THE DEVELOPMENT OF LATER TYPES OF LOCOMOTIVES USED BY THE BALTIMORE AND OHIO RAILROAD COMPANY.

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SUBMITTED

BY

THOS. H. GRAHAM

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THE DEVELOPMENT OF LATER TYPES OF LOCOMOTIVES USED BY THE BALTIMORE AND OHIO RAILROAD COMPANY.

For a long period of time following its establishment, the American people were distrustful of the railroad. A great majority were skeptical that the locomotive would ever replace the horse, the ox, or even the boat as a means of transportation. In fact, some time after the advent of the locomotive, and after lines were laid out carrying freight and passengers, enormous sums of money were spent building canals for the transportation of freight, by boat, between the principal cities of the east.

But by 1850, the locomotive had partially overcome these obstacles and upon it was resting the burden of transportation. Railroading was a more prosperous business. New lines were extended in all parts of the eastern states and were steadily pushing westward. Rapidly growing industries were placing new responsibilities on the railroads. Therefore, it was necessary that more dependable locomotives be built, since those previous to this were incapable.

Moreover, a new era began about 1850 for the Baltimore and Ohio locomotive when standardized types began to be seen; when locomotives identical in appearance were numbered in sequence, so that one only needed to say "the two hundreds", or "the four hundreds" to denote them.

The day was past when experimentation produced locomotives of widely different design as well as appearance. At the beginning of the locomotive there was so little known about steam, and so few devices available to utilize this power for locomotion, it was necessary for inventors in both England and America to create various locomotives and numerous mechanisms in order to choose the most practical and most efficient. But by 1850, locomotives had lost their individualism, and they were built to conform to certain standards of design which were found most practical for their particular uses.

There are two factors which counteract each other in the design of a locomotive--speed and power. One may be increased, but only at a loss of the other. If speed is desired, the drivers must be made as large as possible, and as few in number as will permit steadiness. If power is wanted the drivers are made much smaller in diameter and a number of them are used in tandem. In other words, we see that speed is a function of the diameter of the drivers, and power is determined by the number used.

Passenger trains demanded more dependability and more speed, so in 1856, William Mason, a maker of cotton machinery from Tauton, Massachusetts, took the lead in designing and building locomotives that were the forerunners of the famous American type. These had two pair of drivers 60" in diameter, with a leading four wheel truck to add steadiness.

A new feature for this locomotive was the use of a link motion valve gear, the first to be installed on any locomotive. Because of its short wheel base,it was the fittest type for the peculiar conditions existing in this country at that time - uneven track, bad curves, and many grades.

These locomotives were used extensively for passenger service and were built until 1893 when, like the Atlantic type, they had to give way to engines with more traction. They had become too light for the heavier traffic.

An attempt was made to utilize this type by increasing the size of the boiler and firebox and adding a pair of trailer wheels under the cab to support this added weight. These were built in 1900 and named the Atlantic type, but only six engines were constructed since they were still lacking in traction. Therefore, another pair of drivers were added in 1906 and the popular Pacific type of locomotive was created which reaches the height of its perfection in the "President" series.

Furthermore, The heavy steel trains of the present needed a still more powerful locomotive to draw them over the unusually steep grades of the Allegheny Mountains,so another, or fourth pair of drivers was added and in 1926, the Mountain type was built.

Thus, we may trace the development of the Baltimore and Ohio passenger locomotive from 1850 to 1928, from the small 28 ton William Mason type to the huge Mountain type with its 400,000 pounds weight.

The development of the freight locomotive used by the Baltimore and Ohio Railroad may, in a like manner, be traced from 1848 to the present day.

Ross Winans, of Baltimore, realizing the need of a more powerful and efficient freight locomotive, designed one with four pairs of drivers to give the utmost traction. He placed the engineer's cab over the entire boiler giving rise to its being called the Winans "Camelback" engine. It was placed in operation June 1848.

This type was very successful and was used as the standard until the introduction of the Consolidation type in 1873. About forty of these locomotives were built.

In 1873, a freight locomotive with three pairs of drivers was designed and built at the Mount Clare shops. It had a two wheel leading truck. But, although this type, named the Mogul type, was a good engine, it needed another pair of drivers to furnish sufficient traction.

Therefore from the Mogul type was developed the Consolidation type by the addition of the other pair of drivers. This locomotive was capable of hauling heavy coal trains over the steep grades of the mining regions, so it was developed and built as late as 1910, although the Mikado, the Mallet, and the Santa Fe types were taking its place.

The Consolidation locomotive reached a limit to its size and power when the firebox could not extend beyond a fixed point due to lack of support. It was not thought advisable to add a pair of trailer wheels under the cab because

Of the resulting loss of traction, but the Baldwin Locomotive Works built, in 1897, one of this type with the trailer wheels, and named it the Mikado locomotive since it was for the Nippon Railroad of Japan.

The loss in traction was compensated by the increased boiler capacity and weight, so that, today, the Mikado locomotive hauls all of the fast freight for the Baltimore and Ohio. It replaced the Consolidated engine and, except for unusually heavy freight, is the universal locomotive.

The idea for the articulated locomotive was obtained from Europe due to the necessity for them to utilize the ultimate heat value of coal, since that fuel was scarce. A double or articulated locomotive was developed which consisted of two engine units under one boiler. The size and number of wheels prohibited its use for fast service but this type proved ideal as a pusher for heavy freight.

The first of this kind was built in 1904 for the Baltimore and Ohio from plans of Anatole Mallet, a native of France. Each unit consisted of three pairs of drivers, but all "Mallets" made since then have four pair of drivers per unit. These locomotives are used exclusively on the main lines thru the Allegheny Mountains where a higher factor of traction is needed for the steep grades.

An intermediate type of freight locomotive with five pairs of drivers was built in 1914 for slower freight service than the Mikado serves. This type, with a two wheel leading truck and trailing truck, has been named the Santa Fe locomotive.

From these facts, it might be concluded that the locomotive developed by the mere addition of drivers. However, the super-heater, the automatic stoker, improved valve gearing,and other important features not mentioned before, contributed largely to its development. The invention of the air brake, and the improvement of steel were significant steps toward the construction of modern high speed all steel trains.

Never-the-less, the height of perfection is not attained. Today, numerous problems trouble the designer, since he constantly strives for a more powerful locomotive to meet the always increasing demands of transportation.

APPENDIX

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Containing a more intimate description of
the various locomotives mentioned
in the text.

THE AMERICAN LOCOMOTIVE

Designed and built in 1856 by William Mason of Taunton, Mass.

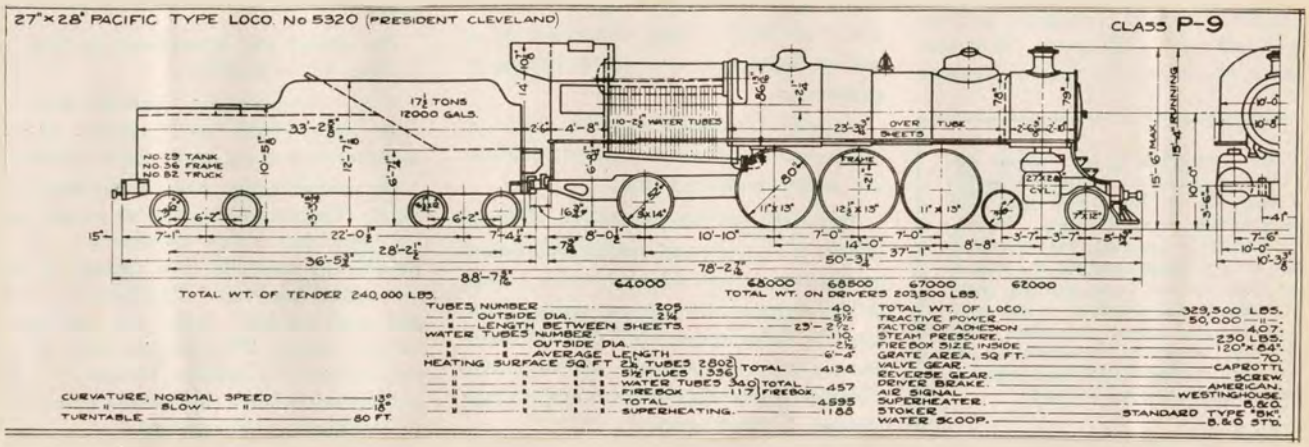
Wheel arrangement 4-4-0

	1856 (first engine)	1893 (latest engine)
Weight (pounds)	56,000	123,400
Tractive Power (pounds)		12,883
Cylinders	15"x 22"	13½"x 24"- 23"x 24"
Steam Pressure (pounds)		165
Diameter of Drivers (inches)	60	

This type was built for speed and was suitable for hauling the light passenger trains of the last century, but with the coming of heavier, faster equiptment, it was necessary to provide more traction for the locomotive. This type, with only two pairs of drivers, was therefore replaced by others.

The locomotive, described as built in 1856, was the first to have the link motion valve gear. The latest of this type was the first compound locomotive ever built and was exhibited at the Chicago Worlds Fair.

THE PACIFIC LOCOMOTIVE



The Pacific type of locomotive is the standard modern passenger engine. It was first designed in 1906, and since then has been developed to the height of its perfection in the "President Cleveland", which was constructed in 1928 at the Mount Clare shops.

THE WINANS CAMELBACK LOCOMOTIVE

Built by Ross Winans of Baltimore for the Baltimore and Ohio Railroad, and put in operation June 1848.

Wheel arrangement in 1848 was 0-8-0, but in 1869 they were made with wheels 4-6-0 as shown in the picture.

Cylinders were horizontal and were first made 17"x 22", later developed to 19"x 22".

Boiler horizontal with inclined top overhanging the firebox.

Valve mechanism consisted of hook motion valve gear, but in 1870 it was changed to the Stephenson link motion.

These were the principal freight locomotives used until the Consolidation type was introduced in 1873, and a few were in service until 1898.

THE MOGUL LOCOMOTIVE

Built by J.C.Davis, master of machinery, at the Mount Clare shops in 1875.

Wheel arrangement 2-6-0

Weight 90,400 pounds, Tractive power 14,520 pounds

Cylinders 19"x 24" Steam pressure 110 pounds

Valve mechanism cosisted of the Stephenson valve gear.

This one locomotive was used originally for hauling heavy passenger trains over the Allegheny Mountains between Peidmont and Altamont, but this type was applied to freight service as well. Its use was restricted, though , due to a lack of traction so it was not developed.

THE CONSOLIDATION LOCOMOTIVE

First designed by Baldwin, of Philadelphia, for the Lehigh Valley Railroad in 1866. It was designed and built for the Baltimore and Ohio by Danforth L. Morse in 1873.

Wheel arrangement 2-8-0

	1873 (first engine)	1910 (latest engine)
Weight (pounds)	105,200	220,370
Tractive power (pounds)	20,400	42,168
Cylinders	20"x 24"	24"x 30"
Steam pressure (pounds)	125	215
Quality of steam	saturated	super-heated

Some notable improvements were made on this type by A. J. Cromwell, a capable designer, in 1888. He made the firebox extend over the rear wheels, and eliminated the previously used deck plates: he constructed a brick arch in the firebox to retain the flame until more of its heat value could be utilized. He strengthened weak parts, and thus contributed a great deal toward the development of this type of freight locomotive. These were used as the heaviest freight haulers until more improved types were necessary.

THE MIKADO LOCOMOTIVE

First designed by Baldwin in 1897 for the Nippon Railway of Japan, and it was built for the Baltimore and Ohio railroad in 1911.

Wheel arrangament 2-8-2

	1911 (first engine)	1923 (latest engine)
Weight (pounds)	267,030	281,000
Tractive power (pounds)	50,184	54,600
Cylinders	24"x 32"	26"x 32"
Steam pressure (pounds)	205	220
Diameter of drivers (inches)	64	64

This type is the universal freight locomotive except where grades are unusually steep.

THE MALLET ARTICULATED LOCOMOTIVE

Designed in 1904 by J.E.Muhlfeld in conjunction with the American Locomotive Works.

This Mallet, the first of its kind built in this country, consisted of two engine units, each with three pairs of drivers. The two units were constructed as a compound engine, that is, two were low pressure cylinders and two were high pressure cylinders. It was found, by trail, that excessive back pressure was developed at any but a very slow speed. Hence, all Mallet locomotives made since are constructed with simple engine units. They are also made with four pairs of drivers per unit, as shown below. The forward

SIMPLE MALLET

engine is pivoted to allow the locomotive to round curves.