficiency of the American Corporation as exemplified to day.
Gauges and templates of every discipline of work to be done.

The original templates are kept as 'Standards' and are meant used upon any work itself, from them proof duplicates are made and used and to which all work is required to conform.

The working gauges are compared to the 'standards' at regular intervals, thus maintaining absolute uniformity for every possible important detail of construction.
A distinguishing feature which characterizes the means for securing absolute uniformity of the essential details parts of all locomotives of the same class is the use of Standard Gage and templates, which has resulted in the formation of the Department of Standard Gages and is looked after by a Special Division and an adequate force of skilled workmen. It is recognized many years ago that line parts of similar engines should be absolutely uniform and interchangeable, which results in insuring to the purchaser a minimum cost for repairs and renewing parts. By this method, it is extraordinarily increasing output of these works.

This department contains Standard
Mathew W. Baldwin was born on Dec. 10th in Elizabeth, N.J. in the year 1790. He was elected Vice President of the Franklin Institute in 1850. He learned the trade of a Thresher, was in the service of Fletcher Gardner, Silversmiths & Threshers, until about 1819 when he began business for himself opening a small shop. From this similar line—meeting with indifferent success, in 1825, he formed a partnership with David Ellerson, a machinist in manufacturing books, binders' tools, and cylinders for calico printing. Their business prospered and steam power became necessary. The engine they bought proved unsatisfactory. Baldwin designed and built an engine suitable to their requirements, which in a short while proved itself so efficient that he received orders for additional engines of this type. This original 'High Speed Stationary'
Engine, built prior to 1830, is still in good order carefully preserved at the West Point. Thus Mr. Baldwin became interested in the manufacture of Stationary Engines and steamboat engines. Afterwards Saratoga from his company.

Steam as a motive power on Rail Roads engaged the attention of American Engineers about in 1829-30. Few new locomotives had been imported from England. One was built at the West Point Foundry, in New York City.

In 1831, Mr. Baldwin completed a miniature locomotive for Mr. Furness Peale, for exhibition in the illusiveness of the speed. The result was such that Mr. Baldwin received his first order for a locomotive from the Baltimore and Ohio Town Meeting Merchants A.R. Co.
In those early days, it was almost a superhuman task to work.

predecessors, such a time. Mechanics were very few; suitable tools hardly obtained. Cylinders had to be bored with a chisel, fastened in a block of wood, while, to find blacksmiths who could weld bars of iron exceeding 1/4 inches square, were exceedingly few or not to be had—therefore else. Welding had to be done mostly by the man himself, in order to educate the men who assisted him to fashion its necessary tools for its various processes.

The work was prosecuted notwithstanding the locomotive completed & tried on 23rd November 1837 a day was the

famed Old Ironside", in the Works. 30 men were employed. The Valley portion was graded by a Jewish contractor, for each cylinder, the straps of each had two arms attached one above, one below; on the
driving axle back of the fire box. The three arms were prolonged backwards under the footboard, with a hook upon the inner side of its end of each: the first shop had arms above or below its eyes and the houses of the two rods were secured by lead to engage with either arm, thus producing forward or the reverse motion.

In 1834, five locomotives were completed at the main shops becoming too small for the increasing business, a new shop was erected at Broad Street, Hamilton St. etc. the business removed to it in 1835. The important devices adopted were employed in other early engines being the result of the M. Baldwin's steady and experiments made patented in 1834, etc.

Some patented cover the following inventions:

1. The half crank.
2. New method of constructing wheels for locomotives and cars.
3. A new mode of forming the joints of steam or other tubes.
4. A new mode of forming the joints and other parts of the supply pumps and of locating the pumps itself.

This invention consisted in utilizing the hollow guide bars traversing, not only as the pumps' barrel, the plunger of which was attached to the piston, but

Mr. Baldwin laid great stress upon the position of the driving wheel, by placing it near the base of the iron rod, thus throwing one half its weight upon them, one half upon the wheels, thus extending the wheel base and producing steadiness less wear damage.

The application of ground sliding joints in the sliding pipes, made especially to the success of his early engines. In 1839, Mr. Baldwin bought the E.J. Wilson Patent, this being a method of increasing the adhesion of the locomotion.
by throwing a part of the sewer upon the
rear of the engine.

In the early part of 1835, the new
Broad St. Shops was completed—occupied.

In this year the first outside connected
Embodied
was built. It
was put in service upon the Philadelphia
Trenton R.R. Later on, Mr. Baldwin
used Brass and Wire, but they wore
out so rapidly that they were replaced
by iron ones—

1835-14 Engines were constructed—
1836-40—
1837-40—
1838-23—
1839-26—
1840-9—

The average weight of these locomotives
was between 20,000 and 26,000 pounds
when loaded. The number of men
employed was 300. To this force was
reduced weekly, the demand for Engines
rapidly falling off in 1838, as will be seen
from the above enumerated Productions.
On April 3rd 1835 Mr. Baldwin took out a Patent for certain improvements in the Wheels and Jubes of locomotives that for the Wheels related to casting the Jubes or Spokes together having the Spokes terminate in Segments of a circle. The improvement in Jubes consisted in driving a copper female or strimble upon the outside end of the tube, instead of driving it into the tube as had been previous practice—the object had been to make a tight joint with the Jube; but the advantage gained by the outside female was to strengthen the tube in case a tight joint with the sheet metal left the tube free and unobstructed in certain respects. This Patent proved extremely valuable and was more generally practiced...
In the latter part of 1839, the old wooden frame disappeared. The winding, liners, pedestals of the driving boxes being attached to the boiler; an iron frame took its place, and we find that 8-wheel tenders were first being pressed about this line.

In 1847, Mr. Baldwin secured a patent for his flexible beam, which contributed more than to any of his subsequent patents or innovations. To the front of his fortune and led to the construction of his well-known 6-wheel connected locomotive, which had six fixed front drivers —

in a flexible beam — its rear wheels were rigidly placed in the frame, behind its fire box with inside bearings —

The action of the flexible beam was such that the engine, in passing a curve, its middle pair of drivers could move laterally in one direction, say to the
Right, while the front pair would swing in the opposite direction, or to the left, the two edges of the blade remaining parallel to each other and to the new driving edge. The operation resembles that of a parallel rule—on a tangent the edge, became for me, a rectangle, or a curve, a parallelogram—we call attention to this flexible tool.

Yale as it was fundamental to the perfection future development of the Baldwin locomotive.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1842</td>
<td>14</td>
</tr>
<tr>
<td>1843</td>
<td>12</td>
</tr>
<tr>
<td>1844</td>
<td>22</td>
</tr>
<tr>
<td>1845</td>
<td>27</td>
</tr>
<tr>
<td>1846</td>
<td>42</td>
</tr>
<tr>
<td>1847</td>
<td>39</td>
</tr>
<tr>
<td>1848</td>
<td>20</td>
</tr>
<tr>
<td>1849</td>
<td>30</td>
</tr>
<tr>
<td>1850</td>
<td>37</td>
</tr>
<tr>
<td>1851</td>
<td>60</td>
</tr>
<tr>
<td>1852</td>
<td>49</td>
</tr>
<tr>
<td>1853</td>
<td>60</td>
</tr>
<tr>
<td>1854</td>
<td>62</td>
</tr>
<tr>
<td>1855</td>
<td>500 men employed</td>
</tr>
</tbody>
</table>
The performance of the first locomotive, using its new feature, the flexible frames, yielded widespread interest. The weight of the engine was but 12 tons, its boiler was 250 tons upon a grade of 36 feet per mile.

In 1842, the method was in use of giving to each class of locomotives, a distinct classification, comprised of a number and a letter. This was adopted. Besides, many systematizing the details in the management of the business.

Mr. Baldwin first used iron frames in 1844. The advantage obvious was found in the fact that the iron frame stood a higher expanded action. While the enameled expansion of iron plates or copper plates caused leady action. Steam motion was first introduced in 1845, and also the half-stroke cut off.

The present design of 4-wheel on 4-wheeled trucks was finally adopted in 1846.

In 1846, a 3-wheel connected type of engine was built, and as this concept the wooden cab with sash windows was added.

In 1847, gears with varying hands were introduced.
In 1848, fast-speed passenger locomotives were built, capable of traveling 60 miles an hour. In 1849, outside-connected engines were built, almost exclusively.

In 1850, the wagon-top boiler superseded the old 'Dome' boiler which had been used since 1834.

In 1852, the 10-wheel engine was placed in the Baldwin classification, yet was not until 1860, did this type of engine largely supersede the old pattern of low 8-wheel connected. In this year, Dr. Baldwin patented his 'Variable Cut Off,' which device came into more universal practice, whereas was introduced at this time or rapidly failing. It was first applied to the Baldwin Works in 1853-4, and in 1857. It was adopted more widely. The firebox in the fire box was used and was of a similar type in the American boiler. It was not until the 1850s that water pipes were carried to the firebox, and it was necessary to return to the sizes of the fire box as its bottom was cumbersome.
The adoption of the special auditor clearly means its dividing line into its earlier experimental and its present type of locomotive and practice. Changes since then have been but in detail principally, yet it has been in the perfection of these details that we have to say the efficient. Representative complete piece of mechanism which stands out as one of the greatest tributes to the ingenuity of men's to-day. Even one can hardly realize the almost innumerable difficulties which have been overcome to bring the locomotion to its high condition of efficiency and in perfection, with the Baldwin line has made some sense shown in its success.

The production of the Wrens was, viz: In 1855, 47 engines completed and 430 men employed —
In 1856 - 59, engines completed:

- 1857 - 66.
- 1858 - 33.
- 1859 - 70.
- 1860 - 83.

The greater number of these locomotives were of the ordinary type, 4:driven, 4-wheelled truck varying in weight from 15 to 27 tons. A few 10-wheelled engines were built, the mean number were the No. 6 and No. 7.

The demand for these was rapidly falling off, with 10-wheelled engines being taken into prominence. By 1857 they ceased to be built save in exceptional cases for export. Intense interest was taken at this time in the proper means to be employed in combustion and various experiments were tried to win the fire
Before the need, study, and experiment led Dr. Baldwin to the conclusion, that the ordinary form of boiler, with plain fire-box, was right, with perhaps the addition of the fire-brick arch — that the secret of successful and economical firing was of coal, was in the means of firing, rather than in any particular design of fire-box.

A notable falling off in building occurred: the booming out of the Civil war suspended trade. Its production was as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Locomotives</th>
</tr>
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<tbody>
<tr>
<td>1861</td>
<td>75</td>
</tr>
<tr>
<td>1862</td>
<td>96</td>
</tr>
<tr>
<td>1863</td>
<td>130</td>
</tr>
<tr>
<td>1864</td>
<td>115</td>
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</table>
In 1861, 18 inches cylinder single-locos were built. This is the first instance of the use of these "Pony" locos in these works.

The introduction of steel in locomotive construction became a distinctive feature at this time and has frequently replaced wrought iron. Steel tins, steel fire boxes, another distinctive feature at this time was driving the cylinders horizontally. The casting of the cylinder itself was solid. The valve gear box was designed by Messrs. Baldwin. It resulted from his original method of construction.
Builder to adopt an outside cylinder, he constructed it (like his early engines) with a circular flanged segment cast to it—its order to be bolted to the boiler—forces high inclinations, the cylinders were gradually brought to less, until the horizontal position was attained and maintained to keep—the advantages of this arrangement have resulted in simplicity and economy, because the cylinders being right, kept our patterns with answer for six.

The production was:

<table>
<thead>
<tr>
<th>Year</th>
<th>1866</th>
<th>113, locomotives</th>
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<tbody>
<tr>
<td></td>
<td>1867</td>
<td>127.</td>
</tr>
<tr>
<td></td>
<td>1868</td>
<td>124.</td>
</tr>
<tr>
<td></td>
<td>1869</td>
<td>235.</td>
</tr>
<tr>
<td></td>
<td>1870</td>
<td>230.</td>
</tr>
<tr>
<td></td>
<td>1871</td>
<td>331.</td>
</tr>
</tbody>
</table>
In July 1866, the Consolidation type came into vogue, the first engine being the "Consolidation" built for the Allegheny Valley R.R. Co. It had 4 pairs of drivers connected on Brevett-Pony-trunnion - the following year (1867) the "Illinois" class of engines, with 3 pairs of drivers connected and a swinging pony-trunnion, took its place in the practice of these woods, from the "C. A. Douglas" built for the Shrewsbury Iron Co. This place of engine was rapidly grown in favor for freight duty upon grades where heavy loads are to be moved.

Steel frames were first used in 10 wheel freight engines in 1868—Steel Boilers also. The same year.
The 1854 type of engine, having a straight boiler and two domes, was revived in 1866 and until 1880 both straight and wagon-top boilers were built. Yet since 1880 the two domes have been seldom specified on. The first narrow-gauge locomotive (3 3/4 feet) was built in 1868.

Locomotives for single-track lines were built in 1878-79.

Locomotives to operate in Illinois were first built in 1870. These were for narrow-gauge and were over 5 1/2 feet in height.

A locomotive for a fledgling rail in California was built in 1876, the gauge being but 20 inches.

Steel rails were first introduced without being secured by spikes or Rivets as early as 1870, now it is the prevailing custom.
In 1872, 427 locomotives built.
1873 - 437
and nearly 3,000 men were employed.
In 1874, 205 locomotives built.
1875 - 130

A small locomotive operated by compressed air was built in 1874.
In 1876, 232 locomotives were built.

In the year a new department in locomotive engineering was opened, with
experimental steam steam cars,
which proved in great measure a success. The next step was the construction of a
collective car, to which one or more
ordinary cars could be attached.
These small boxes were vertical combustion,
in the side sheets were placed ashes by
these Works in 1876.
The first compressed air locomotive
was built during the year 1885.
In 1883, the steamer "Reconstruction" was built in 10-wheel connected with a "Pony" from: this engine's wheel base was 17 feet; the rear flanged driving wheels were placed on quarter inch more on the outside than the next adjacent pair of the second and third pairs were placed, while the front pairs were flanged; the locomotive could therefore pass a curve of a radius as short as 300 feet without the proper spread between the rails upon a curve. A locomotive was constructed during the year having an outside frame.

In 1887, a new form of boiler was built. For the 10-wheel engine, a long wagon-top was used, extending to allow the stoker to be placed in front of the firebox. Means to support the hearth were placed in front of the firebox, means to the center of the boiler, having the Crown sheet supported by radial stays from the outside shell. Many boilers of this type have since been constructed.

The first locomotive built in Japan was shipped in June 1887.
During 1888-89, a large demand sprung up for steam locomotives for short railways of their own service. 95 of them were built. Also

Two (2) back-tired locomotives of the Wiggenbach system were for foreign service were constructed.

In October 1889, its first compound locomotive was completed: it was the 4-cylinder type, designed and patented by Mr. S. H. Vanwall, then its Geo. Eng. of the Works—because of its fuel and water economy, its efficiency in both passenger and freight service, led to its introduction upon nearly all leading Railroads; that they became popular and rapidly into use is evidenced by the fact that in

The year 1889, one only was built

1890: 3
1891: 82
1892: 213
1893: 100
1894: 30
1895: 51
1896: 173
The award of the Elliott Cresson Medal of the Franklin Institute.
In Sep. 1890, the Committee on Science and Art of the Franklin Institute appointed a sub-committee of their members to investigate and report upon the Vaucherian Compound locomotion. This committee presented their report, and it was adopted at their meeting in June 1891.

To briefly note its conclusions arrived at, especially as its merits of the invention were seen in its rapid adoption by numerous railroads that tried or witnessed their performance in active service. The Committee concludes their report as follows: "That the Vaucherian Compound locomotion is a distinct, novel, and original type of locomotion. It is the most remarkable departure from the usual construction of engines that has elicited general satisfaction whereas introduced..."
In 1889, a trial was made to see if a short time a locomotive could be built. The order was given up on March 7th for a narrow gauge locomotive for American type passenger service upon July 2nd it was completed leaving consequences but 8 working days from the raw material.

In this year, the manufacture of Wrough iron Wheel Centres for both Inner and Driving Wheels was begun under the Taveraes.

In 1890 the 1st narrow gauge locomotive under the Cabo system was constructed for the Rice's Pears R.R. During this year 1893 four locomotives of this type were built for this road, the grades varying from 8 to 25%—(see Chart) 3 British type of 1 meter gauge were built and shipped to Palestine.
In 1891, ten larger locomotives were built for service in the Spanish (melodey the St. Clair River) of the Grand Incause Rail Way. They were 10-wheel connected, with Jack on the tender and weigh 480,000 lbs — of the Deapo pattern. Five compound locomotives were built for the Erie R. R.

The first locomotives for Africa were built this year; they were of the Mogul type — for 3 ft 6 in gauge —

In 1892-93, 731 and in 1893, 772 engines were constructed. Four, one of each type of locomotives were built of 25 compound "Jonesy" locomotives which operated the Elevated Road at the Columbian Exhibition, where also were seen the splendid exhibit of 17 locomotives, the product of these works — illustrating the various types of both standard and narrow gauge locomotives; it was approved in several Buchanan clubs and in some states.
December 31, 1893, had serious effect upon the Works. Our final report showed the number of engines completed in 1894 was 315. Fewer than 1895 of a new type of passenger locomotive was brought out, see chart. This the "Atlantic" type was given; its advantages are a large fire box and boiler, enabling high speeds.

The first electric locomotive was built this year for the New American Co.

In other Illinois electric locomotives were built in 1895 in cooperation with the Westinghouse Elec. Mfg. Co. It was supplied with electric parts.

A high speed passenger locomotive was built for the Reading R.R. leaving on a single pair of tracks 84 1/2 miles between Philadelphia and Jersey City in one hour.
In 90 miles, they accomplished this in 103 minutes, making six stops—
a combination Rack & Adhesion locomotive was built for service in St. Domingo. It was
of the Compound type, having the compound cylinders to operate two pairs of connected
adhesion wheels and a pair of single expansion cylinders to operate a single Rack wheel, con-
ducted upon the 'Old System.' This engine was furnished with two complete sets of
machinery, entirely independent of each other and was built, eventually, to remove the
rack attachments and to operate by adhesion solely—During this year and in 1896-138
locomotives of the 4-cylinder Compound type were sent to Russia—
In 1896, two combination Rack & adhesion
locomotives were sent to Chile—
having Compound cylinders connected to the
Driving Wheels through Walking Beams—
Two pairs of wheels are secured to triangles by
Clutches and act as adhesion Driving Wheels,
and the new wheels are loose on their axle and
act only as coupling Wheels. All 3-coupled axles
carry Rack pinions of the Old 'System.' The
two pairs of adhesion wheels are turned into operation by clutches.

Six 10-wheel locomotives were built for the Baltimore Ohio R.R. for Express Passenger Service. (See cuts) they have been operated with great efficiency.

In 1897, the Reading R.R. placed a pair of Express trains for service between Camden and Atlantic City. 4.5. 55 1/2 miles, requiring 52 minutes for the run, equivalent to a speed of 64 miles per hour. The R.R. records showed that for 67 days July 1 to Aug. 31 1897 the average time consumed was 57 48 minutes or a speed of 69 miles per hour and over.

The trains covered the distance in 46 1/2 minutes or 71 5/8 miles per hour. These engines were of the Atlantic type, Vanclaine Compound.

En Cd.

In 1898, a Consolidation Vanclaine Compound locomotive was placed in service upon the mountain between Copley & Grosvenor House on the Schuylkill Valley R.R. It was guaranteed to hand a load of 1000 net tons (exclusive of...
The weight of the engine (Taunton) upon a grade of 60 feet was 82,000. It was unsuccessful in the test, and 14 additional locomotives were subsequently ordered by the Company.

In 1899, two "Atlantic" type, Vautrin locomotives were built for the Burlington RR. for fast mail service west of Chicago.

During this year there was a large increase in foreign business, including 30 locomotives for the Midland and 20 for the Great Northern and 20 for Great Central Railways of England. 10 locomotives were ordered by the French State and 10 by the Three Summer Railways in the French Colonies of Algiers. Also two Vautrin "Consolidation" freight locomotives for the Bavarian State Railways — and in 1890 the Co. ordered 2 passenger engines of the Compound "Atlantic" type and tenderbody in their passenger rolling stock, the new features
During 1900, three Womers exhibited at the Paris Exposition - a "goods locomotive" type for the French National Railways of France; an Atlantic type Passenger locomotive for the French State Railways; also a Compound American type Passenger locomotive for the same road. Three engines were built in the regular course of business for their respective companies and were put into service immediately after the close of the Exhibition.

The Company filled large orders this year for the Chinese Eastern R.R.; the Paris-Orleans R.R.; the Italian State; the Egyptian State, and the Belgian State Railways.
The incoming of the 20th century witnessed an industrial boom, and general prosperity throughout America and in consequence entailed extraordinary demands for high transportation; cars were designed to build to carry heavier loads, resulting in improved road beds, heavier rails, Stronger Bridges and more powerful locomotives. As the demand for increased horse-power, involving greater streamlining capacity and a larger rate and evolved the "Atlantic" type locomotives from the "American" or 8-wheeled passenger engine. So, in order to produce a locomotive to cope with its enhanced conditions, viz; heavier trains at higher speeds, three-worn designed its "Prairie" type engine, a type resembling from its illogical 10-wheel locomotives; this engine has a pony boiler, 3 pairs of driving wheels and a wide firebox extending over its frame, replaced some of the driving wheels - to support
This overhanging weight, a pair of trucking wheels is placed beneath the fire box. Fifty of these locomotives were built for the "Burlington" and forty-five for the Atchison Road - in 1901 -

A new departure in locomotive practice was exhibited by steam Worts, at the Pan-American Exhibition, at Buffalo, N.Y., in 1901, being a 10-wheel locomotive built for the Illinois Central R. R., the fire box embodying the inventions of Mr. Cornelius Vanderbilt. Mr. S. the fire box was cylindrical in form, its axis eccentric to that of the boiler, its center being in the second from the bottom by the usual means and supported at the bottom by the usual means, otherwise entirely disconnected from the outer shell and so disconnected with stays or crown bars, thus permitting easy removal and absence of its general repair.

The feature of the tender is a cylindrical instead of a V-shaped tunnel placed back of its coal space. The advantage being a better distribution of its weight in its tender, less dead weight and more economical.
The year 1901 was especially noticeable for its large volume of locomotive business, there being a very large demand for its West and Southwestern Rail Roads. The Pennsylvania, too, ordered over 150 locomotives of various types, and the Allegheny, Ohio & Pittsburgh, placed an order for over 100 locomotives. 1,375 locomotives were built, 526 being compounds: 6 for compressed air and 45 Electric: 208 were exported: the average number of men employed per week was 9,875.

In February 1901, the 20,000th locomotive was completed. This engine embodied several interesting features: 6-cyl. compound cylinders with the new arrangement. One main type: 2-cyl. 6-cyl. 0-6-0.

In May of this year, the largest locomotive ever built was turned out; it was a 12-cylinder for the Central R.R. Co. The total weight

[Note: The last line of the text is partially obscured and difficult to read.]
of the engine alone was 267,800 pounds—it was designed for heavy hauling upon steep grades.

The steed class type of locomotive was established this year. Its requirement called for a powerful engine with a large fire box and ample grate surface for burning inferior coal or lignite. This type consisted of 8 wheels connected, with its fire box behind them supported by a pair of trailing wheels and a pony truck in front.

Oil burning locomotives were built this year for the Atchison, Topeka and Santa Fe Railroad. However, Standard Oil and the American type of locomotive—Electric locomotives, for surface service, had a place among the new fire water—

were also among orders for Electric Motor Trains.
In compiling their report, your committee have been obliged to give
but a brief outline of the growth of
these Works, to overlook many inter-
esting and valuable details of
construction and patent, confining
themselves to the fundamental points
of detail which were essential to the
successful development of their
inventions — and would recommend
for originality, function, design,
system and management, the award
of the "Elliot Browne" Gold Medal and
Diploma of the Franklin Institute.

[Signature]
a 4-wheeled engine, weighing 13,750 pounds, running on two tracks, each of the cylinders, which were 9 1/2 inches in diameter by 18 inches stroke and attached horizontally to the outside of the engine box. The wheels were heavy carbon steel, wood, pine, and wrought iron. The boiler was 30 inches in diameter, with a 72 1/3 copper tube. The tender was a flat steel platform, wooden sides, carried on an iron box from a water tank. The front was for fuel in front. The water motion was at first given by a single force. There were two cylinders placed on the axle between the cranks, each of which had a half-circular slot, reeling the wheel as it revolved, the inside of the reservoir a step on the axle at the cranks' center. The engine was reversed by changing the