

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

MEETINGS:

Report presented to
General Committee:

Final Action:

Award

To

Report, Medal, and Certificate presented
forwarded to Inventor

submersible until today they form ~~an~~ ^{are} commanding the respect and admiration of the world -

From their first locomotive which consumed over a year to complete, they are today turning out nearly fifty two (52) completed Engines every week, while it is fair 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 run of their existence, they have kept abreast of the rapidly increasing requirements of the 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 anywhere - 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 type of Locomotive, the 'American' type developed, having four (4) Driving Wheels and a four (4) wheeled Tender; then followed the "Mogul" pattern, then the "Consolidation", the "Leastodon", 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 Letters-Patents, owned and controlled
by this Company are "legion" in point
of numbers, so that it is impossible ~~to~~
~~the list~~ to enumerate ^{all of} them - your
sub-committee confining themselves to
those that were essential to the ~~high~~
efficiency of the American Locomotive
as exemplified to day —

Gauges and Templates of every-
description of work to be done.

The original Templates are kept
as 'Standards' and are never
used upon any work itself; from
them exact 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 detail-parts of all locomotives of the same class, is the use of Standard Gauges and Dies, which has resulted in the formation of the "Department of Standard Gauges" and is looked after by a Special Foreman and an adequate force of skilled workmen, it being recognized many years ago that like parts of similar Engines should be absolutely uniform and interchangeable. This results in insuring to the purchaser, a minimum cost for repairs and rendering possible by this method, the extraordinarily increasing output of these Works.

(over)

This department contains Standard

Matthews W. Baldwin, was born

on Dec. 10th

in Elizabeth, N. J. in the year 1795.

He was elected Vice Presd. of the Franklin Institute in

1855

he learned the trade of a Jeweler &

was in the service of Fletcher & Gardner,
Silversmiths & Jewelers, until about

1819 when he began business for himself

opening a small Shop upon ~~the~~ similar

lines - meeting with indifferent success,

in 1825, he formed a partnership

with David Mason, a machinist.

in manufacturing brass binders' tools &

cylinders for Calico printing, their business

prospered & Steam power became necessary;

the Engine they bought, ^{proving} ~~proved~~ ~~was~~ ~~not~~ ~~satisfactory~~

Mr. Baldwin designed & built an Engine
suitable to their requirements - which in

a short while proved ~~itself~~ so efficient, that

he received orders for additional ^{ones} Engines

of this type - This original 'Highly' Stationary

Engine, built prior to 1830. is still
 in good order & carefully preserved
 at the Works; thus Mr. Baldwin
 became interested in the manufacture
 of Stationary Engines; ~~after the war~~ ^{shortly}
~~afterwards withdrew from the~~ ^{partnership} ~~company~~
~~Steam~~ ^{as} a Motive Power on
 Rail Roads engaged the attention of
 American Engineers ~~early~~ in 1825-30;
 a few 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. Francis
 Peale, for exhibition in his Museum -
 the success of the model was such
 that Mr. Baldwin received his first
 order for a locomotive from the Philadelphia,
 Germantown & Merriamtown R.R. Co. -

In those early days, it was almost a
 superhuman task to ~~finish~~ ~~construct~~
 undertakes such a ^{work} ~~task~~: 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 1/4 inches square. were ex-
 ceedingly few, or not to be had -
 therefore Mr. Baldwin had to do most
 of the work himself, in order to educate
 the men who assisted him to fashion
 the necessary tools for the various processes.
 The work was prosecuted notwithstanding,
 & the locomotive completed & tried on
 23^d of November 1830 & this was the
 famous "Old Ironsides" ^{30 men were employed} - ^{in the works}
 In the 2^d locomotive built ^{actuated}
 The Valve motion was ~~given~~ ^{actuated} by a fixed eccentric
 for each cylinder. the straps of each had
 two arms attached one above, one below; ~~the~~

driving axle ^{being} ~~back~~ back of the Fire Box
 these arms were prolonged backwards
 under the footboard, with a hook upon the
 inner side of the end of each; the Rock-shaft
~~had~~ had arms above & below its axis and
 the hooks of the two rods were moved by hand-
 levers, to engage ~~with~~ with either arm, thus
 producing forward or the reverse motion.

In 1834, five locomotives were completed,
 & the ~~iron~~ Shop becoming too small for the
 increasing business, a new Shop was erected
 at Broad & Hamilton Sts. & ~~the~~ the business
 removed to it in 1835. The important devices
 adopted & employed in these early Engines
 being the result of Mr. Baldwin's study and
 experiments were patented in 1834 & the

same Patent covered the following inventions.

- viz: 1. The half crane,
- 2. New method of constructing wheels for locomotion and cars.
- 3. A new mode of forming the joints of steam & other tubes.

4. A new mode of forming the joints and other parts of the supply pumps and of locating the pump itself -

This innovation consisted in utilizing the hollow Guide Bar & making it do duty as the pump-barrel - the plunger of which was attached to the Piston rod -

Mr. Baldwin laid great stress upon the position of the driving wheel, by placing three bars of the size 3 1/2, thus throwing one half the weight upon them & one half upon the 4-wheeled truck. thus extending the wheel base and producing steadiness & less truck damage -

The ~~new~~ application of ground steam joints in the steam pipes, added greatly to the success of his early Engines - In 1839, Mr. Baldwin bought the E. J. Miller Patent, this being a method of increasing the adhesion of the locomotive

from impression made

by throwing a part of the Tackle, upon the
nose of the Engine -

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

⊕
→
Locomotive
↑

In this year, the first outside connected
was built. it ^{embodied} the 'Miller' device -
it was put in service upon the Philada' &
Trenton R.R. - later on, Mr. Baldwin
used Brass Tire Drivers, ~~but~~ they wore
out so rapidly that they were replaced
by iron ones -

In 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. yet this force was
reduced weekly, the demand for Engines
rapidly falling off in 1838, as will be seen
from the above annual Production -

See Addition to Page 61

On April 3^d 1835. Mr. Baldwin
 took out a Patent for certain im-
 provements in the Wheels and Spokes
 of the cornmills - that for the wheels
 related to casting the hubs & spokes
 together having the spokes terminate
 in segments of a rim: the improvements
 in hubs consisted in dividing a
 copper female or trundle upon the
 outside end of the tube, instead of
 dividing it into the tube as had
 been previous practice - the object
 had been to make a tight joint with
 the tube shut & the advantage gained
 by the outside female was to strengthen
 the tube & make a tight joint with the
 sheet ~~and~~ ^{it} left the tube free and
 unobstructed its entire length: this
 Patent proved extremely valuable &
 the method
 is now generally used.

In the latter part of 1839. the old ~~frame~~
 wooden frame disappeared, the machinery,
 truss, 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 used
 about this time -

In 1842, Mr Baldwin secured a
 Patent for his Flexible Truck, which
 contributed more than ~~to~~ any of his
 subsequent Patents ⁽²⁾ or ⁽¹⁾ inventions - to the
 foundation of his fortune and led to
 the construction of his well known
 6-wheel connected locomotive, which
 had the four front drivers ~~connected~~
 in a flexible truck - the rear wheels were
 rigidly placed in the frame, behind
 the fire box - with inside bearings -

The action of the flexible beam was
 such that the engine in passing a curve,
 the 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 axles all the while remaining
 parallel to each other and to the near
 driving axle - The operation resembling
 that of a parallel ruler - on a tangent
 the axles & beams form a Rectangle,
 on a curve a Parallelogram - We
 call attention to this Flexible Truck
 Patent as it was fundamental to the
 future development of the
 & perfection

Baldwin locomotives

~~The following table shows~~

" 1842 -	14			
In 1843 -	12	locomotives -	constructed	
" 1844 -	22	"	"	"
" 1845 -	27	"	"	"
" 1846 -	42	"	"	"
" 1847 -	39	"	"	"
" 1848 -	20	"	"	"
" 1849 -	30	"	"	"
" 1850 -	37	"	"	"
" 1851 -	50	"	"	"
" 1852 -	49	"	"	"
" 1853	60	"	"	"
1854	62	"	+500 men employed -	

The performance of the first locomotive 9' using this new feature, the flexible Tires, excited widespread interest; the weight of the engine was but 12 tons, its haul was 250 tons, upon a grade of 36 feet per mile.

In 1842. ~~the~~ the method was in use of giving to each class of locomotives, a distinct classification, composed of a number and a letter was adopted - besides systematising ^{many} details in the management of the business -

Mr. Baldwin first used Iron Flues or Tubes in 1844 - the advantage derived was found in the fact that the iron flue sheets or tubes expanded alike, while the unequal expansion of iron flues & copper flues caused head off - this motion was first introduced in 1845 - and also the "half stroke cut off" -

The present design of 4 wheels on 4 axles there was finally adopted in 1845 -

In 1846. 8 wheel connected type of engine, was built - and at this time the wooden Cab, with saddle & pass was added -

In 1847. Gales with rocking bars were ^{introduced}

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1848. First speed Passenger locomotives
being ^{built} ~~made~~, capable of travelling 60 miles an
hour - In 1849. Outside-connected engines
were built - almost exclusively -

In 1850. the Wagon-top boiler superseded
the old 'Domest' boiler which had been used
since 1834 -

In 1852. the 10-wheel engine was placed
in the Baldwin classification, yet not
until 1860, did this type of engine wholly
represent the old pattern of low 8-wheel con-
nected - In this year Mr. Baldwin
patented his "Variable Cut off" which device
now came into use - his pistons however
was introduced at this time & rapidly gaining
^{improvement} ~~was~~ first applied at the Baldwin Works
in 1853-4 - in 1857. It was adopted exclusi-
vely - The pin, which in the Fire Box was used
replaced about this time - supported on side
plates - in 1858. water pipes extending obliquely
from the crown down & curving to the
sides of the fire box at the bottom were success-
fully used -

11.

The adoption of the locomotive motion clearly
means the dividing line ^{between} the early
experimental and the present ~~types~~
locomotive ~~ing~~ practice. Changes since
then have been but in detail principally,
yet it has been, in the preparation of
these details that we leave to day, the
efficient, ~~and~~ symmetrical, complete
piece of mechanism, which stands
out as one of the greatest tributes to
the ingenuity of man to day — you
can hardly realize the almost insur-
mountable difficulties which have been
overcome to bring the locomotive to its
high condition of efficiency and in
perfecting all the Baldwin ^{locomotive works} have had
now ~~never~~ shown in its success —

The production of the W ones was, viz:

In 1855. 47 engines completed and
430 men employed —

Jan 1856 -	59	engines completed -	
- 1857 -	66	"	"
" 1858 -	33	"	"
" 1859 -	70	"	"
" 1860 -	83	"	"

The greater number of these locomotives were of the ordinary type. 4 drivers & 4 wheeled trucks - varying in weight from 15 to 27 tons - a few 10-wheeled engines were built, the new ones were the Dupire & these with ^{6 and} 8-wheel connected engines - The demand for these was rapidly falling off & the 10-wheeled & heavy ^{Engines} "C" taking their place & by 1859 they ceased to be built - ^{save} ~~save~~ in exceptional cases for export - Intense interest was taken at this time in the proper means to be employed in combustion: various experiments were tried to run the fire

Prof. the result, ~~and~~ study and
 experiments led Mr. 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
 use of coal was in the manner
 of firing, rather than in any partic-
 ular designs of fire box -

A notable falling off in building
 occurred: the breaking out of the Civil
 war suspended trade - the production
 was as follows:-

Dec 1860.	40,	locomotives built -
" 1861 -	75,	" " "
" 1862 -	96,	" " "
" 1863 -	130,	" " "
" 1864 -	115 -	" " "
" 1865 -	115 -	" " "

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In 1861, 18 inch. cylinder freight locomotives, with 6-wheels connected with a pony truck was built. this is the first instance of the use of the 'pony' truck in these W. ones -

The introduction of Steel in locomotive construction became a distinguishing feature at this time and has gradually replaced wrought iron, the steel tires, steel fire boxes, &c. - another distinguishing feature at this time was placing the cylinders horizontal. The casting of the cylinder & the half saddle in one piece and fitting it to the circular smoke-box was designed by Mr. Baldwin, it resulted from his original method of construction. he was the first American

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builder to adopt an outside cylinder -
 he ~~was~~ constructed it (in
 his early Engines) with a circular
 flanged segment cast to it - in
 order to be bolted to the boiler -
 from high inclination the cylinders
 were gradually brought to less,
 until the horizontal position
 was attained and maintains
 to day - the advantages of this
 arrangement have resulted in
 simplicity and economy because
 the cylinders being right & left -
 our Pattern will answer for either.

The production was

In 1866.	118.	Locomotives -	
" 1867 -	127.	"	-
" 1868 -	124.	"	-
" 1869 -	235.	"	-
" 1870 -	280.	"	-
" 1871 -	331.	"	-

In ~~July~~ 1866, the "Consolidation" type came into vogue, the first engine being the "Consolidation" built for the Delight Valley R.R. Co - it had 4 pairs of drivers connected to Bissell-Pony-truck - the following year (1867),

the 'moguel' class of engines, with 3 pairs of drivers connected and a swinging pony-truck, took its rise in the practice of these works, from the "E.A. Douglass" built for the Thomas Iron Co. this plan of engine has rapidly grown in favor for freight duty up 200 grades & when heavy loads are to be moved.

Steel flues were first used in 10 wheel freight engines in 1868 - Steel Boilers also, the same year.

The 1854 type of engine ~~having~~ 17' having a straight boiler and two domes, was revived in 1866, and until 1880 both the straight & wagon-top boilers were built, yet since 1880 the two domes have been seldom specified. The first narrow gauge ^{locomotive} (3½ feet) was built in 1868. Locomotives for single-rail lines were built in 1878-79. Locomotives to operate in mines were first built in 1870. These were for narrow-gauge, and not over 5½ feet in height.

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

Steel pins were first ~~employed~~ without being secured by bolts or rivets in any form, in 1870. Now this is the prevailing custom.

In 1872, 422 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 -

and during the year a new department in loco-
motive engineering ^{to take place} in these works, an
experimental steam Street Car -
which proving in great measure a success,
the next step was the construction of a
'motor' car, to which one or more
ordinary cars could be attached -
Sheet Iron Boilers with vertical corrugations
in the side sheets were first made by
these works in 1876.

The first compressed air locomotive
was built during the year 1885 -

In 1883, the "Wharfedale" locomotive
 was built 10-wheel connected with a
 "Pony" engine: this engine's wheel base
 was 17 feet: the rear flanged driving
 wheels were given two quarter inch more
 on the rails -
 play than the next adjacent pair: the
 second and third pairs were flanged
 flanged, while the front pair were flanged:
 the locomotive could therefore pass a curve
 of a radius as short as 550 feet: allow-
 ing the proper spread between the rails upon
 a curve - a locomotive was constructed
 during the year ¹⁸⁸⁶ leaving an outside frame,

(see cut) -

In 1887, a new form of boiler was built
 for the 10 wheel engine: a long wagon-top
 was used, extending, to allow the dome
 to be placed in front of the fire box, near
 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 locomotives for Japan were shipped
 in June 1887 -

active

During 1888-89, a ~~heavy~~ demand sprung up for Steam Motors for Street Railway Service. 95 ^{of them} were built: also

Two (2) Portable Locomotives - of the Triggemback system - for foreign service were constructed.

In October 1889, the first Compound Locomotive was completed: it was the 4 cylinder type, designed and patented by Mr. P. M. Vanclain, then the Gen. Supt. of the Woms - because of its fuel and water economy, its efficiency in both Passenger and freight service, led to its introduction upon many 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	one built.	} in 1897, 86 built -	
"	1891.	82.	"		" 1898, 235 "
"	1892.	213.	"		" 1899, 241 "
"	1893.	160.	"		
"	1894.	30.	"		
"	1895.	51.	"		
"	1896.	173	"		

The award of the Elliott Cross
Medal of the Franklin Institute?

In Sep. 1890 the Committee of Science & Arts
of the Franklin Institute appointed a sub-
committee of their members to investigate
and report upon the Vanclain Compound
locomotive: in ~~the~~ ¹⁸⁹¹. This committee
presented their report, and it was adopted
at their meeting in June 1891; it is interesting
to briefly note the conclusions arrived at, especially
as the merits of the invention was seen in
the rapid adoption by numerous Rail Roads
that tried or witnessed their performance while
in service. The Committee conclude their Report,
as follows: "that the Vanclain Compound loco-
motive is a distinct, new and original type of
locomotive. It is the most marked depar-
ture from the usual construction of engines
that has elicited general satisfaction wherever
introduced & & & & immunity from
Total disablement, ready adaptability within
limits of space, incapable of accommodating
other Compound Engines and general applicability
to and utility in Railway service, & the opinion
of your Committee, deserving of recognition by
(over)

In 1889, a test was made to see in ^{22'}
how short time a locomotive could
be built; the order was given up on
June 27th for a narrow gauge locomotive
"American" type ^{for} passenger service & on
July 2^d it was completed - having
consumed but 8 working days from the
raw material -

In this year, the manufacture of wrought
iron wheel centers, for both Meece and
Waring wheels, was begun, under Patents
of Mr. Vanclaire -

In 1890, the 1st Passenger Rail locomotive
under the 'Cbit' system was constructed
for the Pine's Pass R.R. & during this year
& 1893, four locomotives of this type
were built for this road, the grades
varying from 8 to 25% - (see Cur.)

3 - Hoop type of 1 meter gauge were built
and shipped to Palestine -

In 1891. the largest locomotives in the history of the Wones were designed & built for service in the Tunnel (under the St. Clair River) of the Grand Trunk Rail Way — they were 10-wheel converted, with tanks on the boiler and weighed each, in working order, without fire in firebox, 186,800 lbs — of the Heapsod pattern. Five compound locomotives were built for the Erie R.R.

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

In 1892-93. we fired 731 and in 1893, 772 engines were constructed. For Rail-rail locomotives were built & 25 compound "Foney" 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' & 'Narrow' gauge, locomotives; the depression in general business which set in in the

Summer of 1893. had serious effect upon
the Works - we find the number of Engines
completed in 1894 was 313.

Jan. 1895 - ~~at~~ a new
type of Passenger Locomotion was brought
out. see cut - ^{with} this the "Atlantic" type
was given. its advantages are a large
fire box & boiler, enabling high speeds -

The first Electric Locomotive was
built this year for the W. American Co.

Two other ^{small} electric locomotives
were built in 1896 in co-operation with
the Westinghouse Elec. Mfg. Co. they

supplying the electrical parts -

a high speed Passenger Locomotive was
built for the Reading RR. having ~~a~~ a

single pair of Drivers $84\frac{1}{4}$ inches ⁱⁿ diameter.

This engine is a Duplicate built in 1896 -
an regularly used in hauling trains between
Philadelphia & Jersey City. this distance

25
being 90 miles, they accomplish this
in 105 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-
structed upon the 'abt' system: this engine
was furnished with two complete sets of
machinery, entirely independent of each
other and was built ^{to} run over 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 Persia —

In 1896. Two combination Rack & adhesion
locomotives ~~locomotives~~ were sent to Mexico —
having compound cylinders connected to the
driving wheels through walking beams —
Two pairs of wheels are secured to the axles by
clutches and act as adhesion driving wheels,
and the rack wheels are loose on the axle and
act only as carrying wheels. All 3-coupled axles
carry Rack pinions of the 'abt' system. The

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Two pairs of adhesion wheels are thrown into operation by clutches -

Six 10-wheel locomotives were built for the Baltimore & Annapolis R.R. for Express Passenger service. (See cut) & have been operated with great efficiency -

In 1897 the Reading R.R. placed a fast Express train for service between Camden and Atlantic City, N.J. 55 $\frac{1}{2}$ miles, allowing 52 minutes for the run, equivalent to a speed of 64 miles per hour. The R.R. records show

that for 62 days July 2^d to Aug. 31st '97. The average time consumed was but 48 minutes or a speed of 69 miles per hour and once the train covered the distance in 46 $\frac{1}{2}$ minutes or 71 $\frac{6}{10}$ miles per hour. These engines were of the Atlantic type, Vanclaire Compound.

In cut -

In 1898 a 'Consolidation' Vanclaire Compound locomotive was placed in service upon the mountain between Copton & Fairview upon the Belknap Valley R.R. it was guaranteed to haul a load of 1000 net tons (exclusive of

27-

The weight of the Engine & Tender) upon a grade of 66 feet to the mile. It was so successful in the test, that 14 additional locomotives were subsequently ordered by this Company -
See Crest.

In 1899. Two "Atlantic" type, Vanclain Compound locomotives were built for the 'Burlington' RR. for fast mail service West of Chicago.

During this year there was a large purchase in foreign business, including 30 locomotives for ~~England~~ "Midland" and 20, for the "Great Northern" and 20 for "Great Central Railways of England" - 10 locomotives were ordered by the "Trunk State" and 10 by the "Bône Guelma" Railways in the French Colonies, of Algeria; also Two Vanclain "Consolidation" freight locomotives for the Bavarian State Railways - and in 1890 this Co. ordered 2 passenger engines of the Compound "Atlantic" type and embody in their passenger rolling stock, the new features

contained in these machines -

During 1900. These Works exhibited at
 the Paris Exposition - a "Goods" locomotive
 'loque' type for the Great Northern R.W of
 England; an 'Atlantic' type Passenger
 locomotive for the New York State R.Ways.
 also a Compound American 'type Passenger
 locomotive for this same road: three
 engines were built in the regular course of
 business for their respective Companies &
 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.W.; the Ireland 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 freight transportation: cars were designed & built to carry heavier loads, resulting in improved road beds, heavier rails ~~and~~ stronger bridges and more powerful locomotives. As the demand for increased horse-power, involving greater steaming capacity and a larger grate area evolved the "Atlantic" type locomotive from the "American" or 8-wheeled passenger engine, so, in order to produce a locomotive to cope with the enhanced conditions, viz: heavier trains at higher speeds there was designed the "Prairie" type of engine - a type resulting from the 'Mogul' or 10 wheel locomotives: this engine has a pony boiler, 3 pairs of driving wheels and a wide fire box extending over the frames & placed base of the driving wheels: To support

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the overhanging weight, a pair of trailing wheels is placed beneath the fire box. Fifty of these locomotives were built for the "Burlington" and forty five for the Atchafalpa Rail Roads - in 1901 - a new departure in locomotive ~~practice~~ was exhibited by these Wons, 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 tender embodying the inventions of Mr. Cornelius Vanderbuilt, M. E. the fire box was cylindrical in form its axis eccentric to that of the boiler. is riveted to back head of the boiler and supported at the bottom by the reed ribs - otherwise entirely disconnected from the outer shell and so dispensing with stays bolts & crown bars - thus permitting easy removal and absence of the usual repairs: the feature of the tender is a cylindrical, instead of a U shaped tank placed back of the coal space. the advantages being: a better distribution of its weight in the tender. less dead weight and more economical ^{construction}

The year 1901. was especially noticeable for its large volume of domestic business, there being a very large demand for the West and Southwestern Rail Roads: the Pennsylvania too, ordered over 150 locomotives of various types - and the Baltimore Ohio RR. 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 9,595.

In February 1902, the 20,000th locomotive was completed: this engine embodied several interesting features - viz: Compound cylinders, with the new arrangement, Van-alain type - see Cut - r. r.

In May of this year, the largest locomotive ever built was turned out: it was a 'Wearpood' for the 'Cleveland' RR. Co. the total weight

of the engine above was 267,800 pounds -
it was designed for heavy hauling upon
steep grades -

The Mikado type of locomotive was
established this year - its requirements called
a powerful engine with a large fire box &
ample grate surface for burning inferior coal
or lignite & this type consisted of 8 wheels
connected, with the fire box behind them
supported by a pair of trailing wheels and
a pony truck in front - see cut -

Oil burning locomotives were built this
year for the "Astoria" the Southern Pacific

^{files}
Galveston, Houston & Henderson Road Roads
from the American type of locomotive -

Electric locomotives, for surface mine
haulage showed a marked increase
both in ^{number and} point of design; also many orders
for electric motor trucks were received -

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 Patents, confining
themselves to the fundamental Patents
& details which were essential to the
successful development of their
locomotives - and would recommend
for originality, invention, design,
system and management the award
of the "Elliott Cresson" Gold medal and
Diploma of the Franklin Institute
of ~~Pennsylvania~~ - Penn.
Signed

a 4-wheeled engine, weighing in
running something over 5 Tons —
the main drivers were placed in front of
the fire box; ^{the} front wheels were directly two
of the cylinders, which were $9\frac{1}{2}$ inches in
diameter by 18 inches stroke and attached
horizontally to the outside of the smoke box.
The axles were heavy cast iron hubs, wood
on spores & vice, with wrought iron tires.
The wheels 30 inches in diameter, with ~~6~~ $7\frac{1}{2}$
 $1\frac{1}{2}$ " copper tubes, 7 feet long — the tender was
a 4-wheeled platform, wooden sides & back,
carrying an iron box for a water tank —
& space for fuel in front —
The valve motion was at first given by
a single force eccentric for each cylinder,
placed on the axle between the crank & hub
of wheel; a half circular slot passing half
way round was in the inside of the eccentric
a stop on the axle at the crank-arm, the
minimizing in a pair, axle projected into the
slot — The engine was moved by changing

My life work