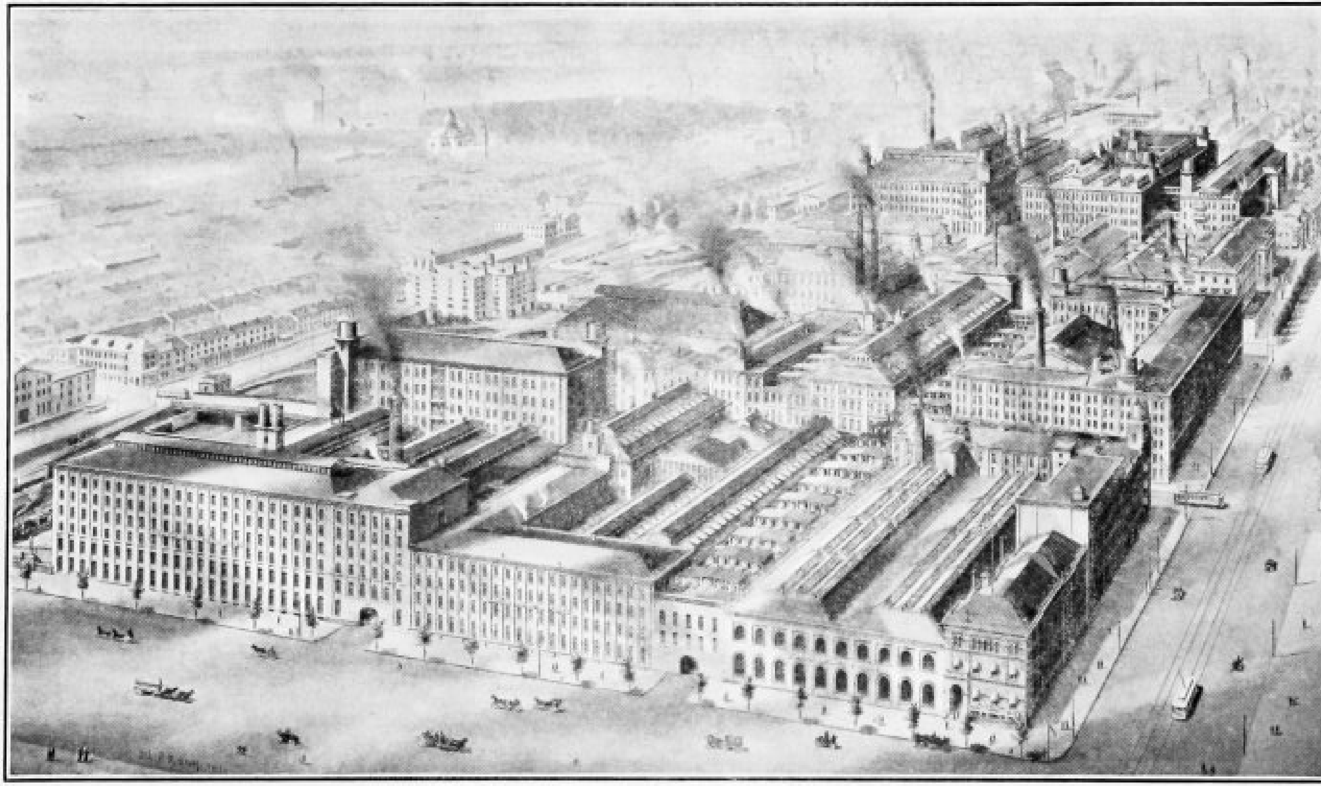
Baldwin Locomotive Works
Locomotives and Detail Parts



GENERAL VIEW OF WORKS

BALDWIN LOCOMOTIVE WORKS

ILLUSTRATED CATALOGUE

OF

LOCOMOTIVES AND DETAIL PARTS

CODE WORD—MEDDIX

BURNHAM, WILLIAMS & COMPANY
PHILADELPHIA, PA., U. S. A.
(CABLE ADDRESS, BALDWIN PHILADELPHIA)

OFFICES AND WORKS

THE BALDWIN LOCOMOTIVE WORKS

1831

MATTHIAS W. BALDWIN

1839

BALDWIN, VAIL & HUFTY

M. W. Baldwin * — George Vail * — George W. Hufty *

1842-45

BALDWIN & WHITNEY

M. W. Baldwin * — Asa Whitney *

1846-53

M. W. BALDWIN

1854

M. W. BALDWIN & CO.

M. W. Baldwin * — Matthew Baird *

1867

M. BAIRD & CO.

Matthew Baird * — George Burnham — Charles T. Parry *

1870

M. BAIRD & CO.

Matthew Baird * — George Burnham — Charles T. Parry *
Edward H. Williams * — William P. Henszey — Edward Longstreth

1873

BURNHAM, PARRY, WILLIAMS & CO.

George Burnham — Charles T. Parry * — Edward H. Williams *
William P. Henszey — Edward Longstreth — John H. Converse

1886

BURNHAM, PARRY, WILLIAMS & CO.

George Burnham — Charles T. Parry * — Edward H. Williams *
William P. Henszey — John H. Converse — William C. Stroud *
William H. Morrow * — William L. Austin

1891

BURNHAM, WILLIAMS & CO.

George Burnham — Edward H. Williams * — William P. Henszey
John H. Converse — William C. Stroud * — William L. Austin

1896

BURNHAM, WILLIAMS & CO.

George Burnham — Edward H. Williams * — William P. Henszey
John H. Converse — William L. Austin — Samuel M. Vauclain
Alba B. Johnson — George Burnham, Jr.

1901

BURNHAM, WILLIAMS & CO.

George Burnham — William P. Henszey — John H. Converse
William L. Austin — Samuel M. Vauclain — Alba B. Johnson
George Burnham, Jr.

1907

BURNHAM, WILLIAMS & CO.

George Burnham — William P. Henszey — John H. Converse
William L. Austin — Samuel M. Vauclain — Alba B. Johnson

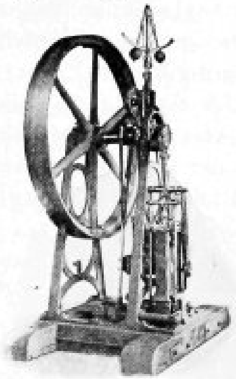
* now deceased

The Baldwin Locomotive Works

THESE Works occupy about sixteen acres in the heart of Philadelphia and one hundred and eighty-four acres at Eddystone, on the Delaware River, twelve miles below the city. The offices and principal machine shops are situated in the rectangle bounded on the north by Spring Garden Street, on the east by Broad Street, on the south by the Philadelphia and Reading Railway Subway and on the west by Eighteenth Street. Finishing, testing and repair shops are also located on the line of the Philadelphia and Reading Railway at Twenty-Sixth to Twenty-Eighth Streets.

The Works dates its origin from the inception of steam railroads in America. Called into existence by the early requirements of the railroad interests of the country, it has grown with their growth and kept pace with their progress. It has reflected in its career the successive stages of American railroad practice, and has itself contributed largely to the development of the locomotive as it exists to-day. A history of the Baldwin Locomotive Works, therefore, is in a great measure a record of the progress of locomotive engineering in this country, and as such cannot fail to be of interest to those who are concerned in this important element of our material progress.

MATTHIAS W. BALDWIN, the founder of the establishment, learned the trade of a jeweler, and entered the service of Fletcher & Gardiner, Jewelers and Silversmiths, Philadelphia, in 1817. Two years later he opened a small shop, in the same line of business, on his own account. The demand for articles of this character falling off, however, he formed a partnership, in 1825, with David Mason, a machinist, in the manufacture of bookbinders' tools and cylinders for calico printing. Their shop was in a small alley which runs north from Walnut Street, above Fourth. They afterward removed to Minor Street, below Sixth. The business was so successful that steam power became necessary in carrying on their manufactures, and an engine was bought for the purpose. This proving unsatisfactory, Mr. Baldwin decided to design and construct one which should be specially adapted to the requirements of his shop. One of these requirements was that it should occupy the least possible space, and this was met by the construction of an upright engine on a novel and ingenious plan. On a bed-plate about five feet square an upright



MR. BALDWIN'S FIRST ENGINE

cylinder was placed; the piston rod connected to a cross bar having two legs, turned downward, and sliding in grooves on the sides of the cylinder, which thus formed the guides. To the sides of these legs, at their lower ends, was connected by pivots an inverted U-shaped frame, prolonged at the arch into a single rod, which took hold of the crank of a fly wheel carried by upright standards on the bed-plate. It will be seen that the length of the ordinary separate guide bars was thus saved, and the whole engine was brought within the smallest possible compass. The design of the machine was not only unique, but its workmanship was so excellent, and its efficiency so great, as readily to procure for Mr. Baldwin orders for additional stationary engines. His attention was thus turned to steam engineering, and the way was prepared for his grappling with the problem of the locomotive when the time should arrive.

This original stationary engine, constructed prior to 1830, is still in good order and carefully preserved at the Works. It has successively supplied the power in six different departments as they have been opened, from time to time, in the growth of the business.

The manufacture of stationary steam engines thus took a prominent place in the establishment and Mr. Mason shortly afterward withdrew from the partnership.

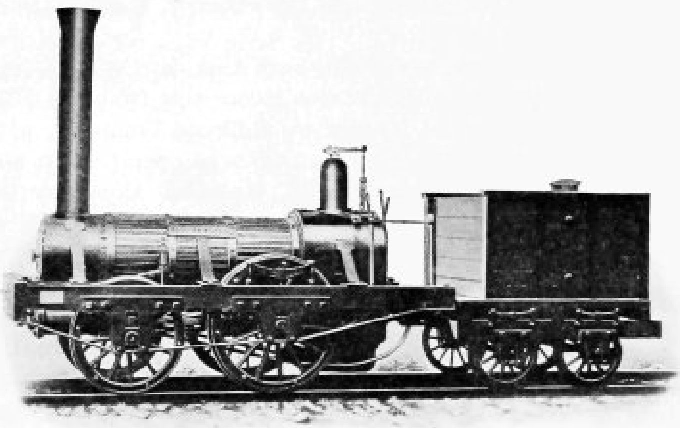
In 1829–30 the use of steam as a motive power on railroads had begun to engage the attention of American engineers. A few locomotives had been imported from England, and one (which, however, was not successful) had been constructed at the West Point Foundry, in New York City. To gratify the public interest in the new motor, Mr. Franklin Peale, then proprietor of the Philadelphia Museum, applied to Mr. Baldwin to construct a miniature locomotive for exhibition in his establishment. With the aid only of the imperfect published descriptions and sketches of the locomotives which had taken part in the Rainhill competition in England, Mr. Baldwin undertook the work, and on the 25th of April, 1831, the miniature locomotive was put in motion on a circular track made of pine boards covered with hoop iron, in the rooms of the Museum. Two small cars, containing seats for four passengers, were attached to it, and the novel spectacle attracted crowds of admiring spectators. Both anthracite and pine-knot coal were used as fuel, and the exhaust steam was discharged into the chimney, thus utilizing it to increase the draught.

The success of the model was such that, in the same year, Mr. Baldwin received an order for a locomotive from the Philadelphia, Germantown and Norristown Railroad Company, whose short line of six miles to Germantown was operated by horse power. The Camden and Amboy Railroad Company had shortly before imported a locomotive from England, which was stored in a shed at Bordentown. It had not yet been put together; but Mr. Baldwin, in company with his friend, Mr. Peale, visited the spot, inspected the detached parts, and made a few memoranda of some of its principal dimensions. Guided by these figures and his experience with the Peale model, Mr. Baldwin commenced the task. The difficulties to be overcome in filling the order can hardly be appreciated at this day. There were few mechanics competent to do any part of the work on a locomotive. Suitable tools were with difficulty obtainable. Cylinders were bored by a chisel fixed in a block of wood and turned by hand. Blacksmiths able to weld a bar of iron exceeding one and one-quarter inches in thickness were few, or not to be had. It was necessary for Mr. Baldwin to do much of the work with his own hands, to educate the workmen who assisted him, and to improvise tools for the various processes.

The work was prosecuted, nevertheless, under all these difficulties, and the locomotive was fully completed, christened "Old Ironsides," and tried on the road, November 23, 1832.

The circumstances of the trial are fully preserved, and are given, farther on, in the extracts from the journals of the day. Despite some imperfections, naturally occurring in a first effort, and which were afterward to a great extent remedied, the engine was, for that early day, a marked and gratifying success. It was put at once into service, as appears from the company's advertisement three days after the trial, and did duty on the Germantown road and others for over a score of years.

The "Ironsides" was a four-wheeled engine, modeled essentially on the English practice of that day, as shown in the Planet class, and weighed, in running order, something over five tons. The rear or driving wheels were fifty-four inches in



THE "OLD IRONSIDES," 1832

diameter on a crank axle placed in front of the firebox. The cranks were thirty-nine inches from center to center. The front wheels, which were simply carrying wheels, were forty-five inches in diameter, on an axle placed just back of the cylinders. The cylinders were nine and one-half inches in diameter by eighteen inches stroke, and were attached horizontally to the outside of the smokebox, which was D-shaped, with the sides receding inwardly, so as to bring the center line of each cylinder in line with the center of the crank. The wheels were made with heavy cast iron hubs, wooden spokes and rims, and wrought iron tires.

The frame was of wood, placed outside the wheels. The boiler was thirty inches in diameter and contained seventy-two copper flues, one and one-half inches in diameter and seven feet long. The tender was a four-wheeled platform, with wooden sides and back, carrying an iron box for a water tank, inclosed in a wooden casing, and with a space for fuel in front. The engine had no cab. The valve motion was at first given by a single loose eccentric for each cylinder, placed on the axle between the crank and the hub of the wheel. On the inside of the eccentric was a half circular slot, running half way around. A stop was fastened to the axle at the arm of the crank, terminating in a pin which projected into the slot. The engine was reversed by changing the position of the eccentric on the axle by a lever operated from the footboard. This form of valve motion was, however, shortly afterward changed, and a single fixed eccentric for each cylinder substituted. The rock shafts, which were under the footboard, had arms above and below, and the eccentric straps had each a forked rod, with a hook, or an upper and lower latch or pin, at their extremities, to engage with the upper or lower arm of the rock shaft. The eccentric rods were raised or lowered by a double treadle, so as to connect with the upper or lower arm of the rock shaft, according as forward or backward gear was desired. A peculiarity in the exhaust of the "Ironsides" was that there was only a single straight pipe running across from one cylinder to the other, with an opening in the upper side of the pipe, midway between the cylinders, to which was attached at right angles the perpendicular pipe into the chimney. The cylinders, therefore, exhausted against each other; and it was found, after the engine had been put in use, that this was a serious objection. This defect was afterward remedied by turning each exhaust pipe upward into the chimney, substantially as it is now done. The steam joints were made with canvas and red lead, as was the practice in English locomotives, and in consequence much trouble was caused, from time to time, by leaking.

The price of the engine was to have been $4000, but some difficulty was found in procuring a settlement. The company claimed that the engine did not perform according to contract;

and objection was also made to some of the defects alluded to. After these had been corrected as far as possible, however, Mr. Baldwin finally succeeded in effecting a compromise settlement, and received from the company $3500 for the machine.

The results of the trial and the impression produced by it on the public mind may be gathered from the following extracts from the newspapers of the day.

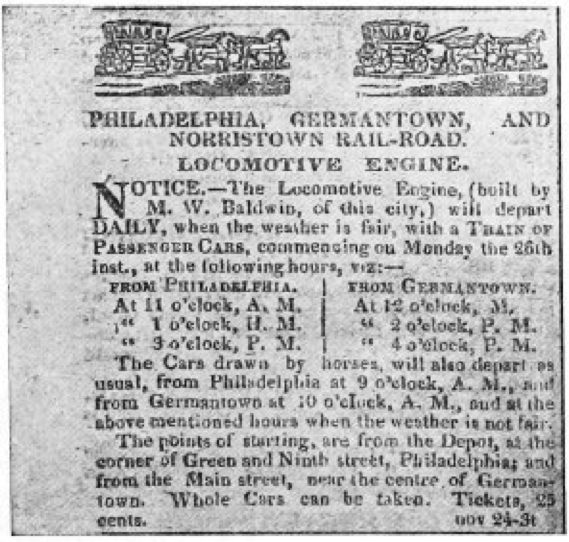
The *United States Gazette*, of November 24, 1832, remarks:

"A most gratifying experiment was made yesterday afternoon on the Philadelphia, Germantown and Norristown Railroad. The beautiful locomotive engine and tender, built by Mr. Baldwin, of this city, whose reputation as an ingenious machinist is well known, were for the first time placed on the road. The engine traveled about six miles, working with perfect accuracy and ease in all its parts, and with great velocity."

The *Chronicle* of the same date noticed the trial more at length, as follows:

"It gives us pleasure to state that the locomotive engine built by our townsman, M. W. Baldwin, has proved highly successful. In the presence of several gentlemen of science and information on such subjects, the engine was yesterday placed upon the road for the first time. All her parts had been previously highly finished and fitted together in Mr. Baldwin's factory. She was taken apart on Tuesday, and removed to the company's depot, and yesterday morning she was completely together ready for travel. After the regular passenger cars had arrived from Germantown in the afternoon, the tracks being clear, preparation was made for her starting. The placing fire in the furnace and raising steam occupied twenty minutes. The engine (with her tender) moved from the depot in beautiful style, working with great ease and uniformity. She proceeded about half a mile beyond the Union Tavern, at the township line, and returned immediately, a distance of six miles, at a speed of about twenty-eight miles to the hour, her speed having been slackened at all the road crossings, and it being after dark, but a portion of her power was used. It is needless to say that the spectators were delighted. From this experiment there is every reason to believe this engine will draw thirty tons gross, at an average speed of forty miles an hour, on a level road. The principal superiority of the engine over any of the English ones known consists in the light weight,— which is but between four and five tons, — her small bulk, and the simplicity of her working machinery. We rejoice at the result of this experiment, as it conclusively shows that Philadelphia, always famous for the skill of her mechanics, is enabled to produce steam engines for railroads combining so many superior qualities as to warrant the belief that her mechanics will hereafter supply nearly all the public works of this description in the country."

On subsequent trials, the "Ironsides" attained a speed of thirty miles per hour, with its usual train attached. So great were the wonder and curiosity which attached to such a prodigy, that people flocked to see the marvel, and eagerly bought the privilege of riding after the strange monster. The officers of the road were not slow to avail themselves of the public interest to increase their passenger receipts, and the following advertisement from *Poulson's American Daily Advertiser*, of November 26, 1832, will show that as yet they regarded the new machine rather as a curiosity and a bait to allure travel than as a practical every-day servant.



PHILADELPHIA, GERMANTOWN, AND NORRISTOWN RAIL-ROAD.

LOCOMOTIVE ENGINE.

NOTICE.—The Locomotive Engine, (built by M. W. Baldwin, of this city,) will depart DAILY, when the weather is fair, with a TRAIN OF PASSENGER CARS, commencing on Monday the 26th inst., at the following hours, viz:—

FROM PHILADELPHIA.	FROM GERMANTOWN.
At 11 o'clock, A. M.	At 12 o'clock, M.
" 1 o'clock, P. M.	" 2 o'clock, P. M.
" 3 o'clock, P. M.	" 4 o'clock, P. M.

The Cars drawn by horses, will also depart as usual, from Philadelphia at 9 o'clock, A. M., and from Germantown at 10 o'clock, A. M., oud at the above mentioned hours when the weather is not fair.

The points of starting, are from the Depot, at the corner of Green and Ninth street, Philadelphia; and from the Main street, near the centre of Germantown. Whole Cars can be taken. Tickets, 25 cents.

nov 24-3t

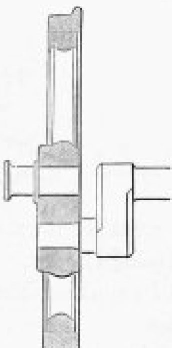
This announcement did not mean that in wet weather horses *would be attached to the locomotive* to aid it in drawing the train, but that the usual horse cars would be employed in making the trips upon the road without the engine.

Upon making the first trip to Germantown with a passenger train with the "Ironsides," one of the drivers slipped upon the axle, causing the wheels to track less than the gauge of the road and drop in between the rails. It was also discovered that the valve arrangement of the pumps was defective, and they failed to supply the boiler with water. The shifting of the driving wheel upon the axle fastened the eccentric, so that it would not operate in backward motion. These mishaps caused delay, and prevented the engine from reaching its destination, to the great disappointment of all concerned. They were corrected in a few days, and the machine was used in experimenting upon its efficiency, making occasional trips with trains to Germantown. The road had an ascending grade, nearly uniform, of thirty-two feet per mile, and for the last half-mile of forty-five feet per mile, and it was found that the engine was too light for the business of the road upon these grades.

Such was Mr. Baldwin's first locomotive; and it is related of him that his discouragement at the difficulties which he had undergone in building it, and in finally procuring a settlement for it, was such that he remarked to one of his friends, with much decision, "That is our last locomotive."

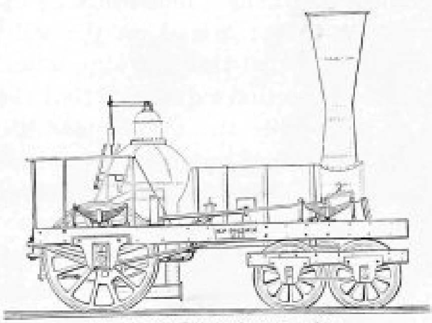
It was sometime before he received an order for another, but meanwhile the subject had become singularly fascinating to him, and occupied his mind so fully that he was eager to work out his new ideas in a tangible form.

Shortly after the "Ironsides" had been placed on the Germantown road, Mr. E. L. Miller, of Charleston, S. C., came to Philadelphia and made a careful examination of the machine. Mr. Miller had, in 1830, contracted to furnish a locomotive to the Charleston and Hamburg Railroad Company, and accordingly the engine "Best Friend" had been built under his direction at the West Point Foundry, New York. After inspecting the "Ironsides," he suggested to Mr. Baldwin to visit the Mohawk and Hudson Railroad, and examine an English locomotive which had been placed on that road in July, 1831, by Messrs. Robert Stephenson & Co., of Newcastle, England. It was originally a four-wheeled engine of the Planet type, with horizontal cylinders and crank axle. The front wheels of this engine were removed about a year after the machine was put at work,


HALF-CRANK

and a four-wheeled swiveling or "bogie" truck substituted. The result of Mr. Baldwin's investigations was the adoption of this design, but with some important improvements. Among these was the "half-crank," which he devised on his return from this trip, and which he patented September 10, 1834. In this form of crank, the outer arm is omitted, and the wrist is fixed in a spoke of the wheel. In other words, the wheel itself formed one arm of the crank. The result sought and gained was that the cranks were strengthened, and, being at the extremities of the axle, the boiler could be made larger in diameter and placed lower. The driving axle could also be placed back of the fire-box; the connecting rods passing by the sides of the firebox and taking hold inside of the wheels. This arrangement of the crank also involved the placing of the cylinders outside the smokebox, as was done on the "Ironsides."

By the time the order for the second locomotive was received, Mr. Baldwin had matured this device and was prepared to embody it in practical form. The order came from Mr. E. L. Miller, in behalf of the Charleston and Hamburg Railroad Company, and the engine bore his name, and was completed February 18, 1834. It was on six wheels; one pair being drivers, four and a half feet in diameter, with half-crank axle placed back of the firebox as above described, and the four front wheels combined in a swiveling truck. The driving wheels, it should be observed, were cast in solid bell metal. The combined wood and iron wheels used on the "Ironsides" had proved objectionable, and Mr. Baldwin, in his endeavors to find a satisfactory substitute, had recourse to brass. June 29, 1833, he took out a patent for a cast-brass wheel, his idea being that by varying the hardness of the metal the adhesion of the drivers on the rails could be increased or diminished at will. The brass wheels on the "Miller,"



BALDWIN LOCOMOTIVE, 1834

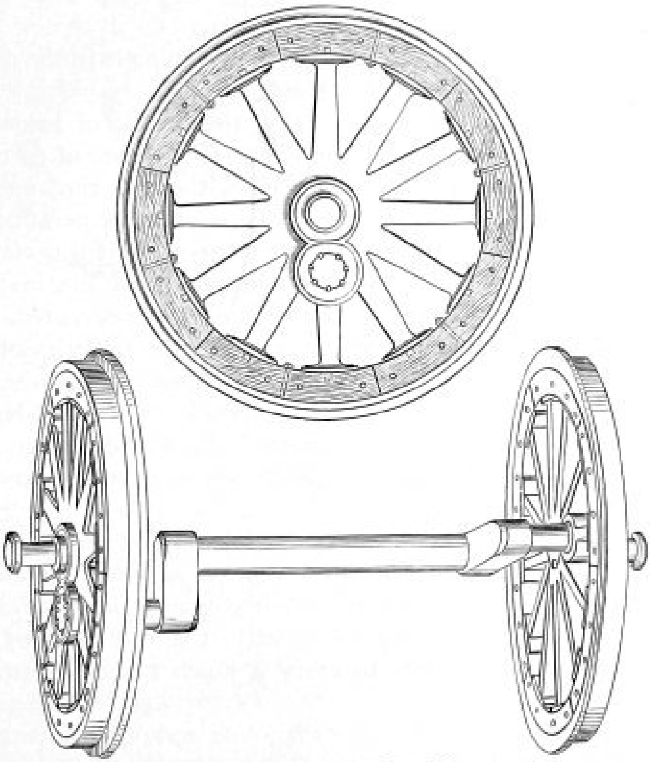
however, soon wore out, and the experiment with this metal was not repeated. The "E. L. Miller" had cylinders ten inches in diameter; stroke of piston, sixteen inches; and weighed, with water in the boiler, seven tons eight hundred-weight. The boiler had a high dome over the firebox; and this form of construction, it may be noted, was followed, with a few exceptions, for many years.

The valve motion was given by a single fixed eccentric for each cylinder. Each eccentric strap had two arms attached to it, one above and the other below, and, as the driving axle was back of the firebox, these arms were prolonged backward under the footboard, with a hook on the inner side of the end of each. The rock shaft had arms above and below its axis, and the hooks of the two rods of each eccentric were moved by hand levers so as to engage with either arm, thus producing backward or forward gear. This form of single eccentric, peculiar to Mr. Baldwin, was in the interest of simplicity in the working parts, and was adhered to for some years. It gave rise to an animated controversy among mechanics as to whether, with its use, it was possible to get a lead on the valve in both directions. Many maintained that this was impracticable; but Mr. Baldwin demonstrated by actual experience that the reverse was the case.

Meanwhile the Commonwealth of Pennsylvania had given Mr. Baldwin an order for a locomotive for the State Road, as it was then called, from Philadelphia to Columbia, which, up to that time had been worked by horses. This engine called the "Lancaster," was completed in June, 1834. It was similar to the "Miller," and weighed seventeen thousand pounds. After it was placed in service, the records show that it hauled at one time nineteen loaded burden cars over the highest grades between Philadelphia and Columbia. This was characterized at the time by the officers of the road as an "unprecedented performance." The success of the machine on its trial trips was such that the Legislature decided to adopt steam power for working the road, and Mr. Baldwin received orders for several additional locomotives. Two others were accordingly delivered to the State in September and November respectively of that year, and one was also built and delivered to the Philadelphia and Trenton Railroad

Company during the same season. This latter engine, which was put in service October 21, 1834, averaged twenty-one thousand miles per year to September 15, 1840.

Five locomotives were thus completed in 1834, and the new business was fairly under way. The building in Lodge Alley, to which Mr. Baldwin had removed from Minor Street, and where



Baldwin Compound Wood and Iron Wheels, 1834

these engines were constructed, began to be found too contracted, and another removal was decided upon. A location on Broad and Hamilton Streets (the site, in part, of the present works) was selected, and a three-story L-shaped brick building, fronting on both streets, erected. This was completed and the business removed to it during the following year (1835). The original building was partially destroyed by fire in 1884, and was replaced by a four-story brick structure.

These early locomotives, built in 1834, were the types of Mr. Baldwin's practice for some years. All, or nearly all of them, embraced several important devices, which were the results of his study and experiments up to that time. The devices referred to were patented September 10, 1834, and the same patent covered the following four inventions, viz.:

1. The half-crank, and method of attaching it to the driving wheel. (This has already been described).

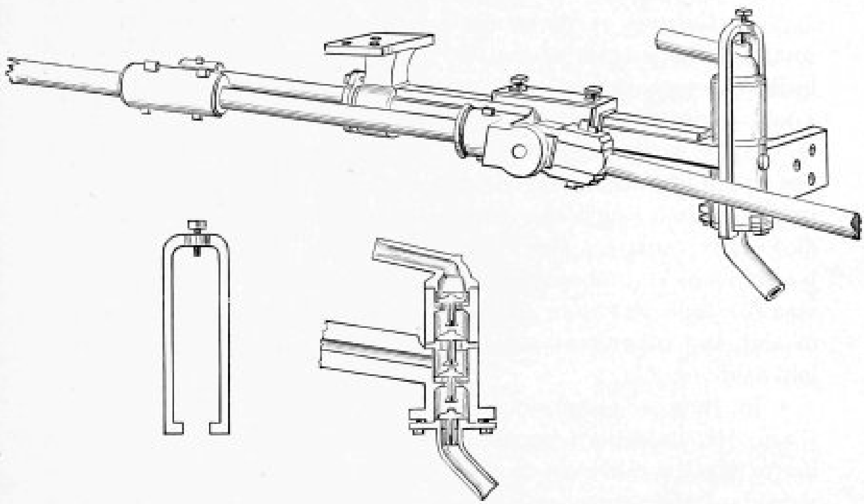
2. A new mode of constructing the wheels of locomotive engines and cars. In this the hub and spokes were of cast iron, cast together. The spokes were cast without a rim, and terminated in segment flanges, each spoke having a separate flange disconnected from its neighbors. By this means, it was claimed, the injurious effect of the unequal expansion of the materials composing the wheels was lessened or altogether prevented. The flanges bore against wooden felloes, made in two thicknesses, and put together so as to break joints. Tenons or pins projected from the flanges into openings made in the wooden felloes, to keep them in place. Around the whole the tire was passed and secured by bolts. The sketch on page 17 shows the device.

3. A new mode of forming the joints of steam and other tubes. This was Mr. Baldwin's invention of ground joints for steam pipes, which was a very valuable improvement over previous methods of making joints with red-lead packing, and which rendered it possible to carry a much higher pressure of steam.

4. A new mode of forming the joints and other parts of the supply pump, and of locating the pump itself. This invention consisted in making the single guide bar hollow and using it for the pump barrel. The pump plunger was attached to the piston rod at a socket or sleeve formed for the purpose, and the hollow guide bar terminated in the vertical pump chamber. This chamber was made in two pieces, joined about midway between the induction and eduction pipes. This joint was ground steam tight, as were also the joints of the induction pipe with the

bottom of the lower chamber, and the flange of the eduction pipe with the top of the upper chamber. All these parts were held together by a stirrup with a set-screw in its arched top, and the arrangement was such that by simply unscrewing this set-screw the different sections of the chamber, with all the valves, could be taken apart for cleaning or adjusting. The cut below illustrates the device.

It is probable that the five engines built during 1834, embodied all, or nearly all, these devices. They all had the half-crank, the ground joints for steam pipes (which were first made by him



PUMP AND STIRRUP

in 1833), and the pump formed in the guide bar, and all had the four-wheeled truck in front, and a single pair of drivers back of the firebox. On this position of the driving wheels Mr. Baldwin laid great stress, as it made a more even distribution of the weight, throwing about one-half on the drivers and one-half on the four-wheeled truck. It also extended the wheel base, making the engine much steadier and less damaging to the track. Mr. William Norris, who had established a locomotive works in Philadelphia in 1832, was at this time building a six-wheeled engine with a truck in front and the driving wheels placed in front of the firebox. Considerable rivalry naturally existed between the two manufacturers as to the comparative merits of their respective plans. In Mr. Norris's engine, the position of the driving axle in front of the firebox threw on it more of the weight of the engine, and thus increased the adhesion and the tractive power. Mr. Baldwin, however, maintained the superiority of his plan, as giving a better distribution of the weight and a longer wheel base, and consequently rendering the machine less destructive to the track. As the iron rails then in use were generally light, and much of the track was of wood, this feature was of some importance.

To the use of the ground joint for steam pipes, however, much of the success of his early engines was due. The English builders were making locomotives with canvas and red-lead joints, permitting a steam pressure of only sixty pounds per square inch to be carried, while Mr. Baldwin's machines were worked at one hundred and twenty pounds with ease. Several locomotives imported from England at about this period by the Commonwealth of Pennsylvania for the State Road (three of which were made by Stephenson) had canvas and red-lead joints, and their efficiency was so much less than that of the Baldwin engines, on account of this and other features of construction, that they were soon laid aside or sold.

In June, 1834, a patent was issued to Mr. E. L. Miller, by whom Mr. Baldwin's second engine was ordered, for a method of increasing the adhesion of a locomotive by throwing a part of the weight of the tender on the rear of the engine, thus increasing the weight on the drivers. Mr. Baldwin adopted this device on an engine built for the Philadelphia and Trenton Railroad Company, May, 1835, and thereafter used it largely, paying one hundred dollars royalty for each engine. Eventually (May 6, 1839), he bought the patent for nine thousand dollars, evidently considering that the device was especially valuable, if not indispensable, in order to render his engine as powerful, when required, as other patterns having the driving wheels in front of the firebox, and therefore utilizing more of the weight of the engine for adhesion.

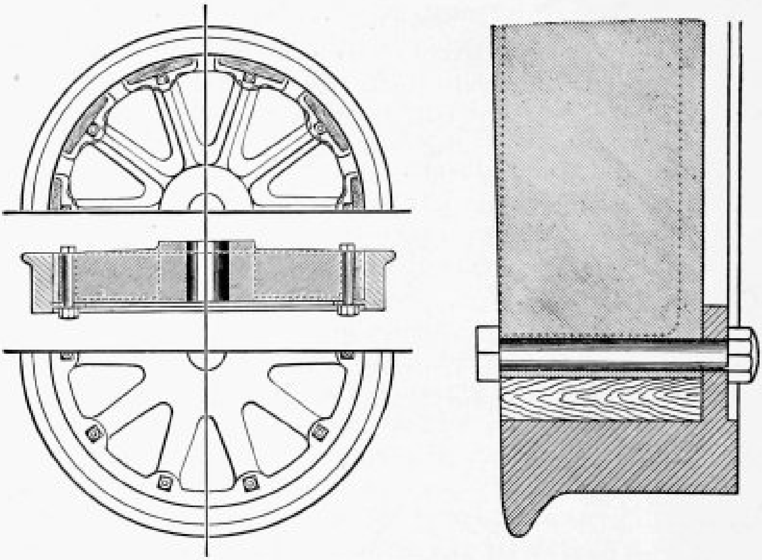
In making the truck and tender wheels of these early locomotives, the hubs were cast in three pieces and afterward banded with wrought iron, the interstices being filled with spelter. This method of construction was adopted on account of the difficulty then found in casting a chilled wheel in one solid piece.

Early in 1835, the new shop on Broad Street was completed and occupied. Mr. Baldwin's attention was thenceforward given to locomotive building exclusively, except that a stationary engine was occasionally constructed.

In May, 1835, his eleventh locomotive, the "Black Hawk," was delivered to the Philadelphia and Trenton Railroad Company. This was the first outside-connected engine of his build. It was also the first engine on which the Miller device of attaching part of the weight of the tender to the engine was employed. On the eighteenth engine, the "Brandywine," built for the Philadelphia and Columbia Railroad Company, brass tires were used on the driving wheels, for the purpose of obtaining more adhesion; but they wore out rapidly and were replaced with iron.

April 3, 1835, Mr. Baldwin took out a patent for certain improvements in the wheels and tubes of locomotive engines. That relating to the wheels provided for casting the hub and spokes together, and having the spokes terminate in segments of a rim; as described in his patent of September 10, 1834. Between the ends of the spokes and the tires, wood was interposed, and the tire might be either of wrought iron or of chilled cast iron. The intention was expressed of making the tire usually of cast iron chilled. The main object, however, was declared to be the interposition between the spokes and the rim of a layer of wood or other substance possessing some degree of elasticity. This method of making driving wheels was followed for several years, the tires being made with a shoulder. See illustration on page 22.

The improvement in locomotive tubes consisted in driving a copper ferrule or thimble on the outside of the end of the tube, and soldering it in place, instead of driving a ferrule into the tube as had previously been the practice. The object of the latter method had been to make a tight joint with the tube sheet; but by putting the ferrule on the outside of the tube, not only was the joint made as tight as before, but the tube was strengthened, and left unobstructed throughout to the full extent of its diameter. This method of setting flues has been generally followed in the Works from that date to the present, the only difference being that, at this time, with iron tubes, the end is swaged down, the copper ferrule brazed on, and the iron end turned or riveted over against the copper thimble and the flue sheet to make the joint perfect.



DRIVING WHEELS, PATENTED SEPTEMBER, 1834

Fourteen engines were constructed in 1835; forty in 1836; forty in 1837; twenty-three in 1838; twenty-six in 1839; and nine in 1840. During all these years the general design continued the same; but, in compliance with the demand for more power, three sizes were furnished as follows:

First class.	Cylinders,	12½ × 16;	weight loaded,	26,000	pounds.
Second class.	"	12 × 16;	" "	23,000	"
Third class.	"	10½ × 16;	" "	20,000	"

The first-class engine he fully believed, in 1838, was as heavy as would be called for, and he declared that it was as large as he intended to make. Most of the engines were built with the half-crank, but occasionally an outside-connected machine was turned out. These latter, however, failed to give as complete satisfaction as the half-crank machine. The drivers were generally four and a half feet in diameter.

A patent was issued to Mr. Baldwin, August 17, 1835, for his device of cylindrical pedestals. In this method of construction, the pedestal was of cast iron, and was bored in a lathe so as to form two concave jaws. The boxes were also turned in a lathe so that their vertical ends were cylindrical, and they were thus fitted in the pedestals. This method of fitting up pedestals and boxes was cheap and effective, and was used for some years for the driving and tender wheels.

As showing the estimation in which these early engines were held, it may not be out of place to refer to the opinions of some of the railroad managers of that period.

Mr. L. A. Sykes, engineer of the New Jersey Transportation Company, under date of June 12, 1838, wrote that he could draw with his engines twenty four-wheeled cars with twenty-six passengers each, at a speed of twenty to twenty-five miles per hour, over grades of twenty-six feet per mile. "As to simplicity of construction," he adds "small liability to get out of order, economy of repairs, and ease to the road, I fully believe Mr. Baldwin's engines stand unrivalled. I consider the simplicity of the engine, the arrangement of the working parts, and the distribution of the weight, far superior to any engine I have ever seen, either of American or English manufacture, and I have not the least hesitation in saying that Mr. Baldwin's engine will do the same amount of work with much less repairs, either to the engine or the track, than any other engine in use."

L. G. Cannon, President of the Rensselaer and Saratoga Railroad Company writes: "Your engines will, in performance and cost of repairs, bear comparison with any other engine made in this or any other country."

Some of Mr. Baldwin's engines on the State Road, in 1837, cost for repairs, only from one and two-tenths to one and six-tenths cents per mile. It is noted that the engine "West Chester," on the same road, weighing twenty thousand seven hundred and thirty-five pounds (ten thousand four hundred and seventy-five on drivers), drew fifty-one cars (four-wheeled), weighing two hundred and eighty-nine net tons, over the road, some of the track being of wood covered with strap-rail.

The financial difficulties of 1836 and 1837, which brought ruin upon so many, did not leave Mr. Baldwin unscathed. His embarrassments became so great that he was unable to proceed, and was forced to call his creditors together for a settlement. After offering to surrender all his property, his shop, tools, house and everything, if they so desired, — all of which would realize only about twenty-five per cent. of their claims,—he proposed to them that they should permit him to go on with the business, and in three years he would pay the full amount of all claims, principal and interest. This was finally acceded to, and the promise was in effect fulfilled, although not without an extension of two years beyond the time originally proposed.

In May, 1837, the number of hands employed was three hundred, but this number was reducing weekly, owing to the falling off in the demand for engines.

These financial troubles had their effect on the demand for locomotives, as will be seen in the decrease in the number built in 1838, 1839, and 1840; and this result was furthered by the establishment of several other locomotive works, and the introduction of other patterns of engines.

The changes and improvements in details made during these years may be summed up as follows:

The subject of burning anthracite coal had engaged much attention. In October, 1836, Mr. Baldwin secured a patent for a grate or fireplace which could be detached from the engine at pleasure, and a new one with a fresh coal fire substituted. The intention was to have the grate with freshly-ignited coal all ready for the engine on its arrival at a station, and placed between the rails over suitable levers, by which it could be attached quickly to the firebox. It is needless to say that this was never practiced. In January, 1838, however, Mr. Baldwin was experimenting with the consumption of coal on the Germantown road, and in July of the same year the records show that he was making a locomotive to burn coal, part of the arrangement being to blow the fire with a fan.

Up to 1838, Mr. Baldwin had made both driving and truck wheels with wrought tires, but during that year chilled wheels for engine and tender trucks were adopted. His tires were furnished by Messrs. S. Vail & Son, Morristown, N. J., who made the only tires then obtainable in America. They were very thin, being only one inch to one and a half inches thick; and Mr. Baldwin in importing some tires from England at that time, insisted on their being made double the ordinary thickness. The manufacturers at first objected and ridiculed the idea, the practice being to use two tires when extra thickness was wanted, but finally they consented to meet his requirements.

All his engines thus far had the single eccentric for each valve, but at about this period double eccentrics were adopted, each terminating in a straight hook, and reversed by hand levers.

At this early period, Mr. Baldwin had begun to feel the necessity of making all like parts of locomotives of the same class in such manner as to be absolutely interchangeable. Steps were taken in this direction, but it was not until many years afterward that the system of standard gauges was perfected, which has since grown to be a distinguishing feature in the establishment.

In March, 1839, Mr. Baldwin's records show that he was building a number of outside-connected engines, and had succeeded in making them strong and durable. He was also making a new chilled wheel, and one which he thought would not break.

On the one hundred and thirty-sixth locomotive, completed October 18, 1839, for the Philadelphia, Germantown and Norristown Railroad, the old pattern of wooden frame was abandoned, and no outside frame whatever was employed,—the machinery, as well as the truck and the pedestals of the driving axles, being attached directly to the naked boiler. The wooden frame thenceforward disappeared gradually, and an iron frame took its place. Another innovation was the adoption of eight-wheeled tenders, the first of which was built at about this period.

April 8, 1839, Mr. Baldwin associated with himself Messrs. Vail & Hufty, and the business was conducted under the firm name of Baldwin, Vail & Hufty until 1841, when Mr. Hufty withdrew, and Baldwin & Vail continued the copartnership until 1842.

The time had now arrived when the increase of business on railroads demanded more powerful locomotives. It had for some years been felt that for freight traffic the engine with one pair of drivers was insufficient. Mr. Baldwin's engine had the single pair of drivers placed back of the firebox; that made by Mr. Norris, one pair in front of the firebox. An engine with two pairs of drivers, one pair in front and one pair behind the firebox, was the next logical step, and Mr. Henry R. Campbell, of Philadelphia, was the first to carry this design into execution. Mr. Campbell, as has been noted, was the Chief Engineer of the Germantown Railroad when the "Ironsides" was placed on that line, and had since given much attention to the subject of locomotive construction. February 5, 1836, Mr. Campbell secured a patent for an eight-wheeled engine with four drivers connected, and a four-wheeled truck in front; and subsequently contracted with James Brooks, of Philadelphia, to build for him such a machine. The work was begun March 16, 1836, and the engine was completed May 8, 1837. This was the first eight-wheeled engine of this type, and from it the standard American locomotive of to-day takes its origin. The engine lacked, however, one essential feature; there were no equalizing beams between the drivers, and nothing but the ordinary steel springs over each journal of the driving axles to equalize the weight upon them. It remained for Messrs. Eastwick & Harrison to supply this deficiency; and in 1837 that firm constructed at their shop in Philadelphia, a locomotive on this plan, but with the driving axles running in a separate square frame, connected to the main frame above it by a single central bearing on each side. This engine had cylinders twelve by eighteen, four coupled driving wheels, forty-four inches in diameter, carrying eight of the twelve tons constituting the total weight. Subsequently, Mr. Joseph Harrison, Jr., of the same firm, substituted "equalizing beams" on engines of this plan afterward constructed by them, substantially in the same manner as since generally employed.

In the *American Railroad Journal* of July 30, 1836, a woodcut showing Mr. Campbell's engine, together with an elaborate calculation of the effective power of an engine on this plan, by William J. Lewis, Esq., Civil Engineer, was published, with a table showing its performance upon grades ranging from a dead level to a rise of one hundred feet per mile. Mr. Campbell stated that his experience at that time (1835-36) convinced him that grades of one hundred feet rise per mile would, if roads were judiciously located, carry railroads over any of the mountain passes in America, without the use of planes with stationary steam power, or, as a general rule, of costly tunnels,—an opinion very extensively verified by the experience of the country since that date.

A step had thus been taken toward a plan of locomotive having more adhesive power. Mr. Baldwin, however, was slow to adopt the new design. He naturally regarded innovations with distrust. He had done much to perfect the old pattern of engine, and had built over a hundred of them, which were in successful operation on various railroads. Many of the details were the subjects of his several patents, and had been greatly simplified in his practice. In fact, simplicity in all the working parts had been so largely his aim, that it was natural that he should distrust any plan involving additional machinery, and he regarded the new design as only an experiment at best. In November, 1838, he wrote to a correspondent that he did not think there was any advantage in the eight-wheeled engine. There being three points in contact, it could not turn a curve, he argued, without slipping one or the other pair of wheels sideways. Another objection was in the multiplicity of machinery and the difficulty in maintaining four driving wheels all of exactly the same size. Some means, however, of getting more adhesion must be had, and the result of his reflections upon this subject was the project of a "geared engine." In August, 1839, he took steps to secure a patent for such a machine, and December 31, 1840, letters patent were granted him for the device. In this engine, an independent shaft or axle was placed between the two axles of the truck, and connected by cranks and coupling rods with cranks on the outside of the driving wheels. This shaft had a central cog-wheel engaging on each side with intermediate cog-wheels, which in turn geared into cog-wheels on each truck axle. The intermediate cog-wheels had wide teeth, so that the truck could pivot while the main shaft remained parallel with the driving axle. The diameters of the cog-wheels were, of course, in such proportion to the driving and truck wheels that the latter should revolve as much oftener than the drivers as their smaller size might require. Of the success of this machine for freight service, Mr. Baldwin was very sanguine. One was put in hand at once, completed in August, 1841, and eventually sold to the Sugarloaf Coal Company. It was an outside-connected engine, weighing thirty thousand pounds, of which eleven thousand seven hundred and seventy-five pounds were on the drivers, and eighteen thousand three hundred and thirty-five on the truck. The driving wheels were forty-four and the truck wheels thirty-three inches in diameter. The cylinders were thirteen inches in diameter by sixteen inches stroke. On a trial of the engine upon the Philadelphia and Reading Railroad, it hauled five hundred and ninety tons from Reading to Philadelphia—a distance of fifty-four miles—in five hours and twenty-two minutes. The superintendent of the road, in writing of the trial, remarked that this train was unprecedented in length and weight both in America and Europe. The performance was noticed in favorable terms by the Philadelphia newspapers, and was made the subject of a report by the Committee on Science and Arts of the Franklin Institute, who strongly recommended this plan of engine for freight service. The success of the trial led Mr. Baldwin at first to believe that the geared engine would be generally adopted for freight traffic; but in this he was disappointed. No further demand was made for such machines, and no more of them were built.

In 1840, Mr. Baldwin received an order, through August Belmont, Esq., of New York, for a locomotive for Austria, and had nearly completed one which was calculated to do the work required, when he learned that only sixty pounds pressure of steam was admissible, whereas his engine was designed to use steam at one hundred pounds and over. He accordingly constructed another, meeting this requirement, and shipped it in the following year. This engine, it may be noted, had a kind of link motion, agreeably to the specification received, and was the first of his make upon which the link was introduced.

Mr. Baldwin's patent of December 31, 1840, already referred to as covering his geared engine, embraced several other devices, as follows:

1. A method of operating a fan or blowing wheel, for the purpose of blowing the fire. The fan was to be placed under the footboard, and driven by the friction of a grooved pulley in contact with the flange of the driving wheel.

2. The substitution of a metallic stuffing, consisting of wire, for the hemp, wool, or other material which had been employed in stuffing boxes.

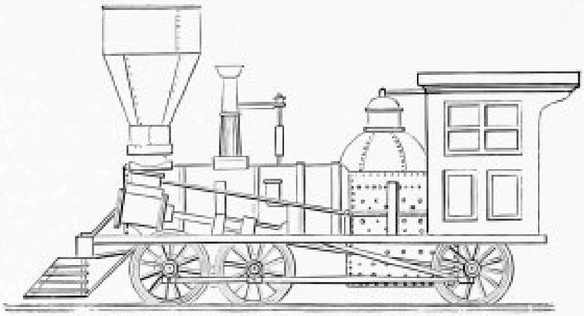
3. The placing of the springs of the engine truck so as to obviate the evil of the locking of the wheels when the truck frame vibrates from the center pin vertically. Spiral as well as semi-elliptic springs, placed at each end of the truck frame, were specified. The spiral spring is described as received in two cups, —one above and one below. The cups were connected together at their centers, by a pin upon one and a socket in the other, so that the cups could approach toward or recede from each other and still preserve their parallelism.

4. An improvement in the manner of constructing the iron frames of locomotives, by making the pedestals in one piece with and constituting part of the frames.

5. The employment of spiral springs in connection with cylindrical pedestals and boxes. A single spiral was at first used, but, not proving sufficiently strong, a combination or nest of spirals curving alternately in opposite directions was afterward employed. Each spiral had its bearing in a spiral recess in the pedestal.

In the specification of this patent a change in the method of making cylindrical pedestals and boxes is noted. Instead of boring and turning them in a lathe, they were cast to the required shape in chills. This method of construction was used for a time, but eventually a return was made to the original plan, as giving a more accurate job.

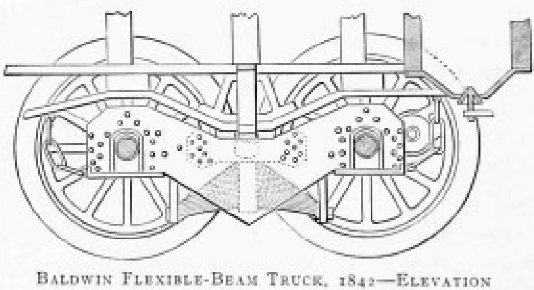
In 1842, Mr. Baldwin constructed, under an arrangement with Mr. Ross Winans, three locomotives for the Western Railroad, of Massachusetts, on a plan which had been designed by that gentleman for freight traffic. These machines had upright boilers, and horizontal cylinders, which worked cranks on a shaft bearing cog-wheels engaging with other cog-wheels on an intermediate shaft. This latter shaft had cranks coupled to four driving wheels on each side. These engines were constructed to burn anthracite coal. Their peculiarly uncouth appearance



BALDWIN SIX-WHEELS-CONNECTED ENGINE, 1842

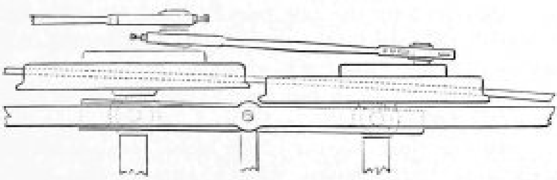
earned for them the name of "crabs," and they were but short-lived in service.

But to return to the progress of Mr. Baldwin's locomotive practice. The geared engine had not proved a success. It was unsatisfactory, as well to its designer as to the railroad community. The problem of utilizing more or all of the weight of the engine for adhesion remained, in Mr. Baldwin's view, yet to



BALDWIN FLEXIBLE-BEAM TRUCK, 1842—ELEVATION

be solved. The plan of coupling four or six wheels had long before been adopted in England, but on the short curves prevalent on American railroads he felt that something more was necessary. The wheels must not only be coupled, but at the same time must be free to adapt themselves to a curve. These two conditions were apparently incompatible, and to reconcile these inconsistencies was the task which Mr. Baldwin set himself to accomplish. He undertook it too, at a time when his business had fallen off greatly and he was involved in the most serious financial embarrassments. The problem was constantly before him, and at length, during a sleepless night, its solution flashed across his mind. The plan so long sought for, and which, subsequently more than any other of his improvements or inventions, contributed to the foundation of his fortune, was his well-known six-wheels-connected locomotive with the four front drivers combined in a flexible truck. For this machine Mr. Baldwin secured a patent, August 25, 1842. Its principal characteristic features are now matters of history, but they deserve here a brief mention. The engine was on six wheels, all con-



HALF PLAN

nected as drivers. The rear wheels were placed rigidly in the frames, usually behind the firebox, with inside bearings. The cylinders were inclined, and with outside connections. The four remaining wheels had inside journals running in boxes held by two wide and deep wrought iron beams, one on each side. These beams were unconnected, and entirely independent of each other. The pedestals formed in them were bored out cylindrically, and into them cylindrical boxes, as patented by him in 1835, were fitted. The engine frame on each side was directly over the beam, and a spherical pin, running down from the frame, bore in a socket in the beam midway between the two axles. It will thus be seen that each side beam independently could turn horizontally or vertically under the spherical pin, and the cylindrical boxes could also turn in the pedestals. Hence, in passing a curve, the middle pair of drivers could move laterally in one direction—say to the right—while the front pair could move in the opposite direction, or to the left; the two axles all the while remaining parallel to each other and to the rear driving axle. The operation of these beams, was therefore, like that of the parallel ruler. On a straight line the two beams and the two axles formed a rectangle; on curves, a parallelogram, the angles varying with the degree of curvature. The coupling rods were made with cylindrical brasses, thus forming ball-and-socket joints, to enable them to accommodate themselves to the lateral movements of the wheels. Colburn, in his "Locomotive Engineering," remarks of this arrangement of rods as follows:

> "Geometrically, no doubt, this combination of wheels could only work properly around curves by a lengthening and shortening of the rods which served to couple the principal pair of driving wheels with the hind truck wheels. But if the coupling rods from the principal pair of driving wheels be five feet long, and if the beams of the truck frame be four feet long (the radius of curve described by the axle boxes around the spherical side-bearings being two feet), then the total corresponding lengthening of the coupling rods, in order to allow the hind truck wheels to move one inch to one side, and the front wheels of the truck one inch to the other side of their normal position on a straight line would be $\sqrt{60^2+1^2}-60+24-\sqrt{24^2-1^2}=0.0275$ inch, or less than one thirty-second of an inch. And if only one pair of driving wheels were thus coupled with a four-wheeled truck, the total wheel base being nine feet, the motion permitted by this slight elongation of the coupling rods (an elongation provided for by a trifling slackness in the brasses) would enable three pairs of wheels to stand without binding in a curve of only one hundred feet radius."

The first engine of the new plan was finished early in December, 1842, being one of fourteen engines constructed in that year, and was sent to the Georgia Railroad, on the order of Mr. J. Edgar Thomson, then Chief Engineer and Superintendent of that line. It weighed twelve tons, and drew, besides its own weight, two hundred and fifty tons up a grade of thirty-six feet to the mile.

Other orders soon followed. The new machine was received generally with great favor. The loads hauled by it exceeded anything so far known in American railroad practice, and sagacious managers hailed it as a means of largely reducing operating expenses. On the Central Railroad of Georgia, one of these twelve-ton engines drew nineteen eight-wheeled cars, with seven hundred and fifty bales of cotton, each bale weighing four hundred and fifty pounds, over maximum grades of thirty feet per mile, and the manager of the road declared that it could readily take one thousand bales. On the Philadelphia and Reading Railroad a similar engine of eighteen tons weight drew one hundred and fifty loaded cars (total weight of cars and lading, one thousand one hundred and thirty tons) from Schuylkill Haven to Philadelphia, at a speed of seven miles per hour. The regular load was one hundred loaded cars, which were hauled at a speed of from twelve to fifteen miles per hour on a level.

The following extract from a letter, dated August 10, 1844, of Mr. G. A. Nicolls, then superintendent of that line, gives the particulars of the performance of these machines, and shows the estimation in which they were held.

"We have had two of these engines in operation for about four weeks. Each engine weighs about forty thousand pounds with water and fuel, equally distributed on six wheels, all of which are coupled, thus gaining the whole adhesion of the engines' weight. Their cylinders are fifteen by eighteen inches.

"The daily allotted load of each of these engines is one hundred coal cars, each loaded with three and six-tenths tons of coal, and weighing two and fifteen one-hundredths tons each, empty; making a net weight of three hundred and sixty tons of coal carried, and a gross weight of train of five hundred and seventy-five tons, all of two thousand two hundred and forty pounds.

"This train is hauled over the ninety-four miles of the road, half of which is level, at the rate of twelve miles per hour; and with it the engine is able to make fourteen to fifteen miles per hour on a level.

"Were all the cars on the road of sufficient strength, and making the trip by daylight, nearly one-half being now performed at night, I have no doubt of these engines being quite equal to a load of eight hundred tons gross, as their average daily performance on any of the levels of our road, some of which are eight miles long.

"In strength of make, quality of workmanship, finish, and proportion of parts, I consider them equal to any, and superior to most, freight engines I have seen. They are remarkably easy on the rail, either in their vertical or horizontal action, from the equalization of their weight, and the improved truck under the forward part of the engine. This latter adapts itself to all the curves of the road, including some of seven hundred and sixteen feet radius in the main track, and moves with great ease around our turning **Y** curves at Richmond, of about three hundred feet radius.

direction—say to the right—while the front pair could move in the opposite direction, or to the left; the two axles all the while remaining parallel to each other and to the rear driving axle. The operation of these beams, was therefore, like that of the parallel ruler. On a straight line the two beams and the two axles formed a rectangle; on curves, a parallelogram, the angles varying with the degree of curvature. The coupling rods were made with cylindrical brasses, thus forming ball-and-socket joints, to enable them to accommodate themselves to the lateral movements of the wheels. Colburn, in his "Locomotive Engineering," remarks of this arrangement of rods as follows:

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"I consider these engines as near perfection, in the arrangement of their parts, and their general efficiency, as the present improvements in machinery and the locomotive engine will admit of. They are saving us thirty per cent in every trip on the former cost of motive or engine power."

But the flexible beam truck also enabled Mr. Baldwin to meet the demand for an engine with four drivers connected. Other builders were making engines with four drivers and a four-wheeled truck, of the present American standard type. To compete with this design, Mr. Baldwin modified his six-wheels-connected engine by connecting only two out of the three pairs of wheels as drivers, making the forward wheels of smaller diameter as leading wheels, but combining them with the front drivers in a flexible beam truck. The first engine on this plan was sent to the Erie and Kalamazoo Railroad, in October, 1843, and gave great satisfaction. The superintendent of the road was enthusiastic in its praise, and wrote to Mr. Baldwin that he doubted "if anything could be got up which would answer the business of the road so well." One was also sent to the Utica and Schenectady Railroad a few weeks later, of which the superintendent remarked that "it worked beautifully, and there were not wagons enough to give it a full load." In this plan the leading wheels were usually made thirty-six and the drivers fifty-four inches in diameter.

This machine, of course, came in competition with the eight-wheeled engine having four drivers, and Mr. Baldwin claimed for his plan a decided superiority. In each case about two-thirds of the total weight was carried on the four drivers and Mr. Baldwin maintained that his engine, having only six instead of eight wheels, was simpler and more effective.

At about this period Mr. Baldwin's attention was called by Mr. Levi Bissell to an "Air-Spring" which the latter had devised, and which it was imagined was destined to be a cheap, effective, and perpetual spring. The device consisted of a small cylinder placed above the frame over the axle box, and having a piston fitted air tight into it. The piston rod was to bear on the axle box and the proper quantity of air was to be pumped into the cylinder above the piston, and the cylinder then hermetically closed. The piston had a leather packing which was to be kept moist by some fluid (molasses was proposed) previously introduced into the cylinder. Mr. Baldwin at first proposed to equalize the weight between the two pairs of drivers by connecting two air springs on each side by a pipe, the use of an equalizing beam being covered by Messrs. Eastwick & Harrison's patent. The air springs were found, however, not to work practically and were never applied. It may be added that a model of an equalizing air spring was exhibited by Mr. Joseph Harrison, Jr., at the Franklin Institute, in 1838 or 1839.

With the introduction of the new machine business began at once to revive, and the tide of prosperity turned once more in Mr. Baldwin's favor. Twelve engines were constructed in 1843, all but four of them of the new pattern; twenty-two engines in 1844, all of the new pattern; and twenty-seven in 1845. Three of this number were of the old type, with one pair of drivers, but from that time forward the old pattern with the single pair of drivers disappeared from the practice of the establishment, save occasionally for exceptional purposes.

In 1842, the partnership with Mr. Vail was dissolved, and Mr. Asa Whitney, who had been superintendent of the Mohawk and Hudson Railroad, became a partner with Mr. Baldwin, and the firm continued as Baldwin & Whitney until 1846, when the latter withdrew to engage in the manufacture of car wheels, establishing the firm of A. Whitney & Sons, Philadelphia.

Mr. Whitney brought to the firm a railroad experience and thorough business talent. He introduced a system in many details of the management of the business, which Mr. Baldwin, whose mind was devoted more exclusively to mechanical subjects, had failed to establish or wholly ignored. The method at present in use in the establishment, of giving to each class of locomotives a distinctive designation, composed of a number and a letter, originated very shortly after Mr. Whitney's connection with the business. For the purpose of representing the different designs, sheets with engravings of locomotives were employed. The sheet showing the engine with one pair of drivers was marked B; that with two pairs, C; that with three, D; and that with four, E. Taking its rise from this circumstance, it became customary to designate as B engines those with one pair of drivers;

as C engines, those with two pairs; as D engines, those with three pairs; and as E engines, those with four pairs. Shortly afterward, a number, indicating the weight in gross tons, was added. Thus the 12 D engine was one with three pairs of drivers, and weighing twelve tons; the 12 C, an engine of same weight, but with only four wheels connected. A modification of this method of designating the several plans and sizes is still in use, and is explained elsewhere.

It will be observed that the classification as thus established began with the B engines. The letter A was reserved for an engine intended to run at very high speeds, and so designed that the driving wheels should make two revolutions for each reciprocation of the pistons. This was to be accomplished by means of gearing. The general plan of the engine was determined in Mr. Baldwin's mind, but was never carried into execution.

The adoption of the plan of six-wheels-connected engines opened the way at once to increasing their size. The weight being almost evenly distributed on six points, heavier machines were admissible, the weight on any one pair of drivers being little, if any, greater than had been the practice with the old plan of engine having a single pair of drivers. Hence engines of eighteen and twenty tons weight were shortly introduced, and in 1844, three of twenty tons weight, with cylinders sixteen and one-half inches diameter by eighteen inches stroke, were constructed for the Western Railroad of Massachusetts, and six of eighteen tons weight, with cylinders fifteen by eighteen, and drivers forty-six inches in diameter, were built for the Philadelphia and Reading Railroad. It should be noted that three of these latter engines had iron flues. This was the first instance in which Mr. Baldwin had employed tubes of this material, although they had been previously used by others. Lap-welded iron flues were made by Morris, Tasker & Co., of Philadelphia, about 1838, and butt-welded iron tubes had previously been made by the same firm. Ross Winans, of Baltimore, had also made iron tubes by hand for locomotives of his manufacture, before 1838. The advantage found to result from the use of iron tubes, apart from their less cost, was that the tubes and boiler shell, being of the same material, expanded and contracted alike, while in the case of copper tubes, the expansion of the metal by heat varied from that of the boiler shell, and as a consequence there was greater liability to leakage at the joints with the tube sheets. The opinion prevailed largely at that time that some advantage resulted in the evaporation of water, owing to the superiority of copper as a conductor of heat. To determine this question, an experiment was tried with two of the six engines referred to above, one of which the "Ontario," had copper flues, and another, the "New England," iron flues. In other respects they were precisely alike. The two engines were run from Richmond to Mount Carbon, August 27, 1844, each drawing a train of one hundred and one empty cars, and returning, from Mount Carbon to Richmond, on the following day each with one hundred loaded cars. The quantity of water evaporated and wood consumed was noted, with the result shown in the following table:

	Up Trip, Aug. 27, 1844		Down Trip, Aug. 28, 1844	
	"Ontario." (Copper Flues)	"New England." (Iron Flues)	"Ontario." (Copper Flues)	"New England." (Iron Flues)
Time, running	9h. 7m.	7h. 41m.	10h. 44m.	8h. 19m.
Time standing at stations	4h. 2m.	3h. 7m.	2h. 12m.	3h. 8m.
Cords of wood burned	6.68	5.50	6.94	6.
Cubic feet of water evaporated	925.75	757.26	837.46	656.39
Ratio, cubic feet of water to a cord of wood	138.57	137.68	120.67	109.39

The conditions of the experiments not being absolutely the same in each case, the results could not of course be accepted as entirely accurate. They seemed to show, however, no considerable difference in the evaporative efficacy of copper and iron tubes.

The period under consideration was marked also by the introduction of the French & Baird stack, which proved at once to be one of the most successful spark arresters thus far employed, and which was for years used almost exclusively wherever, as on the cotton-carrying railroads of the South, a thoroughly effective spark arrester was required. This stack was introduced by Mr. Baird, then a foreman in the Works, who purchased the patent right of what had been known as the Grimes stack, and combined with it some of the features of the stack made by Mr. Richard French, then Master Mechanic of the Germantown Railroad, together with certain improvements of his own. The cone over the straight inside pipe was made with volute flanges on its under side, which gave a rotary motion to the sparks. Around the cone was a casing about six inches smaller in diameter than the outside stack. Apertures were cut in the sides of this casing, through which the sparks in their rotary motion were discharged, and thus fell to the bottom of the space between the straight inside pipe and the outside stack. The opening in the top of the stack was fitted with a series of V-shaped iron circles perforated with numerous holes, thus presenting an enlarged area, through which the smoke escaped. The patent right for this stack was subsequently sold to Messrs. Radley & Hunter, and its essential principle is still used in the Radley & Hunter stack as at present made.

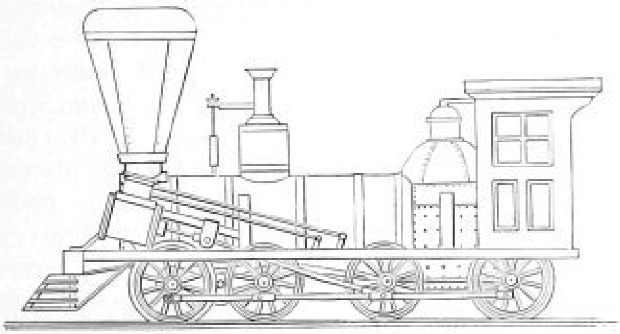
In 1845, Mr. Baldwin built three locomotives for the Royal Railroad Company of Würtemberg. They were of fifteen tons weight, on six wheels, four of them being sixty inches in diameter and coupled. The front drivers were combined by the flexible beams into a truck with the smaller leading wheels. The cylinders were inclined and outside, and the connecting rods took hold of a half-crank axle back of the firebox. It was specified that these engines should have the link motion which had shortly before been introduced in England by the Stephensons. Mr. Baldwin accordingly applied a link of a peculiar character to suit his own ideas of the device. The link was made solid, and of a truncated V-section, and the block was grooved so as to fit and slide on the outside of the link.

During the year 1845, another important feature in locomotive construction—the cut-off valve—was added to Mr. Baldwin's practice. Up to that time the valve motion had been the two eccentrics, with the single flat hook for each cylinder. Since 1841, Mr. Baldwin had contemplated the addition of some device allowing the steam to be used expansively, and he now added the "half-stroke-cut-off." In this device the steam chest was separated by a horizontal plate into an upper and a lower compartment. In the upper compartment, a valve worked by a separate eccentric, and having a single opening, admitted steam through a port in this plate to the lower steam chamber. The valve rod of the upper valve terminated in a notch or hook, which engaged with the upper arm of its rock shaft. When thus working, it acted as a cut-off at a fixed part of the stroke, determined by the setting of the eccentric. This was usually at half the stroke. When it was desired to dispense with the cut-off and work steam for the full stroke, the hook of the valve rod was lifted from the pin on the upper arm of the rock shaft by a lever worked from the footboard, and the valve rod was held in a notched rest fastened to the side of the boiler. This left the opening through the upper valve and the port in the partition plate open for the free passage of steam throughout the whole stroke. The first application of the half-stroke cut-off was made on the engine "Champlain" (20 D), built for the Philadelphia and Reading Railroad Company, in 1845. It at once became the practice to apply the cut-off on all passenger engines, while the six and eight-wheels-connected freight engines were, with a few exceptions, built for a time longer with the single valve admitting steam for the full stroke.

After building, during the years 1843, 1844 and 1845, ten four-wheels-connected engines on the plan above described, viz., six wheels in all, the leading wheels and the front drivers being combined into a truck by the flexible beams, Mr. Baldwin finally adopted the present design of four drivers and a four-wheeled truck. Some of his customers who were favorable to the latter plan had ordered such machines of other builders, and Colonel Gadsden, President of the South Carolina Railroad Company, called on him in 1845 to build for that line some passenger engines of this pattern. He accordingly bought the patent right for this plan of engine of Mr. H. R. Campbell, and for the equalizing beams used between the drivers, of Messrs. Eastwick & Harrison, and delivered to the South Carolina Railroad Company, in December, 1845, his first eight-wheeled engine with four drivers and a four-wheeled truck. This machine had cylinders thirteen and three-quarters by eighteen and drivers sixty inches in diameter, with the springs between them arranged as equalizers. Its weight was fifteen tons. It had the half-crank axle, the cylinders being inside the frame but outside the smoke-box. The inside connected engine (counterweighting being as yet unknown) was admitted to be steadier in running, and hence more suitable for passenger service. With the completion of the first eight-wheeled C engine, Mr. Baldwin's feelings underwent a revulsion in favor of this plan, and his partiality for it became as great as had been his antipathy before. Commenting on the machine, he recorded himself as "more pleased with its appearance and action than any engine he had turned out." In addition to the three engines of this description for the South Carolina Railroad Company, a duplicate was sent to the Camden and Amboy Railroad Company, and a similar but lighter one to the Wilmington and Baltimore Railroad Company, shortly afterward. The engine for the Camden and Amboy Railroad Company, and perhaps the others, had the half-stroke cut-off.

From that time forward all of his four-wheels-connected machines were built on this plan, and the six-wheeled C engine was abandoned, except in the case of one built for the Philadelphia, Germantown and Norristown Railroad Company, in 1846, and this was afterward rebuilt into a six-wheels-connected machine. Three methods of carrying out the general design were, however, subsequently followed. At first the half-crank was used; then horizontal cylinders inclosed in the chimney seat and working a full-crank axle, which form of construction had been practiced at the Lowell Works; and eventually outside cylinders with outside connections.

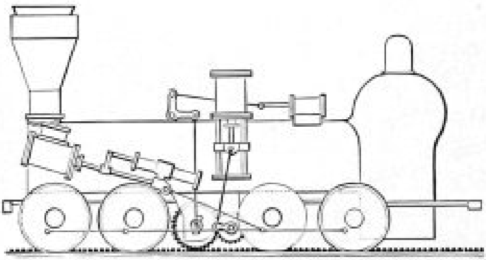
Meanwhile, the flexible truck machine maintained its popularity for heavy freight service. All the engines thus far built on this plan had been six-wheeled, some with the rear driving axle back of the firebox, and others with it in front. The next step, following logically after the adoption of the eight-wheeled C engine, was to increase the size of the freight machine, and distribute the weight on eight wheels all connected, the two rear pairs being rigid in the frame, and the two front pairs combined into the flexible beam truck. This was first done in 1846, when seventeen engines on this plan were constructed on one order for the Philadelphia and Reading Railroad Company. Fifteen of these were of twenty tons weight, with cylinders fifteen and a half by twenty, and wheels forty-six inches in diameter; and two of twenty-five tons weight, with cylinders seventeen and a quarter by eighteen, and drivers forty-two inches in diameter. These engines were the first on which Mr. Baldwin placed sand boxes, and they were also the first built by him with roofs. On all previous engines the footboard had only been inclosed by a



BALDWIN EIGHT-WHEELS-CONNECTED ENGINE, 1846

railing. On these engines for the Reading Railroad four iron posts were carried up, and a wooden roof supported by them. The engine men added curtains at the sides and front, and Mr. Baldwin on subsequent engines added sides, with sash and glass. The cab proper, however, was of New England origin, where the severity of the climate demanded it, and where it had been used previous to this period.

Forty-two engines were completed in 1846, and thirty-nine in 1847. The only novelty to be noted among them was the engine "M. G. Bright," built for operating the inclined plane on the Madison and Indianapolis Railroad. The rise of this incline was one in seventeen, from the bank of the Ohio River at Madison. The engine had eight wheels, forty-two inches in diameter, connected, and worked in the usual manner by outside inclined cylinders, fifteen and one-half inches diameter by twenty inches stroke. A second pair of cylinders, seventeen inches in diameter with eighteen inches stroke of piston was placed vertically over the boiler, midway between the furnace and smoke arch. The connecting rods, worked by these cylinders, connected with cranks on a shaft under the boiler. This shaft carried a single cog-wheel at its center, and this cog-wheel engaged with another of about twice its diameter on a second shaft adjacent to it and in the same plane. The cog-wheel on this latter shaft worked in a rack-rail placed in the center of the track. The shaft itself had its bearings in the lower ends of two vertical rods, one on each side of the boiler, and these rods were united over the boiler by a horizontal bar, which was connected by means of a bent lever and connecting rod to the piston worked by a small horizontal cylinder placed on top of the boiler. By means of this cylinder, the yoke carrying the shaft and cog-wheel could be depressed and held down so as to engage the cogs with the rack-rail, or raised out of the way when only the ordinary drivers were required. This device was designed by Mr. Andrew Cathcart, Master Mechanic of the Madison and Indianapolis Railroad. A similar machine, the "John Brough," for the same plane, was built by Mr. Baldwin in 1850. The incline was worked with a rack-rail and these engines until it was finally abandoned and a line with easier gradients substituted.



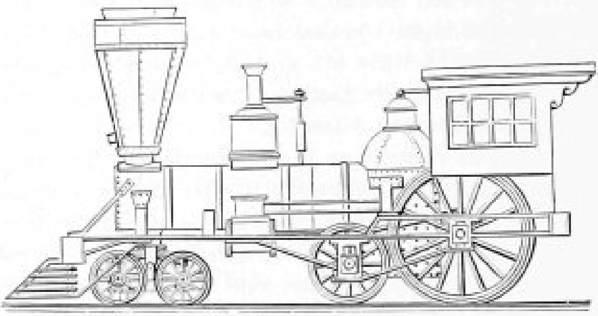
BALDWIN ENGINE FOR RACK-RAIL, 1847

The use of iron tubes in freight engines grew in favor, and in October, 1847, Mr. Baldwin noted that he was fitting his flues with copper ends, "for riveting to the boiler."

The subject of burning coal continued to engage much attention, but the use of anthracite had not as yet been generally successful. In October, 1847, the Baltimore and Ohio Railroad Company advertised for proposals for four engines to burn Cumberland coal, and the order was taken and filled by Mr. Baldwin with four of his eight-wheels-connected machines. These engines had a heater on top of the boiler for heating the feed water, and a grate with a rocking bar in the center, having fingers on each side which interlocked with projections on fixed bars, one in front and one behind. The rocking bar was operated from the footboard. This appears to have been the first instance of the use of a rocking grate in the practice of these Works.

The year 1848, showed a falling off in business and only twenty engines were turned out. In the following year, however, there was a rapid recovery and the production of the Works increased to thirty, followed by thirty-seven in 1850, and fifty in 1851. These engines, with a few exceptions, were confined to three patterns: the eight-wheeled, four coupled engine, from twelve to nineteen tons in weight, for passengers and freight, and the six and eight-wheels-connected engine, for freight exclusively, the six-wheeled machine weighing from twelve to seventeen tons, and the eight-wheeled from eighteen to twenty-seven tons. The drivers of these six and eight-wheels-connected machines were made generally forty-two, with occasional variations up to forty-eight inches in diameter.

The exceptions referred to in the practice of these years were the fast passenger engines built by Mr. Baldwin during this period. Early in 1848, the Vermont Central Railroad was approaching completion, and Governor Paine, the President of the Company, conceived the idea that the passenger service on the road required locomotives capable of running at very high velocities. Henry R. Campbell, Esq., was a contractor in building the line, and was authorized by Governor Paine to come to Philadelphia and offer Mr. Baldwin ten thousand dollars for a locomotive, which could run with a passenger train at a speed of sixty miles per hour. Mr. Baldwin at once undertook to meet these conditions. The work was begun early in 1848, and in March of that year Mr. Baldwin filed a caveat for his design. The engine was completed in 1849, and was named the "Governor Paine." It had one pair of driving wheels, six and a half feet in diameter, placed back of the firebox. Another pair of wheels but smaller and unconnected, was placed directly in front of the firebox, and a four-wheeled truck carried the front of the engine. The cylinders were seventeen and a quarter inches diameter and twenty inches stroke, and were placed horizontally between the frames and the boiler, at about the middle of the waist. The connecting rods took hold of "half cranks" inside of the driving wheels. The object of placing the cylinders at the middle of the boiler was to lessen or obviate the lateral motion of the engine, produced when the cylinders were attached to the smoke arch. The bearings on the two rear axles were so contrived that, by means of a lever, a part of the weight of the engine usually carried on the wheels in front of the firebox could be transferred to the driving axle. The "Governor Paine" was used for several years on the Vermont Central Railroad, and then rebuilt into a four coupled machine. During its career, it was stated by the officers of the road that it could be started from a state of rest and run a mile in forty-three seconds. Three



BALDWIN FAST PASSENGER ENGINE, 1848

engines on the same plan, but with cylinders fourteen by twenty, and six-feet driving wheels, the "Mifflin," "Blair," and "Indiana," were also built for the Pennsylvania Railroad Company in 1849. They weighed each about forty-seven thousand pounds, distributed as follows: Eighteen thousand on the drivers, fourteen thousand on the pair of wheels in front of the firebox, and fifteen thousand on the truck. By applying the lever, the weight on the drivers could be increased to about twenty-four thousand pounds, the weight on the wheels in front of the firebox being correspondingly reduced. A speed of four miles in three minutes is recorded for them, and upon one occasion President Taylor was taken in a special train over the road by one of these machines at a speed of sixty miles an hour. One other engine of this pattern, the "Susquehanna" was built for the Hudson River Railroad Company in 1850. Its cylinders were fifteen inches diameter by twenty inches stroke, and drivers six feet in diameter. All these engines, however, were short-lived, and died young, of insufficient adhesion.

Eight engines, with four drivers connected and half-crank axles, were built for the New York and Erie Railroad Company in 1849, with seventeen by twenty-inch cylinders; one-half of the number with six-feet and the rest with five-feet drivers. These machines were among the last on which the half-crank axle was used. Thereafter, outside-connected engines were constructed almost exclusively.

In May, 1848, Mr. Baldwin filed a caveat for a four-cylinder locomotive, but never carried the design into execution. The first instance of the use of steel axles in the practice of the establishment occurred during the same year,—a set being placed as an experiment under an engine constructed for the Pennsylvania Railroad Company. In 1850, the old form of dome boiler, which had characterized the Baldwin engine since 1834, was abandoned, and the wagon top form substituted.

The business in 1851 had reached the full capacity of the shop, and the next year marked the completion of about an equal number of engines (forty-nine). Contracts for work extended a year ahead, and to meet the demand, the facilities in the various departments were increased, and resulted in the construction of sixty engines in 1853, and sixty-two in 1854.

At the beginning of the latter year, Mr. Matthew Baird, who had been connected with the Works since 1836, as one of its foremen, entered into partnership with Mr. Baldwin, and the style of the firm was made M. W. Baldwin & Co.

The only novelty in the general plan of engines during this period was the addition of a ten-wheeled engine to the patterns of the establishment. The success of Mr. Baldwin's engines with all six or eight wheels connected, and the two front pairs combined by the parallel beams into a flexible truck, had been so marked that it was natural that he should oppose any other plan for freight service. The ten-wheeled engine, with six drivers connected, had however, now become a competitor.

This plan of engine was first patented by Septimus Norris, of Philadelphia, in 1846, and the original design was apparently to produce an engine which should have equal tractive power with the Baldwin six-wheels-connected machine. This the Norris patent sought to accomplish by proposing an engine with six drivers connected, and so disposed as to carry substantially the whole weight, the forward drivers being in advance of the center of gravity of the engine, and the truck only serving as a guide, the front of the engine being connected with it by a pivot pin but without a bearing on the center plate. Mr. Norris's first engine on this plan was tried in April, 1847, and was found not to pass curves as readily as was expected. As the truck carried little or no weight, it would not keep the track. The New York and Erie Railroad Company, of which John Brandt was then Master Mechanic, shortly afterward adopted the ten-wheeled engine, modified in plan so as to carry a part of the weight on the truck. Mr. Baldwin filled an order for this company, in 1850, of four eight-wheels-connected engines, and in making the contract he agreed to substitute a truck for the front pair of wheels if desired after trial. This, however, he was not called upon to do.

In February, 1852, Mr. J. Edgar Thomson, President of the Pennsylvania Railroad Company, invited proposals for a number of freight locomotives of fifty-six thousand pounds weight each. They were to be adapted to burn bituminous coal, and to have six wheels connected and a truck in front, which might be either of two or four wheels. Mr. Baldwin secured the contract, and built twelve engines of the prescribed dimensions, viz.: cylinders eighteen by twenty-two; drivers forty-four inches diameter, with chilled tires. Several of these engines were constructed with a single pair of truck wheels in front of the drivers, but back of the cylinders. It was found, however, after the engines were put in service, that the two truck wheels carried eighteen thousand or nineteen thousand pounds, and this was objected to by the company as too great a weight to be carried on a single pair of wheels. On the rest of the engines of the order, therefore, a four-wheeled truck in front was employed.

The ten-wheeled engine thereafter assumed a place in the

Baldwin classification, but it was some years—not until after 1860, however—before this pattern of engine wholly superseded in Mr. Baldwin's practice the old plan of freight engine on six or eight wheels, all connected.

In 1855–56, two locomotives of twenty-seven tons weight, nineteen by twenty-two cylinders, forty-eight inch drivers, were built for the Portage Railroad, and three for the Pennsylvania Railroad. In 1855, '56 and '57, fourteen of the same dimensions were built for the Cleveland and Pittsburg Railroad; four for the Pittsburg, Fort Wayne and Chicago Railroad; and one for the Marietta and Cincinnati Railroad. In 1858 and '59, one was constructed for the South Carolina Railroad, of the same size, and six lighter ten-wheelers, with cylinders fifteen and one-half by twenty-two, and four-feet drivers, and two with cylinders sixteen by twenty-two and four-feet drivers, were sent out to railroads in Cuba.

On three locomotives—the "Clinton," "Athens," and "Sparta"—completed for the Central Railroad of Georgia in July, 1852, the driving boxes were made with a slot or cavity in the line of the vertical bearing on the journal. The object was to produce a more uniform distribution of the wear over the entire surface of the bearing. This was the first instance in which this device, which has since come into general use, was employed in the Works, and the boxes were so made by direction of Mr. Charles Whiting, then Master Mechanic of the Central Railroad of Georgia. He subsequently informed Mr. Baldwin that this method of fitting up driving boxes had been in use on the road for several years previous to his connection with the company. As this device was subsequently made the subject of a patent by Mr. David Matthew, these facts may not be without interest.

In 1853, Mr. Charles Ellet, Chief Engineer of the Virginia Central Railroad, laid a temporary track across the Blue Ridge, at Rock Fish Gap, for use during the construction of a tunnel through the mountain. This track was twelve thousand five hundred feet in length on the eastern slope, ascending in that distance six hundred and ten feet, or at the average rate of one in twenty and a half feet. The maximum grade was calculated for two hundred and ninety-six feet per mile, and prevailed for half a mile. It was found, however, in fact, that the grade in places exceeded three hundred feet per mile. The shortest radius of curvature was two hundred and thirty-eight feet. On the western slope, which was ten thousand six hundred and fifty feet in length, the maximum grade was two hundred and eighty feet per mile, and the ruling radius of curvature three hundred feet. This track was worked by two of the Baldwin six-wheels-connected flexible beam truck locomotives constructed in 1853–54. From a description of this track, and the mode of working it, published by Mr. Ellet, in 1856, the following is extracted:

"The locomotives mainly relied on for this severe duty were designed and constructed by the firm of M. W. Baldwin & Company, of Philadelphia. The slight modifications introduced at the instance of the writer, to adapt them better to the particular service to be performed in crossing the Blue Ridge, did not touch the working proportions or principle of the engines, the merits of which are due to the patentee, M. W. Baldwin, Esq.

"These engines are mounted on six wheels, all of which are drivers, and coupled, and forty-two inches diameter. The wheels are set very close, so that the distance between the extreme points of contact of the wheels and the rail, of the front and rear drivers, is nine feet four inches. This closeness of the wheels, of course, greatly reduces the difficulty of turning the short curves of the road. The diameter of the cylinders is sixteen and a half inches, and the length of the stroke twenty inches. To increase the adhesion, and at the same time avoid the resistance of a tender, the engine carries its tank upon the boiler, and the footboard is lengthened out and provided with suspended side boxes, where a supply of fuel may be stored. By this means the weight of wood and water, instead of abstracting from the effective power of the engine, contributes to its adhesion and consequent ability to climb the mountain. The total weight of these engines is fifty-five thousand pounds, or twenty-seven and a half tons, when the boiler and tank are supplied with water, and fuel enough for a trip of eight miles is on board. The capacity of the tank is sufficient to hold one hundred cubic feet of water, and it has storage room on top for one hundred cubic feet of wood, in addition to what may be carried in the side boxes and on the footboard.

"To enable the engines to better adapt themselves to the flexures of the road, the front and middle pairs of drivers are held in position by wrought iron beams, having cylindrical boxes in each end for the journal bearings, which beams vibrate on spherical pins fixed in the frame of the engine on each side, and resting on the centers of the beams. The object of this arrangement is to form a truck, somewhat flexible, which enables the drivers more readily to traverse the curves of the road.

"The writer has never permitted the power of the engines on this mountain road to be fully tested. The object has been to work the line regularly, economically, and above all, *safely;* and these conditions are incompatible with experimental loads subjecting the machinery to severe strains. The regular daily service of each of the engines is to make four trips, of eight miles, over the mountain, drawing one eight-wheeled baggage car, together with two eight-wheeled passenger cars, in each direction.

"In conveying freight, the regular train on the mountain is three of the eight-wheeled house cars, fully loaded, or four of them when empty or partly loaded.

"These three cars when full, weigh with their loads, from forty to forty-three tons. Sometimes, though rarely, when the business has been unusually heavy, the loads have exceeded fifty tons.

"With such trains the engines are stopped on the track, ascending or descending, and are started again, on the steepest grades, at the discretion of the engineer.

"Water for the supply of the engines has been found difficult to obtain on the mountain; and since the road was constructed a tank has been established on the eastern slope, where the ascending engines stop daily on a grade of two hundred and eighty feet per mile, and are there held by the brakes while the tank is being filled, and started again at the signal and without any difficulty.

"The ordinary speed of the engines, when loaded, is seven and a half miles an hour on the ascending grades, and from five and a half to six miles an hour on the descent.

"When the road was first opened, it speedily appeared that the difference of forty-three feet on the western side, and fifty-eight on the eastern side, between the grades on curves of three hundred feet radius and those on straight lines, was not sufficient to compensate for the increased friction due to such curvature. The velocity, with a constant supply of steam, was promptly retarded on passing from a straight line to a curve, and promptly accelerated again on passing from the curve to the straight line. But, after a little experience in the working of the road, it was found advisable to supply a small amount of grease to the flange of the engine by means of a sponge, saturated with oil, which, when needed, is kept in contact with the wheel by a spring. Since the use of the oil was introduced, the difficulty of turning the curves has been so far diminished that it is no longer possible to determine whether grades of two hundred and thirty-seven and six-tenths feet per mile on curves of three hundred feet radius, or grades of two hundred and ninety-six feet per mile on straight lines, are traversed most rapidly by the engine.

"When the track is in good condition, the brakes of only two of the cars possess sufficient power to control and regulate the movement of the train,—that is to say, they will hold back the two cars and the engine. When there are three or more cars in the train, the brakes on the cars, of course, command the train so much the more easily.

"But the safety of the train is not dependent on the brakes of the car. There is also a valve or air cock in the steam chest, under the control of the engineer. This air cock forms an independent brake, exclusively at the command of the engineer, and which can always be applied when the engine itself is in working order. The action of this power may be made ever so gradual, either slightly relieving the duty of the brakes on the cars, or bringing into play the entire power of the engine. The train is thus held in complete command."

The Mountain Top Track, it may be added, was worked successfully for several years by the engines described in the above extract, until it was abandoned on the completion of the tunnel. The exceptionally steep grades and short curves which characterized the line afforded a complete and satisfactory test of the adaptation of these machines to such peculiar service.

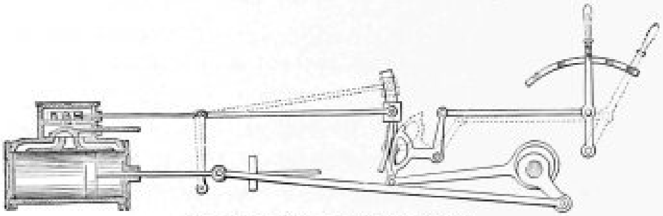
But the period now under consideration was marked by another and most important step in the progress of American locomotive practice. We refer to the introduction of the link motion. Although this device was first employed by William T. James, of New York, in 1832, and eleven years later by the Stephensons, in England, and was by them applied thenceforward on their engines, it was not until 1849 that it was adopted in this country. In that year, Mr. Thomas Rogers, of the Rogers Locomotive and Machine Company, introduced it in his practice. Other builders, however, strenuously resisted the innovation, and none more so than Mr. Baldwin. The theoretical objections which confessedly apply to the device, but which practically have been proved to be unimportant, were urged from the first by Mr. Baldwin as arguments against its use. The strong claim of the advocates of the link motion, that it gave a means of cutting off steam at any point of the stroke, could not be gainsaid, and this was admitted to be a consideration of the first importance. This very circumstance undoubtedly turned Mr. Baldwin's attention to the subject of methods for cutting off steam, and one of the first results was his "Variable Cut-off," patented April 27, 1852. This device consisted of two valves, the upper sliding upon the lower, and worked by an eccentric and rock shaft in the usual manner. The lower valve fitted steam tight to the sides of the steam chest and the under surface of the upper valve. When the piston reached each end of its stroke, the full pressure of steam from the boiler was admitted around the upper valve, and transferred the lower valve instantaneously from one end of the steam chest to the other. The openings through the two valves were so arranged that steam was admitted to the cylinder only for a part of the stroke. The effect was, therefore, to cut off steam at a given point, and to open the induction and exhaust ports substantially at the same instant and to their full extent. The exhaust port, in addition, remained fully opened while the induction port was gradually closing, and after it had entirely closed. Although this device was never put in use, it may be noted in passing that it contained substantially the principle of the steam pump, as since patented and constructed.

Early in 1853, Mr. Baldwin abandoned the half-stroke cut-off previously described, and which he had been using since 1845, and adopted the variable cut-off, which was already employed by other builders. One of his letters, written in January, 1853, states his position, as follows:

> "I shall put on an improvement in the shape of a variable cut-off, which can be operated by the engineer while the machine is running, and which will cut off anywhere from six to twelve inches, according to the load and amount of steam wanted, and this without the link motion, which I could never be entirely satisfied with. I still have the independent cut-off, and the additional machinery to make it variable will be simple and not liable to be deranged."

This form of cut-off was a separate valve, sliding on a partition plate between it and the main steam valve, and worked by an independent eccentric and rock shaft. The upper arm of the rock shaft was curved so as to form a radius arm, on which a sliding block, forming the termination of the upper valve rod, could be adjusted and held at varying distances from the axis, thus producing a variable travel of the upper valve. This device did not give an absolutely perfect cut-off, as it was not operative in backward gear, but when running forward it would cut off with great accuracy at any point of the stroke, was quick in its movement, and economical in the consumption of fuel.

After a short experience with this arrangement of the cut-off, the partition plate was omitted, and the upper valve was made to slide directly on the lower. This was eventually found objectionable, however, as the lower valve would soon cut a hollow in the valve face. Several unsuccessful attempts were made to remedy this defect by making the lower valve of brass, with long bearings, and making the valve face of the cylinder of hardened



VARIABLE CUT-OFF ADJUSTMENT

steel; finally, however, the plan of one valve on the other was abandoned, and recourse was again had to an interposed partition plate, as in the original half-stroke cut-off.

Mr. Baldwin did not adopt this form of cut-off without some modification of his own, and the modification in this instance consisted of a peculiar device, patented September 13, 1835, for raising and lowering the block on the radius arm. A quadrant was placed so that its circumference bore nearly against a curved arm projecting down from the sliding block, and which curved in the reverse direction from the quadrant. Two steel straps, side by side, were interposed between the quadrant and this curved arm. One of the straps was connected to the lower end of the quadrant and the upper end of the curved arm; the other, to the upper end of the quadrant and the lower end of the curved arm. The effect was the same as if the quadrant and arm geared into each other in any position by teeth, and theoretically the block was kept steady in whatever position placed on the radius arm of the rock shaft. This was the object sought to be accomplished, and was stated in the specification of the patent as follows:

"The principle of varying the cut-off by means of a vibrating arm and sliding pivot block has long been known, but the contrivances for changing the position of the block upon the arm have been very defective. The radius of motion of the link by which the sliding block is changed on the arm, and the radius of motion of that part of the vibrating arm on which the block is placed, have, in this kind of valve gear, as heretofore constructed, been different, which produced a continual rubbing of the sliding block upon the arm while the arm is vibrating; and as the block, for the greater part of the time, occupies one position on the arm, and only has to be moved toward either extremity occasionally, that part of the arm on which the block is most used soon becomes so worn that the block is loose, and jars."

This method of varying the cut-off was first applied on the engine "Belle," delivered to the Pennsylvania Railroad Company, December 6, 1854, and thereafter was for some time employed by Mr. Baldwin. It was found however, in practice, that the steel straps would stretch sufficiently to allow them to buckle and break, and hence they were soon abandoned and chains substituted between the quadrant and curved arm of the sliding block. These chains in turn proved little better, as they lengthened, allowing lost motion, or broke altogether, so that eventually the quadrant was wholly abandoned, and recourse was finally had to the lever and link for raising and lowering the sliding block. As thus arranged, the cut-off was substantially what was known as the "Cuyahoga Cut-off," as introduced by Mr. Ethan Rogers, of the Cuyahoga Works, Cleveland, Ohio, except that Mr. Baldwin used a partition plate between the upper and the lower valve.

But while Mr. Baldwin, in common with many other builders, was thus resolutely opposing the link motion, it was nevertheless rapidly gaining favor with railroad managers. Engineers and master mechanics were everywhere learning to admire its simplicity, and were manifesting an enthusiastic preference for engines so constructed. At length, therefore, he was forced to succumb; and the link was applied to the "Pennsylvania," one of two engines completed for the Central Railroad of Georgia, in February, 1854. The other engine of the order, the "New Hampshire," had the variable cut-off, and Mr. Baldwin, while yielding to the demand in the former engine, was undoubtedly sanguine that the working of the latter would demonstrate the inferiority of the new device. In this, however, he was disappointed; for in the following year the same company ordered three more engines, on which they specified the link motion. In 1856, seventeen engines for nine different companies had this form of valve gear, and its use was thus incorporated in his practice.

It was not, however, until 1857 that he was induced to adopt it exclusively.

February 14, 1854, Mr. Baldwin and Mr. David Clark, Master Mechanic of the Mine Hill Railroad, took out conjointly a patent for a feed-water heater, placed at the base of a locomotive chimney, and consisting of one large vertical flue, surrounded by a number of smaller ones. The exhaust steam was discharged from the nozzles through the large central flue, creating a draft of the products of combustion through the smaller surrounding flues. The pumps forced the feed water into the chamber around these flues, whence it passed to the boiler by a pipe from the back of the stack. This heater was applied on several engines for the Mine Hill Railroad, and on a few other roads; but its use was exceptional, and lasted only for a year or two.

In December of the same year Mr. Baldwin filed a caveat for a variable exhaust, operated automatically, by the pressure of steam, so as to close when the pressure was lowest in the boiler and open with the increase of pressure. The device was never put in service.

The use of coal, both bituminous and anthracite, as a fuel for locomotives, had by this time become a practical success. The economical combustion of bituminous coal, however, engaged considerable attention. It was felt that much remained to be accomplished in consuming the smoke and deriving the maximum of useful effect from the fuel. Mr. Baird, who was now associated with Mr. Baldwin in the management of the business, made this matter a subject of careful study and investigation. An experiment was conducted under his direction, by placing a sheet iron deflector in the firebox of an engine on the Germantown and Norristown Railroad. The success of the trial was such as to show conclusively that a more complete combustion resulted. As, however, a deflector formed by a single plate of iron would soon be destroyed by the action of the fire, Mr. Baird proposed to use a water leg projecting upward and backward from the front of the firebox under the flues. Drawings and a model of the device were prepared, with a view of patenting it, but subsequently the intention was abandoned, Mr. Baird concluding that a firebrick arch as a deflector to accomplish the same object was preferable. This was accordingly tried on two locomotives built for the Pennsylvania Railroad Company in 1854, and was found so valuable an appliance that its use was at once established, and it was put on a number of engines built for railroads in Cuba and elsewhere. For several years the firebricks were supported on side plugs; but in 1858, in the "Media," built for the West Chester and Philadelphia Railroad Company, water pipes extending from the crown obliquely downward and curving to the sides of the firebox at the bottom, were successfully used for the purpose.

The adoption of the link motion may be regarded as the dividing line between the present and the early and transitional stage of locomotive practice. Changes since that event have been principally in matters of detail, but it is the gradual perfection of these details which has made the locomotive the symmetrical, efficient, and wonderfully complete piece of mechanism it is to-day. In perfecting these minutiæ, the Baldwin Locomotive Works has borne its part, and it only remains to state briefly its contributions in this direction.

The production of the establishment during the six years from 1855 to 1860, inclusive, was as follows: forty-seven engines in 1855; fifty-nine in 1856; sixty-six in 1857; thirty-three in 1858; seventy in 1859; and eighty-three in 1860. The greater number of these were of the ordinary type: four drivers coupled, and a four-wheeled truck, and varying in weight from fifteen ton engines, with cylinders twelve by twenty-two, to twenty-seven ton engines, with cylinders sixteen by twenty-four. A few ten-wheeled engines were built, as has been previously noted, and the remainder were the Baldwin flexible truck six and eight-wheels-connected engines. The demand for these, however, was now rapidly falling off, the ten-wheeled and heavy "C" engines taking their place, and by 1859 they ceased to be built, save in exceptional cases, as for some foreign roads, from which orders for this pattern were still occasionally received.

A few novelties characterizing the engines of this period may be mentioned. Several engines built in 1855 had cross flues placed in the firebox, under the crown in order to increase the heating surface. This feature, however, was found impracticable and was soon abandoned. The intense heat to which the flues were exposed converted the water contained in them into highly superheated steam, which would force its way out through the water around the firebox with violent ebullitions. Four engines were built for the Pennsylvania Railroad Company, in 1856–57, with straight boilers and two domes. The "Delano" grate, by means of which the coal was forced into the firebox from below, was applied on four ten-wheeled engines for the Cleveland and Pittsburg Railroad in 1857. In 1859 several engines were built with the form of boiler introduced on the Cumberland Valley Railroad, in 1851, by Mr. A. F. Smith, and which consisted of a combustion chamber in the waist of the boiler next the firebox. This form of boiler was for some years thereafter largely used in engines for soft coal. It was at first constructed with the "water leg," which was a vertical water space, connecting the top and bottom sheets of the combustion chamber, but eventually this feature was omitted, and an unobstructed combustion chamber employed. Several engines were built for the Philadelphia, Wilmington and Baltimore Railroad Company, in 1859 and thereafter, with the "Dimpfel" boiler in which the tubes contain water, and starting downward from the crown sheet, are curved to the horizontal, and terminate in a narrow water space next to the smokebox. The whole waist of the boiler, therefore, forms a combustion chamber, and the heat and gases, after passing for their whole length along and around the tubes, emerge into the lower part of the smokebox.

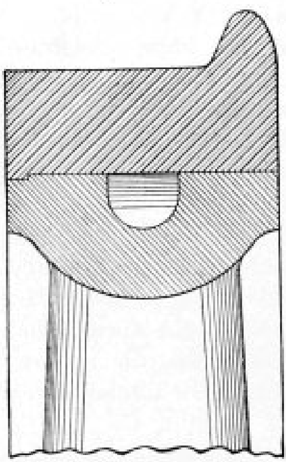
In 1860 an engine was built for the Mine Hill Railroad, with a boiler of a peculiar form. The top sheets sloped upward from both ends toward the center, thus making a raised part or hump in the center. The engine was designed to work on heavy grades, and the object sought by Mr. Wilder, the superintendent of the Mine Hill Railroad, was to have the water always at the same height in the space from which steam was drawn, whether going up or down grade.

All these experiments are indicative of the interest then prevailing upon the subject of coal burning. The result of experience and study had meantime satisfied Mr. Baldwin that to burn soft coal successfully required no peculiar devices; that the ordinary form of boiler, with plain firebox, was right, with perhaps the addition of a firebrick deflector; and that the secret of the economical and successful use of coal was in the mode of firing, rather than in a different form of furnace.

The year 1861 witnessed a marked falling off in the production. The breaking out of the Civil War at first unsettled business, and by many it was thought that railroad traffic would be so largely reduced that the demand for locomotives must cease altogether. A large number of hands were discharged from the Works, and only forty locomotives were turned out during the year. It was even seriously contemplated to turn the resources of the establishment to the manufacture of shot and shell, and other munitions of war, the belief being entertained that the building of locomotives would have to be altogether suspended. So far was this from being the case, however, that after the first excitement had subsided, it was found that the demand for transportation by the General Government, and by the branches of trade and production stimulated by the war, was likely to tax the carrying capacity of the principal Northern railroads to the fullest extent. The government itself became a large purchaser of locomotives, and it is noticeable, as indicating the increase of travel and freight transportation, that heavier machines than had ever before been built became the rule. Seventy-five engines were sent from the Works in 1862; ninety-six in 1863; one hundred and thirty in 1864; and one hundred and fifteen in 1865. During two years of this period, from May, 1862, to June, 1864, thirty-three engines were built for the United States Military Railroads. The demand from the various coal-carrying roads in Pennsylvania and vicinity was particularly active, and large numbers of ten-wheeled engines, and of the heaviest eight-wheeled four coupled engines, were built. Of the latter class, the majority were fifteen and sixteen-inch cylinders, and of the former, seventeen and eighteen-inch cylinders.

The introduction of several important features in construction marks this period. Early in 1861, four eighteen-inch cylinder freight locomotives, with six coupled wheels, fifty-two inches in diameter, and a Bissell pony truck with radius bar in front, were sent to the Louisville and Nashville Railroad Company. This was the first instance of the use of the Bissell truck in the Baldwin Works. These engines, however, were not of the regular Mogul type, as they were only modifications of the ten-wheeler, the drivers retaining the same position well back and a pair of pony wheels on the Bissell plan taking the place of the ordinary four-wheeled truck. Other engines of the same pattern, but with eighteen and one-half inch cylinders, were built in 1862–63, for the same company, and for the Dom Pedro II. Railway of Brazil.

The introduction of steel in locomotive construction was a distinguishing feature of the period. Steel tires were first used in the Works in 1862, on some engines for the Dom Pedro II. Railway of South America. Their general adoption on American Railroads followed slowly. No tires of this material were then made in this country, and it was objected to their use that, as it took from sixty to ninety days to import them, an engine, in case of a breakage of one of its tires, might be laid up useless for several months. To obviate this objection, M. W. Baldwin & Co. imported five hundred steel tires, most of which were kept in stock, from which to fill orders. The steel tires as first used in 1862, on the locomotives for the Dom Pedro Segundo Railway, were made with a "shoulder" at one edge of the internal periphery and were shrunk on the wheel centers. The accompanying sketch shows a section of the tire as then used



Steel Tire, with Shoulder

Steel fireboxes were first built for some engines for the Pennsylvania Railroad Company, in 1861. English steel of a high temper was used, and at the first attempt the fireboxes cracked in fitting them in the boilers, and it became necessary to take them out and substitute copper. American homogeneous cast steel was then tried on engines 231 and 232 completed for the Pennsylvania Railroad in January, 1862, and it was found to work successfully. The fireboxes of nearly all engines thereafter built for that road were of this material, and in 1866, its use for the purpose became general. It may be added that while all steel sheets for fireboxes or boilers are required to be thoroughly annealed before delivery, those which are flanged or worked in the process of boiler construction are a second time annealed before riveting.

Another feature of construction gradually adopted was the placing of the cylinders horizontally. This was first done in the case of an outside-connected engine, the "Ocmulgee," which was sent to the Southwestern Railroad Company, of Georgia, in January, 1858. This engine had a square smokebox, and the cylinders were bolted horizontally to its sides. The plan of casting the cylinder and half-saddle in one piece and fitting it to the round smokebox was introduced by Mr. Baldwin, and grew naturally out of his original method of construction. Mr. Baldwin was the first American builder to use an outside cylinder, and he made it for his early engines with a circular flange cast to it, by which it could be bolted to the boiler. The cylinders were gradually brought lower, and at a less angle, and the flanges prolonged and enlarged. In 1852, three six-wheels-connected engines, for the Mine Hill Railroad Company, were built with the cylinder flanges brought around under the smokebox until they nearly met, the space between them being filled with a sparkbox. This was practically equivalent to making the cylinder and half saddle in one casting. Subsequently, on other engines on which the sparkbox was not used, the half saddles were cast so as almost to meet under the smokebox, and, after the cylinders were adjusted in position, wedges were fitted in the interstices and the saddles bolted together. It was finally discovered that the faces of the two half saddles might be planed and finished so that they could be bolted together and bring the cylinders accurately in position, thus avoiding the troublesome and tedious job of adjusting them by chipping and fitting to the boiler and frames. With this method of construction, the cylinders were placed at a less and less angle, until at length the truck wheels were spread sufficiently, on all new or modified classes of locomotives in the Baldwin list, to admit of the cylinders being hung horizontally, as is the present almost universal American practice. By the year 1865 horizontal cylinders were made in all cases where the patterns would allow it. The advantages of this arrangement are manifestly in the interest of simplicity and economy, as the cylinders are thus rights or lefts, indiscriminately, and a single pattern answers for either side.

A distinguishing feature in the method of construction which characterizes these Works, is the extensive use of a system of standard gauges and templets, to which all work admitting of this process is required to be made. The importance of this arrangement in securing absolute uniformity of essential parts in all engines of the same class is manifest, and with the increased production since 1861, it became a necessity as well as a decided advantage. It has already been noted, that as early as 1839, Mr. Baldwin felt the importance of making all like parts of similar engines absolutely uniform and interchangeable. It was not attempted to accomplish this object, however, by means of a complete system of standard gauges, until many years later. In 1861 a beginning was made of organizing all the departments of manufacture upon this basis, and from it has since grown an elaborate and perfected system, embracing all the essential details of construction. An independent department of the Works, having a separate foreman and an adequate force of skilled workmen with special tools adapted to the purpose, is organized as the Department of Standard Gauges. A system of standard gauges and templets for every description of work to be done is made and kept by this department. The original templets are kept as "standards," and are never used on the work itself, but from them exact duplicates are made, which are issued to the foremen of the various departments, and to which all work is required to conform. The working gauges are compared with the standards at regular intervals, and absolute uniformity is thus maintained. The system is carried into every possible important detail. Frames are planed and slotted to gauges, and drilled to steel bushed templets. Cylinders are bored and planed, and steam ports, with valves and steam chests, finished and fitted to gauges. Tires are bored, centers turned, axles finished, and crossheads, guides, guide bearers, pistons, connecting and parallel rods planed, slotted, or finished by the same method. Every bolt about the engine is made to a gauge, and every hole drilled and reamed to a templet. The result of the system is an absolute uniformity and interchangeableness of parts in engines of the same class, insuring to the purchaser the minimum cost of repairs, and rendering possible, by the application of this method, the large production which these Works have accomplished.

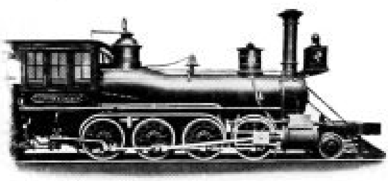
Thus had been developed and perfected the various essential details of existing locomotive practice when Mr. Baldwin died, September 7, 1866. He had been permitted in a life of unusual activity and energy, to witness the rise and wonderful increase of a material interest which had become the distinguishing feature of the century. He had done much, by his own mechanical skill and inventive genius, to contribute to the development of that interest. His name was as "familiar as household words" wherever on the American continent the locomotive had penetrated. An ordinary ambition might well have been satisfied with this achievement. But Mr. Baldwin's claim to the remembrance of his fellow-men rests not alone on the results of his mechanical labors. A merely technical history, such as this, is not the place to do justice to his memory as a man, as a Christian, and as a philanthropist; yet the record would be manifestly imperfect, and would fail properly to reflect the sentiments of his business associates who so long knew him in all relations of life, were no reference made to his many virtues and noble traits of character. Mr. Baldwin was a man of sterling integrity and singular conscientiousness. To do right, absolutely and unreservedly, in all his relations with men, was an instinctive rule of his nature. His heroic struggle to meet every dollar of his liabilities, principal and interest, after his failure, consequent upon the general financial crash in 1837, constitutes a chapter of personal self-denial and determined effort which is seldom paralleled in the annals of commercial experience. When most men would have felt that an equitable compromise with creditors was all that could be demanded in view of the general financial embarrassment, Mr. Baldwin insisted upon paying all claims in full, and succeeded in doing so only after nearly five years of unremitting industry, close economy, and absolute personal sacrifices. As a philanthropist and a sincere and earnest Christian, zealous in every good work, his memory is cherished by many to whom his contributions to locomotive improvement are comparatively unknown. From the earliest years of his business life the practice of systematic benevolence was made a duty and a pleasure. His liberality constantly increased with his means. Indeed he would unhesitatingly give his notes in large sums, for charitable purposes, when money was absolutely wanted to carry on his business. Apart from the thousands which he expended in private charities, and of which, of course, little can be known, Philadelphia contains many monuments of his munificence. Early taking a deep interest in all Christian effort, his contributions to missionary enterprise and church extension were on the grandest scale, and grew with increasing wealth. Numerous church edifices in this city, of the denomination to which he belonged, owe their existence largely to his liberality, and two at least were projected and built by him entirely at his own cost. In his mental character Mr. Baldwin was a man of remarkable firmness of purpose. This trait was strongly shown during his mechanical career, in the persistency with which he would work at a new improvement or resist an innovation. If he was led sometimes to assume an attitude of antagonism to features of locomotive construction which after-experience showed to be valuable, (and the desire for historical accuracy has required the mention, in previous pages, of several instances of this kind,) it is at least certain that his opposition was based upon a conscientious belief in the mechanical impolicy of the proposed changes.

After the death of Mr. Baldwin the business was reorganized in 1867, under the title of "The Baldwin Locomotive Works," M. Baird & Co., proprietors. Messrs. George Burnham and Charles T. Parry, who had been connected with the establishment from an early period, the former in charge of the finances, and the latter as General Superintendent, were associated with Mr. Baird in the copartnership. Three years later Messrs. Edward H. Williams, William P. Henszey, and Edward Longstreth became members of the firm. Mr. Williams had been connected with railway management on various lines since 1850. Mr. Henszey had been Mechanical Engineer, and Mr. Longstreth the General Superintendent of the Works for several years previously.

The production of the Baldwin Locomotive Works from 1866 to 1871, both years inclusive, was as follows:

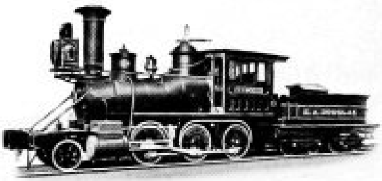
1866, one hundred and eighteen locomotives.
1867, one hundred and twenty-seven "
1868, one hundred and twenty-four "
1869, two hundred and thirty-five "
1870, two hundred and eighty "
1871, three hundred and thirty-one "

In July, 1866, the engine "Consolidation" was built for the Lehigh Valley Railroad, on the plan and specification furnished by Mr. Alexander Mitchell, Master Mechanic of the Mahanoy Division of that Railroad. This engine was intended for working the Mahanoy plane, which rises at the rate of one hundred and thirty-three feet per mile. The "Consolidation" had cylinders twenty by twenty-four, four pairs of drivers connected, forty-eight inches in diameter, and a Bissell pony truck in front, equalized with the front drivers. The weight of the engine, in working order, was ninety thousand pounds, of which all but about ten thousand pounds was on the drivers. This engine has constituted the first of a class to which it has given its name, and Consolidation engines have since been constructed for a large number of railways, not only in the United States, but in Mexico, Brazil and Australia. Later engines of the class for the four feet eight and a half inch gauge have, however, been made heavier.



"Consolidation"

A class of engines known as Moguls, with three pairs of drivers connected, and a swinging pony truck in front equalized with the forward drivers, took its rise in the practice of this establishment from the "E. A. Douglas," built for the Thomas Iron Company in 1867. Several sizes of Moguls have been built, but principally with cylinders sixteen to nineteen inches in diameter, and twenty-two or twenty-four inches stroke, and with drivers from forty-four to fifty-seven inches in diameter. This plan of engine has rapidly grown in favor for freight service on heavy grades or where maximum loads are to be moved, and has been adopted by several leading lines. Utilizing, as it does, nearly the entire weight of the engine for adhesion, the main and back pairs of drivers being equalized together, as also the front drivers and the pony wheels, and the construction of the engine with swing truck and one pair of drivers without flanges allowing it to pass short curves without difficulty, the "Mogul" is generally accepted as a type of engine especially adapted to the economical working of heavy freight traffic.



"MOGUL

In 1867, on a number of eight-wheeled four coupled engines for the Pennsylvania Railroad, the four-wheeled swing bolster truck was first applied, and thereafter a large number of engines have been so constructed. The two-wheeled or "pony truck" has been built both on the Bissell plan, with double inclined slides, and with the ordinary swing bolster, and in both cases with the radius bar pivoting from a point about four feet back from the center of the truck. The four-wheeled truck has been made with swinging or sliding bolster, and both with and without the radius bar. Of the engines above referred to as the first on which the swing bolster truck was applied, four were for express passenger service, with drivers sixty-seven inches in diameter, and cylinders seventeen by twenty-four. One of them, placed on the road September 9, 1867, was in constant service until May 14, 1871, without ever being off its wheels for repairs, making a total mileage of one hundred and fifty-three thousand two hundred and eighty miles. All of these engines have their driving wheels spread eight and one-half feet between centers.

Steel flues were first used in three ten-wheeled freight engines, Numbers 211, 338 and 368, completed for the Pennsylvania Railroad in August, 1868. Steel boilers were first made in 1868 for locomotives for the Pennsylvania Railroad Company, and the use of this material for the barrels of boilers as well as for the fireboxes has now become universal in American practice.

In 1854, four engines for the Pennsylvania Railroad Company, the "Tiger," "Leopard," "Hornet," and "Wasp," were built with straight boilers and two domes each, and in 1866, this method of construction was revived, and until about 1880, the practice of the establishment included both the wagon top boiler with single dome, and the straight boiler with one or two domes. When the straight boiler is used the waist is made about two inches larger in diameter than that of the wagon top form. About equal space for water and steam is thus given in either case, and as the number of flues is the same in both forms, more room for the circulation of water between the flues is afforded in the straight boiler, on account of its larger diameter, than in the wagon top shape. Since 1880, the use of two domes has been exceptional, both wagon top and straight boilers being constructed with one dome.

In 1868, a locomotive of three and a half feet gauge was constructed for the Averill Coal and Oil Company, of West Virginia. This was the first narrow gauge locomotive in the practice of the Works.

In 1869, three locomotives of the same gauge were constructed for the União Valenciana Railway of Brazil, and were the first narrow gauge locomotives constructed at these Works for general passenger and freight traffic. In the following year the Denver and Rio Grande Railway, of Colorado, was projected on the three-feet gauge, and the first locomotives for the line were designed and built in 1871. Two classes for passenger and freight respectively, were constructed. The former were six-wheeled, four wheels coupled forty inches in diameter, nine by sixteen cylinders, and weighed each, loaded, about twenty-five thousand pounds. The latter were eight-wheeled, six wheels coupled, thirty-six inches in diameter, eleven by sixteen cylinders, and weighed each, loaded, about thirty-five thousand pounds.

Each had a swinging truck of a single pair of wheels in front of the cylinders. The latter type has been maintained for freight service up to the present time, but principally of larger sizes, engines as heavy as fifty thousand pounds having been turned out. The former type for passenger service was found to be too small and to be unsteady on the track, owing to its comparatively short wheel base. It was therefore abandoned, and the ordinary American pattern, eight-wheeled, four coupled, substituted. Following the engines for the Denver and Rio Grande Railway others for other narrow gauged lines were called for, and the manufacture of this description of rolling stock soon assumed importance.

The Consolidation type, as first introduced for the four feet eight and one-half inch gauge in 1866, was adapted to the three feet gauge in 1873. In 1877, a locomotive on this plan, weighing in working order about sixty thousand pounds, with cylinders fifteen by twenty, was built for working the Garland extension of the Denver and Rio Grande Railway, which crosses the Rocky Mountains with maximum grades of two hundred and eleven feet per mile, and minimum curves of thirty degrees. The performance of this locomotive, the "Alamosa," is given in the following extract from a letter from the then General Superintendent of that railway.

DENVER, COL., August 31, 1877.

"On the 29th inst. I telegraphed you from Veta Pass—Sangre de Cristo Mountains—that engine 'Alamosa' had just hauled from Garland to the Summit one baggage car and seven coaches, containing one hundred and sixty passengers. Yesterday I received your reply asking for particulars, etc.

"My estimate of the weight was eighty-five net tons, stretched over a distance of three hundred and sixty feet, or including the engine, of four hundred and five feet.

"The occasion of this sized train was an excursion from Denver to Garland and return. The night before in going over from La Veta we had over two hundred passengers, but it was but 8 P. M., and fearing a slippery rail, I put on engine No. 19 as a pusher, although the engineer of the 'Alamosa' said he could haul the train, and I believe he could have done so. The engine and train took up a few feet more than the half circle at 'Mule Shore,' where the radius is one hundred and ninety-three feet. The engine worked splendidly, and moved up the two hundred and eleven feet grades and around the thirty degree curves seemingly with as much ease as our passenger engines on seventy-five feet grades with three coaches and baggage cars.

"The 'Alamosa' hauls regularly eight loaded cars and caboose about one hundred net tons; length of train about two hundred and thirty feet.

"The distance from Garland to Veta Pass is fourteen and one-quarter miles, and the time is one hour and twenty minutes.

"Respectfully yours,

(Signed) W. W. BORST, *Supt.*"

In addition to narrow gauge locomotives for the United States, this branch of the product has included a large number of one meter gauge locomotives for Brazil, three feet gauge locomotives for Cuba, Mexico and Peru, and three and one-half feet gauge for Japan, Costa Rica, Nicaragua, Canada and Australia.

Locomotives for single rail railroads were built in 1878 and early in 1879, adapted respectively to the systems of General Roy Stone and Mr. W. W. Riley.

Mine locomotives, generally of narrow gauge, for underground work, and not over five and one-half feet in height, were first built in 1870. These machines have generally been four-wheels-connected, in many instances with inside cylinders and a crank axle. The width over all of this plan is only sixteen inches greater than the gauge of the track. A number of outside-connected mine locomotives have, however, also been constructed. In this pattern the width is thirty-two inches greater than the gauge of the track. A locomotive of twenty inches gauge for a gold mine in California was built in 1876, and was found entirely practicable and efficient.

In 1870, in some locomotives for the Kansas Pacific Railway, the steel tires were shrunk on without being secured by bolts or rivets in any form, and since that time this method of putting on tires has been the rule.

In 1871, forty locomotives were constructed for the Ohio and Mississippi Railway, the gauge of which was changed from five feet six inches to four feet eight and one-half inches. The entire lot of forty locomotives was completed and delivered in about twelve weeks. The gauge of the road was changed on July 4, and the forty locomotives went at once into service in operating the line on the standard gauge.

During the same year two double-end engines of Class 10–26¼–C were constructed for the Central Railroad of New Jersey, and were the first of this pattern at these Works.

The product of the Works, which had been steadily increasing for some years in sympathy with the requirements of the numerous new railroads which were constructing, reached three hundred and thirty-one locomotives in 1871, and four hundred and twenty-two in 1872. Orders for ninety locomotives for the Northern Pacific Railroad were entered during 1870–71, and for one hundred and twenty-four for the Pennsylvania Railroad during 1872–73, and mostly executed during those years. A contract was also made during 1872, with the Veronej-Rostoff Railway of Russia for ten locomotives to burn Russian anthracite coal. Six were Moguls, with cylinders nineteen by twenty-four, and driving wheels four and one-half feet diameter; and four were passenger locomotives, American pattern, with cylinders seventeen by twenty-four, and driving wheels five and one-half feet diameter. Nine American pattern locomotives, fifteen by twenty-four cylinders, and five feet driving wheels, were also constructed in 1872–73 for the Hango-Hyvinge Railway of Finland.

Early in 1873, Mr. Baird retired from the business, having sold his interest in the Works to his five partners. Mr. Baird died May 19, 1877. A new firm was formed under the style of Burnham, Parry, Williams & Co., dating from January 1, 1873, and Mr. John H. Converse, who had been connected with the Works since 1870, became a partner. The product of this year was four hundred and thirty-seven locomotives, the greatest in the history of the business. During a part of the year ten locomotives per week were turned out. Nearly three thousand men were employed. Forty-five locomotives for the Grand Trunk Railway of Canada were built in August, September and October, 1873, and all were delivered in five weeks after shipment of the first. As in the case of the Ohio and Mississippi Railway, previously noted, these were to meet the requirements of a change of gauge from five and one-half feet to four feet eight and one-half inches. In November, 1873, under circumstances of especial urgency, a small locomotive for the Meier Iron Company, of

St. Louis, was wholly made from the raw material in sixteen working days.

The financial difficulties which prevailed throughout the United States, beginning in September, 1873, and affecting chiefly the railroad interests and all branches of manufacture connected therewith, operated, of course, to curtail the production of locomotives for quite a period. Hence, only one hundred and sixty-two locomotives were built in 1874, and one hundred and thirty in 1875. Among these may be enumerated two sample locomotives for burning anthracite coal (one passenger, sixteen by twenty-four cylinders, and one Mogul freight, eighteen by twenty-four cylinders) for the Technical Department of the Russian Government; also twelve Mogul freight locomotives, nineteen by twenty-four cylinders, for the Charkoff Nicolaieff Railroad of Russia. A small locomotive to work by compressed air, for drawing street cars, was constructed during 1874, for the Compressed Air Locomotive and Street Car Company, of Louisville, Ky. It had cylinders seven by twelve, and four wheels coupled, thirty inches in diameter. Another and smaller locomotive, to work by compressed air, was constructed three years later for the Plymouth Cordage Company, of Massachusetts, for service on a track in and about their works. It had cylinders five by ten, four wheels coupled twenty-four inches diameter, weight, seven thousand pounds, and has been successfully employed for the work required.

The year 1876, noted as the year of the Centennial International Exhibition, in Philadelphia, brought some increase of business, and two hundred and thirty-two locomotives were constructed. An exhibit consisting of eight locomotives was prepared for this occasion. With the view of illustrating not only the different types of American locomotives, but the practice of different railroads, the exhibit consisted chiefly of locomotives constructed to fill orders from various railroad companies of the United States and from the Imperial Government of Brazil. A Consolidation locomotive for burning anthracite coal, for the Lehigh Valley Railroad, for which line the first locomotive of this type was designed and built in 1866; a similar locomotive, to burn bituminous coal, and a passenger locomotive for the same fuel for the Pennsylvania Railroad; a Mogul freight locomotive, the "Principe do Grão Pará," for the Dom Pedro Segundo Railway, of Brazil; and a passenger locomotive (anthracite burner) for the Central Railroad of New Jersey, comprised the larger locomotives contributed by these Works to the Exhibition of 1876. To these were added a mine locomotive and two narrow (three feet) gauge locomotives which were among those used in working the Centennial Narrow Gauge Railway. As this line was in many respects unique, we subjoin the following extracts from an account by its General Manager of the performance of the two three feet gauge locomotives:

"The gauge of the line was three feet, with double track three and a half miles long, or seven miles in all. For its length, it was probably the most crooked road in the world, being made up almost wholly of curves, in order to run near all the principal buildings on the Exhibition grounds. Many of these curves were on our heaviest grades, some having a radius of 215, 230 and 250 feet on grades of 140 and 155 feet per mile. These are unusually heavy grades and curves, and when *combined* as we had them, with only a thirty-five pound iron rail, made the task for our engines exceedingly difficult.

"Your locomotive 'Schuylkill,' Class 8-18-C (eight-wheeled, four wheels coupled three and a half feet diameter; cylinders, twelve by sixteen; weight, forty-two thousand six hundred and fifty pounds), began service May 13, and made one hundred and fifty-six days to the close of the Exhibition. The locomotive 'Delaware,' Class 8–18–D (eight-wheeled, six wheels coupled three feet diameter; cylinders, twelve by sixteen; weight, thirty-nine thousand pounds), came into service June 9, and made one hundred and thirty-one days to the close of the Exhibition. The usual load of each engine was five eight-wheeled passenger cars, frequently carrying over one hundred passengers per car. On special occasions, as many as six and seven loaded cars have been drawn by one of these engines.

"Each engine averaged fully sixteen trips daily, equal to fifty-six miles and as the stations were but a short distance apart, the Westinghouse air brake was applied in making one hundred and sixty daily stops, or a total of twenty-five thousand for each engine. Neither engine was out of service an hour, unless from accidents for which they were in no way responsible."

[NOTE.—Average weight of each loaded car about twelve gross tons.]

The year 1876 was also marked by an extension of locomotive engineering to a new field in the practice of these Works. In the latter part of the previous year an experimental steam street car was constructed for the purpose of testing the appli cability of steam to street railways. This car was completed in November, 1875, and was tried for a few days on a street railway in Philadelphia. It was then sent to Brooklyn, December 25, 1875, where it ran from that time until June, 1876. One engineer ran the car and kept it in working order. Its consumption of fuel was between seven and eight pounds of coal per mile run. It drew regularly, night and morning, an additional car, with passengers going into New York in the morning, and returning at night. On several occasions, where speed was practicable, the car was run at the rate of sixteen to eighteen miles per hour.

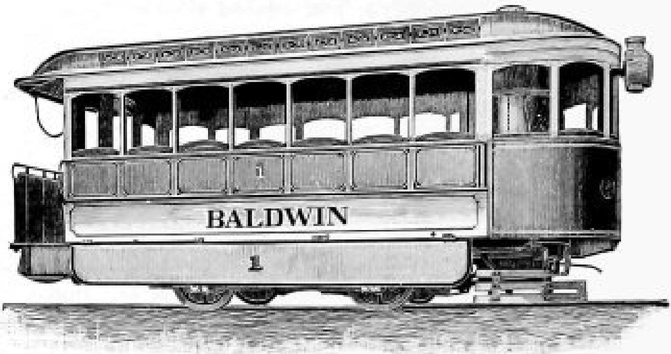
In June, 1876, this car was withdrawn from the Atlantic Avenue Railway of Brooklyn, and placed on the Market Street Railway of Philadelphia. It worked on that line with fair success, and very acceptably to the public, from June till nearly the close of the Centennial Exhibition.

This original steam car was built with cylinders under the body of the car, the connecting rods taking hold of a crank axle, to which the front wheels were attached. The rear wheels of the car were independent, and not coupled with the front wheels. The machinery of the car was attached to an iron bed-plate bolted directly to the wooden framework of the car body. The experiment with this car demonstrated to the satisfaction of its builders the mechanical practicability of the use of steam on street railways, but the defects developed by this experimental car were: first, that it was difficult, or impossible, to make a crank axle which would not break, the same experience being reached in this respect which had already presented itself in locomotive construction; second, it was found that great objection existed to attaching the machinery to the wooden car body, which was not sufficiently rigid for the purpose, and which suffered by being racked and strained by the working of the machinery.

For these reasons this original steam car was reconstructed, in accordance with the experience which nearly a year's service had suggested. The machinery was made "outside-connected," the same as an ordinary locomotive, and a strong iron framework was designed, entirely independent of the car body, and supporting the boiler and all the machinery.

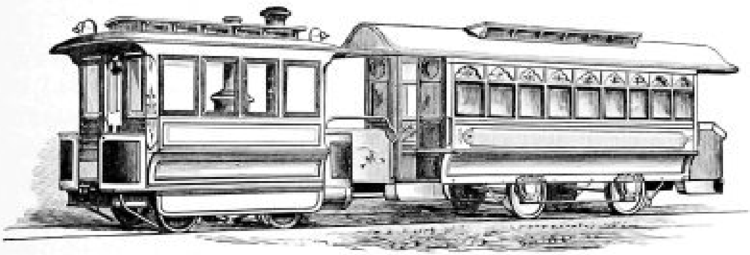
The car as thus reconstructed was named the "Baldwin," and is shown by the illustration herewith.

The next step in this direction was the construction of a separate "motor," to which one or more cars could be attached. Such a machine, weighing about sixteen thousand pounds, was constructed in the fall of 1876, and sent to the Citizens' Railway of Baltimore, which has the maximum grades of seven feet per hundred, or three hundred and sixty-nine and six-tenths feet per mile. It ascended the three hundred and sixty-nine feet grade, drawing one loaded car, when the tracks were covered



STEAM STREET CAR

with mixed snow and dirt to a depth of eight to ten inches in places. Another and smaller motor, weighing only thirteen thousand pounds, was constructed about the same time for the Urbano Railway, of Havana, Cuba. Orders for other similar machines followed, and during the ensuing years, 1877–78–79–80, one hundred and seven separate motors and twelve steam cars were included in the product. Various city and suburban railways have been constructed with the especial view of employing steam power, and have been equipped with these machines. One line, the Hill and West Dubuque Street Railway, of Dubuque, Iowa, was constructed early in 1877, of three and a half feet gauge with a maximum gradient of nine in one hundred, and was worked exclusively by two of these motors. The details and character of construction of these machines are essentially the same as locomotive work, but they are made so as to be substantially noiseless, and to show little or no smoke and steam in operation.



STEAM MOTOR FOR STREET CARS

Steel fireboxes with vertical corrugations in the side sheets were first made by these Works early in 1876, in locomotives for the Central Railroad of New Jersey, and for the Delaware, Lackawanna and Western Railway.

The first American locomotives for New South Wales and Queensland were constructed by the Baldwin Locomotive Works in 1877, and have since been succeeded by additional orders. Six locomotives of the Consolidation type for three and one-half feet gauge were also constructed in the latter year for the Government Railways of New Zealand, and two freight locomotives, six-wheels-connected, with forward truck for the Government of Victoria. Four similar locomotives (ten-wheeled, six coupled, with sixteen by twenty-four cylinders) were also built during the same year for the Norwegian State Railways.

Forty heavy Mogul locomotives (nineteen by twenty-four cylinders, driving wheels four and one-half feet in diameter) were constructed early in 1878 for two Russian Railways (the Koursk Charkof Azof, and the Orel Griazi). The definite order for these locomotives was only received on the sixteenth of December, 1877, and as all were required to be delivered in Russia by the following May, especial despatch was necessary. The working force was increased from eleven hundred to twenty-three hundred men in about two weeks. The first of the forty engines was erected and tried under steam on January 5th, three weeks after receipt of order, and was finished, ready to dismantle and pack for shipment, one week later. The last engine of this order was completed February 13th. The forty engines were thus constructed in about eight weeks, beside twenty-eight additional engines on other orders, which were constructed, wholly or partially, and shipped during the same period.

Four tramway motors of twelve tons weight were built early in 1879, on the order of the New South Wales Government, for a tramway having grades of six per cent., and running from the railway terminus to the Sydney Exhibition Grounds. Subsequently orders have followed for additional motors for other tramways in Sydney.

The five thousandth locomotive, finished in April, 1880, presented some novel features. It was designed for fast passenger service on the Bound Brook line between Philadelphia and New York, and to run with a light train at a speed of sixty miles per hour, using anthracite coal as fuel. It had cylinders eighteen by twenty-four, one pair of driving wheels six and one-half feet in diameter, and a pair of trailing wheels forty-five inches in diameter, and equalized with the driving wheels. Back of the driving wheels and over the trailing wheels space was given for a wide firebox (eight feet long by seven feet wide inside) as required for anthracite coal. By an auxiliary steam cylinder placed under the waist of the boiler, just in front of the firebox, the bearings on the equalizing beams between trailing and driving wheels could be changed to a point forward of their normal position, so as to increase the weight on the driving wheels when required. The adhesion could thus be varied between the limits of thirty-five thousand to forty-five thousand pounds on the single pair of driving wheels. This feature of the locomotive was made the subject of a patent.

In 1881, a compressed air locomotive was constructed for the Pneumatic Tramway Engine Company, of New York, on plans prepared by Mr. Robert Hardie. Air tanks of steel, one-half inch thick, with a capacity of four hundred and sixty-five cubic feet, were combined with an upright cylindrical heater, thirty-two and five-eighths inches in diameter. The weight of the machine was thirty-five thousand pounds, of which twenty-eight thousand pounds were on four driving wheels, forty-two inches in diameter. The cylinders were twelve and one-half inches diameter by eighteen inches stroke. Another novelty of the year was a steam car to take the place of a hand car. Accompanying illustration shows the design. Its cylinders were four by ten inches, and wheels twenty-four inches diameter. Built for standard gauge track, its weight in working order was five thousand one hundred and ten pounds. Similar cars have since been constructed. During this year the largest single order placed on the books to that date was entered for the Mexican National Construction Company. It was for one hundred and fifty locomotives, but only a portion of them were ever built.

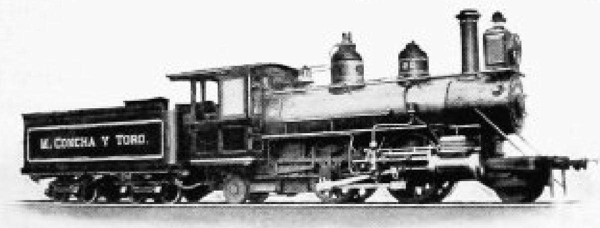
Steam Inspection Car

The year 1882 was marked by a demand for locomotives greater than could be met by the capacity of existing locomotive works. Orders for one thousand three hundred and twenty-one locomotives were entered on the books during the year, deliveries of the greater part being promised only in the following year. The six-thousandth locomotive was completed in January of this year, and the seven-thousandth in October, 1883.

Early in 1882, an inquiry was received from the Brazilian Government for locomotives for the Cantagallo Railway, which were required to meet the following conditions: to haul a train of forty gross tons of cars and lading up a grade of eight and three-tenths per cent. (four hundred and thirty-eight feet per mile), occurring in combination with curves of forty metres radius (one hundred and thirty-one feet radius, or forty-three and eight-tenths degrees). The line is laid with heavy steel rails, and the gauge is one and one-tenth metres, or three feet seven and one-third inches. The track upon which it was proposed to run these locomotives is a constant succession of reverse curves, it being stated that ninety-one curves of the radius named occur within a distance of three thousand four hundred and twenty-nine metres, or about two miles. The line had previously been operated on the "Fell" system, with central rack-rail, and it was proposed to introduce locomotives working by ordinary adhesion, utilizing the central rail for the application of brake power. An order was eventually received to proceed with the construction of three locomotives to do this work. The engines built were of the following general dimensions, viz.: cylinders, eighteen by twenty inches; six driving wheels, connected, thirty-nine inches in diameter; wheel base, nine feet six inches; boiler, fifty-four inches in diameter, with one hundred and ninety flues two inches diameter, ten feet nine inches long; and with side tanks, carried on the locomotive. In March, 1883, they were shipped from Philadelphia, and on a trial made October 17th, in the presence of the officials of the road and other prominent railway officers, the guaranteed performance was accomplished. One of the engines pulled a train weighing forty tons, composed of three freight cars loaded with sleepers, and one passenger car, and made the first distance of eight kilometres to Boca do Mato with a speed of twenty-four kilometres per hour; from there it started, making easily an acclivity of eight and five-tenths per cent. in grade, and against a curve of forty metres in radius. Eight additional locomotives for this line were constructed at intervals during the following ten years, and the road has been worked by locomotives with ordinary adhesion since their adoption as above described.

In 1885 a locomotive was built for the Dom Pedro Segundo Railway of Brazil, having five pairs of driving wheels connected, and a leading two-wheeled truck. From this has arisen the title "Decapod" (having ten feet) as applied to subsequent locomotives of this type. Its cylinders were twenty-two by twenty-six inches; driving wheels forty-five inches diameter, and grouped in a driving wheel base of seventeen feet. The rear flanged driving wheels, however, were given one-quarter of an inch more total play on the rails than the next adjacent pair; the second and third pairs were without flanges, and the front pair was flanged. The locomotive could therefore pass a curve of a radius as short as five hundred feet, the rails being spread one-half inch wider than the gauge of track, as is usual on curves. The flanges of the first and fourth pairs of driving wheels, making practically a rigid wheel base of twelve feet eight inches, determined the friction on a curve. The weight of the engine in working order, was one hundred and forty-one thousand pounds, of which one hundred and twenty-six thousand pounds were on the driving wheels. During this year the first rack-rail locomotive in the practice of these Works was constructed for the Ferro Principe do Grão Pará Railroad of Brazil. Its general dimensions were: cylinders, twelve by twenty inches; pitch line of cog wheel, forty-one and thirty-five one hundredths inches; weight, fifteen and seventy-four one-hundredths tons. Several similar locomotives, of different weights, have since been built for the same line.

At the close of this year Mr. Edward Longstreth withdrew from the firm on account of ill health, and a new partnership was formed, adding Messrs. William C. Stroud, William H. Morrow, and William L. Austin. Mr. Stroud had been connected with the business since 1867, first as bookkeeper and



Locomotive with Outside Frames

subsequently as Financial Manager. Mr. Morrow, since entering the service in 1871, had acquired a varied and valuable experience, first in the accounts, then in the department of extra work, and subsequently as Assistant Superintendent, becoming General Manager on Mr. Longstreth's retirement. Mr. Austin, who entered the Works in 1870, had for several years been assistant to Mr. Henszey in all matters connected with the designing of locomotives.

The eight-thousandth locomotive was completed in June, 1886. A locomotive for the Antofogasta Railway (thirty inches gauge) of Chili, constructed with outside frames, was completed in November, 1886, and is shown by illustration on page 77. The advantages of this method of construction of narrow gauge locomotives in certain cases were evidenced in the working of this machine, in giving a greater width of firebox between the frames, and a greater stability of the engine due to the outside journal bearings.

In 1887, a new form of boiler was brought out in some ten-wheeled locomotives constructed for the Denver and Rio Grande Railroad. A long wagon top was used, extending sufficiently forward of the crown sheet to allow the dome to be placed in front of the firebox and near the center of the boiler, and the crown sheet was supported by radial stays from the outside shell. Many boilers of this type have since been constructed.

Mr. Charles T. Parry who had been connected with the Works almost from their beginning, and a partner since 1867, died on July 18, 1887, after an illness of several months.

The first locomotives for Japan, were shipped in June, 1887, being two six-wheeled engines of three feet six inches gauge for the Mie Kie mines.

Mr. William H. Morrow, a partner since January 1, 1886, and who had been previously associated with the business since 1871, died February 19, 1888.

RACK LOCOMOTIVE, RIGGENBACH SYSTEM

The demand for steam motors for street railway service attained large proportions at this period, and ninety-five were built during the years 1888 and 1889. Two rack-rail locomotives on the Riggenbach system, one with a single cog-wheel and four carrying wheels, and weighing in working order thirty-two thousand pounds, for the Corcovado Railway, of Brazil, and the other having two cog-wheels and eight carrying wheels, and weighing in working order seventy-nine thousand pounds, for the Estrada de Ferro Principe do Grão Pará of Brazil, were constructed during this year. The general plans are shown on pages 78 and 79.

In October, 1889, the first compound locomotive in the practice of the Works was completed and placed on the Baltimore and Ohio Railroad. It was of the four-cylinder type, as designed and patented by Mr. S. M. Vauclain, who had been connected with the Works, since 1883, and its General Superintendent since February 11, 1886. The economy in fuel and water and the efficiency in both passenger and freight service given by this design led to its introduction on many leading railroads. Following the first four-cylinder compound locomotives built in 1889, three were built in 1890, eighty-two in 1891, two hundred and thirteen in 1892, one hundred and sixty in 1893, thirty in 1894, fifty-one in 1895, one hundred and seventy-three during 1896, eighty-six in 1897, two hundred and thirty-five in 1898, and two hundred and forty-one in 1899.

RACK LOCOMOTIVE WITH TWO COG-WHEELS

In 1889, a test case was made to see in how short a time a locomotive could be built. On Saturday, June 22d, Mr. Robert H. Coleman ordered a narrow gauge American type passenger locomotive and tender, which it was agreed should be ready for service on his railroad in Lebanon County, Pa., by the fourth of July following. The boiler material was at once ordered and was received Tuesday, June 25th. The boiler was completed and taken to the erecting shop on Friday, June 28th, and on Monday, July 1st, the machinery, frames, wheels, etc., were attached and the locomotive was tried under steam in the Works. The tender was completed the following day, Tuesday, July 2d, thus making the record of construction of a complete locomotive from the raw material in eight working days.

The manufacture of wrought iron wheel centers for both truck and driving wheels was begun at this time under patents of Mr. S. M. Vauclain, Nos. 462,605, 462,606, and 531,487.

In 1890, the first rack-rail locomotive on the Abt system was constructed for the Pike's Peak Railroad, and during this year and 1893, four locomotives were built for working the grades of that line, which vary from eight to twenty-five per cent. One of these locomotives, weighing in working order fifty-two thousand six hundred and eighty pounds, pushes twenty-five thousand pounds up the maximum grades of one in four. An illustration is here given of one of these locomotives, which is a four-cylinder Compound.

RACK LOCOMOTIVE, ABT SYSTEM

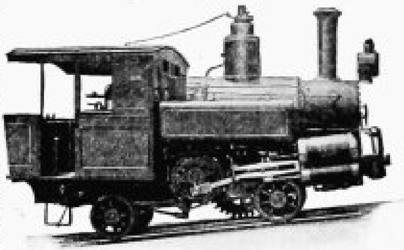
Three Mogul locomotives, of one metre gauge, fifteen by eighteen cylinders, driving wheels forty-one inches diameter, were completed and shipped in July, 1890, for working the Jaffa and Jerusalem Railway in Palestine, and two additional locomotives for the same line were constructed in 1892.

In 1891, the largest locomotives in the practice of the Works were designed and constructed for the St. Clair Tunnel of the Grand Trunk Railway, under the St. Clair River. Four tank locomotives were supplied, each with cylinders twenty-two by twenty-eight; five pairs of driving wheels connected, fifty inches diameter in a wheel base of eighteen feet five inches; boiler, seventy-four inches diameter; firebox, eleven feet long by three and one-half feet wide; and tanks on the boiler of twenty-one hundred and ten gallons capacity. The weight in working order of each engine was one hundred and eighty-six thousand eight hundred pounds without fire in firebox. The tunnel is six thousand feet long, with grades of two per cent. at each entrance, twenty-five hundred, and nineteen hundred and fifty feet long respectively. Each locomotive was required to take a train load of seven hundred and sixty tons exclusive of its own

"DECAPOD"

weight, and in actual operation each of these locomotives has hauled from twenty-five to thirty-three loaded cars in one train through the tunnel.

For the New York, Lake Erie and Western Railroad, five compound locomotives of the Decapod class were completed in December, 1891. Their general dimensions were as follows: cylinders, high-pressure sixteen inches, low-pressure twenty-seven inches diameter, stroke twenty-eight inches; five pairs of driving wheels coupled, fifty inches diameter, in a wheel base of eighteen feet ten inches; boiler, seventy-six inches diameter; three hundred and fifty-four tubes, two inches diameter, twelve feet long; firebox (Wootten type), eleven feet long, eight feet two inches wide inside; combustion chamber, thirty-six inches long; weight in working order, one hundred and ninety-five thousand pounds; weight on driving wheels one hundred and seventy-two thousand pounds; weight of eight-wheeled tender with fuel and four thousand five hundred gallons of water, eighty-nine thousand four hundred and twenty pounds. The first, fourth and fifth pairs of driving wheels were flanged, but the fifth pair had one-fourth inch additional play on the track. These locomotives were used as pushers on the Susquehanna Hill, where curves of five degrees are combined with grades of sixty feet per mile, doing the work of two ordinary Consolidation locomotives. From one thousand two hundred and fifty to one thousand three hundred net tons of cars and lading, making a train of forty-five loaded cars, were hauled by one of these locomotives in connection with a twenty by twenty-four cylinder Consolidation.



S. Ellero-Saltino (Vallombrosa)

Mr. William C. Stroud, who had been a partner since 1886, died on September 21, 1891.

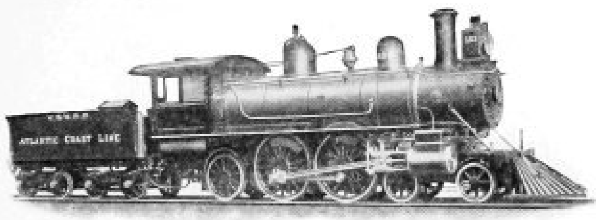
The first locomotives for Africa were constructed during this year. They were of the Mogul type, with cylinders eighteen by twenty-two inches, driving wheels forty-eight inches diameter, and for three feet six inches gauge.

The product of 1892 and 1893, included, as novelties, two rack-rail locomotives for a mountain railway near Florence, Italy, and twenty-five compound Forney locomotives for the South Side Elevated Railroad, of Chicago. At the World's Columbian Exposition in Chicago, May to October inclusive, an exhibit was made, consisting of seventeen locomotives, as follows:

STANDARD GAUGE.—A Decapod locomotive similar to those above described, built in 1891 for the New York, Lake Erie and Western Railroad. A high-speed locomotive of new type, with Vauclain compound cylinders, a two-wheeled leading truck, two pairs of driving wheels, and a pair of trailing wheels under the firebox. This locomotive was named "Columbia," and the same name has been applied to the type. An express passenger locomotive of the pattern used by the Central Railroad of New Jersey; one of the pattern used by the Philadelphia and Reading Railroad, and one of the pattern used by the Baltimore and Ohio Railroad. The three roads mentioned operate together the "Royal Blue Line" between New York and Washington. A saddle tank double-ender type locomotive with steam windlass illustrating typical logging locomotive practice. A single-expansion, cylinders eighteen by twenty-four inches, American type locomotive. A single-expansion, cylinders nineteen by twenty-four inches, Mogul locomotive. A single-expansion, cylinders twenty by twenty-four inches, ten-wheeled freight locomotive for the Baltimore and Ohio Southwestern Railroad. A compound ten-wheeled passenger locomotive shown in connection with a train exhibited by the Pullman Palace Car Company. A compound Consolidation locomotive for the Norfolk and Western Railroad. Three locomotives were shown in connection with the special exhibit of the Baltimore and Ohio Railroad, viz.: one compound, one single-expansion, and one ten-wheeled passenger locomotive.

NARROW GAUGE.—A one metre gauge compound American type locomotive; a three feet gauge ten-wheeled compound locomotive, with outside frames, for the Mexican National Railroad; and a thirty inch gauge saddle tank locomotive for mill or furnace work.

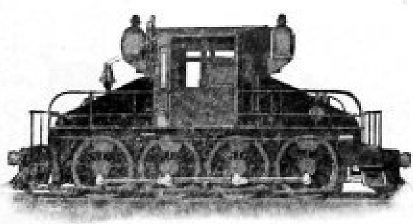
The depression of business which began in the summer of 1893, reduced the output of the Works for that year to seven hundred and seventy-two, and in 1894, to three hundred and thirteen locomotives. Early in 1895, a new type of passenger locomotive was brought out, illustrated by annexed cut. To this the name Atlantic type was given. The advantages found in this design are a large boiler, fitting the engine for high speed; a firebox of liberal proportions and of desirable form placed over the rear frames, but of ample depth and width; and the location of the driving wheels in front of the firebox, allowing the boiler to be placed lower than in the ordinary American and ten-wheeled types.



Atlantic Type

For the enginemen, who in this class of locomotive, ride behind, instead of over the driving wheels, greater ease in riding, and greater safety in case of the breakage of a side rod, are important advantages.

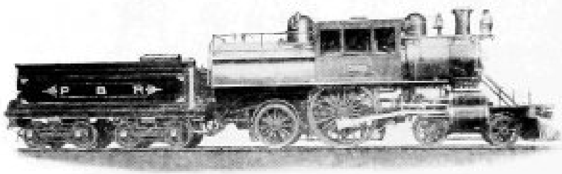
The first electric locomotive was constructed in 1895 and was intended for experimental work for account of the North American Company. The electrical parts were designed by Messrs. Sprague, Duncan & Hutchison, Electrical Engineers, New York. Two other electric locomotives for use in connection with mining operations were built in 1896, in co-operation with the Westinghouse Electric and Manufacturing Company, which supplied the electrical parts.



Electric Locomotive

A high-speed passenger locomotive, embracing several novel features, was built in 1895, for service on the New York division of the Philadelphia and Reading Railroad. The boiler was of the Wootten type, the cylinders were compound, thirteen and twenty-two by twenty-six, and the driving wheels (one pair) were eighty-four and one-quarter inches diameter. The cut below shows the general design.

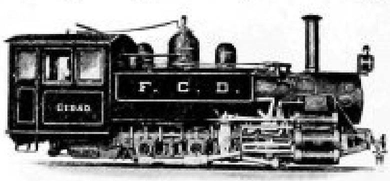
The weight of the engine in working order was as follows: On front truck, thirty-nine thousand pounds; on trailing wheels, twenty-eight thousand pounds; on the driving wheels, forty-eight thousand pounds. This locomotive and a duplicate built



High-Speed Locomotive

in the following year were regularly used in passenger service, hauling five cars and making the distance between Jersey City and Philadelphia, ninety miles, in one hundred and five minutes, including six stops.

In July, 1895, for the San Domingo Improvement Company, a combination rack and adhesion locomotive was constructed, having compound cylinders eight inches and thirteen inches diameter by eighteen inches stroke to operate two pairs of coupled adhesion wheels, and a pair of single-expansion cylinders, eleven inches by eighteen inches, to operate a single rack-wheel constructed upon the Abt system.



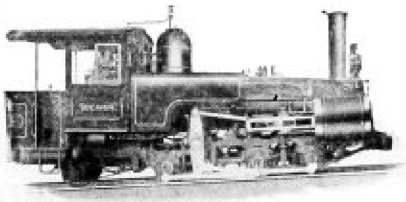
Combination Rack and Adhesion Locomotive

This locomotive was furnished with two complete sets of machinery, entirely independent of each other, and was built with the view eventually to remove the rack attachments and operate the locomotive by adhesion alone.

During the years 1895 and 1896, contracts were executed for several railroads in Russia, aggregating one hundred and thirty-eight locomotives of the four-cylinder compound type.

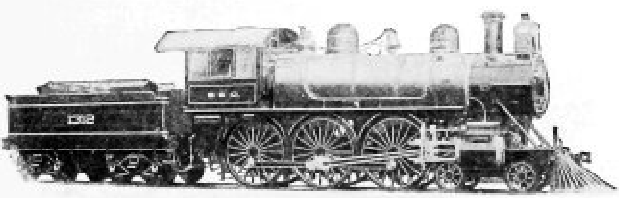
On January 1, 1896, Samuel M. Vauclain, Alba B. Johnson, and George Burnham, Jr., were admitted to partnership.

Two combination rack and adhesion locomotives, for the Peñoles Mining Company, of Mexico, were built in 1896, having compound cylinders nine and one-half and fifteen inches diameter by twenty-two inches stroke, 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 rear wheels are loose on the axle, and act only as carrying wheels. All three coupled axles carry rack pinions of the Abt system. The two pairs of adhesion wheels are thrown into operation by means of the clutches.



Combinat.on Rack and Adhesion Locomotive

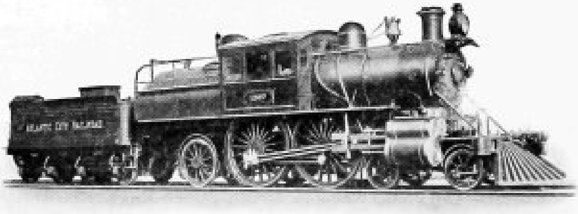
In the latter part of the year 1896, six locomotives were built for the Baltimore and Ohio Railroad for express passenger service. One of these locomotives, No. 1312, is here illustrated. They are the ten-wheeled type, with cylinders twenty-one by



Ten-Wheeled Locomotive
For Baltimore and Ohio Railroad

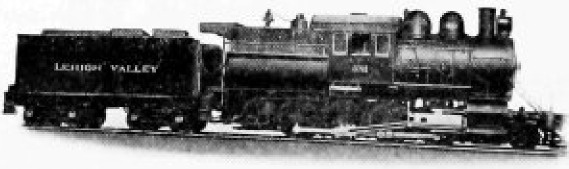
twenty-six inches, driving wheels seventy-eight inches diameter, and weigh, each, in working order, about one hundred and forty-five thousand pounds, about one hundred and thirteen thousand pounds of which are on the driving wheels. These locomotives have handled with great efficiency, the fast passenger trains on the Baltimore and Ohio Railroad running between Philadelphia, Baltimore and Washington.

In the summer of 1897, the Reading Railway placed a fast train on its Atlantic City Division, allowing fifty-two minutes for running time from Camden to Atlantic City, a distance of fifty-five and one-half miles, making the average rate of speed sixty-four miles per hour. The trains averaged five and six cars, having a total weight of about two hundred tons, not including



ATLANTIC TYPE LOCOMOTIVE
For Philadelphia and Reading Railway

the engine and tender. This train was hauled by a locomotive of the Atlantic type, having Vauclain compound cylinders thirteen and twenty-two inches in diameter by twenty-six inches stroke, with driving wheels eighty-four and one-quarter inches, and weighing, in working order on driving wheels,



CONSOLIDATION LOCOMOTIVE
For Lehigh Valley Railroad

seventy-eight thousand six hundred pounds, the total weight of engine and tender complete being two hundred and twenty-seven thousand pounds. The records show that for fifty-two days from July 2d to August 31, 1897, the average time consumed on the run was forty-eight minutes, equivalent to a uniform rate of speed from start to stop of sixty-nine miles per hour. On one occasion the distance was covered in forty-six and one-half minutes an average of seventy-one and six-tenths miles per hour. The service proved so popular that additional trains, making equally high speed, were subsequently established.

In 1898, the first cast steel frames used by the Baldwin Locomotive Works were applied to a consignment of Consolidation locomotives built for the Atchison, Topeka and Santa Fe Railway Company.

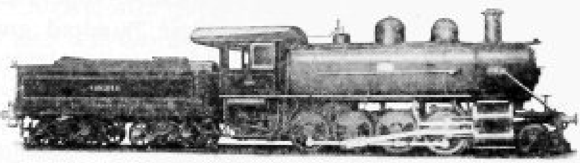
In November, 1898, a locomotive was built for the Lehigh Valley Railroad for use on the mountain cut-off between Coxton and Fairview, near Wilkesbarre. This locomotive was of the Consolidation type, with Vauclain compound cylinders, and of the general dimensions following: cylinders, eighteen and thirty inches diameter, thirty inches stroke; driving wheels, fifty-five inches outside diameter; boiler, Wootten type, eighty inches diameter at smallest ring, with a total heating surface of four thousand one hundred and five square feet; weight, in working order, on drivers, two hundred and two thousand two hundred and thirty-two pounds; weight, total engine, two hundred and twenty-six thousand pounds; tank capacity seven thousand gallons; weight of engine and tender about three hundred and forty-six thousand pounds. This locomotive was guaranteed to haul a load of one thousand net tons exclusive of the weight of the engine and tender, on a grade of sixty-six feet per mile, at an average speed of seventeen miles per hour. It fulfilled this guarantee and fourteen similar locomotives were subsequently ordered by this company.

Atlantic Type Locomotive
For Chicago, Burlington and Quincy Railroad

In March, 1899, two locomotives were built for the Chicago, Burlington and Quincy Railroad, for the fast mail service west of Chicago. These were of the Atlantic type with Vauclain compound cylinders, thirteen and one-half and twenty-three inches in diameter, and twenty-six inches stroke; driving wheels eighty-four and one-quarter inches in diameter; weight, in working order, eighty-five thousand eight hundred and fifty pounds on driving wheels, and one hundred and fifty-nine thousand pounds total of engine. The total weight of engine and tender complete was about two hundred and fifty-four thousand pounds.

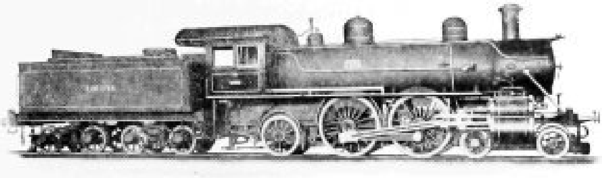
Dr. Edward H. Williams, who had been connected with the Works as a partner since 1870, died December 21, 1899, at Santa Barbara, California.

The year 1899, was marked by a large increase in foreign business, notably in England and France. Contracts were made in England covering thirty locomotives for the Midland Railway, wenty locomotives for the Great Northern Railway, and twenty ocomotives for the Great Central Railway. Ten locomotives were also ordered by the French State Railways, and ten by the Bone Guelma Railway, in the French colonies of Algiers.



Compound Consolidation Locomotive
For the Bavarian State Railways

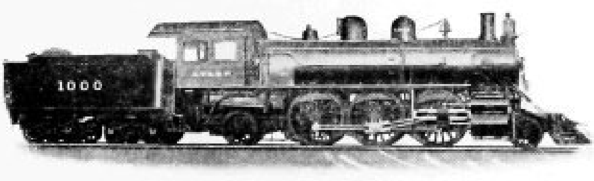
In the fall of this year two Vauclain compound Consolidation freight locomotives were built for the Bavarian State Railways. These were ordered as samples, the company practically announcing its intention of modeling future locomotives for their freight traffic after these engines. So well did these sample locomotives perform, that in the following year, the management decided to order two passenger engines of the compound Atlantic type, and also embody in their passenger rolling stock the new features contained in these machines.



COMPOUND ATLANTIC TYPE LOCOMOTIVE
For the Bavarian State Railways

The Baldwin Locomotive Works exhibited two locomotives at the Paris Exposition of 1900—a "Goods" locomotive, Mogul type, for the Great Northern Railway, of England, and an Atlantic type passenger locomotive for the French State Railways. The exhibit of the French State Railways also included a compound American type passenger locomotive built by the Baldwin Locomotive Works. These engines were built in the regular course of business for the companies whose names they bore, and went into service on these roads immediately after the exposition was over. In this year also large orders were filled for the Chinese Eastern Railroad, the Paris-Orleans Railway, the Finland State, the Egyptian State and the Belgian State Railways.

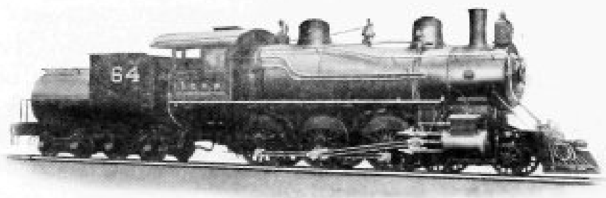
The beginning of the twentieth century witnessed great industrial prosperity in America and large demands for railway freight transportation. The introduction of cars of large



COMPOUND PRAIRIE TYPE LOCOMOTIVE
For the Atchison, Topeka & Santa Fe Railway

capacity became general on American railroads, a tendency which had been gradually developing for some years. This involved increased train tonnage, improved road beds, heavier rails, stronger bridges, and more powerful locomotives. The locomotive has always reflected the changes in railroad practice. Just as the demand for increased horse power, involving greater steaming capacity and a larger grate area, evolved the Atlantic type engine from the American or eight-wheeled passenger engine; so in order to secure a locomotive with ample heating surface and suitable firebox to handle heavy trains at high speed, the Prairie type was designed, being a logical development from the Mogul and ten-wheeled engines. The Prairie type engine has a leading pony truck, three pairs of driving wheels, and a wide firebox extending over the frames and placed back of the driving wheels. To support this overhanging weight, a pair of trailing wheels is placed underneath the firebox. Fifty locomotives of this type were built for the Chicago, Burlington and Quincy Railroad, and forty-five for the Atchison, Topeka and Santa Fe Railway, in 1901.

At the Pan-American Exposition, held at Buffalo, N. Y., during this year, a new departure in locomotive practice was exhibited by the Baldwin Locomotive Works. This was a ten-wheeled locomotive, built for the Illinois Central Rail-



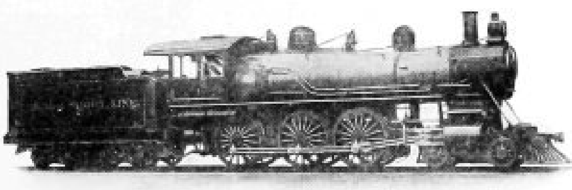
TEN-WHEELED LOCOMOTIVE
With Vanderbilt Boiler and Tender

road, the firebox and tender of which were of special construction, embodying the inventions of Mr. Cornelius Vanderbilt, M. E. This construction is briefly as follows:

The firebox is cylindrical in form, with annular corrugations, its axis eccentric to that of the boiler. It is suspended at the rear, where it is riveted to the back head of the boiler, and is supported at the bottom by the mud rings—otherwise the firebox is entirely disconnected from the outer shell, thus eliminating stay bolts and crown bars, necessary to flat surfaces in usual construction. The ease with which the firebox can be removed and the absence of the usual repairs incidental to the renewal of stay bolts commend it. The feature of the tender was a cylindrical nstead of the ordinary U-shaped tank placed back of the coal space, the advantage being a better distribution of the weight in the tender, a smaller proportion of dead weight to carrying capacity and a more economical construction.

The year 1901, was especially noticeable for the large volume of domestic business handled, there being great demand for motive power from the railroads of the West and Southwest. Large orders were placed with the Baldwin Locomotive Works in this year by the Union Pacific; Chicago, Burlington and Quincy; Choctaw, Oklahoma and Gulf; Toledo, St. Louis and Western; Atchison, Topeka and Santa Fe; Chicago and Alton; Missouri, Kansas and Texas; Chicago, Milwaukee and St. Paul, and Southern Pacific Railroads. The Pennsylvania Railroad in this year, ordered over one hundred and fifty locomotives of various types from the Baldwin Locomotive Works, and the Baltimore and Ohio Railroad also placed an order for over one hundred locomotives.

In 1901, one thousand three hundred and seventy-five locomotives were built, of which five hundred and twenty-six were

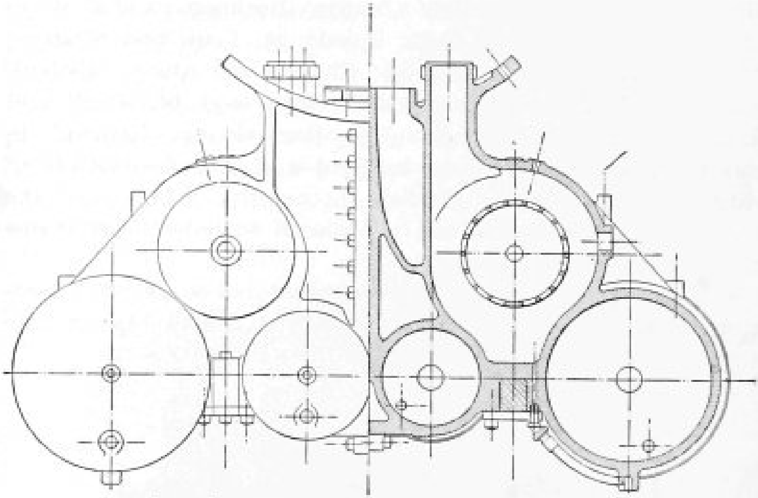


BALANCED COMPOUND LOCOMOTIVE

compounds, six compressed air and forty-five electric. Two hundred and eight locomotives, or fifteen and twelve one-hundredths per cent. of the total product, were exported. The average number of men employed per week for the whole year was nine thousand five hundred and ninety-five.

The month of February, 1902, witnessed the completion of the twenty-thousandth locomotive built by the Baldwin Locomotive Works. This engine embodied several interesting features, chief among which were the compound cylinders with which the locomotive was equipped. These were of the Vauclain system, but with a new arrangement, as follows:

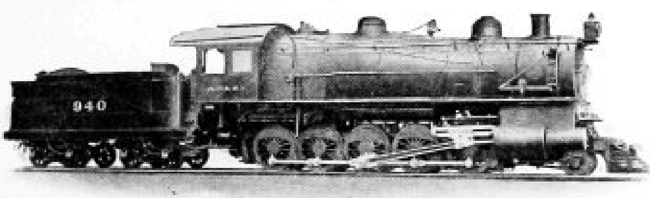
The cylinders are four in number, two high-pressure and two low-pressure. The axes of the four cylinders are parallel and in the same horizontal plane. The low-pressure cylinders lie outside the frame and the high-pressure cylinders lie inside the frame on each side of the locomotive. A valve of the balanced piston type controls the passage of steam to each pair



Cross Section of Balanced Compound Cylinders

of cylinders, and admits steam to the high and low-pressure cylinders in such a manner that the high and low-pressure crossheads work in opposite directions, starting their stroke at opposite ends of the guides. Each cylinder has a separate piston, and each of the four pistons is connected with a separate crosshead working in separate parallel guides. The low-pressure crossheads and guides on each side of the locomotive are located outside the frames, and the crosshead is connected to the main driving wheels (which in this locomotive, are the front wheels). In addition, the main axle has two cranks, set at right angles to each other, one on each side of the center of the locomotive; and each crank is coupled to a crosshead of one of the high-pressure pistons. The crank on the axle and the crank pin in the wheel for the corresponding high and low-pressure cylinders are set at an angle of one hundred and eighty degrees. The two axle cranks are set at an angle of ninety degrees. The result is that as the reciprocating weights on the same side of the locomotive oppose one another in movement, their disturbing effects are neutralized. The perfection of balance secured by the crank axle and crank pins connected with pistons traveling in opposite directions, gives a machine allowing the maximum load on driving wheels without detriment to the track, there being no unbalanced rotating weight in the wheels tending either to lift the wheel or exert additional weight on the rail. The combination of a large boiler, with the improved balance obtained by this method of arranging the working gear, makes a locomotive well adapted for high speed with heavy passenger trains.

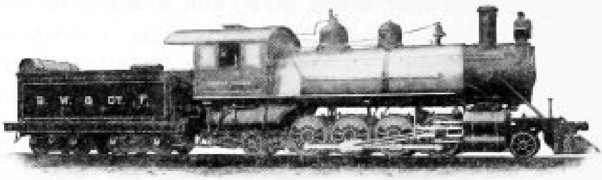
The construction of the twenty-thousandth locomotive and the completion of seventy years of continuous operation were celebrated on the evening of February 27, 1902, at the Union League, of Philadelphia, by a banquet at which two hundred and fifty guests, including many of the most representative men in the United States were present.



Decapod Type Locomotive
For the Atchison, Topeka & Santa Fe Railway

In May, 1902, a Decapod locomotive was built for the Atchison, Topeka and Santa Fe Railway. This was the first tandem compound in the experience of the Works and the heaviest locomotive built up to that time. The total weight of the engine alone was two hundred and sixty-seven thousand eight hundred pounds, of which two hundred and thirty-seven thousand eight hundred pounds were on the five pairs of driving wheels. It was designed for heavy freight hauling on the steep grades encountered on one section of this road.

A locomotive built for the Bismarck, Washburn and Great Falls Railway (four feet eight and one-half inches gauge) in the same year, established a type which has assumed a permanent place in locomotive practice. The requirement covered a powerful locomotive with a firebox of large capacity and ample grate area for burning inferior coal or lignite. To meet these conditions a firebox, back of eight coupled wheels and over a trailing truck was provided. The illustration herewith shows the design. Some locomotives of similar plan having previously been constructed for the Japan Railway Company, the name Mikado type was adopted for the class.



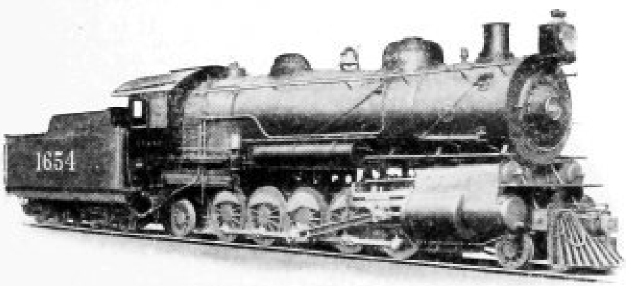
MIKADO TYPE LOCOMOTIVE
For the Bismarck, Washburn & Great Falls Railway

AMERICAN TYPE OIL-BURNING LOCOMOTIVE

The discovery of large quantities of crude petroleum in "gushers" located in the Beaumont oil fields, of Texas, caused the railroads tapping this field to adopt, to some extent, this fuel on their locomotives. Oil-burning locomotives were built for the Atchison, Topeka and Santa Fe, the Southern Pacific, and the Galveston, Houston and Henderson Railroads, in 1902.

With the increased use of electrically driven trains for inter-urban, elevated and subway traffic, many orders were received for electric motor trucks in this year. Electrical locomotives, both for surface and mine haulage, showed a marked increase in this year also, both in variety of design and the number constructed.

In the year 1903, the Baldwin LocomotiveW orks completed two thousand and twenty-two locomotives, its largest annual output up to that time. Among these were four four-cylinder balanced compound Atlantic type locomotives for the Atchison, Topeka and Santa Fe Railway, which proved highly successful. The same road received twenty-six single-expansion Pacific type locomotives for heavy passenger service, and also a consignment of tandem compound locomotives for freight service. These



TANDEM COMPOUND SANTA FE TYPE LOCOMOTIVE
For the Atchison, Topeka & Santa Fe Railway

engines were similar to the Decapod locomotive previously described, except that a trailing truck was added. This improved the curving qualities of the engines, when running backward. These locomotives were at the time the heaviest in the experience of the Works. They have a total weight of two hundred and eighty-seven thousand two hundred and forty pounds, exclusive of the tender, and a weight on driving wheels of two hundred and thirty-four thousand five hundred and eighty pounds. One of them is illustrated on page 95.

During the year 1903, standard locomotive designs were prepared at these Works for the "Associated Lines," which comprise the Southern Pacific Company, Union Pacific Railroad, Oregon Short Line Railroad, Oregon Railroad and Navigation Company, and the Chicago and Alton Railway. As the various lines were already equipped with sufficient light power, only heavy designs for common standards were adopted. Six such designs were prepared: an Atlantic and a Pacific type locomotive for passenger service, a light and a heavy Consolidation engine for freight service, a Mogul locomotive for fast freight, and a six-wheeled switcher.

Owing to the rapid increase in the production of the Works, additional erecting facilities were required; and in 1903 a new erecting shop, arranged on a novel plan, was completed at Twenty-sixth Street and Pennsylvania Avenue. This shop is built in the form of a roundhouse, having twenty-seven stalls, with an eighty foot turn-table in the center. It is equipped with radial electric traveling cranes, which operate on a circular runway. Each stall is provided with a pit, and there is a complete system of smoke ducts for carrying off the smoke from engines which are under steam. This shop is used principally for finishing and testing purposes.

In 1904, there was a temporary falling off in production, one thousand four hundred and eighty-five locomotives being completed during that year. At the Louisiana Purchase Exposition, held at St. Louis, from May to November of this year, the Baldwin Locomotive Works exhibited the following locomotives:

Standard Gauge.—A balanced compound Atlantic type locomotive, for the Atchison, Topeka and Santa Fe Railway. (Illustrated on page 97).

A four-cylinder compound Atlantic type locomotive for the Chicago, Burlington and Quincy Railroad. (This engine had been built two years previously, and was withdrawn from service to be placed on exhibition).

A tandem compound Santa Fe type locomotive for the Atchison, Topeka and Santa Fe Railway.

BALANCED COMPOUND ATLANTIC TYPE LOCOMOTIVE
For the Atchison, Topeka & Santa Fe Railway

A "common standard" Atlantic type locomotive for the Chicago and Alton Railway.

A "common standard" Pacific type locomotive for the Union Pacific Railroad.

A Pacific type locomotive for the St. Louis and San Francisco Railroad.

A two-cylinder compound Consolidation type locomotive for the Norfolk and Western Railway.

A single-expansion Consolidation type locomotive for the Norfolk and Western Railway.

A ten-wheeled locomotive for the Norfolk and Western Railway.

An Atlantic type locomotive for the Norfolk and Western Railway.

A Consolidation type locomotive with Wootten firebox, for the Delaware, Lackawanna and Western Railroad.

A Mogul type locomotive for the Missouri, Kansas and Texas Railway.

A "common standard" Consolidation type locomotive for the Southern Pacific Company.

NARROW GAUGE.—An electric mining locomotive for the Norfolk Coal and Coke Company. (Gauge three feet six inches.)

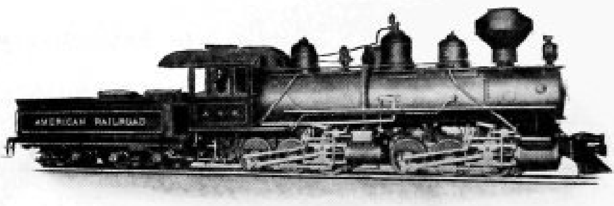
An electric mining locomotive for the Berwind-White Coal Mining Company. (Gauge three feet).

An electric locomotive for industrial haulage. (Gauge two feet).

There were also shown four examples of electric trucks, which were designed for standard gauge track.

The electric locomotives and trucks were exhibited in the Palace of Electricity in conjunction with the Westinghouse Electric and Manufacturing Company, which furnished the electrical equipment.

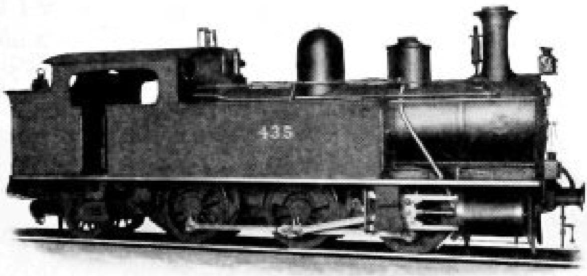
During this year three Mallet compound articulated locomotives, designed for metre gauge were built for the American Railroad of Porto Rico. One of these engines is illustrated herewith.



MALLET COMPOUND ARTICULATED LOCOMOTIVE
For the American Railroad of Porto Rico

There are three pairs of driving wheels, thirty-seven inches in diameter, in each group. The cylinders are twelve and one-half and nineteen inches in diameter by twenty inches stroke. The boiler is fifty-four inches in diameter and carries a steam pressure of two hundred pounds per square inch. The rigid wheel base is six feet ten inches, and the total wheel base is twenty feet four inches. The total weight of the locomotive is one hundred and six thousand six hundred and fifty pounds, and the tractive power is twenty-two thousand five hundred pounds working compound.

Among other interesting locomotives exported during 1904, may be mentioned sixteen tank engines for the Imperial Government Railways of Japan. These engines have three pairs of driving wheels and a two-wheeled rear truck. They are constructed with plate frames, which are suspended directly on the springs without the intervention of equalizing beams. The steam chests are placed between the frames and the slide valves



SIX COUPLED TANK LOCOMOTIVE
For the Imperial Government Railways of Japan

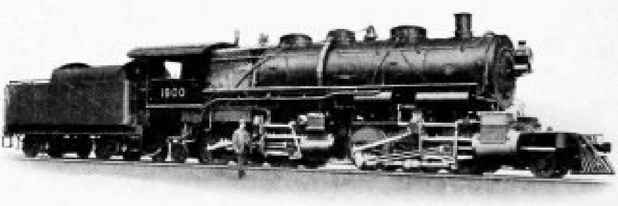
driven by direct motion. The cylinders are sixteen inches in diameter by twenty-four inches stroke, and the driving wheels are forty-nine inches in diameter. The boiler has a copper fire-box and brass tubes, and carries a steam pressure of one hundred and sixty pounds per square inch. The water supply is carried in two side tanks and one rear tank. The total weight of the engine is one hundred and two thousand pounds, of which the driving wheels carry eighty-two thousand seven hundred pounds. One hundred and fifty additional locomotives of the same type were subsequently ordered.

Toward the close of the year 1904, the output began to increase, and in 1905, two thousand two hundred and fifty locomotives were turned out. Among these were five hundred and seventy-two engines for the Pennsylvania Railroad System, including the lines east and west of Pittsburg. One hundred and sixty of these locomotives, all of the Consolidation type, were completed between October 10th and November 22d. This year witnessed the introduction of the Walschaerts valve motion on several American railroads. It was applied to a large number of the Pennsylvania Railroad engines above referred to, and also to thirty-eight ten-wheeled locomotives for the Chicago, Rock Island and Pacific Railway.

Among the locomotives exported during the year 1905, may be mentioned twenty of the ten-wheeled type, built for the New South Wales Government Railways. These engines were built to the railway company's drawings and specifications. A large number of special features, including plate frames, and the Allen valve motion, entered into their construction. One hundred and fifty tank locomotives, similar to those constructed in 1904, were built for the Imperial Government Railways of Japan.

During the year 1905, four balanced compound Pacific type locomotives, built to Associated Lines standards, were supplied to the Oregon Railroad and Navigation Company; and thirty locomotives of the same type were built for the Atchison, Topeka and Santa Fe Railway Company. These engines were assigned to divisions having heavy grades, and were followed in 1906 by eleven more of the same type, all of which were supplied to the Santa Fe System.

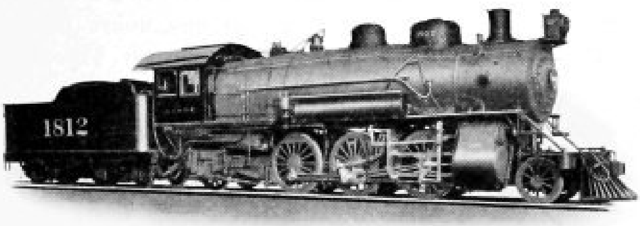
The year 1906, witnessed another increase in production, and two thousand six hundred and sixty-six locomotives were completed, the largest number thus far in the experience of the Works. This number included two hundred and three electric locomotives, while a total of two hundred and ninety-two engines were exported. The largest electric locomotives were furnished to the New York, New Haven and Hartford Railroad Company, for the purpose of replacing steam locomotives in the vicinity of New York City. Each of these locomotives is mounted on two four-wheeled trucks, and is equipped with four single phase alternating current motors, which rotate the axles without intermediate gearing. The nominal capacity of each unit is one thousand horse power.



Mallet Compound Articulated Locomotive
For the Great Northern Railway

The heaviest locomotives in the experience of these Works, were built during 1906 for the Great Northern Railway. These engines, five of which were constructed, are of the Mallet articulated type. They are carried on six pairs of driving wheels divided into two groups, and a two-wheeled truck front and back. The cylinders are twenty-one and one-half and thirty-three inches in diameter by thirty-two inches stroke. With a boiler pressure of two hundred pounds, and fifty-five inch driving wheels, the tractive power is seventy-one thousand seven hundred pounds. The boiler is of the Belpaire type, eighty-four inches in diameter. The total weight of the engine is three hundred and fifty-five thousand pounds, of which three hundred and sixteen thousand pounds are carried on the driving wheels. One of these locomotives is illustrated on opposite page.

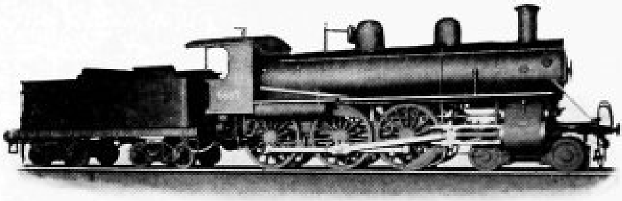
During this year an order was also received for fifty-seven balanced compound Prairie type locomotives for the Atchison, Topeka and Santa Fe Railway. These engines have inside high-pressure cylinders, which are inclined at an angle of seven degrees, in order that their main rods may clear the



Balanced Compound Prairie Type Locomotive
For the Atchison, Topeka & Santa Fe Railway

first driving axle. The second pair of driving wheels is the main pair. The cylinders are seventeen and one-half and twenty-nine inches in diameter by twenty-eight inches stroke. The driving wheels are sixty-nine inches in diameter, and the steam pressure is two hundred and twenty-five pounds per square inch. The total weight in working order is two hundred and forty-eight thousand two hundred pounds, of which the driving wheels carry one hundred and seventy-four thousand seven hundred pounds. The engines were designed for fast freight service. One of them is illustrated on page 101.

Among the important foreign orders filled during the year 1906, may be mentioned one from the Italian Government Railways for twenty locomotives. The number was equally divided between balanced compound ten-wheeled locomotives for passenger service, and single-expansion Consolidation locomotives for freight service. One of the passenger locomotives is illustrated herewith.



Balanced Compound Ten-Wheeled Locomotive
For the Italian Government Railways

Owing to the increasing demand for electric trucks, a new shop equipped with the most approved machinery for turning out this class of work, was built early in 1906. This shop has a capacity of one hundred trucks per week.

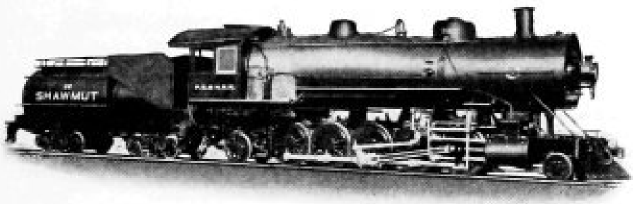
During the same year, a tract of one hundred and eighty-four acres was purchased at Eddystone, Pa., about twelve miles from the city, where extensive foundries and blacksmith shops were erected. The removal of these shops from the Philadelphia plant, allowed room for additional machine and erecting shops. The old foundry at Philadelphia was rebuilt as an erecting shop, which is specially equipped for erecting and packing foreign locomotives.

A life size bronze statue of Matthias W. Baldwin was unveiled on June 2, 1906, and presented by the Baldwin Locomotive Works to the Park Commission of the City of Philadelphia. This statue occupies a prominent position in front of the main office.

On December 31, 1906, Mr. George Burnham, Jr., who had been a member of the firm since 1896, retired from the partnership.

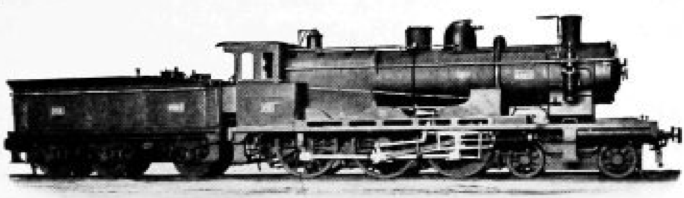
On January 29, 1907, fire partially destroyed the shop building located at the southeast corner of Fifteenth and Spring Garden Streets. The several departments affected were at once moved into other quarters, and work was continued with but little delay.

In February 1907, the thirty-thousandth locomotive was completed. This engine is of the "Santa Fe" type, having single-expansion cylinders and a smokebox superheater. It was built for the Pittsburg, Shawmut and Northern Railroad Company, and is illustrated herewith.



Santa Fe Type Locomotive
For the Pittsburg, Shawmut and Northern Railroad

In May and June, 1907, twenty balanced compound locomotives of the ten-wheeled type were completed for the Paris-Orleans Railway of France. The compound features were arranged on the de Glehn system, and the engines were built throughout to drawings and specifications furnished by the railway company. All measurements were made on the metric system, this being the first instance in the experience of the Works where metric standards were used exclusively in the construction of a locomotive. An illustration of one of these engines is presented herewith.



Balanced Compound Locomotive
For the Paris-Orleans Railway of France

During this same year, two steam inspection cars and twenty Consolidation type locomotives were built for the South Manchurian Railways. All these locomotives are of standard gauge. The Consolidation engines have cylinders twenty-one inches in diameter by twenty-eight inches stroke, and driving wheels fifty-four inches in diameter. The weight in working order is one hundred and sixty-nine thousand and one hundred pounds, of which the driving wheels carry one hundred and forty-eight thousand and eight hundred pounds.

The production during the years 1872–1907 was as follows:

	Locomotives		Locomotives		Locomotives		Locomotives
1872	422	1881	554	1890	946	1899	901
1873	437	1882	563	1891	899	1900	1217
1874	162	1883	557	1892	731	1901	1375
1875	130	1884	429	1893	772	1902	1533
1876	232	1885	242	1894	313	1903	2022
1877	185	1886	550	1895	401	1904	1485
1878	292	1887	653	1896	547	1905	2250
1879	398	1888	737	1897	501	1906	2666
1880	577	1889	827	1898	755	1907	2663

The following figures are interesting as indicating the growth of the Works:

Works established 1831

1,000th	locomotive	built,	1861	17,000th	locomotive	built,	1899
2,000th	"	"	1869	18,000th	"	"	1900
3,000th	"	"	1872	19,000th	"	"	1901
4,000th	"	"	1876	20,000th	"	"	1902
5,000th	"	"	1880	21,000th	"	"	1902
6,000th	"	"	1882	22,000th	"	"	1903
7,000th	"	"	1883	23,000th	"	"	1903
8,000th	"	"	1886	24,000th	"	"	1904
9,000th	"	"	1888	25,000th	"	"	1905
10,000th	"	"	1889	26,000th	"	"	1905
11,000th	"	"	1890	27,000th	"	"	1905
12,000th	"	"	1891	28,000th	"	"	1906
13,000th	"	"	1892	29,000th	"	"	1906
14,000th	"	"	1894	30,000th	"	"	1907
15,000th	"	"	1896	31,000th	"	"	1907
16,000th	"	"	1898	32,000th	"	"	1907

It will be seen from the foregoing, that while thirty years were occupied in building the first one thousand locomotives, more than two and one-half times as many were built in the single year of 1907.

The present organization based upon an annual capacity of two thousand five hundred locomotives, is as follows:

Number of men employed		19,000
Hours of labor per man per day		10
Principal departments run continuously, hours per day		23
Horse power employed	Steam engines	12,138
	Oil engines	4,850
Number of buildings comprised in the Works		47
Acreage comprised in the Works	Philadelphia	17.8
	Eddystone	184.0
Acreage of floor space comprised in buildings		63.2
Number of dynamos for furnishing light, arc		16
Number of dynamos for furnishing light, incandescent		7
Horse power of electric motors employed for power transmission, aggregate		14,200
Number of electric lamps in service, incandescent		7,000
Number of electric lamps in service, arc		951
Number of electric motors in service		1,115
Consumption of coal in net tons, per week, about		3,000
" of iron, in net tons, per week, about		5,000
" of other materials, in net tons, per week, about		1,460

The location of the Works, in the largest American manufacturing city, gives special facilities and advantages. Proximity to the principal coal and iron regions of the country renders all required materials promptly available. A large permanent population of skilled mechanics, employed in similar branches in other Philadelphia workshops, gives an abundant force of expert workmen from which to draw, when necessary. All parts of locomotives and tenders, except the boiler and tank plates, chilled wheels, boiler tubes and special patented appliances, are made in the main or adjunct works from the raw materials.

Preface to Catalogue

THE following pages present and illustrate a series of locomotives for both standard and narrow gauge, which it is believed include suitable designs for all ordinary requirements of service.

These patterns admit of modifications to suit the preferences of railroad managers, and where locomotives of peculiar construction for special service are required, designs will be prepared and submitted or locomotives built to specifications furnished.

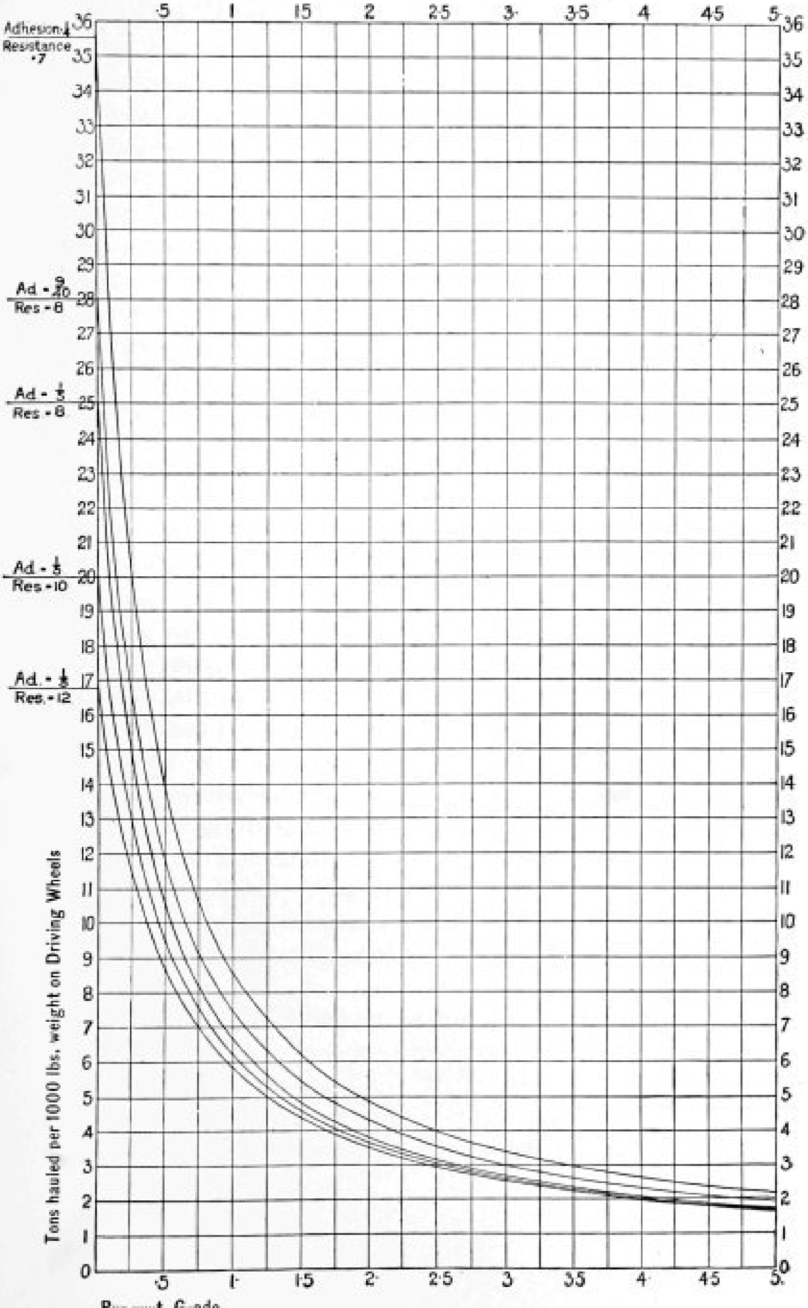
The locomotives herewith presented are adapted to the consumption of wood, coke, or bituminous coal as fuel. By making the necessary changes any of these designs can be arranged to burn petroleum.

By the system of manufacture employed, all important parts are accurately made to gauges and templets; they are therefore interchangeable throughout any number of locomotives of the same class. This system permits of any parts needed for repairs being supplied either with the locomotive or whenever subsequently required. Such parts are made to the same gauges and templets which were originally used in the construction of the locomotive, and in this manner the expense of repairs is reduced to a minimum and the maintenance of locomotive power is attended with the least possible inconvenience and delay. It is only necessary to give the construction number of the locomotive and describe the part which is required, and it can be furnished from the Works at the shortest notice, guaranteed to fit in place.

Particulars are given of the hauling capacity of the various classes illustrated, based upon actual work done. The basis of these calculations is a factor of adhesion of nine-fortieths (or say two hundred and twenty-five thousandths) of the weight on driving wheels, whilst the maximum mean effective pressure on pistons at slow speed is taken at eighty-five per cent. of the normal boiler pressure. It is assumed that the frictional resistance of the cars hauled will not exceed eight pounds per ton of 2240 pounds. These conditions are taken as those prevailing under ordinarily

Hauling Capacity in tons (of 2240 lbs.) for each 1000 lbs. on Driving Wheels

The weight of the locomotive is included in the load, slow speed and straight tracks are assumed



favorable conditions, with track and cars in good order, and exclusive of the resistance of curves. Allowance for the latter may be made by considering each degree of curvature as equivalent to the resistance of a straight grade of one and one-half feet per mile. One degree of curvature is 5730 feet radius. Therefore the actual radius divided into 5730 gives the number of degrees of any curve.

The diagram on page 107 shows graphically the number of tons (of 2240 pounds) which should be hauled on grades from level to five per cent., at slow speed, by any locomotive, inclusive of the weight of the engine and tender, for each 1000 pounds weight on driving wheels. The weight of engine and tender, in tons of 2240 pounds, must be deducted to get the weight of cars and lading. Five bases of calculation are shown by separate lines in this diagram. Under the most favorable conditions, such as well-surfaced track, dry rails, well lubricated rolling-stock, etc., adhesion equal to one-fourth or ten-fortieths of the weight on driving wheels may be developed; but as these conditions cannot at all times be realized, the loads given in the following tables are based on the second line, or nine-fortieths of the weight on driving wheels. Even this basis, which may be considered as representing average excellent conditions, is more favorable than frequently prevails on narrow gauge lines having light rails or poorly laid track, logging railroads, etc. The other three lines are added to the diagram to make provision for such cases. The selection of the basis of calculation must of course be made in each instance with reference to the actual or probable condition of the road and its rolling equipment.

Designs and estimates for any sizes or patterns of locomotives not given in this catalogue will be submitted on application. The delivery of locomotives at any point which can be reached by rail or vessel will be included in contracts if desired.

In ordering locomotives the following particulars should be given:

1. Gauge of track—exact distance between the rails.
2. Kind of fuel which will be used.
3. Kind and height of couplings of cars.
4. Limitations, if any, in height and width, by tunnels, overhead bridges, etc.
5. Mark, name, or number.

The cable address is "Baldwin, Philadelphia." Each of the following tables has a code word in the line opposite the class number, the use of which indicates that a locomotive of the class and general dimensions shown on the line referred to is required. The following codes are used: Lieber's; A-1; A-B-C, fourth and fifth editions; Western Union; Vanguard; Commercial Code (Atlantic Cable Code), and Baldwin Locomotive Works' Private Code.

Physical Tests of Materials and General Specifications

The materials used in the construction of locomotives conform to the physical and chemical requirements given below. All purchases are made upon the basis of these specifications, and the conformity of all materials therewith is carefully verified in a well-equipped testing laboratory. Likewise numerous tests are made daily of the cast iron and other materials manufactured in the Works. Complete records are kept for each locomotive, and in the event of accident or litigation accurate testimony can be furnished.

All materials used in the construction of the locomotive shall be of the best quality of their respective kinds, carefully inspected, and subjected to the following tests. Notwithstanding these tests should any defects be developed in working, the corresponding part will be rejected.

Boiler and Firebox Steel. All plates must be rolled from steel manufactured by the open hearth process, and must conform to the following chemical analysis:

	Boiler Steel	Furnace Steel
Carbon between....	0.15 and 0.25 per cent.	0.15 and 0.25 per cent.
Phosphorus not over	0.05 "	0.03 "
Manganese "	0.45 "	0.45 "
Silicon "	0.03 "	0.03 "
Sulphur "	0.05 "	0.035 "

No sheets will be used that show mechanical defects. A test strip taken lengthwise from each sheet rolled should without annealing have a tensile strength of 60,000 pounds per square inch, and an elongation of twenty-five per cent. in a section originally 8 inches long. Sheets will not be used if the test shows a tensile strength of less than 55,000 pounds, or more than 65,000 pounds, per square inch, or if the elongation falls below 20 per cent.

Firebox Copper. Copper plates for fireboxes must be rolled from best quality Lake Superior ingots; they must contain at least 99.75 per cent. pure copper, and should have a tensile strength of 30,000 pounds per square inch, and an elongation of at least 35 per cent. in a section originally 2 inches long. Plates showing a tensile strength of less than 29,500 pounds per square inch will not be used.

Stay Bolt Iron. Iron for stay bolts must be double refined, and must show an ultimate tensile strength of at least 48,000 pounds per square inch, with a minimum elongation of 25 per cent. in a test section 8 inches long. Pieces 24 inches long must stand bending double both ways, without showing fracture or flaw. The iron must be rolled true to gauges furnished by the Baldwin Locomotive Works, and must permit of cutting a clean, sharp thread.

Copper Stay Bolts. Copper stay bolts must be manufactured from the best Lake Superior ingots; they must contain a minimum of 99.75 per cent. pure copper, and when annealed should have an ultimate tensile strength of 30,000 pounds per square inch, and an elongation of at least 35 per cent. in a section originally 2 inches long. Copper with a tensile strength of less than 29,500 pounds per square inch will not be used.

Boiler Tubes. All boiler tubes will be carefully inspected and must be free from pit-holes or other imperfections. Each tube must be subjected by the manufacturers, before delivery, to an internal hydraulic pressure of not less than 500 pounds per square inch. They must be rolled accurately to the gauge furnished by the Baldwin Locomotive Works, filling the gauge to a plump fit. They must be expanded in the boiler without crack or flaw, and must conform to the following test requirements:

Charcoal Iron. A test section $1\frac{1}{4}$ inches long, cut from any tube, must permit of vertical hammering without showing transverse cracks when flattened down.

Seamless Steel. All tubes must be drawn from steel manufactured by the open hearth process and must conform to the following analysis:

Carbon	0.18 to 0.24 per cent.
Manganese	0.40 to 0.65 "
Phosphorus, not over	0.04 per cent.
Sulphur "	0.05 "

A length of 1¼ inches, cut from any tube, must stand collapsing by vertical hammering without showing any cracks.

A length of 4 inches, cut from any tube, must stand horizontal collapsing until the sides meet without cracking.

Boiler Tubes of Brass or Copper, Brass and Copper Pipes. Tubes of brass or copper to be of uniform circumferential thickness and solid drawn; to be perfectly round, and to resist an internal hydraulic pressure of 500 pounds per square inch. After annealing they must stand the following cold bending and flanging tests:

A length of 4 inches cut from any tube, must stand being sawn lengthwise and doubled inside out without showing signs of cracks. Any tube must stand having one end flanged without cracking. The tube will be held in a die with the end to be flanged projecting. For tubes of diameters between 1¾ and 2½ inches this projecting end is to be five-eighths of an inch long. For other diameters a proportionate length is to be flanged.

Bar Iron. Bar iron should have a tensile strength of 50,000 pounds per square inch, and an elongation of 20 per cent. in a section originally 2 inches long. Iron will not be used if tensile strength falls below 48,000 pounds, or if elongation is less than 15 per cent., or if it shows a granular fracture.

Steel Tank Plates. Tank plates to be rolled from homogeneous steel billets, and must be of good finish and free from surface defects, such as spalling or bad buckling. The steel to be of such quality that pieces taken lengthwise of any plate shall show no signs of fracture when bent double while cold, over a mandrel whose diameter is one and one-half times the thickness of plate so tested.

Steel for Forgings. All blooms for use in axles, pins, rods, guides and similar forgings, must be made by the open hearth process and be free from seams, slivers, and other surface defects.

Drillings will be taken from a point midway between the center and the surface of the bloom, and must conform to the following specification when analyzed by Baldwin Locomotive Works' standard method:

Carbon, about	0.40	per cent.
Manganese, not over	0.70	"
Phosphorus "	0.05	"
Sulphur "	0.05	"

These blooms should be of such quality that a test piece machined cold from a full-sized bloom of each heat used, has, when tested, an ultimate tensile strength of 80,000 pounds per square inch, and an elongation of 20 per cent. in a test section originally 2 inches long.

Blooms will not be used that show an ultimate tensile strength of less than 75,000 or more than 90,000 pounds per square inch, or an elongation of less than 15 per cent.

All forgings which develop seams or pipes upon machining will be rejected.

Chilled Wheels. Of approved make and of following guaranteed mileage:

For 28-inch Wheels	40,000	miles
For 30-inch "	45,000	"
For 33-inch "	50,000	"

Other sizes in proportion.

(Adopted by Joint Committee Master Car Builders' Association, American Railway Master Mechanics' Association, and Association of Manufacturers of Chilled Car Wheels, November 21, 1889).

Deficient mileage will be adjusted upon return of the defective wheel, or that part of same containing the defect causing withdrawal from service. Or, if preferred, wheels will be furnished subject to approved specification and drop test without mileage guarantee.

Spring Steel. All spring steel must be manufactured by the open hearth or by the crucible process, and must be free from any physical defects. The metal desired has the following composition:

Carbon	1.00	per cent.
Manganese	0.25	"
Phosphorus, no over	0.03	"
Silicon "	0.15	"
Sulphur "	0.03	"

Steel will not be used which shows on analysis less than 0.90 or over 1.10 per cent. of carbon, or over 0.50 per cent. of manganese, 0.05 per cent. of phosphorus, 0.25 per cent. of silicon, or 0.05 per cent. of sulphur. A tempered bar resting upon supports 24 inches between centers must not take a permanent set of more than 0.05 inch after the first application of a load corresponding to a fibre stress of 135,000 pounds per square inch, or more than 7.5 per cent. of the total deflection under 160,000 pounds fibre stress, or any further set after 5 additional applications of a load giving a fibre stress of 150,000 pounds per square inch.

Bearing Metal. All bearing metal to be made from new metals and should show the following analysis:

Copper	80.00	per cent.
Lead	15.00	"
Tin	5.00	"

Bearing metal will not be used should analysis show results outside the following limits:

Tin........below 4.00 per cent.
Lead....... " 12.00 per cent. or over 18.00 per cent.

Bearing metal will also be rejected in case it contains 0.50 per cent. of any substance other than the three elements mentioned in this specification.

Steel Tires. All tires to be made of dense, homogeneous bottom-poured ingots, and to insure freedom from pipes, segregations and other imperfections, the steel must be cast in long, hexagonal ingots, and not less than 20 per cent. of the weight of the ingot must be discarded from the top portion.

Tires must conform to the following chemical analysis and physical test :

American Practice

Chemical Analysis

Carbon	.65 to .75 per cent.
Phosphorus	Under .05 " "
Silicon	Under .25 " "
Manganese	.50 to .70 " "
Sulphur	Under .05 " "

Physical Test

Tensile Strength	110,000 to 125,000 pounds
Elastic Limit	55,000 to 65,000 "
Elongation in 2-inch Section	10 to 15 per cent.

Japanese Practice

Chemical Analysis

Carbon	.55 to .65 per cent.
Silicon	Under .20 " "
Phosphorus	Under .05 " "
Manganese	.55 to .65 " "
Sulphur	Under .045 " "

Physical Test

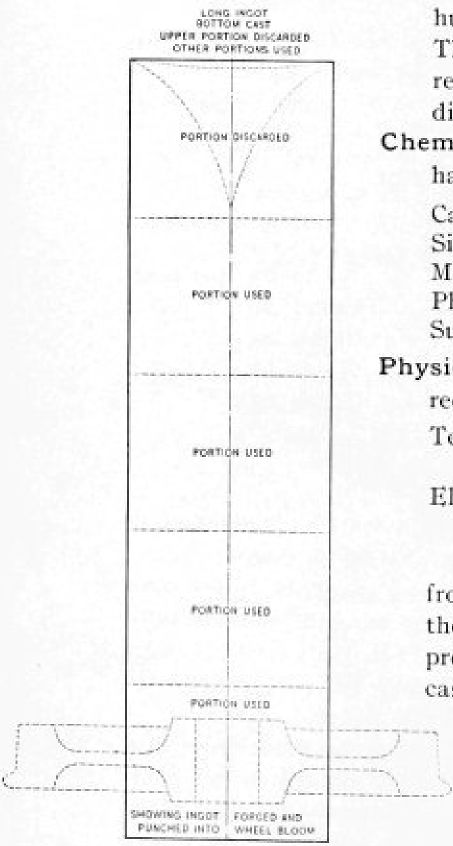
Tensile Strength	100,000 to 107,500 pounds
Elastic Limit	50,000 to 55,000 "
Contraction of Area	20 to 29 per cent.
Elongation in 2-inch Section	15 to 18 per cent.

Forged and Rolled Steel Wheels

Process of Manufacture. Wheels must be made from acid open hearth steel, bottom cast in long ingots; 20 per cent. from the top of the ingots being discarded to remove all segregation and piping, the remainder being cut into billets of proper weight. (See illustration.)

Forging and Rolling. The ingots when cut must be thoroughly forged or compressed, and the central portion, namely, the central line of billet, corresponding to the central line of ingot, must be punched out. (See illustration.) The wheel is then rolled from this forged, compressed and punched billet.

Machining. The rolled wheel must be carefully turned on the outside to insure perfect concentricity with the axis of the hub; and to the exact diameter required, and the flanges dressed to the required contour. The hubs must be faced and rough bored. The wheels in this condition are then ready for service, without any additional work except finish boring.



Chemical Analysis. Steel for wheels to have the following composition :

Carbon	.65 to .75	per cent.
Silicon, not less than . . .	.20	" "
Manganese	.60 to .80	" "
Phosphorus, not over . . .	.05	" "
Sulphur, not over	.05	" "

Physical Test. The physical qualities required shall be as follows :

Tensile Strength, per square inch, 110,000 to 130,000 lbs.
Elongation in 2 inches, not less than . . . . 10 per cent.

The tensile specimen will be taken from a billet forged from a test ingot, the amount of work on the billet being proportionately the same as in the case of the wheels.

FILE............

SPECIFICATION

Baldwin Locomotive Works

BURNHAM, WILLIAMS & CO.

PHILADELPHIA..........................

Class.................. Drawing No.........

Of a............Locomotive Engine having.......pairs of coupled wheels and a...... wheeled truck.......................... for the...

This specification may be designated in cabling by code word............................General design illustrated by attached photograph of negative No..............................

PRINCIPAL DIMENSIONS

Gauge..........Ft...........Ins. Fuel..................
Cylinders................. Diameter...... Stroke............
Drivers, Diameter..........Ins. Working Pressure........Lbs.
Boiler, Diameter...........Ins. Type.......................
Firebox................Ins. Long..................Ins. Wide.
Tubes, No........Diameter......Ins. Length.......Ft.....Ins.
Heating Surface (approximate) Firebox...............Sq. Ft.
Tubes...................Sq. Ft.
Total...................Sq. Ft.
Grate Area......Sq. Ft.—Ratio to Heating Surface, 1 to.........
Wheel Base, Driving...................Ft..................Ins.
" Total Engine...................Ft..................Ins.
" Engine and Tender...........Ft..................Ins.
Weight (approximate) on Drivers.............lbs.
total Engine.............lbs.
Tender...................lbs.
(In working order.)
Tractive Power........lbs. Ratio of Adhesion....................
Tank Capacity............Gals. Limits...........................

The locomotive to be provided with the following equipment:
Headlight..
Power Brake..
Couplers..
Steam Heat.................Sander........................

Details of Construction

Boiler. Made of plates of homogeneous steel for a working pressure of........pounds per square inch, and tested with steam to at least 20 pounds per square inch above working pressure, and with hot water to one-third above the working pressure.

Waist...........inches in diameter at smokebox end, made.................top, with one dome placed...... Waist plates..................inch thick. All longitudinal seams..

All boiler and firebox seams caulked inside and outside where possible. All holes reamed perfectly true after sheets are put together, holes slightly countersunk on inside and outside edges. No hand riveting permitted except where it is impossible to use power riveters. All caulking edges of plates planed where possible and caulked with round pointed caulking tool, insuring plates against injury by chipping in caulking with sharp edged tools. All boiler brace jaws drop forged, with holes drilled. All rivet and pin holes in braces to be drilled. All jaw pins to be turned to give full body bearing on both sides of jaw, and to be held in position by nut, washer and cotter pin. All T-irons fastened to the interior of boiler shell to be machined accurately to fit the radius of boiler. Tube sheets to be thoroughly annealed and tube holes accurately reamed to gauges; sharp corners carefully rounded to avoid cutting tubes in setting.

Throat sheet of sufficient thickness to prevent undue thinning where flanged. All parts well and thoroughly stayed. Liners on inside of side sheets, providing double thickness of metal for studs of expansion braces, if side sheets are less than nine-sixteenths of an inch thick.

Dome. Dome ring to be of seamless open hearth forged steel, turned and accurately fitted to the interior of dome sheet before being drilled and riveted. Dome cap to be of forged steel. Dome base to be of seamless open hearth forged steel, flanged and radially planed to fit the outer shell of boiler. The interior bored to receive the body sheet of dome. All rivets connecting dome to boiler to be driven by hydraulic pressure.

Tubes. Of.................... No....... wire gauge, with copper ferrules and swaged ends in firebox tube sheet...... in number........ inches in diameter, and........ feet.... inches in length.

Firebox. To burn .... inches long and .... inches wide inside; of homogeneous steel, all flanged plates thoroughly annealed after flanging; side sheets........ inch, back sheets...... inch, crown sheet ...... inch thick, flue sheet........ inch thick. Water space........ inches sides and back,........ inches front. Outside and inside surfaces of water space frame, against which the sheets of the firebox and outer shell are riveted, to be machined smooth and fitted to gauges.

Stay Bolts. Stay bolts of iron, screwed and riveted to inside and outside sheets. All side stay bolts to have three-sixteenths inch hole, $1\frac{1}{4}$ inches deep from outside to indicate when broken in service. All stay bolt threads turned off between sheets.

Firedoor opening formed by flanging and riveting together the inner and outer sheets, except on small engines. Tool guard to be cast on lower part of firedoor frame.

Firebrick arch..................................

Crown Staying. Crown sheet supported by crown bars each made of two pieces of wrought iron, bearing on side sheets, and stayed by braces to outside of boiler. Crown sheet held by crown bar bolts with head on under side of crown sheet; or,

By ⊥-bars above crown supported by braces from outside shell of boiler. The crown sheet held by crown bar bolts with taper fit through crown sheet and button head under crown sheet; or, By radial stay bolts screwed through crown sheet and roof of boiler, and riveted over. Central rows with heads below crown sheet on boilers 42 inches diameter and larger. Provision to be made for vertical expansion of firebox tube sheet, if diameter of waist is 46 inches or over.

Cleaning Holes. Cleaning plugs located where necessary for proper cleaning of boiler.

Steam Pipes. In smokebox, of iron. Dry pipe inside boiler of wrought iron or steel.

Throttle Valve. Balance poppet throttle valve of cast iron, in vertical arm of dry pipe.

Grates. ....

Ash Pan. With dampers..................................

Smokestack. ....

Smokebox. ....

Frames. Of.................. made in sections.

Front rails bolted and keyed to main frames, and with front and back lugs for cylinder connections.

Pedestals. Pedestals in one piece with main frames, and protected from wear of boxes by cast iron gibs and wedges. Pedestal caps fitted and bolted to bottom of pedestals.

Engine Truck. Center-bearing swiveling ....wheeled truck..

Truck frame of wrought iron, well braced; fitted with swinging bolster or with fixed center-bearing.

Wheels. ....wheels...........inches diameter.

Axles. Of hammered steel with journals.......inches in diameter and..........inches long.

Springs. Of cast steel tempered in oil.

....

....

Cylinders. High-pressure cylinders..........inches diameter and..........inches stroke.

Low-pressure cylinders..........inches diameter and ....inches stroke.

Of close-grained iron as hard as can be worked. Each cylinder cast in one piece with half saddle. When placed horizontally right- and left-hand cylinders to be reversible and interchangeable, accurately planed and fitted, and bolted together in the most approved manner. Valve face and steam chest seat raised above face of cylinder to allow for wear, except when piston valves are used. Cylinders oiled by ....automatic sight feed lubricator placed in cab, and connected to steam chest by copper pipes.

Pistons. Heads of cast iron, fitted with approved form of steam packing. Piston rods of steel, ground and keyed or bolted to crossheads, and securely fastened to pistons.

Packing. Metallic packing for piston rods and valve stems.

Guides. Of steel, fitted to guide yoke of wrought iron or cast steel.

Crossheads. Cast....................with suitable bearings ....

Valve Motion. Shifting link motion, graduated to cut off equally at all points of stroke. Links, sliding blocks, pins, lifting links, and eccentric rod jaws made of hammered iron, well case hardened. Sliding blocks with long flanges to give ample wearing surface. Rock shafts of wrought iron or cast steel; reverse shaft of wrought iron. Slide Valves ....

Driving Wheels. ......in number,......inches in diameter. Centers of cast..........turned to......inches diameter ....

Tires. Of cast steel.......inches thick when finished;........ pairs flanged.......inches wide,.........pairs plain..... inches wide.

Axles. Of hammered steel; journals..........inches diameter and ......inches long.

Driving Boxes. Of..........., with bronze bearings.......

Springs. Of cast steel, tempered in oil. Equalizing beams of wrought iron or cast steel.

Rods. Connecting and parallel rods of hammered steel. Connecting rods forged solid, and furnished with all necessary straps, keys and brasses. Parallel rods with straps, keys and brasses or with solid ends and heavy bronze bushings. Bushings put in by hydraulic pressure, and well secured from turning in rod..

Oil Cups. Lubrication of all bearings carefully provided for, and oil cups attached where required. Wick, plunger or adjustable needle oil cups on rods and guides.

Wrist Pins. Wrist pins of steel.

Feed Water. Supplied by .... injectors.

Cab. Substantially built of .... well finished, and substantially fitted together. .... To be provided with suitable windows and doors, conveniently arranged, and glazed with first quality double American crystal glass. Cab seats, cab seat cushions and an engineer's arm rest to be provided.

Pilot. Of wood braced with iron.. ....

Furniture. Engine furnished with .... sand box, ... bell and cord, extra fusible plug, engineer's torch.

BOILER FITTINGS: Whistle,.. .... blow-off cock, blower valve, ... safety valves, ... steam gauge and glass water gauge with lamps, gauge cocks.

TOOLS: Two jack screws and levers, one pinch bar with steel point and heel, complete set of wrenches to fit all nuts and bolts on engine, two monkey wrenches, one set of driving box packing tools, one machinist's hammer, one soft hammer, and three cold chisels (two flat and one cape).

CANS: One long spout quart oil can, one two-gallon oil can and one tallow pot.

FIRING IRONS: To suit fuel.

Finish. Boiler lagged with approved magnesia boiler covering, neatly jacketed and secured by iron bands. Dome lagged with same material as boiler, with painted iron casing on body and cast iron top and bottom rings. Cylinders lagged with same material as boiler, and neatly cased with iron, painted. Cylinder head covers of hydraulic forged steel, painted or polished. Steam chest bodies cased with painted iron, except when piston valves are used.

Hand rails of iron. Running boards of wood.

Painting. Engine and tender to be well painted and varnished. Lettering and numbering to be painted as specified by purchaser.

Case Hardening. All finished movable nuts made of steel, or iron case hardened.

Alloy. All wearing brasses made of phosphor bronze, or ingot copper, lead and tin alloyed in proportion to give best mixture for wearing bearings.

Threads. All threads on bolts to be United States standard.

Gauges. All principal parts of engine accurately fitted to gauges and templets, and thoroughly interchangeable.

Patents. Builders not responsible for patented appliances specified by purchaser.

Tender

Tank. Tank of steel strongly put together with angle iron corners and well braced. Top and bottom plates.......... thick, inside plates....... thick, outside plates........ thick, riveted with ....inch rivets,........inches pitch.

Capacity...........gallons (of 231 cubic inches), ...

Shape of tank..

Frame. Tender frame substantially built of..........., strongly braced.

Trucks. Two four-wheeled center-bearing trucks, made with steel or iron side bars and cross beams of steel channels ....Additional bearings at sides of back truck.............Springs, cast steel, tempered in oil.

Wheels. ....wheels.........inches diameter Brakes on all wheels.

Axles of hammered steel; outside journals......... inches diameter and........inches long. Oil tight boxes with bronze bearings.

Tool Boxes. Tool boxes of hard wood, fitted with locks and keys.

Class Designation

The designation of the different classes of locomotives, as used by the Baldwin Locomotive Works, embodies the combination of certain figures with one of the letters, A, B, C, D, E, or F, to indicate both the number and kind of wheels and size of cylinders. The method of designating the number of driving wheels by letter was first used in 1842, and has been continued without change since that time; thus a locomotive having one pair of driving wheels is classed B; that with two pairs, C; that with three pairs, D; that with four pairs, E; and that with five pairs, F. The letter A is used for a special class of high-speed locomotives, with a single pair of driving wheels, and for a rack-rail locomotive with a single pinion. A figure (4, 6, 8, 10, 12, etc.) is used as an initial figure to indicate the total number of wheels under the locomotive. A figure or figures following the initial figure indicates the diameter of the cylinders, and the figure or figures following the class designation represents the consecutive class number of the locomotive on which it appears. Thus, 8-26-C 500 indicates a locomotive with eight wheels in all, having cylinders sixteen inches in diameter, with two pairs of driving wheels, and the five hundredth locomotive of its class.

The number representing the cylinder diameter is an arbitrary figure, orginally intended to represent the weight of the locomotive in tons, but in present practice it has no such reference—forty representing a twenty-three inch cylinder, thirty-eight a twenty-two inch cylinder, thirty-six a twenty-one inch cylinder, and so on. The size of the cylinder may be found by dividing this number by two and adding three to the quotient, or the figures for cylinder in the class designation may be obtained by subtracting three from the number indicating the diameter of the cylinder in inches and multiplying the remainder by two.

The same rule is carried out in the classification of compound locomotives. In this case, however, a number is given to indicate the diameter of each cylinder, that indicating the high-pressure being written over the low-pressure. Thus, 10-$\frac{22}{42}$-D 100 indicates a compound locomotive, with ten wheels in all, having high-pressure cylinders fourteen inches in diameter and low-pressure cylinders twenty-four inches in diameter, with three pairs of driving wheels, and the one hundredth locomotive of its class.

The addition of the fraction $\frac{1}{4}$ to any class indicates that there is a truck placed at each end of the locomotive. The addition of the fraction $\frac{1}{3}$ to any class indicates that there is no front truck, but that a rear truck is placed back of the firebox.

As a further illustration, the figures indicating the diameter of the cylinders are as follows:

8 indicates cylinders 7 inches in diameter.

10½ indicates cylinders 8 inches in diameter.

11 indicates cylinders 9 inches in diameter with stroke not exceeding 14 inches.

12 indicates cylinders 9 inches in diameter with stroke exceeding 14 inches.

14 indicates cyls. 10″ dia.
16 indicates cyls. 11″ dia.
18 indicates cyls. 12″ dia.
20 indicates cyls. 13″ dia.
22 indicates cyls. 14″ dia.
24 indicates cyls. 15″ dia.
26 indicates cyls. 16″ dia.
28 indicates cyls. 17″ dia.
30 indicates cyls. 18″ dia.
32 indicates cyls. 19″ dia.
34 indicates cyls. 20″ dia.
36 indicates cyls. 21″ dia.
38 indicates cyls. 22″ dia.
40 indicates cyls. 23″ dia.
42 indicates cyls. 24″ dia.
44 indicates cyls. 25″ dia.
46 indicates cyls. 26″ dia.
48 indicates cyls. 27″ dia.
50 indicates cyls. 28″ dia.
52 indicates cyls. 29″ dia.

Thus, 8-24-C indicates a locomotive with eight wheels in all, having four wheels coupled, and cylinders fifteen inches in diameter.

From the above system of classification, and omitting the figures indicating the cylinder diameter for particular sizes, the following type designations are deduced. The diagrams show the location of cylinders and arrangement of wheels.

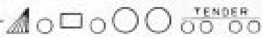
4-C Tank—□ ○ ○ Two pairs of coupled wheels, with saddle or side tanks, no trucks.

4-C Tender—□ ○ ○ TENDER ○○ ○○ Two pairs of coupled wheels with separate tender, no trucks.

6-C Tank— Two pairs of coupled wheels, and two-wheeled front truck, with saddle or side tanks.

6-C Tender— Two pairs of coupled wheels, and two-wheeled front truck, with separate tender.

6⅓-C Tank— Two pairs of coupled wheels and two-wheeled back truck, with saddle, side, or rear tanks.

8-C Tender— American type—Two pairs of coupled wheels, four-wheeled front truck, and separate tender.

8¼-C Tank— Two pairs of coupled wheels, with two-wheeled front and two-wheeled back truck, with saddle or side tanks.

8⅓-C Tank— Two pairs of coupled wheels, with four-wheeled back truck, tank at rear.

10¼-C Tank— Two pairs of coupled wheels, two-wheeled front truck, and a four-wheeled back truck, tank at rear.

10¼-C Tender— Atlantic type—Two pairs of coupled wheels, four-wheeled front truck, and one pair of trailing wheels under firebox, with separate tender.

6-D Tank— Three pairs of coupled wheels, with saddle or side tanks, no trucks.

6-D Tender— Three pairs of coupled wheels, with separate tender, no trucks.

8-D Tender— Mogul type—Three pairs of coupled wheels, two-wheeled front truck, and separate tender.

8⅓-D Tank— Three pairs of coupled wheels and two-wheeled back truck, with saddle, side, or rear tanks.

10-D Tender— Three pairs of coupled wheels, four-wheeled front truck, and separate tender.

10¼-D Tank— Three pairs of coupled wheels, two-wheeled front and two-wheeled back truck, with saddle or side tanks.

10¼-D Tender— Prairie type—Three pairs of coupled wheels, two-wheeled front and two-wheeled back truck, with separate tender.

12¼-D Tank— Three pairs of coupled wheels, four-wheeled front and two-wheeled back truck, with saddle or side tanks.

12¼-D Tender—

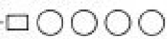
Pacific type—Three pairs of coupled wheels, four-wheeled front and two-wheeled back truck, with separate tender.

12-D D Tender—

Mallet articulated type—Three pairs of coupled wheels in each group, no trucks, and separate tender.

16¼-D D Tender—

Mallet articulated type—Three pairs of coupled wheels in each group, two-wheeled front and two-wheeled back truck, and separate tender.

8-E Tank— Four pairs of coupled wheels, with saddle or side tanks, no trucks.

8-E Tender—

Four pairs of coupled wheels, with separate tender, no trucks.

10-E Tender—

Consolidation type—Four pairs of coupled wheels, two-wheeled front truck, and separate tender.

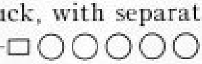
12-E Tender—

Four pairs of coupled wheels, four-wheeled front truck, and separate tender.

12¼-E Tank— Four pairs of coupled wheels, two-wheeled front and two-wheeled back truck, with saddle or side tanks.

12¼-E Tender—

Mikado type—Four pairs of coupled wheels, two-wheeled front and two-wheeled back truck, with separate tender.

10-F Tank— Five pairs of coupled wheels, with saddle or side tanks, no trucks.

12-F Tender—

Decapod type—Five pairs of coupled wheels, two-wheeled front truck, with separate tender.

14¼-F Tender—

Santa Fe type—Five pairs of coupled wheels, two-wheeled front and two-wheeled back truck, with separate tender.

Four Coupled Locomotives with Four-Wheeled Leading Trucks

American Type

With Fireboxes between Driving Axles, and Separate Tenders

Gauge, 3 Feet 6 Inches, or 1 Metre — Fuel, Bituminous Coal or Wood

CODE WORD	Class	Cylinders Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches.	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels — Ft.	Wheel Base: Of Driving Wheels — Ins.	Wheel Base: Total — Ft.	Wheel Base: Total — Ins.	Capacity of Tender for Water — 8⅓-lb. Gallons	Load in Tons (of 2240 pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Lutosum	8-14 C	10 x 16	42	160	5,180	25,000	40,000	6	9	17	10	1500	600	235	135	90	65	50	35
Lutraria	8-16 C	11 x 16	42	160	6,260	28,000	44,000	6	9	17	10	1600	730	290	170	115	80	60	45
Lutrin	8-18 C	12 x 18 or 20	48 to 56	160	7,150	32,000	49,000	7	6	21	1	1800	825	325	190	130	90	70	55
Luttasses	8-20 C	13 x 18 or 20	48 to 56	160	8,400	37,000	57,000	7	10	21	9	2000	975	390	230	155	110	85	65
Lutteriez	8-22 C	14 x 18 or 20	48 to 56	160	9,750	42,000	64,000	8	2	22	1	2200	1120	445	260	175	130	95	75
Lutterons	8-24 C	15 x 18 or 20	48 to 56	160	11,350	48,000	72,000	8	6	22	5	2400	1280	510	300	205	150	115	85

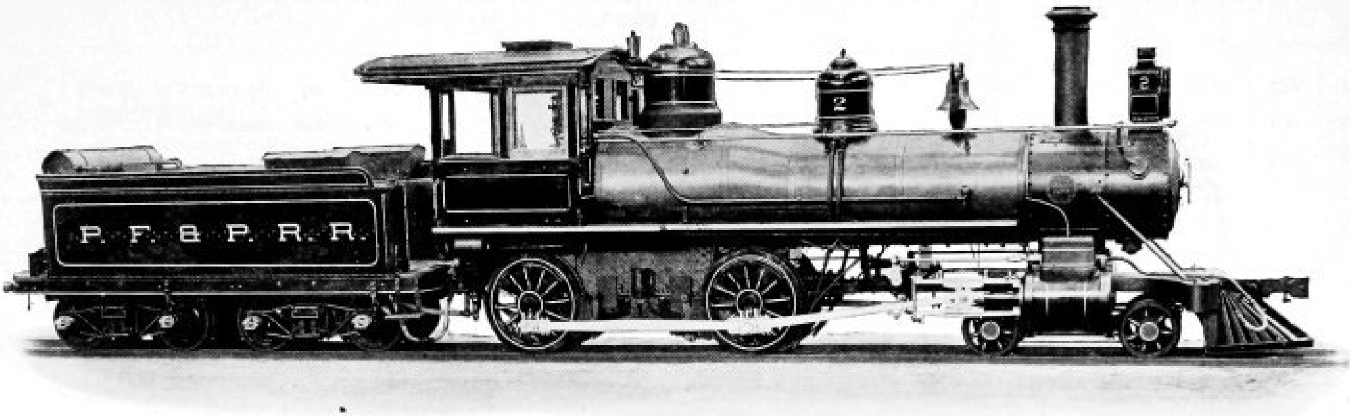
This type is suitable for passenger, freight, or mixed service, where the run is of such length as to require a separate tender, or for short lines intended ultimately to be extended. It is called the American type because of its use in former years throughout the United States for nearly every variety of service. Heavier locomotives of the American type are described on page 130.

The total wheel base of engine, with six-wheeled tender attached, varies from 36 feet for Class 8-14 C, to 38 feet 6 inches for Class 8-24 C. From 18 inches to 2 feet should be added, to give the length of turn-table required.

Assuming that steel rails, properly supported by crossties, can sustain, as a maximum, a weight per wheel of 3000 pounds for each 10 pounds weight per yard of rail, Classes 8-18 C and 8-20 C can be used on rails of 30 to 35 pounds per yard, and Classes 8-22 C and 8-24 C, 35 to 40 pounds.

For remarks on tractive power, see pages 106 to 109.

$\frac{9}{10}$ and 8, T x 20



AMERICAN TYPE LOCOMOTIVE WITH FIREBOX BETWEEN DRIVING AXLES

Four Coupled Locomotives with Four-Wheeled Leading Trucks

American Type

With Fireboxes over Rear Driving Axles, and Separate Tenders

Gauge, 3 Feet 6 Inches, or 1 Metre — Fuel, Bituminous Coal

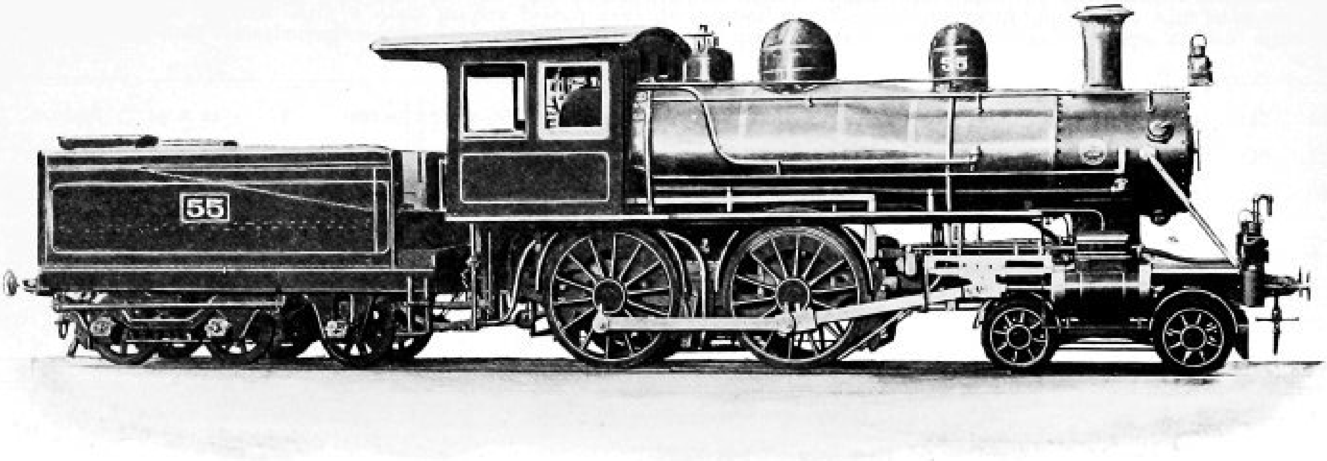
CODE WORD	Class	Cylinders. Diameter Stroke — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels — Ft.	Ins.	Wheel Base: Total — Ft.	Ins.	Capacity of Tender for Water — 8⅓-lb. Gallons	Load in Tons (of 2240 pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Luttons	8-22 C	14 x 20 or 22	54	160	10,350	44,000	64,000	6	0	18	2	2200	1150	470	275	190	135	105	80
Luttuoso	8-24 C	15 x 22 or 24	60	160	11,750	50,000	72,000	6	6	19	6	2400	1320	535	315	215	160	120	95
Lutulencia	8-26 C	16 x 22 or 24	60	160	13,350	56,000	80,000	7	0	20	4	2600	1475	600	355	240	175	135	105

The locomotives described on page 128 have deep fireboxes between the driving axles, placed over depressed slab frames. In the larger classes of eight-wheeled or American type locomotives the grate area which can be thus obtained is limited by the spread of driving wheels practicable. To obtain increased grate area the firebox is extended back over the rear driving axle, and the frames are, therefore, depressed only at the front of the firebox to give sufficient depth under the tubes. In this construction it is practicable and desirable to shorten the spread of driving wheels. This form of firebox is suitable for burning coal, but the deeper fireboxes are preferable for wood-burning locomotives.

Assuming that steel rails, properly supported by crossties, can sustain, as a maximum, a weight per wheel of 3000 pounds for each 10 pounds weight per yard of rail, Class 8-22 C can be used on rails of 40 pounds per yard, Class 8-24 C, 45 pounds, and Class 8-26 C, 50 pounds.

For remarks on tractive power, see pages 106 to 109.

$\frac{7}{10}$ and 8, T x 20



AMERICAN TYPE LOCOMOTIVE WITH FIREBOX ABOVE REAR DRIVING AXLE

Four Coupled Locomotives

Atlantic Type

With Four-Wheeled Leading Trucks, One Pair of Trailing Wheels, and Separate Tenders

Gauge, 3 Feet 6 Inches, or 1 Metre

Fuel, Bituminous Coal or Wood

CODE WORD	Class	Cylinders Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order. On all Driving Wheels — Pounds	Weight in Working Order. Total — Pounds	Wheel Base. Of Driving Wheels — Ft.	Ins.	Wheel Base. Total — Ft.	Ins.	Capacity of Tank for Water. — 8⅓-lb. Gallons	LOAD IN TONS (OF 2240 POUNDS) OF CARS AND LADING. On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Lutulentas	10-22¼ C	14 x 20	50	160	10,660	42,000	72,000	4	7	18	2	2600	1100	435	255	170	120	90	70
Luurgoed	10-24¼ C	15 x 22	54	160	12,470	50,000	82,000	5	0	19	4	2800	1300	525	310	210	150	115	85
Luurkorf	10-26¼ C	16 x 22	54	160	14,180	56,000	90,000	5	0	19	4	3000	1475	585	345	230	165	125	95

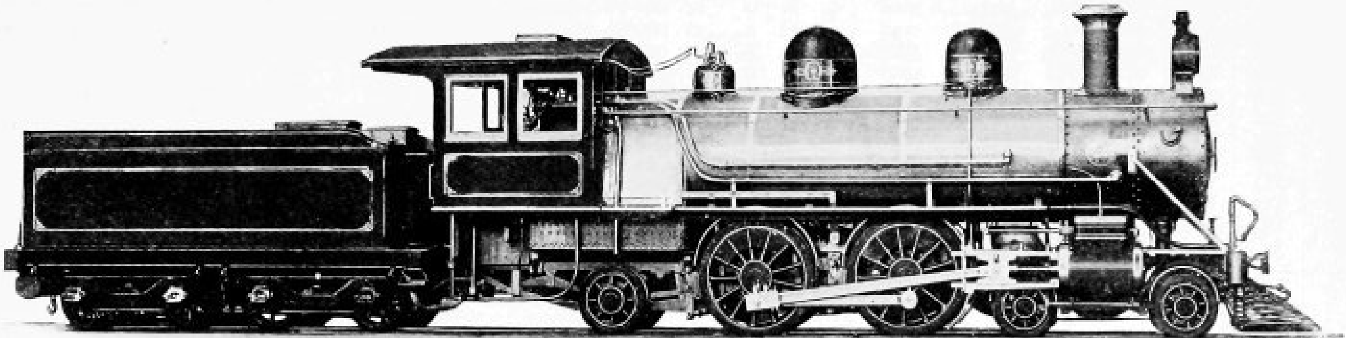
Locomotives of this plan are especially adapted to high speed service. The driving wheels are placed forward of the firebox, allowing the use of a boiler of large heating surface, with a deep firebox placed over the frames, and giving a low center of gravity with large driving wheels. Excessive weight per axle is obviated by the introduction of a pair of trailing wheels at the rear, under the overhanging firebox. The driving wheels are coupled closely together, affording a short parallel rod, which is an important consideration in high speed service, at the same time giving ample length of main rod. The coupled and trailing wheels are equalized together, giving the locomotive a smooth and easy motion when running at high speed.

The total wheel base of engine, with eight-wheeled tender attached, varies from 41 feet 6 inches for Class 10-22¼ C, to 43 feet for Class 10-26¼ C. From 18 inches to 2 feet should be added to give length of turn-table desired.

Assuming that steel rails, properly supported by crossties, can sustain, as a maximum, a weight per wheel of 3000 pounds for each 10 pounds weight per yard of rail, Class 10-22¼ C, can be used on rails of 40 pounds per yard, Class 10-24¼ C, 45 pounds, and 10-26¼ C, 50 pounds.

For remarks on tractive power, see pages 106 to 109.

$\frac{7}{16}$ and 8, T x 20.



ATLANTIC TYPE LOCOMOTIVE

Six Coupled Locomotives

Mogul Type

With Two-Wheeled Leading Trucks, and Separate Tenders

Gauge, 3 Feet 6 Inches, or 1 Metre

Fuel, Bituminous Coal or Wood

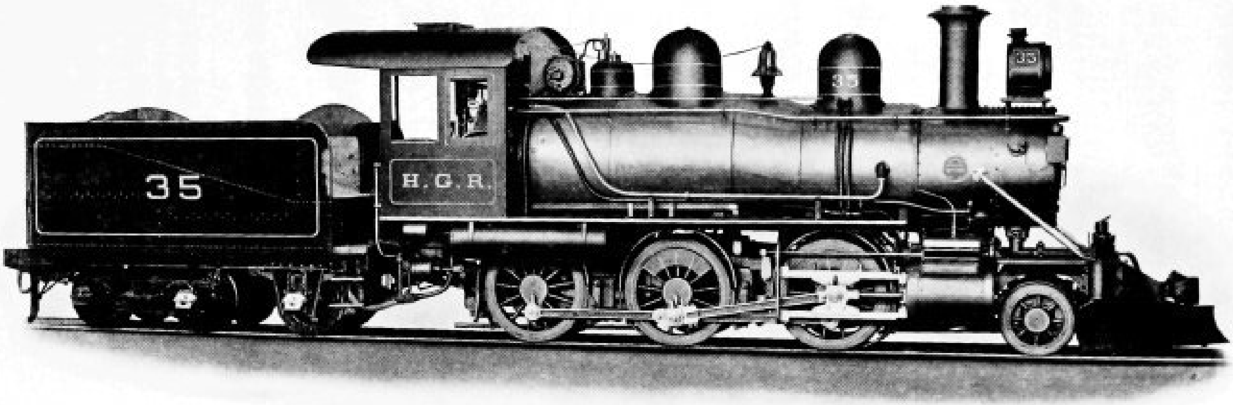
CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels — Ft.	Ins.	Wheel Base: Total — Ft.	Ins.	Capacity of Tender for Water. — 8⅓-lb. Gallons	Load in Tons (of 2240 Pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Luurmand . .	8-14 D	10 x 16	38	160	5,720	24,000	30,000	8	0	14	1	1400	675	255	150	100	75	55	45
Luurmanden .	8-16 D	11 x 16	38	160	6,920	30,000	36,000	8	4	14	5	1600	775	320	190	130	95	75	55
Luveiro . .	8-18 D	12 x 18	42	160	8,390	36,000	44,000	9	0	15	2	1800	950	390	230	160	115	90	70
Luvetto .	8-20 D	13 x 18	42	160	9,850	42,000	51,000	9	8	16	0	2000	1100	450	270	185	135	105	85
Luvhalter .	8-22 D	14 x 18	42	160	11,430	48,000	57,000	9	8	16	3	2200	1275	520	310	215	155	120	95
Luvseite . .	8-24 D	15 x 18	42	160	13,110	56,000	66,000	10	9	18	0	2400	1500	605	365	250	185	145	115
Luvwaerts .	8-26 D	16 x 18	42	160	14,920	62,000	72,000	11	3	18	6	2600	1650	675	405	280	205	160	130
Luwer . . .	8-26 D	16 x 20	48	160	14,500	64,000	74,000	11	3	18	6	2600	1700	695	415	290	215	165	135
Luxabimus	8-28 D	17 x 20	42	160	18,720	70,000	81,000	11	6	18	11	2800	1875	760	455	315	235	185	145
Luxacao . .	8-28 D	17 x 22	48	160	18,000	72,000	83,000	11	6	18	11	2800	1975	805	485	335	250	195	155
Luxaciones	8-30 D	18 x 20	42	160	20,980	78,000	90,000	12	0	19	8	3000	2100	850	510	355	265	205	165
Luxada	8-30 D	18 x 22	48	160	20,200	80,000	92,000	12	0	19	8	3000	2200	895	535	370	275	215	175

Locomotives of this type are suitable for passenger, freight, or mixed service, where the eight-wheeled, or American type, would not afford sufficient power, or where the requisite weight on the driving wheels, if carried by only two pairs, would be greater than the rails could safely bear.

The front and back driving wheels must have flanged tires in this type of locomotive; the middle or main driving wheels have wide tires without flanges. The "pony truck" has a swinging bolster, and by means of a radius bar is made to radiate about a point located between itself and the front driving axle.

Assuming that steel rails, properly supported by crossties, can sustain, as a maximum, a weight per wheel of 3000 pounds for each 10 pounds weight per yard of rail, Classes 8-14 D to 8-20 D can be used on rails of 20 to 25 pounds per yard; Classes 8-22 D and 8-24 D, 30 to 35 pounds; Classes 8-26 D and 8-28 D, 35 to 45 pounds; Class 8-30 D, 50 pounds.

For remarks on tractive power, see pages 106 to 109.



MOGUL TYPE LOCOMOTIVE

Six Coupled Locomotives

Ten-Wheeled Type

With Four-Wheeled Leading Trucks, and Separate Tenders

Gauge, 3 Feet 6 Inches, or 1 Metre

Fuel, Bituminous Coal or Wood

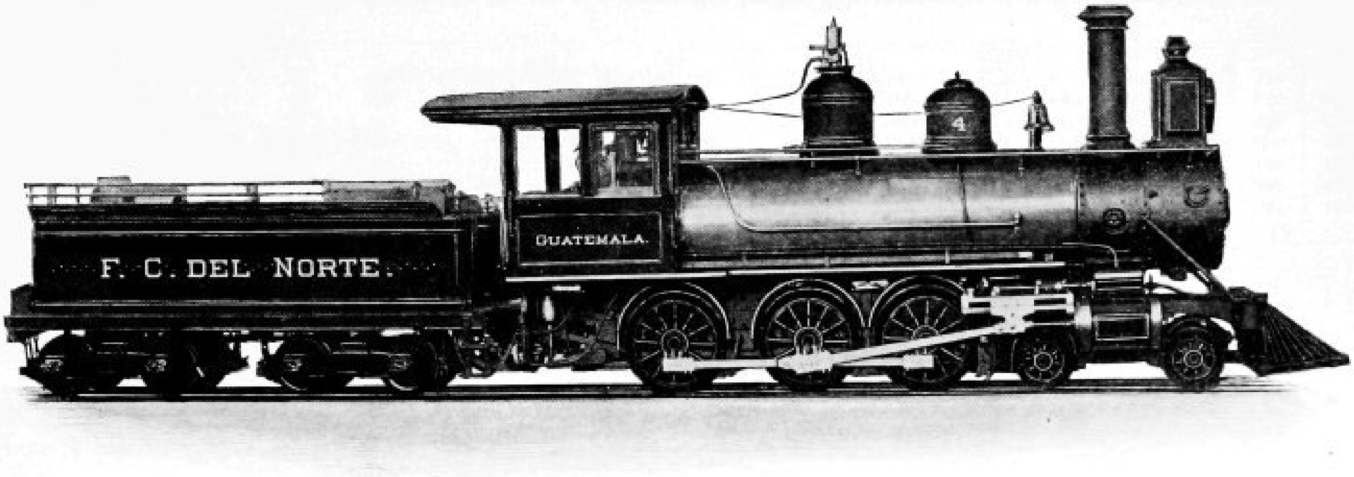
CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order. On all Driving Wheels — Pounds	Weight in Working Order. Total — Pounds	Wheel Base. Of Driving Wheels — Ft.	Ins.	Wheel Base. Total — Ft.	Ins.	Capacity of Tender for Water. — 8⅓-lb. Gallons	Load in Tons (of 2240 pounds) of Cars and Lading. On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Luxaremus.	10-18 D	12 x 18	42	160	8,390	36,000	48,000	9	0	17	7	1800	950	385	230	155	115	85	70
Luxation.	10-20 D	13 x 18	42	160	9,850	42,000	55,000	9	8	18	5	2000	1100	450	265	185	135	105	80
Luxationem	10-22 D	14 x 18	42	160	11,430	48,000	62,000	9	8	18	8	2200	1275	515	305	210	155	120	95
Luxationis.	10-24 D	15 x 18	42	160	13,110	56,000	71,000	10	9	19	10	2400	1500	605	360	250	185	140	110
Luxaveras	10-26 D	16 x 18	42	160	14,920	62,000	78,000	11	0	20	4	2600	1650	670	400	275	205	160	125
Luxaverint.	10-26 D	16 x 20	48	160	14,500	64,000	80,000	11	0	20	4	2600	1700	690	410	285	210	165	130
Luxavit	10-28 D	17 x 20	42	160	18,720	70,000	87,000	11	6	21	3	2800	1875	760	455	315	230	180	145
Luxero.	10-28 D	17 x 22	48	160	18,000	76,000	93,000	11	6	21	3	2800	2000	825	495	345	255	200	160
Luxissent	10-30 D	18 x 20	42	160	20,980	82,000	100,000	12	0	21	9	3000	2200	890	535	370	275	215	170
Luxistis	10-30 D	18 x 22	48	160	20,200	86,000	104,000	12	0	21	9	3000	2300	940	565	390	290	225	180

This type is suitable for passenger, freight, or mixed service, where a locomotive of the American type would not afford sufficient power, or where the requisite weight, if carried on only two pairs of driving wheels, would be greater than the rails could safely bear. The greater length of an engine of this plan admits of a longer boiler, and consequently, greater heating surface.

If the curves are of short radius, the front and rear driving wheels are, preferably, flanged, and the truck made with swing bolster. For lines of easy curvature the middle and rear driving wheels may be flanged and the truck made with rigid center.

Assuming that steel rails, properly supported by crossties, can sustain, as a maximum, a weight per wheel of 3000 pounds for each 10 pounds weight per yard of rail; Classes 10-18 D to 10-22 D can be used on rails of 20 to 30 pounds per yard; and Classes 10-24 D and 10-26 D, 35 to 40 pounds; and Classes 10-28 D and 10-30 D, 40 to 50 pounds.

For remarks on tractive power, see pages 106 to 109.



TEN-WHEELED TYPE LOCOMOTIVE

Eight Coupled Locomotives

Consolidation Type

With Two-Wheeled Leading Trucks, and Separate Tenders

Gauge, 3 Feet 6 Inches, or 1 Metre — Fuel, Bituminous Coal or Wood

CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels Ft.	Ins.	Wheel Base: Total Ft.	Ins.	Capacity of Tender for Water — 8⅓-lb. Gallons	Load in Tons (of 2240 Pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Luxueux	10-24 E	15 x 18	38	160	14,500	58,000	67,000	11	3	17	8	2400	1550	635	385	270	185	150	115
Luxuliane	10-24½ E	15 x 20	38	160	16,100	64,000	73,000	11	10	18	6	2500	1700	705	425	295	220	175	140
Luxuria	10-26 E	16 x 20	42	160	16,580	70,000	79,000	12	3	18	11	2600	1875	765	460	320	240	185	150
Luxuriabit	10-28 E	17 x 20	42	160	18,720	76,000	87,000	13	3	20	1	2800	2025	825	500	350	260	205	165
Luxuriamus	10-30 E	18 x 20	42	160	20,980	83,000	96,000	13	11	20	9	3000	2215	910	545	380	285	225	180
Luxuriance	10-32 E	19 x 22	48	160	22,500	90,000	104,000	14	0	21	6	3200	2425	990	595	415	310	245	195
Luxuriant	10-34 E	20 x 22	48	160	24,930	98,000	112,000	14	0	21	6	3400	2625	1075	650	455	340	265	215

Where adequate adhesion cannot be obtained by the use of a locomotive having only three pairs of driving wheels, without overloading the rails, a locomotive of the Consolidation type, as described above, having the adhesive weight distributed over four pairs of driving wheels, may be employed, to afford the maximum power. In this type of locomotive the front and back pairs of driving wheels have flanged tires, the intermediate pairs have tires without flanges. The pony truck has a swinging bolster and radius bar.

Assuming that steel rails, properly supported by crossties, can sustain, as a maximum, a weight per wheel of 3000 pounds for each 10 pounds weight per yard of rail, Classes 10-24 E and 10-24½ E can be used on rails of 25 to 30 pounds per yard; Classes 10-26 E to 10-30 E, 30 to 35 pounds; Classes 10-32 E and 10-34 E, 40 to 45 pounds. If practicable, however, it is desirable to have rails heavy enough to give a greater factor of strength.

Any of the locomotives described above, with six-wheeled tenders attached, except Classes 10-32 E and 10-34 E, can be constructed to turn on 40 feet turn-tables. Classes 10-32 E and 10-34 E, would require turn-tables 43 feet 6 inches and 45 feet long respectively.

For remarks on tractive power, see pages 106 to 109.

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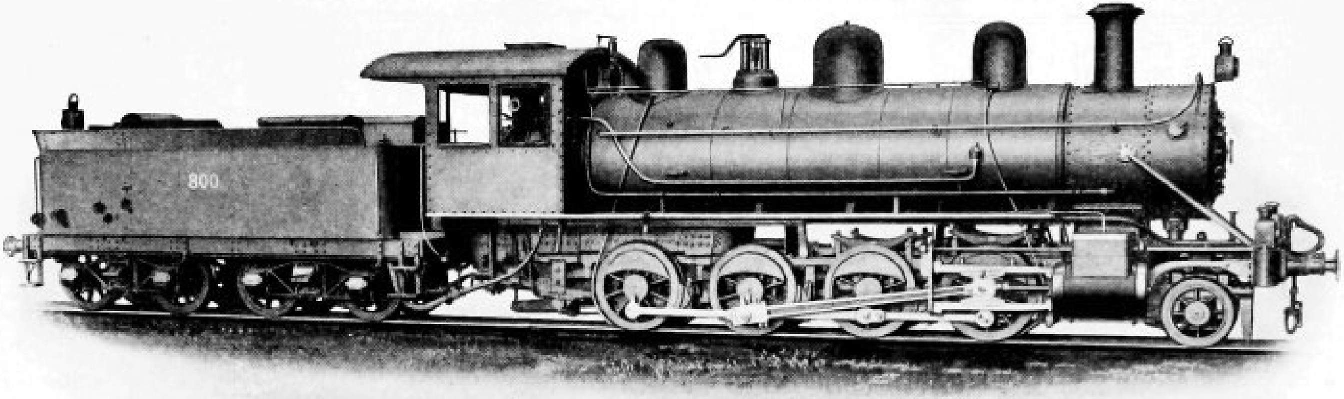


CONSOLIDATION TYPE LOCOMOTIVE

Four Coupled Locomotives

With Saddle or Side Tanks

Gauge, 3 Feet 6 Inches, or 1 Metre — Fuel, Bituminous Coal or Wood

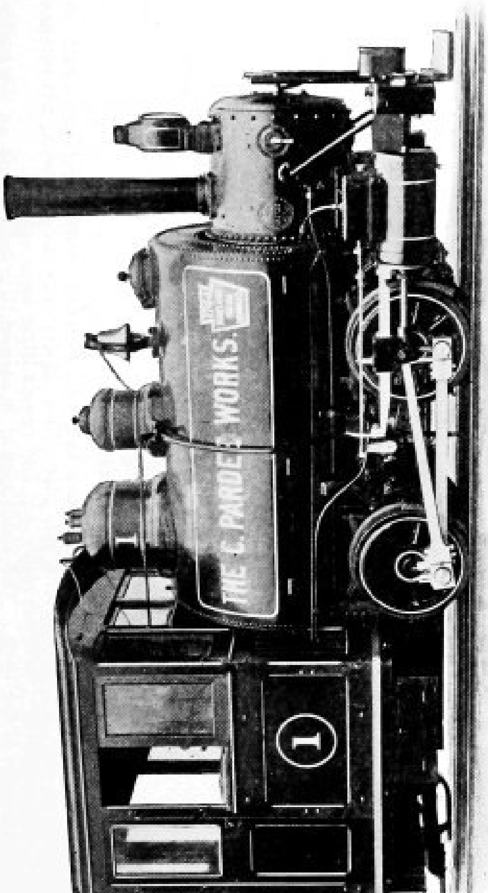
CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order — Pounds	Wheel Base — Ft.	Wheel Base — Ins.	Capacity of Tank for Water — 8⅓-lb. Gallons	Load in Tons (of 2240 Pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Luxuriavis	4-6 C	6 x 12	24	160	2,440	12,000	3	10	110	275	120	75	50	40	30	25
Luxuries	4-8 C	7 x 12	26	160	3,070	14,000	3	10	150	350	145	90	60	45	35	30
Luxurieux	4-10½ C	8 x 12	28	160	3,730	17,000	4	0	200	430	180	110	75	60	45	35
Luxuriosis	4-11 C	9 x 14	30	160	5,140	21,000	4	0	300	500	215	130	90	70	55	45
Luxurioso	4-12 C	9 x 16	33	160	5,340	28,000	5	0	350	650	270	165	115	90	70	60
Luxurists	4-14 C	10 x 16	33	160	6,590	31,000	5	0	400	775	325	200	140	105	85	70
Luxury	4-16 C	11 x 16	33 to 38	160	7,410	36,000	5	6	450	850	350	220	155	120	95	75
Luxus	4-18 C	12 x 16	33 to 38	160	8,820	40,000	5	6	500	980	415	255	180	135	110	90
Luytosa	4-20 C	13 x 18	38 to 42	160	10,350	47,000	6	0	550	1175	495	300	215	165	130	105
Luzbel	4-22 C	14 x 18	38 to 42	160	12,000	54,000	6	6	600	1375	575	350	250	190	155	125
Luzeiro	4-24 C	15 x 20	42 to 48	160	13,600	62,000	7	0	700	1500	640	390	275	210	170	140

This type of locomotive is the simplest for service on short lines, where a sufficient supply of fuel and water can be carried on the engine. It is also suitable for special service in mills, mines, furnaces, plantations, etc. All the weight, being on the driving wheels, is utilized for adhesion, and the maximum load consistent with the weight of the engine can be drawn. Having but two pairs of wheels allows of a wheel base short enough to pass the sharpest curves without difficulty. Engines of this type can be run equally well in either direction.

Assuming that steel rails, properly supported by crossties, can sustain, as a maximum, a weight per wheel of 3000 pounds for each 10 pounds weight per yard of rail, Classes 4-6 C and 4-8 C, can be used on rails of 12 to 16 pounds per yard; Classes 4-10½ C and 4-11 C, 20 pounds; Classes 4-12 C to 4-16 C, 25 to 30 pounds; Classes 4-18 C and 4-20 C, 35 to 40 pounds. If practicable, however, it is desirable to have rails heavy enough to give a greater factor of strength.

For remarks on tractive power, see pages 106 to 109.

$\frac{9}{40}$ and 8, ½ T C.



FOUR COUPLED TANK LOCOMOTIVE

Four Coupled Locomotives

With Two-Wheeled Rear Trucks, and Saddle or Side Tanks

Gauge, 3 Feet 6 Inches, or 1 Metre — Fuel, Bituminous Coal or Wood

CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order. On all Driving Wheels — Pounds	Weight in Working Order. Total — Pounds	Wheel Base. Of Driving Wheels Ft.	Wheel Base. Of Driving Wheels Ins.	Wheel Base. Total Ft.	Wheel Base. Total Ins.	Capacity of Tank for Water. — 8⅓-lb. Gallons	Load in Tons (of 2240 Pounds) of Cars and Lading. On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Luzerner	6-10⅓ C	8 x 12	28	160	3,730	19,000	23,000	3	9	9	7	300	450	180	110	80	60	50	40
Luzerniere	6-11⅓ C	9 x 14	33	160	4,670	23,000	28,000	4	0	10	0	350	550	230	140	100	75	60	50
Luzette	6-12⅓ C	9 x 16	33	160	5,340	27,000	32,000	4	6	10	6	400	625	265	160	115	85	70	55
Luzidio	6-14⅓ C	10 x 16	37	160	5,880	30,000	35,000	5	0	11	8	450	700	290	175	125	95	75	60
Luzimento	6-16⅓ C	11 x 16	37	160	7,110	34,000	40,000	5	0	12	0	500	825	345	210	150	110	90	75
Luzola	6-18⅓ C	12 x 18	42	160	8,390	40,000	47,000	5	8	13	3	600	1000	420	255	180	140	110	90
Luzuriaga	6-20⅓ C	13 x 18	42	160	9,850	47,000	54,000	6	0	14	1	700	1175	490	300	210	160	130	105
Lyncean	6-22⅓ C	14 x 20	48	160	11,100	54,000	62,000	6	6	15	0	800	1350	560	340	240	185	145	120
Lynceorum	6-24⅓ C	15 x 20	48	160	12,750	62,000	70,000	6	6	15	4	900	1550	640	390	275	210	165	135

The driving wheels of this type are equalized together, the truck is center-bearing, with swinging bolster and radius bar. For operating short lines, where a limited supply of water and fuel is sufficient, this plan of locomotive has the following advantages:

Having six wheels it is steady, rides smoothly, without plunging, and causes little wear of track.

The fuel is carried on the engine frames at the back. The water supply is carried in a saddle tank on the boiler or in side tanks on each side of the boiler. The weight of the water adds to the adhesion and increases the hauling capacity. The pony truck carries the weight of the fuel, with part of the weight of the overhanging firebox.

The engine can be run either way without turning, and will readily traverse curves of short radius.

Assuming that steel rails, properly supported by crossties, can sustain, as a maximum, a weight per wheel of 3000 pounds for each 10 pounds weight per yard of rail, Classes 6-10⅓ C and 6-11⅓ C, can be used on rails of 20 pounds per yard; Classes 6-12⅓ C and 6-14⅓ C, 25 to 30 pounds; 6-16⅓ C and 6-18⅓ C, 30 to 35 pounds; 6-20⅓ C and 6-22⅓ C, 40 to 50 pounds; and 6-24⅓ C, 55 to 60 pounds.

For remarks on tractive power, see pages 106 to 109.

$\frac{7}{10}$ and 8, ½ T C.

FOUR COUPLED TANK LOCOMOTIVE WITH TWO-WHEELED REAR TRUCK

Four Coupled Locomotives

Forney Type

With Four-Wheeled Trailing Trucks, and Rear Tanks

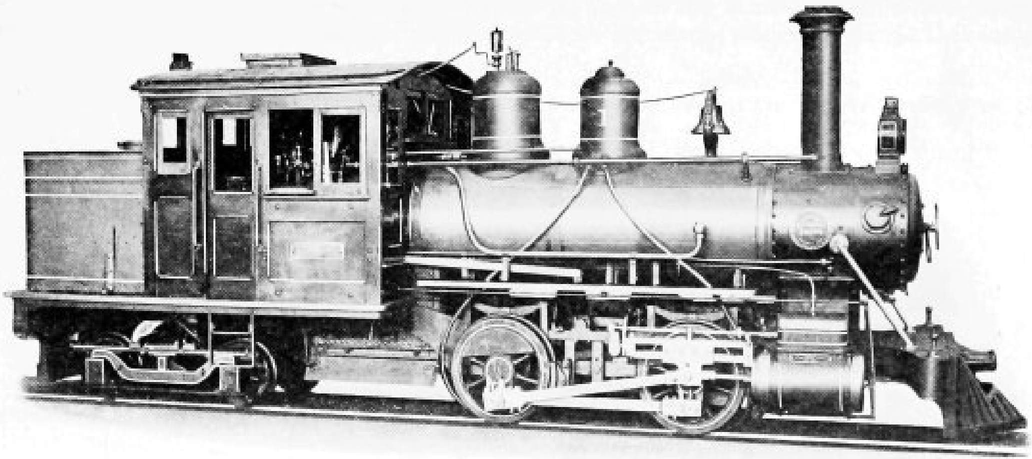
Gauge, 3 Feet 6 Inches, or 1 Metre — Fuel, Bituminous Coal or Wood

CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels — Ft.	Ins.	Wheel Base: Total — Ft.	Ins.	Capacity of Tank for Water — 8⅓-lb. Gallons	Load in Tons (of 2240 pounds) of Cars and Lading: On a Level	On a Grade per Mile of: 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Lyncestium	8-10⅓ C	8 x 12	28	160	3,730	16,000	27,000	3	9	12	9	400	400	175	105	70	55	40	35
Lynched	8-11⅓ C	9 x 14	33	160	4,670	20,000	32,000	4	0	13	0	500	500	220	135	95	70	55	45
Lynching	8-12⅓ C	9 x 16	33	160	5,340	23,000	36,000	4	6	13	9	600	600	250	150	105	80	60	50
Lyncibus	8-14⅓ C	10 x 16	37	160	5,880	26,000	40,000	5	0	15	11	700	685	285	170	120	90	70	55
Lyncida	8-16⅓ C	11 x 16	37	160	7,110	31,000	46,000	5	0	16	3	800	820	345	210	145	110	85	70
Lyncides	8-18⅓ C	12 x 18	42	160	8,390	37,000	53,000	5	8	17	9	900	980	410	250	175	130	105	85
Lyncurios	8-20⅓ C	13 x 18	42	160	9,850	44,000	61,000	6	0	18	8	1000	1180	490	300	210	160	125	100
Lyncurium	8-22⅓ C	14 x 20	48	160	11,100	50,000	68,000	6	6	20	2	1100	1350	555	340	240	180	145	115
Lyntraria	8-24⅓ C	15 x 20	48	160	12,750	56,000	76,000	6	6	20	7	1200	1500	625	380	265	200	160	130
Lynxes	8-26⅓ C	16 x 20	48	160	14,500	62,000	86,000	7	0	22	0	1300	1650	690	420	295	225	175	145

Locomotives of this type are compact and powerful for their aggregate weight, and are suitable for suburban passenger traffic, logging plantation and other service where the run is not long enough to necessitate a separate tender. As the whole weight of the boiler rests on the driving wheels, the adhesion is ample and the starting power great. They are designed to run either forward or backward, but the wear on driving wheel flanges is least when running with truck ahead. The driving wheels are equalized together; the truck is center-bearing and has a swinging bolster. As the weight is carried on two side equalizers between the driving wheels and the center pin of the truck, each wheel finds a bearing, notwithstanding any unevenness of the track. The engine, therefore, rides as smoothly as an eight-wheeled or American type locomotive. Locomotives of this plan readily traverse curves of short radius.

Assuming that steel rails, properly supported by crossties, can sustain, as a maximum, a weight per wheel of 3000 pounds for each 10 pounds weight per yard of rail, Classes 8-10⅓ C and 8-11⅓ C may be used on rails of 20 pounds per yard; Classes 8-12⅓ C to 8-16⅓ C, 25 to 30 pounds; Classes 8-18⅓ C and 8-20⅓ C, 35 to 40 pounds; Classes 8-22⅓ C to 8-26⅓ C, 45 to 55 pounds.

For remarks on tractive power, see pages 106 to 109.



FORNEY TYPE LOCOMOTIVE

Four Coupled Locomotives

With Two-Wheeled Leading Trucks, and Separate Tenders

Gauge, 3 Feet 6 Inches, or 1 Metre — Fuel, Bituminous Coal or Wood

CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels — Ft.	Wheel Base: Of Driving Wheels — Ins.	Wheel Base: Total — Ft.	Wheel Base: Total — Ins.	Capacity of Tender for Water — 8⅓-lb. Gallons	Load in Tons (of 2240 pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Lynxwet . . .	6-10 C	8 x 14	33	160	3,690	16,000	20,000	5	0	10	3	500	420	175	105	75	55	40	35
Lyonnais . .	6-11 C	9 x 14	33	160	4,670	20,000	25,000	5	0	10	8	600	525	220	130	90	70	55	40
Lypornix . .	6-12 C	9 x 16	33	160	5,340	23,000	28,000	5	6	11	2	700	600	250	150	105	80	60	50
Lyprops . .	6-14 C	10 x 16	37	160	5,880	26,000	32,000	5	6	11	7	800	685	285	170	115	90	70	55
Lypsimene . .	6-16 C	11 x 16	37	160	7,110	31,000	37,000	6	0	12	5	1000	830	340	205	140	105	80	65
Lyrcæus . .	6-18 C	12 x 18	42	160	8,390	37,000	44,000	6	0	13	0	1200	980	405	245	170	125	100	80
Lyrcearum . .	6-20 C	13 x 18	42	160	9,850	44,000	52,000	7	0	13	10	1400	1170	480	290	200	150	115	95
Lyrcius . .	6-22 C	14 x 20	48	160	11,100	50,000	59,000	7	6	15	2	1600	1325	540	325	225	170	130	105
Lyréide . .	6-24 C	15 x 20	48	160	12,750	56,000	66,000	7	6	15	2	1800	1500	615	370	260	190	150	120

Locomotives of this plan are suitable for local passenger, switching, logging and special service, where the runs are short and speed moderate. The firebox is placed over the rear axle. This form of firebox is suitable for burning coal or wood. Two pairs of wheels are equalized together, either the two pairs of driving wheels or the front pair of driving wheels with the pony truck. The pony truck has a swinging bolster and radius bar. Engines of this type, owing to the action of the pony truck and the short wheel bases, readily traverse curves of short radius.

Assuming that steel rails, properly supported by crossties, can sustain, as a maximum, a weight per wheel of 3000 pounds for each 10 pounds weight per yard of rail, Classes 6-10 C and 6-11 C, can be used on rails of 20 pounds per yard; Classes 6-12 C, to 6-16 C, 25 to 30 pounds; Classes 6-18 C and 6-20 C, 35 to 40 pounds; Classes 6-22 C and 6-24 C, 45 to 50 pounds.

For remarks on tractive power, see pages 106 to 109.

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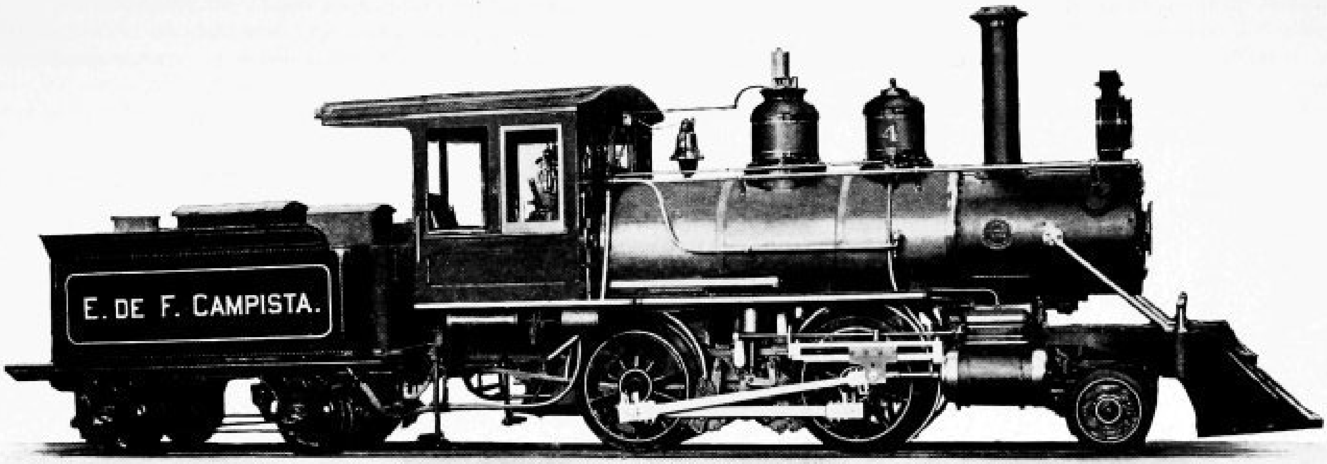


FOUR COUPLED LOCOMOTIVE WITH TWO-WHEELED LEADING TRUCK

Four Coupled Double-Ender Locomotives

With Two-Wheeled Leading and Trailing Trucks, and Saddle or Side Tanks

Gauge, 3 Feet 6 Inches, or 1 Metre — Fuel, Bituminous Coal or Wood

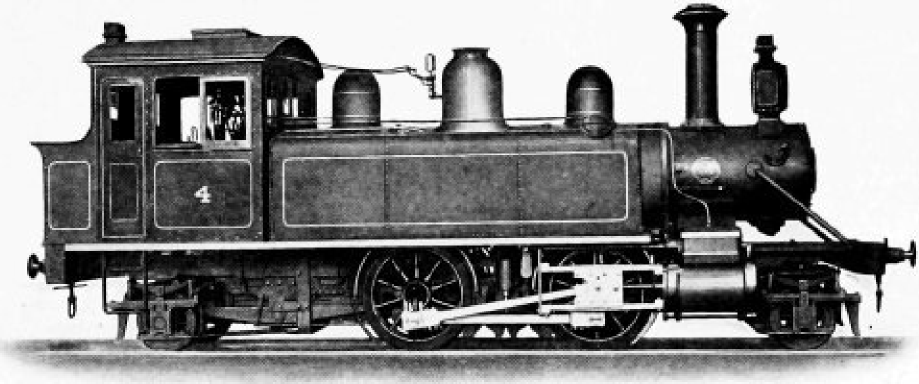
Code Word	Class	Cylinders. Diameter Stroke — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order. On all Driving Wheels — Pounds	Weight in Working Order. Total — Pounds	Wheel Base. Of Driving Wheels — Ft.	Wheel Base. Of Driving Wheels — Ins.	Wheel Base. Total — Ft	Wheel Base. Total — Ins.	Capacity of Tank for Water — 8⅓-lb. Gallons	Load in Tons (of 2240 pounds) of Cars and Lading. On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Lyrichord	8-10¼ C	8 x 12	33 to 37	160	2,980	15,000	26,000	4	3	15	0	350	325	140	85	60	40	30	25
Lyricinis	8-11¼ C	9 x 14	33 to 37	160	4,400	19,000	32,000	4	6	15	7	400	425	185	110	75	55	45	35
Lyricinum	8-12¼ C	9 x 16	37 to 41	160	4,520	22,000	35,000	4	6	15	10	450	500	205	125	85	65	50	40
Lyricism	8-14¼ C	10 x 16	37 to 41	160	5,580	26,000	40,000	5	0	17	8	500	600	250	150	105	75	60	50
Lyricorum	8-16¼ C	11 x 16	37 to 41	160	6,750	30,000	46,000	5	0	18	0	600	725	305	185	130	95	75	60
Lyricos	8-18¼ C	12 x 18	41 to 45	160	8,200	38,000	58,000	5	8	19	7	700	925	385	230	160	120	95	75
Lyricum	8-20¼ C	13 x 18	41 to 45	160	9,620	44,000	66,000	6	0	20	8	800	1050	440	265	185	140	110	85
Lyrifere	8-22¼ C	14 x 20	45 to 48	160	11,500	52,000	76,000	6	6	22	0	900	1275	530	320	225	170	130	105
Lyriforme	8-24¼ C	15 x 20	48	160	12,750	58,000	84,000	6	6	22	6	1000	1450	590	360	250	190	150	120

This type of engine is suitable for suburban passenger, switching and logging service, where it is desirable to run forward and backward without turning, and where the run is not long enough to necessitate a separate tender. The front truck is center-bearing and is equalized with the forward driving wheels. The rear truck is side-bearing and is equalized with the rear driving wheels. The back of the engine is thus carried on two side-bearings at the fulcrums. The engine will, therefore, ride smoothly, and all the wheels find a bearing on the most uneven track. Each truck has a swinging bolster and radius bar and protects the flanges of the driving wheels when curving. The short rigid wheel base of this plan, in proportion to its total wheel base and power, enables it to traverse curves of short radius.

Assuming that steel rails, properly supported by crossties, can sustain, as a maximum, a weight per wheel of 3000 pounds for each 10 pounds weight per yard of rail, Classes 8-10¼ C and 8-11¼ C can be used on rails of 15 to 20 pounds per yard; Classes 8-12¼ C to 8-16¼ C, 20 to 25 pounds; Classes 8-18¼ C and 8-20¼ C, 30 to 40 pounds; Classes 8-22¼ C and 8-24¼ C, 45 to 50 pounds.

For remarks on tractive power, see pages 106 to 109.

$\frac{7}{6}$ and 8, ½ T C.



FOUR COUPLED DOUBLE-ENDER TANK LOCOMOTIVE

Six Coupled Locomotives

With Two-Wheeled Rear Trucks,

and Saddle or Side Tanks

Gauge, 3 Feet 6 Inches, or 1 Metre

Fuel, Bituminous Coal or Wood

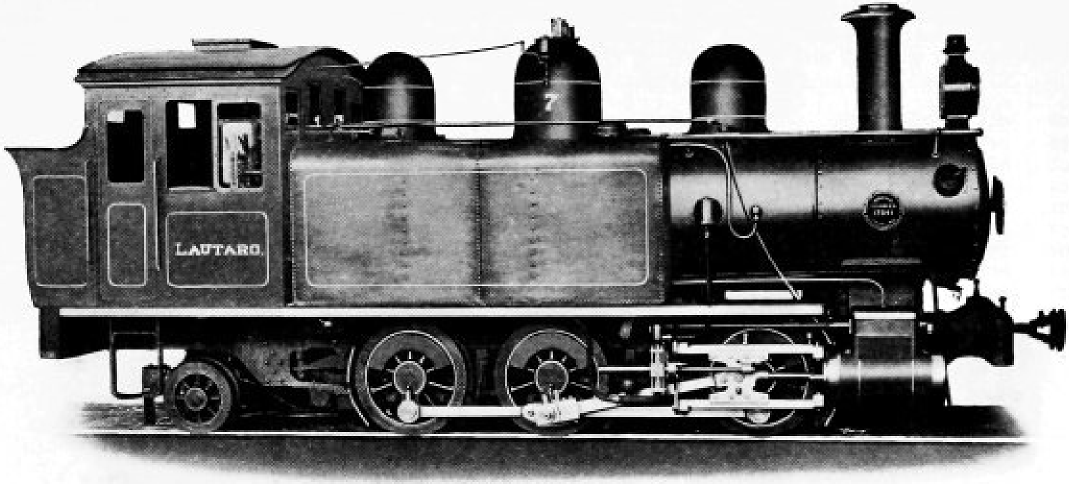
CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels — Ft.	Of Driving Wheels — Ins.	Wheel Base: Total — Ft.	Total — Ins.	Capacity of Tank for Water. — 8⅓-lb. Gallons	Load in Tons (of 2240 Pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Lyrique	8-10⅓ D	8 x 12	28	160	3730	19,000	23,000	5	5	11	3	350	425	175	105	75	55	45	35
Lyrisch	8-11⅓ D	9 x 14	33	160	4670	24,000	28,000	6	6	12	9	400	550	235	140	100	75	60	50
Lyrisches	8-12⅓ D	9 x 16	33	160	5340	26,000	30,500	7	4	13	4	450	600	255	155	110	80	65	55
Lyrisme	8-14⅓ D	10 x 16	38	160	5720	29,000	34,000	7	6	14	2	500	675	275	165	120	90	70	60
Lyristarum	8-16⅓ D	11 x 16	38	160	6920	36,000	42,000	7	9	14	9	550	825	355	215	155	110	90	75
Lyristes	8-18⅓ D	12 x 18	44	160	8010	41,000	47,000	8	8	16	3	600	975	400	245	170	130	105	85
Lyristria	8-20⅓ D	13 x 18	44	160	9400	48,000	55,000	9	0	17	1	700	1125	470	285	200	150	120	100
Lyrnesi	8-22⅓ D	14 x 20	48	160	11100	56,000	63,000	9	5	17	11	800	1350	560	340	240	185	145	120
Lyrnesium	8-24⅓ D	15 x 20	48	160	12750	63,000	71,000	9	7	18	5	900	1525	625	380	270	205	165	135
Lyrnesos	8-24⅓ D	15 x 22	48	160	14020	68,000	77,000	9	10	18	8	950	1625	670	410	290	220	175	145
Lyrnessus	8-26⅓ D	16 x 22	48	160	15950	76,000	86,000	10	0	19	2	1000	1825	760	465	330	250	200	165

Locomotives of this plan are suitable for plantation, logging, or special service, where the runs are not long enough to require a separate tender. The addition of a truck avoids the plunging or galloping motion to which a four-wheeled or six-wheeled tank locomotive is subject when run at more than a moderate speed. The increased space back of the cab also permits of greater fuel capacity and more room for the enginemen than is practicable without the truck. The three pairs of driving wheels are equalized together; the truck is center-bearing, and has a swinging bolster and radius bar.

Assuming that steel rails, properly supported by crossties, can sustain, as a maximum, a weight per wheel of 3000 pounds for each 10 pounds weight per yard of rail, Classes 8-10⅓ D to 8-14⅓ D, can be used on rails of 15 to 20 pounds per yard; Classes 8-16⅓ D and 8-18⅓ D, 20 to 25 pounds; Classes 8-20⅓ D and 8-22⅓ D, 30 to 35 pounds; Class 8-24⅓ D, 40 pounds, and Class 8-26⅓ D, 45 pounds.

For remarks on tractive power, see pages 106 to 109.

8/40 and 8, ½ T C.



SIX COUPLED LOCOMOTIVE WITH TWO-WHEELED REAR TRUCK

Six Coupled Double-Ender Locomotives

With Two-Wheeled Leading and Trailing Trucks,

and Saddle or Side Tanks

Gauge, 3 Feet 6 Inches, or 1 Metre

Fuel, Bituminous Coal or Wood

CODE WORD	Class	Cylinders, Diameter Stroke	Driving Wheels, Diam.	Boiler Pressure	Cylinder Tractive Power	Weight in Working Order		Wheel Base				Capacity of Tank for Water	LOAD IN TONS (OF 2240 POUNDS) OF CARS AND LADING						
						On all Driving Wheels	Total	Of Driving Wheels		Total			On a Level	On a Grade per Mile of					
		Inches	Inches	Pounds per Sq. Inch	Pounds	Pounds	Pounds	Ft.	Ins.	Ft.	Ins.	8⅓-lb. Gallons		26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Lyrophore	10-16¼ D	11 x 16	38	160	6,920	34,000	48,000	8	8	19	6	550	825	340	205	145	110	85	70
Lyrops	10-18¼ D	12 x 18	44	160	8,010	40,000	54,000	9	0	20	8	650	950	400	240	170	125	100	80
Lysandrien	10-20¼ D	13 x 18	44	160	9,400	46,000	62,000	9	4	21	3	700	1125	460	280	200	150	120	95
Lysandro	10-22¼ D	14 x 20	48	160	11,100	56,000	75,000	9	8	22	3	850	1325	555	335	235	180	140	115
Lysanias	10-24¼ D	15 x 20	48	160	12,750	60,000	80,000	9	9	22	2	900	1500	620	380	265	200	160	130
Lysantem	10-24¼ D	15 x 22	48	160	14,020	66,000	88,000	10	0	23	3	1000	1650	690	420	295	225	175	145
Lysantis	10-26¼ D	16 x 22	48	160	15,950	72,000	96,000	11	0	24	6	1100	1800	745	450	320	240	190	155
Lysas	10-28¼ D	17 x 22	48	160	18,000	80,000	104,000	11	0	24	10	1200	2015	835	510	360	270	215	175
Lysiaci	10-30¼ D	18 x 22	48	160	20,200	90,000	114,000	12	0	26	0	1300	2275	935	570	405	305	245	200

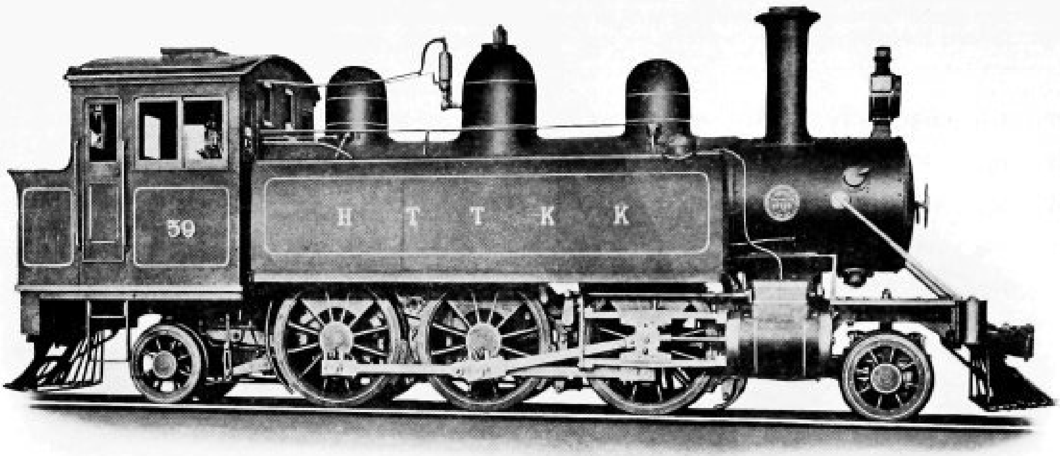
This plan is suitable for suburban passenger or local freight service, where it is desirable to run forward or backward without turning, and where an engine with only two pairs of driving wheels, but otherwise of the same design, would not afford adequate adhesion, or where the required weight, if carried by only two pairs of driving wheels, would be greater than the rails could safely bear. It has the following advantages:

The forward truck is equalized with the forward pair of driving wheels, and the middle and rear pairs of driving wheels are equalized with the rear truck. The front truck is center-bearing; the trailing truck is side-bearing. Each truck has a swinging bolster and radius bar. This arrangement enables the engine to ride smoothly and find a bearing on the most uneven track. The truck guides the engine around curves and relieves the flanges of the driving wheels of excessive friction.

Assuming that steel rails, properly supported by crossties, can sustain, as a maximum, a weight per wheel of 3000 pounds for each 10 pounds weight per yard of rail, Classes 10-16¼ D and 10-18¼ D can be used on rails of 20 to 25 pounds per yard; Classes 10-20¼ D and 10-22¼ D, 30 to 35 pounds; Classes 10-24¼ D to 10-26¼ D, 35 to 40 pounds; Classes 10-28¼ D and 10-30¼ D, 45 to 50 pounds.

For remarks on tractive power, see pages 106 to 109.

$\frac{9}{16}$ and 8, ¼ T C.



SIX COUPLED DOUBLE-ENDER TANK LOCOMOTIVE

Eight Coupled Double-Ender Locomotives

With Two-Wheeled Leading and Trailing Trucks, and Saddle or Side Tanks

Gauge, 3 Feet 6 Inches, or 1 Metre

Fuel, Bituminous Coal or Wood

ODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order. On all Driving Wheels — Pounds	Weight in Working Order. Total — Pounds	Wheel Base. Of Driving Wheels Ft.	Ins.	Wheel Base. Total Ft.	Ins.	Capacity of Tank for Water. — 8⅓-lb. Gallons	Load in Tons (of 2240 Pounds) of Cars and Lading. On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Lysiacos	12-26¼ E	16 x 20	42	160	16,580	76,000	98,000	12	3	25	0	1100	1800	745	450	315	240	190	155
Lysiacum	12-28¼ E	17 x 20	42	160	18,720	83,000	106,000	12	6	26	0	1200	1975	810	490	345	260	205	170
Lysiades	12-30¼ E	18 x 20	42	160	20,980	91,000	117,000	13	2	27	8	1300	2150	890	540	380	285	225	185
Lysianasse	12-32¼ E	19 x 22	48	160	22,500	98,000	127,000	13	10	29	0	1400	2325	955	580	405	305	245	200
Lysianax	12-34¼ E	20 x 22	48	160	24,930	106,000	139,000	14	6	30	6	1500	2500	1030	625	440	330	265	215

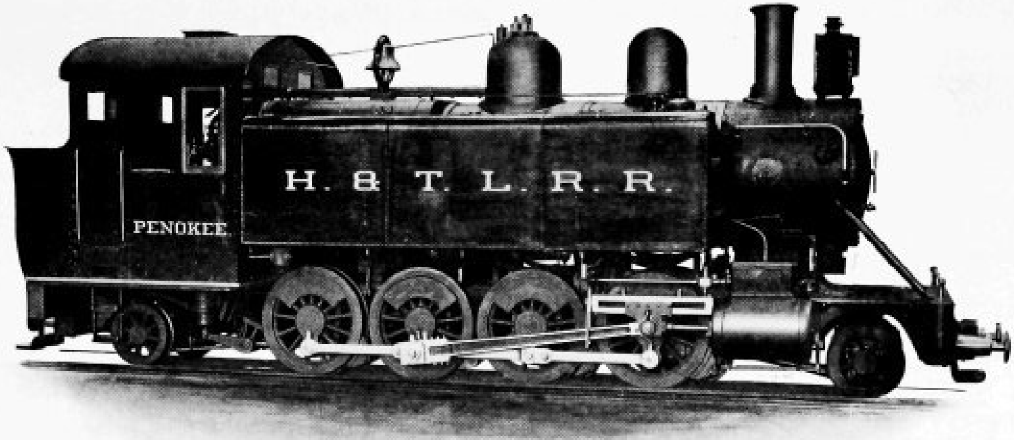
This type is suitable for local freight service, where it is desirable to run forward or backward without turning, and where an engine with only three pairs of driving wheels, but otherwise of the same design, would not afford adequate adhesion, or, where the required weight, if carried by only three pairs of driving wheels, would be greater than the rails could safely bear. It has the following advantages:

The forward truck is equalized with the two forward pairs of driving wheels, and the rear truck is equalized with the two rear pairs of driving wheels. The front truck is center-bearing; the trailing truck is side-bearing. Each truck has a swinging bolster and radius bar. This arrangement enables the engine to ride smoothly and find a bearing on the most uneven track. The trucks guide the engine around curves and relieve the flanges of the driving wheels of excessive friction.

Assuming that steel rails, properly supported by crossties, can sustain, as a maximum, a weight per wheel of 3000 pounds for each 10 pounds weight per yard of rail, Classes 12-26¼ E and 12-28¼ E can be used on rails of 35 to 40 pounds per yard; and Classes 12-30¼ E to 12-34¼ E, 40 to 45 pounds.

For remarks on tractive power, see pages 106 to 109.

2/10 and 8, ¼ T C.



EIGHT COUPLED DOUBLE-ENDER TANK LOCOMOTIVE

Six Coupled Locomotives

With Saddle or Side Tanks

Gauge, 3 Feet 6 Inches, or 1 Metre

Fuel, Bituminous Coal or Wood

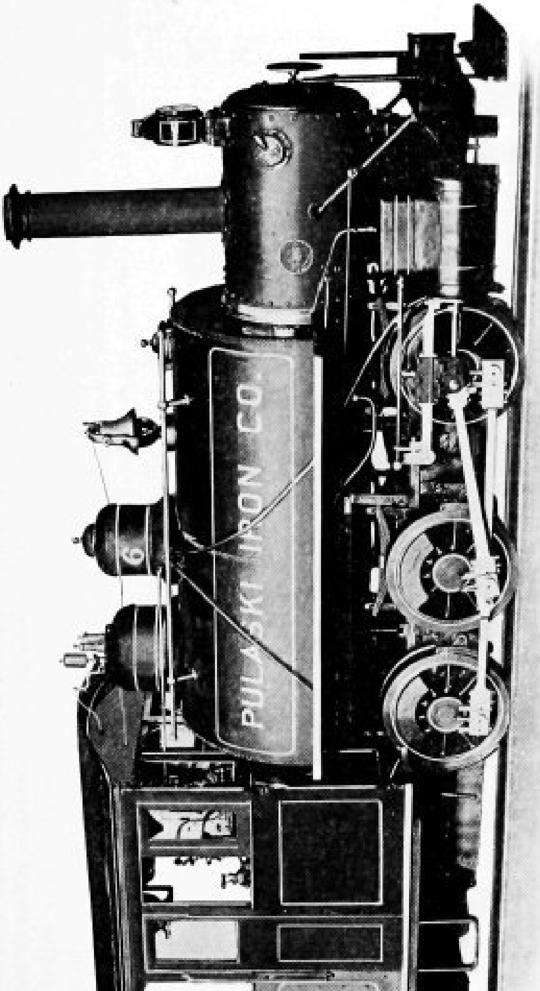
CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order. — Pounds	Wheel Base — Ft.	Wheel Base — Ins.	Capacity of Tank for Water. — 8⅓-lb. Gallons	Load in Tons (of 2240 pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Lysidicus	6-8 D	7 x 10	22	160	3,030	14,000	4	10	200	325	145	85	60	45	35	30
Lysidis	6-10 D	8 x 12	28	160	3,730	18,000	5	5	250	425	180	110	75	60	50	40
Lysikles	6-11 D	9 x 14	30	160	5,140	24,000	6	3	300	600	250	150	105	80	65	50
Lysimache	6-12 D	9 x 16	33	160	5,340	26,000	6	11	350	650	270	165	115	90	70	55
Lysimachia	6-14 D	10 x 16	33	160	6,590	31,000	7	6	400	750	315	190	135	105	85	70
Lysimachos	6-16 D	11 x 16	33 to 38	160	7,410	35,000	7	8	450	825	350	215	150	115	90	75
Lysimaque	6-18 D	12 x 18	38 to 42	160	8,810	42,000	8	6	500	1025	430	260	185	140	115	90
Lysimelia	6-20 D	13 x 20	38 to 42	160	11,500	51,000	9	0	600	1300	540	330	235	175	140	115
Lysimetre	6-22 D	14 x 20	38 to 42	160	13,350	58,000	10	0	700	1500	610	375	265	200	160	130
Lysineme	6-24 D	15 x 22	42 to 48	160	15,000	68,000	10	6	800	1700	710	435	310	235	190	155
Lysinia	6-26 D	16 x 22	42 to 48	160	17,000	78,000	11	0	1000	1900	800	490	350	265	215	175

This type is suitable for switching, logging, or plantation service, where short runs render a tender unnecessary, or, where the weight of the engine, if carried on only two pairs of wheels, would be greater than the rails could bear.

Assuming that steel rails, properly supported by crossties, can sustain, as a maximum, a weight per wheel of 3000 pounds for each 10 pounds weight per yard of rail, Classes 6-8 D and 6-10 D can be used on rails of 10 to 12 pounds per yard; Classes 6-11 D and 6-12 D, 15 to 20 pounds; Classes 6-14 D to 6-18 D, 20 to 25 pounds; 6-20 D and 6-22 D, 30 to 35 pounds; 6-24 D and 6-26 D, 40 to 45 pounds. If practicable, however, it is desirable to have rails heavy enough to give a greater factor of strength.

For remarks on tractive power, see pages 106 to 109.

$\frac{4}{40}$ and 8, ½ T C.



SIX COUPLED TANK LOCOMOTIVE

Six Coupled Locomotives

With Separate Tenders

Gauge, 3 Feet 6 Inches, or 1 Metre

Fuel, Bituminous Coal or Wood

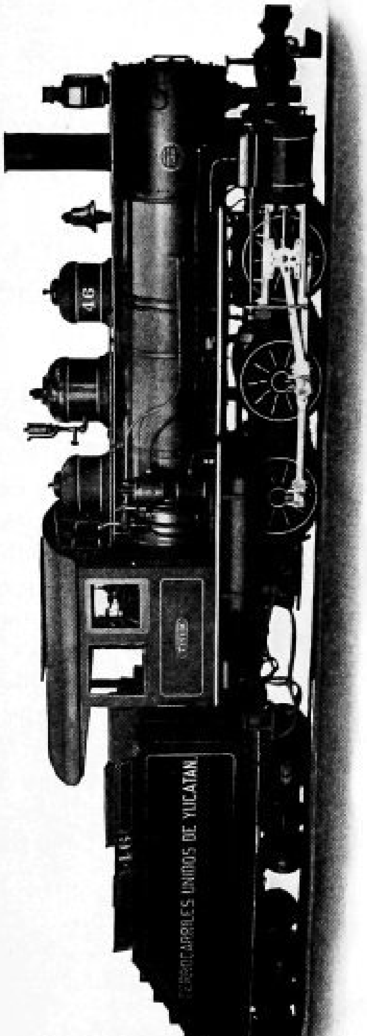
CODE WORD	Class	Cylinders. Diameter Stroke — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order — Pounds	Wheel Base — Ft.	Wheel Base — Ins.	Capacity of Tender for Water — 8⅓-lb. Gallons	Load in Tons (of 2240 pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Lysipome	6-8 D	7 x 10	22	160	3,030	12,000	4	10	400	300	130	80	55	40	30	25
Lysippe	6-10 D	8 x 12	28	160	3,730	16,000	5	5	500	400	175	105	75	55	45	35
Lysippos	6-11 D	9 x 14	30	160	5,140	21,000	6	3	550	550	230	140	95	75	55	45
Lysippum	6-12 D	9 x 16	33	160	5,340	23,000	6	11	600	600	255	155	105	80	65	50
Lysitani	6-14 D	10 x 16	33	160	6,590	27,000	7	6	1000	700	295	180	125	95	75	60
Lysithides	6-16 D	11 x 16	33 to 38	160	7,410	31,000	7	8	1100	800	340	205	135	105	85	65
Lysithoe	6-18 D	12 x 18	38 to 42	160	8,810	37,000	8	6	1200	975	410	245	170	130	100	80
Lysithous	6-20 D	13 x 20	38 to 42	160	11,500	45,000	9	0	1400	1200	495	300	210	155	125	100
Lysmate	6-22 D	14 x 20	38 to 42	160	13,350	52,000	10	0	1500	1400	575	345	245	185	145	115
Lystreni	6-24 D	15 x 22	42 to 48	160	15,000	60,000	10	6	1600	1600	665	400	280	210	170	135

This type is suitable for switching, logging, plantation, or mixed service. It is especially suitable where the conditions make it advisable to distribute the weight over more than two pairs of driving wheels. In the heavier classes of narrow-gauge switching engines, the six-wheeled type, with tender, is preferable, to avoid raising the center of gravity. The separate tender is somewhat more convenient, and as it affords a greater supply of fuel and water than a tank engine, longer runs are permissible. The water capacity of the tender mentioned for the respective classes is generally found sufficient, but it can be varied to suit special requirements.

Assuming that steel rails, properly supported by crossties, can sustain, as a maximum, a weight per wheel of 3000 pounds for each 10 pounds weight per yard of rail, Classes 6-8 D and 6-10 D can be used on rails of 10 pounds per yard; Classes 6-11 D to 6-14 D, 12 to 15 pounds; Classes 6-16 D to 6-20 D, 20 to 25 pounds; Classes 6-22 D to 6-24 D, 30 to 35 pounds.

For remarks on tractive power, see pages 106 to 109.

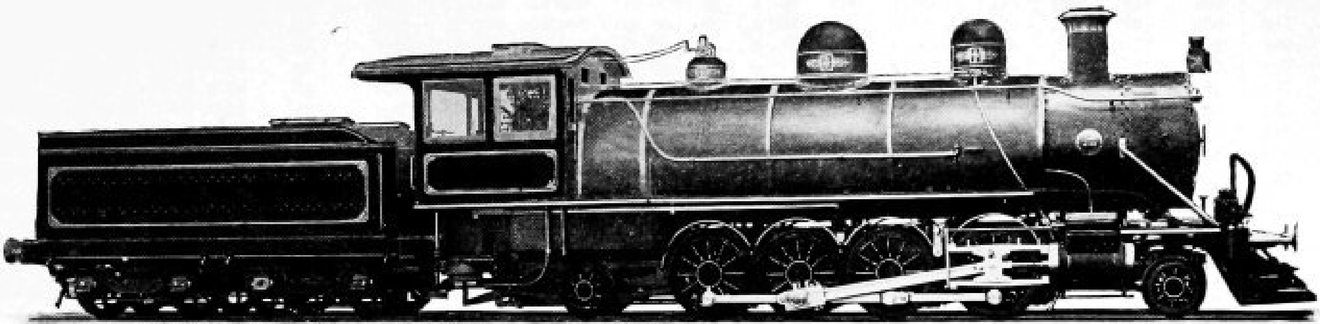
$\frac{2}{40}$ and 8, T x 20



SIX COUPLED LOCOMOTIVE

Special Conditions of Service

THE locomotives described in the foregoing tables comprise designs adapted to the conditions of service usually prevailing, and the dimensions of boilers and fireboxes are generally based upon the presumption that the fuel will be coal of ordinarily good quality. Any of these designs can, however, be modified to meet unusual requirements, and on pages 133 and 161 locomotives are shown having enlarged grate areas adapted for inferior coal. Trials of these locomotives having such special designs of fireboxes and grates show that excellent results are obtained with coal ordinarily considered unsuitable for such use. To determine the suitability of any fuel for locomotives, a small quantity of same may be sent to the Baldwin Locomotive Works for analysis and laboratory tests, when, if practicable, specifications and designs will be submitted for locomotives guaranteed to meet the conditions thus ascertained.



FREIGHT LOCOMOTIVE WITH LARGE FIREBOX

Four Coupled Locomotives with Four-Wheeled Leading Trucks

American Type

With Fireboxes between Driving Axles, and Separate Tenders

Gauge, 4 Feet 8½ Inches

Fuel, Bituminous Coal or Wood

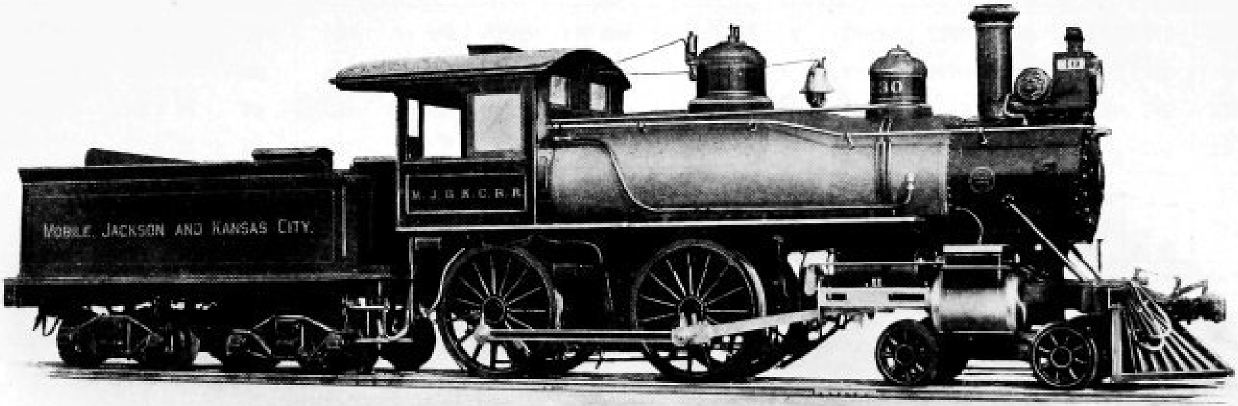
CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels Ft.	Wheel Base: Of Driving Wheels Ins.	Wheel Base: Total Ft.	Wheel Base: Total Ins.	Capacity of Tender for Water — 8⅓-lb. Gallons.	Load in Tons (of 2240 Pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Meddlesome	8-14 C	10 x 20	50	160	5,440	24,000	38,000	5	6	16	4	1400	580	250	145	100	70	55	40
Medeamur	8-16 C	11 x 22	50	160	7,240	31,000	48,000	6	5	18	4	1600	775	340	200	135	100	75	60
Medebar	8-18 C	12 x 22	50	160	8,610	35,000	54,000	6	6	19	1	1800	885	385	230	155	115	85	65
Medebidden	8-20 C	13 x 22	50	160	10,110	42,000	64,000	7	0	20	5½	2000	1065	465	275	190	140	105	80
Medebijten	8-22 C	14 x 22	56	160	10,480	47,000	75,000	7	8	21	3½	2200	1125	490	290	195	145	110	85
Medebimur	8-24 C	15 x 24	62	160	11,850	52,000	80,000	8	0	21	9	2500	1270	555	330	225	165	125	95
Medeblaten	8-26 C	16 x 24	62	160	13,480	58,000	90,000	8	6	22	9	2800	1450	635	375	255	190	145	110
Medeboeler	8-28 C	17 x 24	62	160	15,220	67,000	104,000	9	1	23	1	3000	1635	715	425	290	215	160	125
Medeborg	8-30 C	18 x 24	66	170	17,030	73,000	116,000	9	1	24	3½	3500	1830	800	475	325	235	180	140

This type is suitable for general road service, where a separate tender is required, and where the weight necessary for adhesion can be carried on two pairs of driving wheels.

The total wheel base of engine and tender, varies from approximately 36 feet for Class 8-14 C, to 47 feet for Class 8-30 C. From 18 inches to 2 feet should be added, to give the minimum length of turn-table required.

For remarks on tractive power, see pages 106 to 109.

9/16 and 8, T x 20



AMERICAN TYPE LOCOMOTIVE WITH FIREBOX BETWEEN DRIVING AXLES

Four Coupled Locomotives with Four-Wheeled Leading Trucks

American Type

With Fireboxes above Rear Driving Axles,

and Separate Tenders

Gauge, 4 Feet 8½ Inches

Fuel, Bituminous Coal

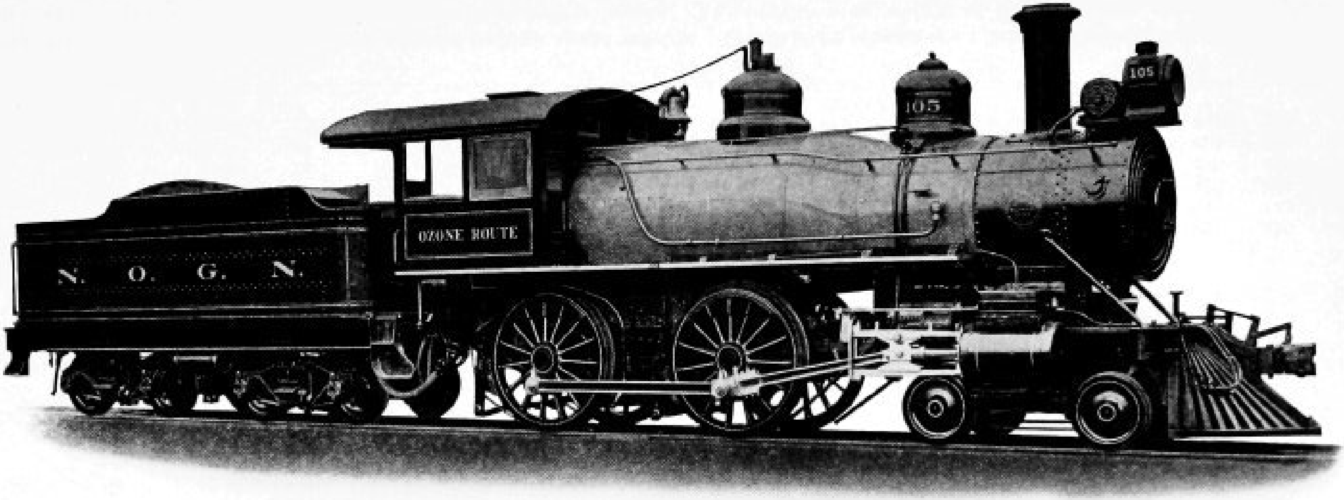
CODE WORD	Class	Cylinders. Diameter Stroke — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels — Ft.	Ins.	Wheel Base: Total — Ft.	Ins.	Capacity of Tender for Water — 8⅓-lb. Gallons	Load in Tons (of 2240 Pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Medebraden .	8-28 C	17 x 24	66	180	16,080	72,000	105,000	7	6	21	5	3500	1730	755	445	305	225	170	130
Medeburger. .	8-30 C	18 x 24	66	180	18,020	80,000	116,000	7	6	21	6	4000	1935	850	505	345	250	190	150
Medecin.	8-32 C	19 x 24	66	180	20,070	85,000	128,000	8	0	22	11	4500	2150	940	555	380	280	210	165
Mededansen .	8-34 C	20 x 24	66	180	22,260	92,000	136,000	8	6	23	4	5000	2330	1020	605	410	300	230	180

In this type sufficient grate area is secured by extending the firebox over the rear driving axle, thus avoiding excessive spread of driving wheels. These engines are particuarly suitable for coal burning.

The total wheel base of engine and tender varies from approximately 48 feet for Class 8-28 C, to 53 feet for Class 8-34 C. From 18 inches to 2 feet should be added, to give the minimum length of turn-table admissible.

For remarks on tractive power, see pages 106 to 109.

$\frac{2}{46}$ and 8, T x 20.



AMERICAN TYPE LOCOMOTIVE WITH FIREBOX ABOVE REAR DRIVING AXLE

Four Coupled Locomotives

Atlantic Type

With Four-Wheeled Leading Trucks, One Pair of Trailing Wheels, and Separate Tenders

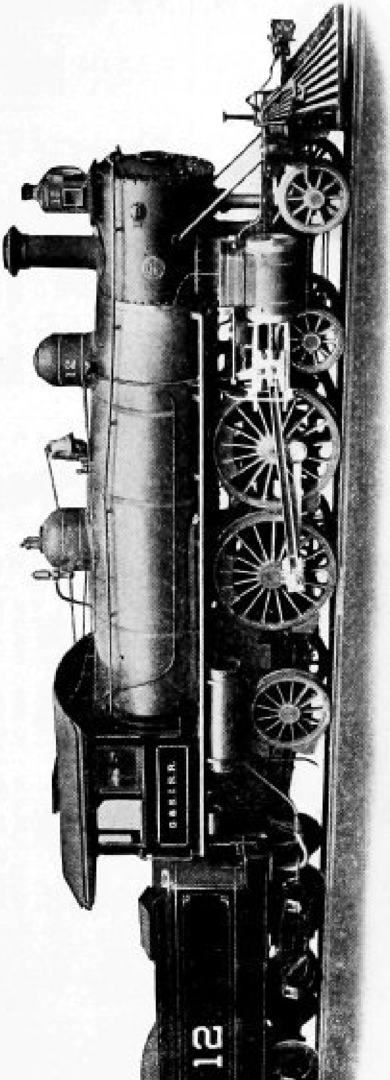
Gauge, 4 Feet 8½ Inches | Fuel, Bituminous Coal

CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels — Ft.	Wheel Base: Of Driving Wheels — Ins.	Wheel Base: Total — Ft.	Wheel Base: Total — Ins.	Capacity of Tender for Water — 8⅓-lb. Gallons.	Load in Tons (of 2240 Pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Mededingen...	10-30¼ C	18 x 24	68	180	17,500	70,000	126,000	6	0	23	6	4500	1750	760	440	295	210	160	120
Mededoen.....	10-32¼ C	19 x 24	72	180	18,410	74,000	132,000	6	3	23	8	5000	1850	800	465	310	225	165	125
Mededraven ..	10-34¼ C	20 x 26	78	180	20,400	88,000	159,000	6	9	26	0	5500	2175	940	550	370	265	195	150
Medegaan.....	10-36¼ C	21 x 26	78	180	22,490	95,000	178,000	7	0	27	0	6000	2380	1030	600	400	290	215	160
Medegast......	10-36¼ C	21 x 26	78	200	25,000	105,000	184,000	7	0	27	3	6000	2650	1150	675	455	330	250	190
Medegegaan ..	10-36¼ C	21 x 28	78	200	26,920	111,000	198,000	7	6	30	6¼	6000	2800	1215	715	485	350	265	205

Locomotives of this type are especially adapted to high speed service. The driving wheels are placed in front of the firebox, which can thus be made of ample depth without raising the boiler to an excessive height. The overhanging weight of the firebox is carried by a pair of trailing wheels. The driving wheels are closely coupled, thus affording the use of a short coupling rod, which is an important consideration when running at high speed.

The total wheel base of engine and tender varies from approximately 51 feet for Class 10-30¼ C, to 56 feet for Class 10-36¼ C. From 18 inches to 2 feet should be added, to give minimum length of turn-table admissible.

For remarks on tractive power, see pages 106 to 109.



ATLANTIC TYPE LOCOMOTIVE

Six Coupled Locomotives with Two-Wheeled Leading Trucks

Mogul Type

With Fireboxes between Main and Rear Driving Axles,

and Separate Tenders

Gauge, 4 Feet 8½ Inches

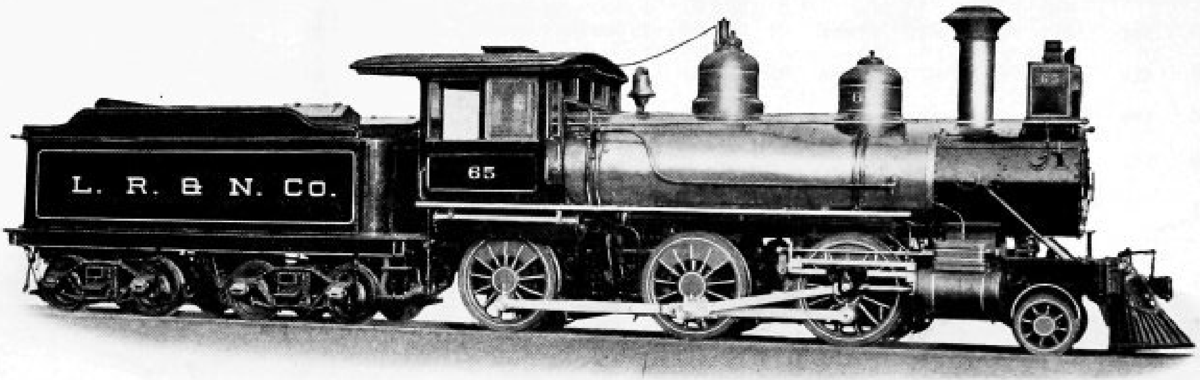
Fuel, Bituminous Coal or Wood

CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order. On all Driving Wheels — Pounds	Weight in Working Order. Total — Pounds	Wheel Base. Of Driving Wheels — Ft.	Wheel Base. Of Driving Wheels — Ins.	Wheel Base. Total — Ft.	Wheel Base. Total — Ins.	Capacity of Tender for Water. — 8⅓-lb. Gallons	Load in Tons (of 2240 Pounds) of Cars and Lading. On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Medegenoot...	8-16 D	11 x 18	37	160	8,000	34,000	42,000	9	4	15	6	1600	865	380	230	155	115	90	70
Medegeven ...	8-18 D	12 x 18	37	160	9,520	39,000	48,000	10	0	16	2	1800	995	440	260	180	135	105	85
Medegooien...	8-20 D	13 x 20	42	160	10,930	46,000	56,000	12	0	18	10	2000	1175	520	310	215	160	125	100
Medegraven...	8-22 D	14 x 22	44	160	13,320	54,000	64,000	12	0	18	10	2200	1380	610	370	255	190	150	120
Medehelpen...	8-24 D	15 x 24	50	160	14,680	62,000	74,000	13	2	20	6	2500	1585	700	420	295	220	170	135
Medehulp.....	8-26 D	16 x 24	50	170	17,770	74,000	89,000	14	6	21	10	2800	1895	840	510	350	260	205	165
Medejagen....	8-28 D	17 x 24	50	170	20,040	82,000	100,000	15	0	22	8	3000	2095	935	563	390	290	230	185
Medejassen...	8-30 D	18 x 24	50	170	22,460	90,000	108,000	15	0	22	8	3500	2300	1020	615	430	320	250	200
Medekampen.	8-32 D	19 x 24	54	170	23,180	96,000	115,000	15	2	23	6	4000	2450	1085	655	455	340	265	210

Locomotives of the Mogul type are particularly suitable for freight service. The engines described above are provided with deep fireboxes which may be adapted for bituminous coal or wood as fuel. The leading truck has a swinging bolster and radius bar, and is equalized with the driving wheels.

The total wheel base of engine and tender, varies from approximately 36 feet for Class 8-16 D, to 47 feet for Class 8-32 D. From 18 inches to 2 feet should be added, to give minimum length of turn-table admissible.

For remarks on tractive power, see pages 106 to 109.



MOGUL TYPE LOCOMOTIVE WITH FIREBOX BETWEEN DRIVING AXLES

Six Coupled Locomotives with Two-Wheeled Leading Trucks

Mogul Type

With Fireboxes above Rear Driving Axles,
and Separate Tenders

Gauge, 4 Feet 8½ Inches

Fuel, Bituminous Coal

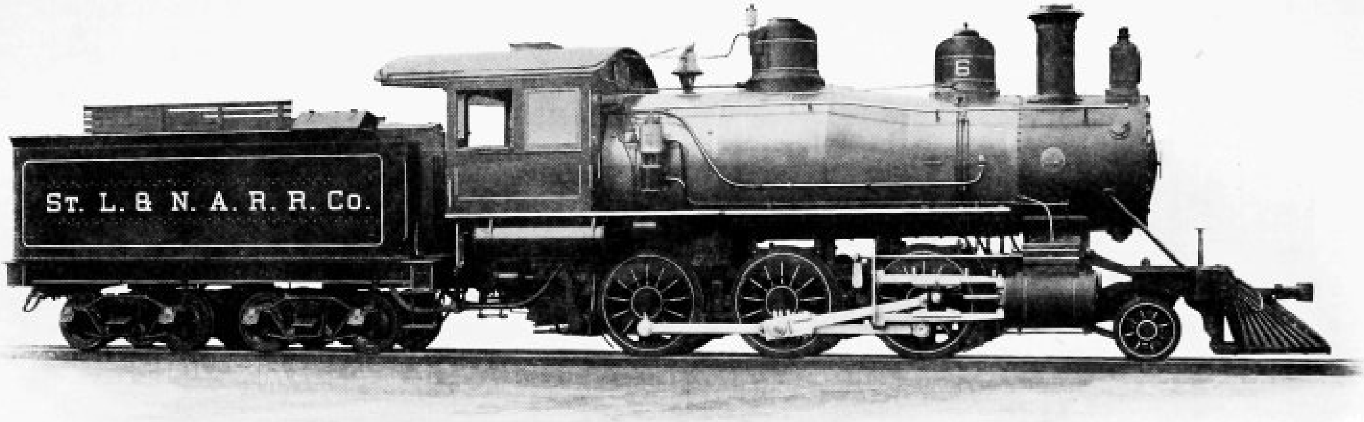
CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels Ft.	Wheel Base: Of Driving Wheels Ins.	Wheel Base: Total Ft.	Wheel Base: Total Ins.	Capacity of Tender for Water. — 8⅓-lb. Gallons	Load in Tons (of 2240 pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Medekeffen . .	8-26 D	16 x 24	54	180	17,400	75,000	90,000	11	10	19	7	3000	1890	835	505	350	260	205	160
Medeklagen . .	8-28 D	17 x 24	54	180	19,650	84,000	100,000	11	10	19	7	3500	2135	945	570	395	295	230	185
Medeklank	8-30 D	18 x 24	54	180	22,040	92,000	108,000	12	6	19	9	4000	2350	1040	625	435	325	250	200
Medeknecht . . .	8-32 D	19 x 24	56	180	23,680	104,000	121,000	12	0	20	3	4000	2570	1140	685	475	355	275	220
Medekolven . . .	8-34 D	20 x 24	56	180	26,220	115,000	132,000	13	0	21	4	5000	2850	1260	755	525	390	305	240
Medekomen . . .	8-34 D	20 x 26	56	200	31,570	130,000	147,000	14	0	22	5	5500	3325	1475	890	620	465	360	290
Medela	8-36 D	21 x 28	62	200	33,850	138,000	160,000	15	2	23	3	6000	3525	1565	940	655	490	380	305

These locomotives have comparatively long and shallow fireboxes, which are suitable for coal burning, but not well adapted to the use of wood.

The total wheel base of engine and tender, varies from approximately 46 feet for Class 8-26 D, to 52 feet for Class 8-36 D. From 18 inches to 2 feet should be added, to give minimum length of turn-table admissible.

For remarks on tractive power, see pages 106 to 109.

2/40 and 8, T x 20.



MOGUL TYPE LOCOMOTIVE WITH FIREBOX ABOVE REAR DRIVING AXLE

Six Coupled Locomotives

Prairie Type

With Two-Wheeled Leading and Trailing Trucks,

and Separate Tenders

Gauge, 4 Feet 8½ Inches

Fuel, Bituminous Coal

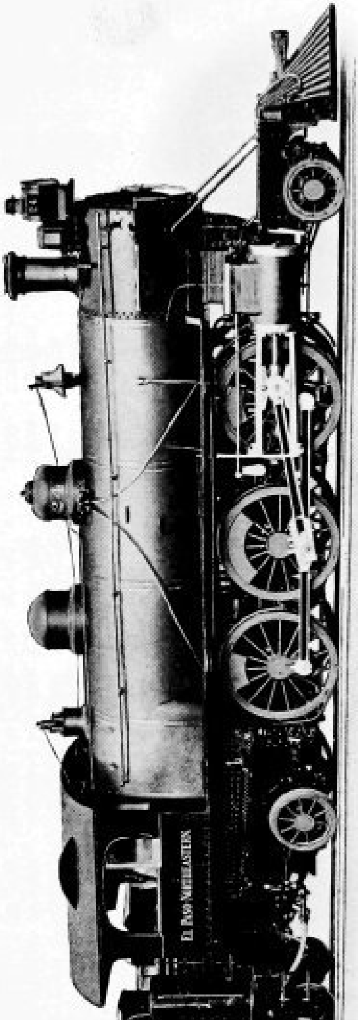
CODE WORD	Class	Cylinders. Diameter Stroke — Inches	Driving Wheels Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels — Ft.	Wheel Base: Of Driving Wheels — Ins.	Wheel Base: Total — Ft.	Wheel Base: Total — Ins.	Capacity of Tender for Water — 8⅓-lb. Gallons	Load in Tons (of 2240 Pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Medelachen...	10-30¼ D	18 x 26	62	180	20,790	95,000	135,000	11	9	27	1	4500	2240	980	580	395	290	220	175
Medeladen....	10-32¼ D	19 x 26	62	180	23,160	102,000	152,000	12	0	28	0	5000	2500	1095	645	440	325	245	195
Medelarum....	10-34¼ D	20 x 26	62	180	25,670	110,000	164,000	12	0	28	0	5500	2770	1215	725	495	365	280	220
Medeleeren....	10-36¼ D	21 x 28	68	180	27,700	125,000	185,000	13	4	31	6	6000	3000	1310	775	530	390	295	230
Medelezers....	10-38¼ D	22 x 28	68	180	30,490	132,000	200,000	13	6	32	0	6000	3300	1445	860	590	430	330	260
Medelid......	10-38¼ D	22 x 30	68	200	36,300	150,000	218,000	13	0	30	9	7000	3800	1675	1000	685	505	390	305

This type is suitable for fast freight or heavy passenger service. The firebox is placed back of the rear driving wheels, and a large grate area is readily secured. Both trucks have radius bars, so that curves are traversed without difficulty.

The total wheel base of engine and tender varies from approximately 52 feet for Class 10-30¼ D, to 63 feet for Class 10-38¼ D. From 18 inches to 2 feet should be added to give minimum length of turn-table admissible.

For remarks on tractive power, see pages 106 to 109.

$\frac{2}{48}$ and 8, T x 20.



PRAIRIE TYPE LOCOMOTIVE

Six Coupled Locomotives with Four-Wheeled Leading Trucks

Ten-Wheeled Type

With Fireboxes between Main and Rear Driving Axles,

and Separate Tenders

Gauge, 4 Feet 8½ Inches

Fuel, Bituminous Coal or Wood

CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels — Ft.	Wheel Base: Of Driving Wheels — Ins.	Wheel Base: Total — Ft.	Wheel Base: Total — Ins.	Capacity of Tender for Water. — 8⅓-lb. Gallons	Load in Tons (of 2240 pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Medelokken	10-20 D	13 x 20	42	160	10,930	45,000	60,000	10	8	19	8	2000	1145	505	300	205	155	120	95
Medeloopen	10-22 D	14 x 22	44	160	13,320	56,000	75,000	11	3	20	9	2200	1425	630	375	260	195	150	120
Medemaaien	10-24 D	15 x 24	50	160	14,680	60,000	85,000	12	6	22	7¾	2500	1525	675	400	275	205	160	125
Medemakker	10-26 D	16 x 24	56	170	15,850	68,000	96,000	12	10	22	11¾	2800	1710	755	450	315	235	180	140
Medemauwen	10-28 D	17 x 24	56	170	17,900	74,000	105,000	12	10	22	11¾	3000	1885	830	495	340	255	195	155
Medemensch	10-30 D	18 x 24	56	170	20,060	82,000	112,000	13	10	24	0¾	3500	2090	920	550	380	280	220	175
Medendam	10-32 D	19 x 24	56	170	22,360	95,000	127,000	14	0	24	9	4000	2420	1070	640	445	430	255	205

Locomotives of the ten-wheeled type are suitable for passenger, freight or mixed service, where a four coupled engine would not afford sufficient power, or where the necessary weight, if carried on only two pairs of driving wheels, would be greater than the rails could safely bear. The engines described above are provided with deep fireboxes, which are particularly suitable for bituminous coal or wood as fuel.

The total wheel base of engine and tender varies from approximately 42 feet for Class 10-20 D, to 49 feet for Class 10-32 D. From 18 inches to 2 feet should be added, to give minimum length of turn-table admissible.

For remarks on tractive power, see pages 106 to 109.

9/40 and 8, T x 20

TEN-WHEELED TYPE LOCOMOTIVE WITH FIREBOX BETWEEN DRIVING AXLES

Six Coupled Locomotives with Four-Wheeled Leading Trucks

Ten-Wheeled Type

With Fireboxes above Rear Driving Axles,

and Separate Tenders

Gauge, 4 Feet 8½ Inches

Fuel, Bituminous Coal

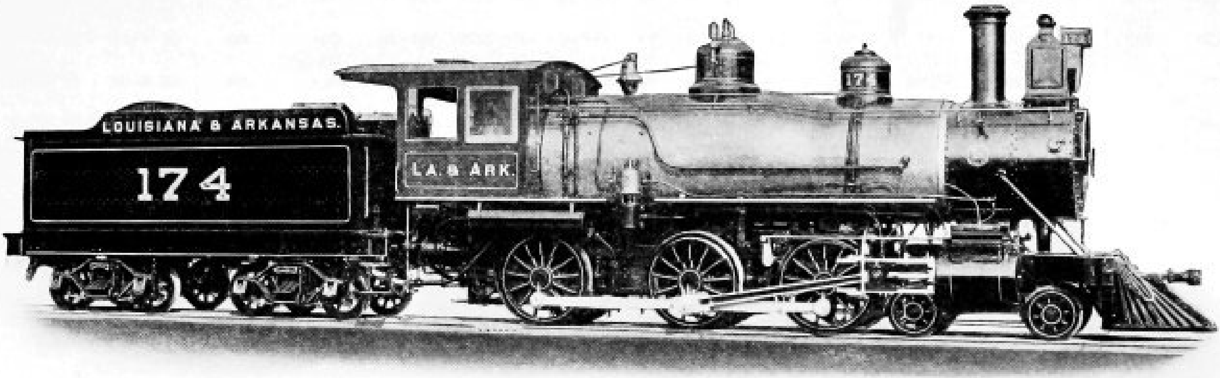
CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels — Ft.	Ins.	Wheel Base: Total — Ft.	Ins.	Capacity of Tender for Water. — 8⅓-lb. Gallons	Load in Tons (of 2240 Pounds) of Cars and Lading: On a Level	On a Grade per Mile of: 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Medendi......	10-26 D	16 x 24	56	180	16,780	73,000	95,000	10	0	20	1¾	3000	1815	800	480	330	245	190	150
Medendorum..	10-28 D	17 x 24	56	180	18,950	82,000	105,000	11	0	21	3	3500	2050	905	540	375	275	215	170
Medendos.....	10-30 D	18 x 24	56	180	21,240	88,000	115,000	11	4	21	7	4000	2240	990	590	410	305	235	185
Medenemen...	10-32 D	19 x 26	62	180	23,160	100,000	135,000	13	4	24	6	4500	2500	1105	660	455	335	260	205
Medenijgen...	10-34 D	20 x 26	62	180	25,670	118,000	150,000	13	6	24	6	5000	2775	1220	730	500	370	285	225
Medeole......	10-36 D	21 x 26	62	180	28,300	130,000	170,000	14	10	25	10	5000	3060	1350	810	560	415	320	255
Medepleger...	10-36 D	21 x 28	68	200	30,870	145,000	187,000	15	0	26	2	6000	3335	1470	875	605	445	345	270
Medepraten...	10-38 D	22 x 28	62	200	37,160	160,000	203,000	13	10	25	10	6000	4035	1790	1075	745	555	435	350

These locomotives have comparatively long and shallow fireboxes, which are suitable for coal burning, but are not well adapted to the use of wood.

The total wheel base of engine and tender, varies from approximately 47 feet for Class 10-26 D, to 58 feet for Class 10-38 D. From 18 inches to 2 feet should be added, to give minimum length of turn-table admissible.

For remarks on tractive power, see pages 106 to 109.

9/40 and 8, T x 20.



TEN-WHEELED TYPE LOCOMOTIVE WITH FIREBOX ABOVE REAR DRIVING AXLE

Six Coupled Locomotives with Four-Wheeled Leading Trucks

Ten-Wheeled Type

With Wide Fireboxes over Rear Driving Wheels,

and Separate Tenders

Gauge, 4 Feet 8½ Inches

Fuel, Bituminous Coal

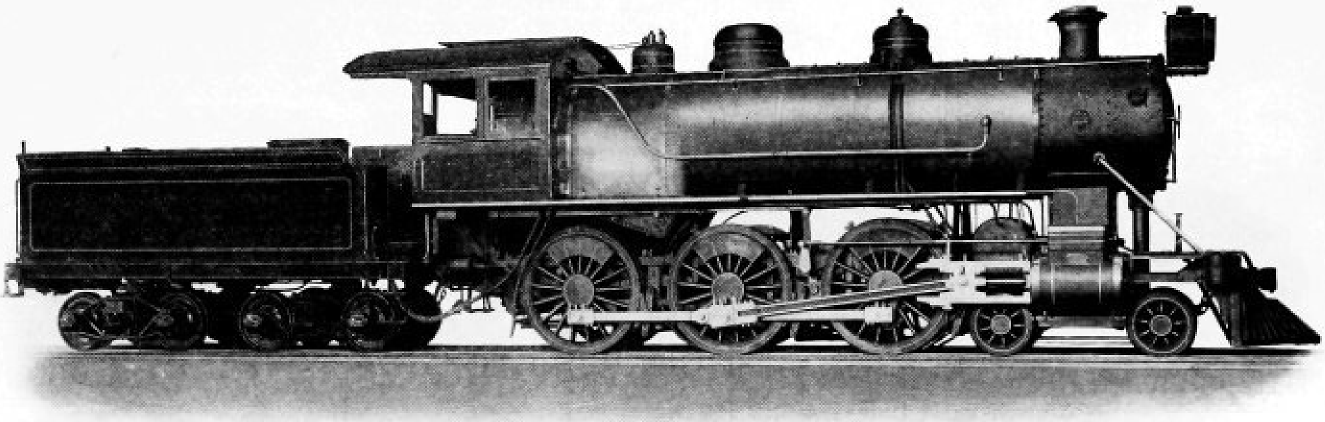
CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels — Ft.	Ins.	Wheel Base: Total — Ft.	Ins.	Capacity of Tender for Water — 8⅓-lb. Gallons	Load in Tons (of 2240 Pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Mederapfel....	10-32 D	19 x 26	62	180	23,160	105,000	145,000	13	6	24	4	4500	2500	1105	660	455	335	260	205
Mederegent...	10-34 D	20 x 26	62	180	25,670	114,000	158,000	14	0	25	1	5000	2775	1220	730	500	370	285	225
Medereizen....	10-36 D	21 x 26	62	200	31,440	134,000	176,000	14	4	25	11	5000	3410	1510	910	630	470	365	295
Mederiacum ..	10-36 D	21 x 28	62	200	33,850	142,000	187,000	14	4	25	11	6000	3620	1600	960	665	495	385	305

These locomotives have wide fireboxes placed above the driving wheels, so that ample grate area can be readily obtained without using a furnace of excessive length.

The total wheel base of engine and tender, varies from approximately 51 feet for Class 10-32 D, to 57 feet for Class 10-36 D. From 18 inches to 2 feet should be added to give minimum length of turn-table admissible.

For remarks on tractive power, see pages 106 to 109.

4/10 and 8, T x 20.



TEN-WHEELED TYPE LOCOMOTIVE WITH WIDE FIRE BOX

Six Coupled Locomotives

Pacific Type

With Four-Wheeled Leading and Two-Wheeled Trailing Trucks, and Separate Tenders

Gauge, 4 Feet 8½ Inches — Fuel, Bituminous Coal

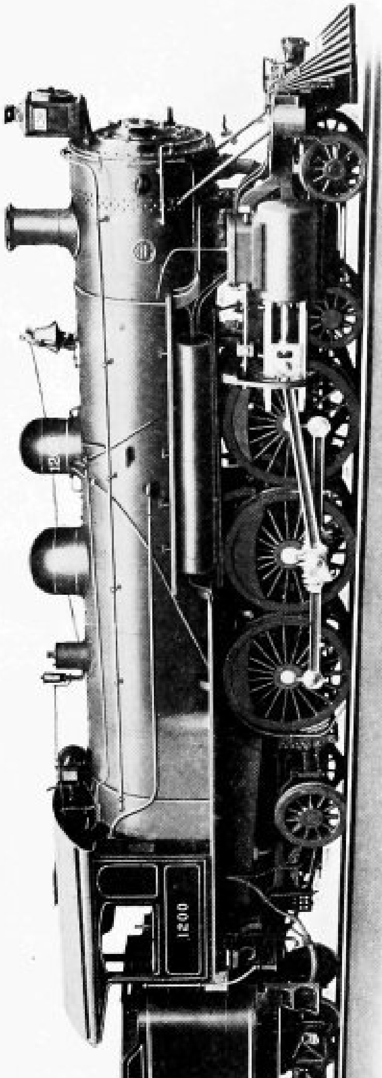
CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels — Ft.	Ins.	Wheel Base: Total — Ft.	Ins.	Capacity of Tender for Water — 8⅓-lb. Gallons	Load in Tons (of 2240 Pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Mederico......	12-30¼ D	18 x 26	62	180	20,780	95,000	150,000	11	0	28	9	4500	2230	970	575	390	285	215	165
Medesimita....	12-32¼ D	19 x 26	62	180	23,160	102,000	159,000	11	0	29	6	5000	2490	1090	645	440	320	245	190
Medesimo.....	12-34¼ D	20 x 26	62	180	25,670	110,000	172,000	11	0	30	0	5500	2765	1215	720	495	360	275	215
Medeslaan....	12-36¼ D	21 x 28	68	180	27,700	125,000	193,000	12	0	31	6	6000	2985	1305	770	525	385	290	225
Medespeler....	12-38¼ D	22 x 28	68	180	30,490	132,000	217,000	12	0	32	0	6000	3280	1435	850	580	425	325	255
Medestrijd....	12-38¼ D	22 x 28	73	200	31,550	144,000	231,000	12	10	32	8	7000	3385	1475	870	590	430	330	255

This type is suitable for heavy and fast passenger service. The firebox is placed back of the rear driving wheels, and a large grate area is readily secured. The four-wheeled front truck has a swing bolster and the two-wheeled rear truck is provided with swing links and a radius bar, so that the engine can traverse curves without difficulty.

The total wheel base of engine and tender, varies from approximately 53 feet for Class 12-30¼ D, to 64 feet for Class 12-38¼ D. From 18 inches to 2 feet should be added, to give minimum length of turn-table admissible.

For remarks on tractive power, see pages 106 to 109.

$\frac{9}{40}$ and 8 T x 20.



PACIFIC TYPE LOCOMOTIVE

Eight Coupled Locomotives with Two-Wheeled Leading Trucks

Consolidation Type

With Long Fireboxes above Rear Driving Axles, and Separate Tenders

Gauge, 4 Feet 8½ Inches

Fuel, Bituminous Coal

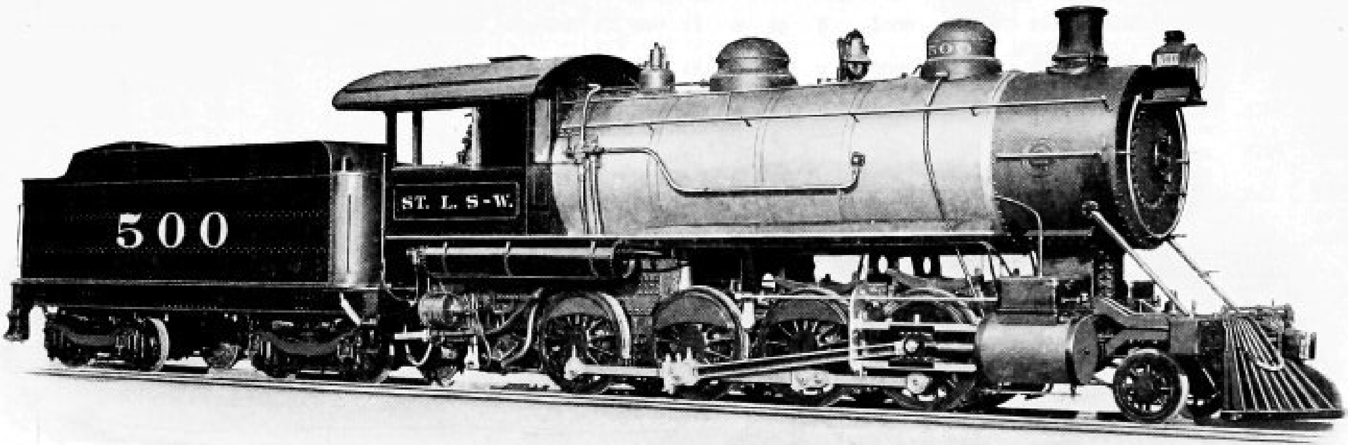
CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels — Ft.	Wheel Base: Of Driving Wheels — Ins.	Wheel Base: Total — Ft.	Wheel Base: Total — Ins.	Capacity of Tender for Water. — 8⅓-lb. Gallons	Load in Tons (of 2240 Pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Medetorsen....	10-26 E	16 x 24	44	160	18,980	81,000	92,000	13	0	20	2	3000	2065	920	555	385	290	225	180
Medevallen....	10-28 E	17 x 24	44	160	21,440	88,000	100,000	13	0	20	2	3500	2250	1000	605	420	315	245	195
Medevaren....	10-30 E	18 x 24	50	170	22,460	97,000	110,000	13	6	20	8	3500	2450	1090	655	460	345	270	215
Medewerker....	10-32 E	19 x 24	50	170	25,040	108,000	122,000	13	8	21	4	4000	2725	1210	730	510	380	300	240
Medeweten....	10-34 E	20 x 24	50	170	27,740	118,000	135,000	14	0	21	6	4000	3025	1345	815	570	425	330	265
Medewillen....	10-34 E	20 x 26	56	180	28,410	126,000	142,000	15	0	23	0	5000	3085	1370	825	575	430	335	270
Medezakken...	10-36 E	21 x 26	56	180	31,330	140,000	154,000	15	1	23	1	5000	3410	1520	915	640	480	375	300
Medezenden ..	10-36 E	21 x 28	56	180	33,740	148,000	163,000	15	5	23	6	5500	3670	1630	985	685	515	400	325
Medezuster....	10-38 E	22 x 28	56	180	37,000	165,000	182,000	15	4	23	8	6000	4030	1790	1080	755	565	440	355
Mediabais....	10-38 E	22 x 28	56	200	41,140	175,000	194,000	15	4	23	8	6000	4500	2000	1210	850	635	500	405
Mediabimus...	10-38 E	22 x 30	56	200	44,080	185,000	205,000	15	8	24	4	7000	4750	2110	1275	890	670	525	420

These locomotives are suitable for heavy freight service, where the necessary weight if carried on only three pairs of driving wheels, would be greater than the rails could safely bear. The engines described above have long fireboxes which are particularly suitable for burning coal, although wood can be used as fuel if desired.

The total wheel base of engine and tender, varies from approximately 46 feet for Class 10-26 E, to 56 feet for Class 10-38 E. From 18 inches to 2 feet should be added, to give minimum length of turn-table admissible.

For remarks on tractive power, see pages 106 to 109.

$\frac{9}{10}$ and 8, T x 20.



CONSOLIDATION TYPE LOCOMOTIVE WITH LONG FIREBOX

Eight Coupled Locomotives with Two-Wheeled Leading Trucks

Consolidation Type

With Wide Fireboxes above Rear Driving Wheels, and Separate Tenders

Gauge, 4 Feet 8½ Inches — Fuel, Bituminous Coal

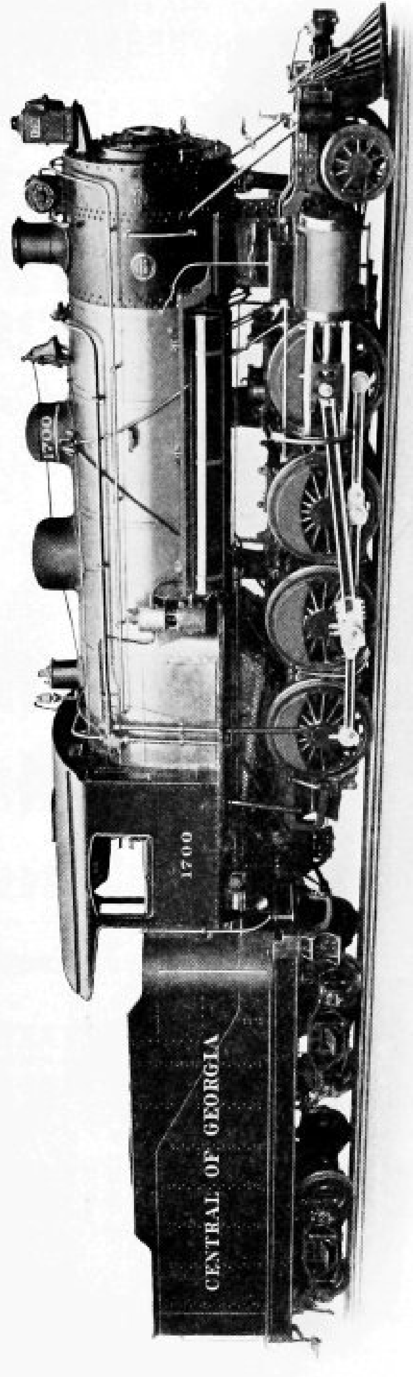
CODE WORD	Class	Cylinders, Diameter Stroke. — Inches	Driving Wheels Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels — Ft.	Wheel Base: Of Driving Wheels — Ins.	Wheel Base: Total — Ft.	Wheel Base: Total — Ins.	Capacity of Tender for Water. — 8⅓-lb. Gallons	Load in Tons (of 2240 Pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Mediada	10-36 E	21 x 28	56	180	33,740	149,000	169,000	15	4	23	8	5500	3670	1630	985	685	515	400	325
Mediadora	10-38 E	22 x 28	56	180	37,000	160,000	180,000	15	4	23	11	6000	4030	1790	1080	755	565	440	355
Mediaire	10-38 E	22 x 28	56	200	41,140	175,000	196,000	16	2	25	1	6000	4500	2000	1210	850	635	500	405
Medialibus	10-38 E	22 x 30	56	200	44,080	185,000	205,000	15	8	24	4	7000	4750	2110	1275	890	670	525	420
Medialium	10-40 E	23 x 30	56	200	48,180	192,000	215,000	15	9	24	6	7000	4925	2195	1320	925	695	545	440
Medianader	10-42 E	24 x 32	63	200	49,740	210,000	237,000	17	0	26	6	7000	5400	2405	1455	1020	765	600	485

These locomotives have wide fireboxes, so that a large grate area is readily secured without using a furnace of excessive length. This form of firebox is suitable for coal burning, but is not adapted to the use of wood as fuel.

The total wheel base of engine and tender, varies from approximately 56 feet for Class 10-36 E, to 60 feet for Class 10-42 E. From 18 inches to 2 feet should be added, to give minimum length of turn-table admissible.

For remarks on tractive power, see pages 106 to 109.

$\frac{9}{40}$ and 8, T x 20



CONSOLIDATION TYPE LOCOMOTIVE WITH WIDE FIREBOX

Four Coupled Locomotives

With Saddle or Side Tanks

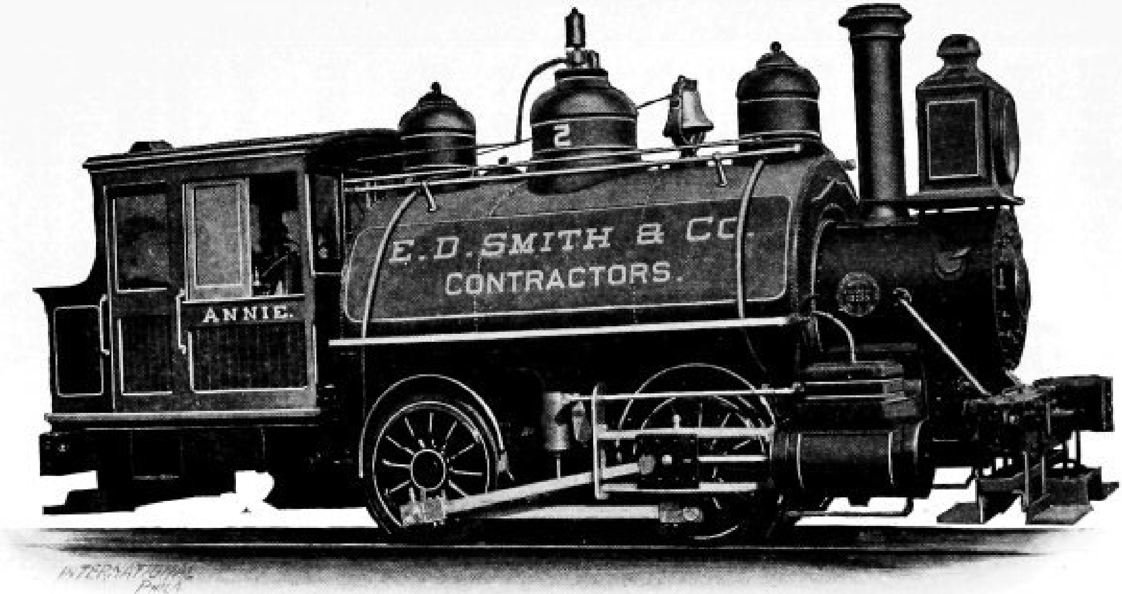
Gauge, 4 Feet 8½ Inches — Fuel, Bituminous Coal or Wood

CODE WORD	Class	Cylinders. Diameter Stroke — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order — Pounds	Wheel Base — Ft.	Wheel Base — Ins.	Capacity of Tank for Water — 8⅓-lb. Gallons	Load in Tons (of 2240 pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Medianarum	4- 8 C	7 x 12	26	150	2,880	16,000	4	8	150	315	140	85	60	45	35	30
Medianeiro	4-10½ C	8 x 14	28	150	4,080	22,000	4	8	200	450	200	120	85	65	50	40
Medianeja	4-11 C	9 x 14	30	150	4,810	28,000	5	0	300	525	235	145	100	75	60	50
Medianejos	4-12 C	9 x 16	33	160	5,340	30,000	6	0	350	585	260	160	110	85	65	55
Medianidad	4-14 C	10 x 16	33	160	6,590	36,000	6	0	400	720	325	195	140	105	85	65
Medianiles	4-16 C	11 x 16	33	160	7,970	40,000	6	0	500	875	395	240	170	130	105	85
Medianique	4-18 C	12 x 18	37	160	9,520	46,000	6	0	600	1050	475	290	205	155	125	105
Medianista	4-20 C	13 x 20	42	160	10,930	52,000	6	0	700	1200	545	335	235	180	145	120
Medianito	4-20 C	13 x 22	44	160	11,480	56,000	6	6	750	1265	570	350	250	190	150	125
Mediano	4-22 C	14 x 22	44	160	13,320	61,000	7	0	800	1470	665	410	290	225	180	150
Medianoche	4-22 C	14 x 24	44	160	14,530	66,000	7	0	900	1600	725	445	320	245	195	160
Mediaretis	4-24 C	15 x 24	44	160	16,690	75,000	7	0	1000	1840	835	515	365	280	225	185
Mediari	4-26 C	16 x 24	44	160	18,980	88,000	7	0	1200	2090	950	585	415	320	255	210
Mediariais	4-28 C	17 x 24	50	170	20,040	95,000	7	0	1400	2210	1000	615	435	335	270	220
Mediastino	4-30 C	18 x 24	50	170	22,460	105,000	7	6	1500	2480	1120	690	490	375	300	250

Locomotives of this type are suitable for switching service where a separate tender is unnecessary, and where the weight required can be carried on two pairs of driving wheels. They are also well adapted to special service in mills, mines, furnaces and on plantations. These engines are simple in construction and compact in design, and can readily traverse curves of from 75 to 90 feet radius. All the weight is carried on the driving wheels, and is therefore available for adhesion.

For remarks on tractive power, see pages 106 to 109.

$\frac{9}{40}$ and 8, ½ T C.



FOUR COUPLED TANK LOCOMOTIVE

Four Coupled Locomotives

With Separate Tenders

Gauge, 4 Feet 8½ Inches

Fuel, Wood or Bituminous Coal

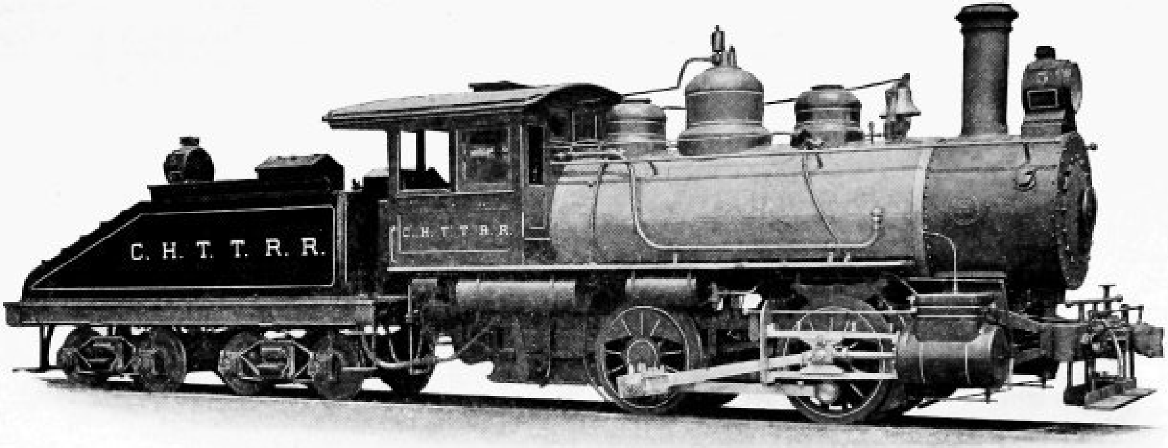
CODE WORD	Class	Cylinders, Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order — Pounds	Wheel Base — Ft.	Wheel Base — Ins.	Capacity of Tender for Water — 8⅓-lb. Gallons	Load in Tons (of 2240 Pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Mediatario	4-12 C	9 x 16	33	160	5,340	28,000	5	0	800	575	255	155	105	80	60	50
Mediately	4-14 C	10 x 16	33	160	6,590	32,000	5	6	1000	715	320	190	135	100	80	60
Mediatenus	4-16 C	11 x 16	33	160	7,970	36,000	6	0	1200	870	385	235	160	120	95	75
Mediateur	4-18 C	12 x 18	37	160	9,520	42,000	6	0	1400	1030	465	280	195	145	115	95
Mediatiser	4-20 C	13 x 20	42	160	10,930	48,000	6	6	1600	1190	535	325	225	170	140	110
Mediatized	4-20 C	13 x 22	44	160	11,480	52,000	6	6	1600	1250	560	340	235	180	143	112
Mediatoris	4-22 C	14 x 22	44	160	13,320	58,000	7	0	1800	1450	650	395	275	210	165	135
Mediatorum	4-22 C	14 x 24	44	160	14,530	64,000	7	0	1800	1590	710	430	300	230	180	145
Mediaturam	4-24 C	15 x 24	44	160	16,690	71,000	7	0	2000	1825	815	495	350	265	210	170
Mediaturos	4-26 C	16 x 24	44	160	18,980	81,000	7	6	2200	2080	930	565	400	300	240	195
Mediaverat	4-28 C	17 x 24	50	170	20,040	90,000	7	6	2400	2190	980	595	420	315	250	205
Mediaveris	4-30 C	18 x 24	50	170	22,460	100,000	7	6	2600	2450	1100	665	470	355	280	225

Locomotives of this type are suitable for general switching service where the weight necessary for adhesion can be carried on two pairs of driving wheels, and where a separate tender is desired. These engines can traverse curves from 75 to 90 feet radius.

The tank can be made straight or with sloping back, as preferred. Two sand boxes are provided to sand in front of the driving wheels when running in either direction.

For remarks on tractive power, see pages 106 to 109.

$\frac{2}{10}$ and 8, T x 20.



FOUR COUPLED LOCOMOTIVE

Four Coupled Locomotives

With Two-Wheeled Rear Trucks and Saddle or Side Tanks

Gauge, 4 Feet 8½ Inches

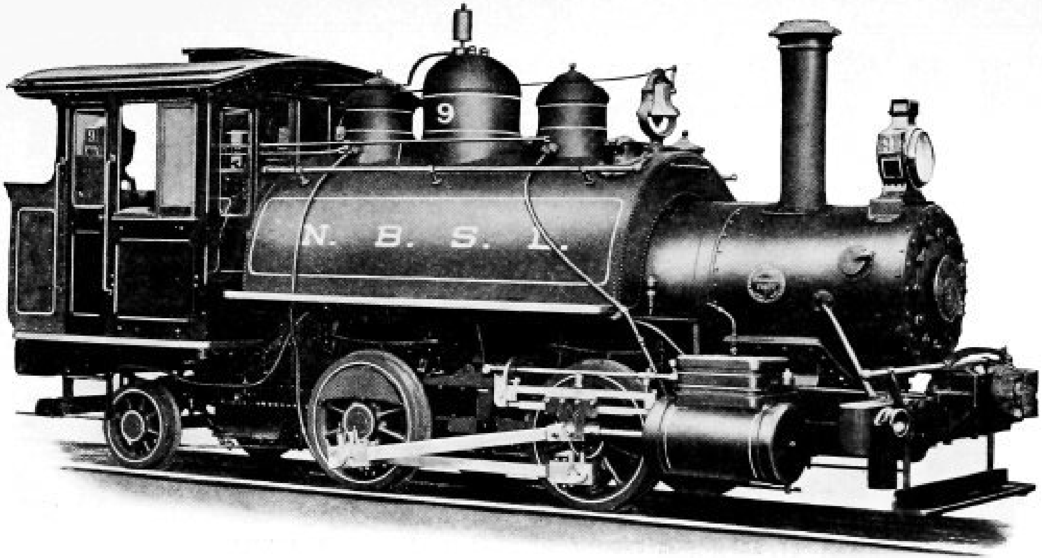
Fuel, Bituminous Coal or Wood

CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches.	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels — Ft.	Ins.	Wheel Base: Total — Ft.	Ins.	Capacity of Tank for Water. — 8⅓-lb. Gallons	Load in Tons (of 2240 Pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132 ft. or 2½%	158.4 ft. or 3%
Mediazione....	6-10⅓ C	8 x 14	30	150	3,800	20,000	24,000	4	8	10	2	300	415	185	110	80	60	45	35
Medibilis......	6-11⅓ C	9 x 14	30	150	4,810	23,000	28,000	5	0	10	0	350	525	235	145	100	75	60	50
Medibilium....	6-12⅓ C	9 x 16	33	160	5,340	26 000	32,000	5	0	10	9	400	585	260	160	110	85	65	55
Medica.........	6-14⅓ C	10 x 16	33	160	6,590	32,000	38,000	5	0	11	6	450	720	325	200	140	105	85	70
Medicabile.....	6-16⅓ C	11 x 16	33	160	7,970	37,000	43,000	5	0	11	9	500	875	395	240	170	130	105	85
Medicabulo....	6-18⅓ C	12 x 18	37	160	9,520	42,000	48,000	5	9	12	6	600	1050	475	290	205	155	125	105
Medicacao.....	6-20⅓ C	13 x 20	42	160	10,930	48,000	55,000	6	6	13	6	700	1135	510	315	220	170	135	110
Medicado......	6-22⅓ C	14 x 22	44	160	13,320	57,000	64,000	7	0	14	6	800	1400	630	385	275	210	165	135
Medically......	6-24⅓ C	15 x 22	44	160	15,300	66,000	74,000	7	0	15	3	1000	1630	735	450	320	245	195	160
Medicament ..	6-26⅓ C	16 x 24	50	160	16,710	74,000	86,000	7	6	16	0	1200	1815	820	500	355	270	220	180
Medicandos...	6-28⅓ C	17 x 24	50	160	18,870	82,000	94,000	7	6	16	0	1200	2025	915	560	400	305	245	200

Locomotives of this class are suitable for switching, plantation, industrial and other special service. The driving wheels are equalized together, while the truck has a swinging bolster and radius bar. The weight is thus well distributed while each wheel finds a bearing on an uneven track, and sharp curves are easily traversed. The weight of the water is carried principally by the driving wheels, thus increasing the adhesion. The fuel supply is carried back of the cab.

For remarks on tractive power, see pages 106 to 109.

$\frac{4}{10}$ and 8, ⅓ T C.



FOUR COUPLED TANK LOCOMOTIVE WITH TWO-WHEELED REAR TRUCK

Four Coupled Locomotives

Forney Type

With Four-Wheeled Trailing Trucks and Rear Tanks

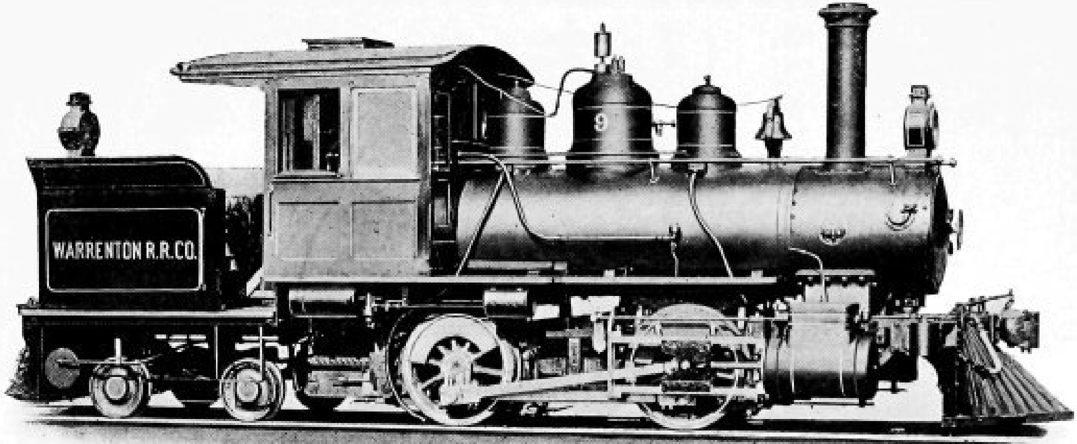
Gauge, 4 Feet 8½ Inches — Fuel, Bituminous Coal or Wood

CODE WORD	Class	Cylinders Diameter Stroke. — Inches.	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels — Ft.	Ins.	Wheel Base: Total — Ft.	Ins.	Capacity of Tank for Water — 8⅓-lb. Gallons	Load in Tons (of 2240 Pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Medicasse	8-12⅓ C	9 x 16	37	160	4,760	22,000	34,000	5	0	14	8	500	520	230	140	95	75	55	45
Medicastro	8-14⅓ C	10 x 16	37	160	5,880	26,000	40,000	5	0	16	1	600	640	285	175	120	90	70	60
Medicatore	8-16⅓ C	11 x 18	42	160	7,050	32,000	48,000	5	0	16	1	700	770	345	210	145	110	85	70
Medicatriz	8-18⅓ C	12 x 18	42	160	8,390	40,000	58,000	6	6	17	4	800	915	410	250	175	130	105	85
Medicatura	8-20⅓ C	13 x 20	44	160	10,430	48,000	68,000	6	0	17	5	900	1145	510	310	220	165	130	105
Medicean	8-22⅓ C	14 x 22	50	160	11,730	54,000	74,000	6	0	18	0	1000	1285	575	350	245	185	150	120
Mediceera	8-24⅓ C	15 x 22	50	160	13,470	60,000	80,000	6	6	19	6	1200	1475	665	405	285	215	170	140
Medicetis	8-26⅓ C	16 x 24	50	160	16,710	68,000	90,000	7	0	21	0½	1500	1760	790	485	340	260	210	170
Medicherei	8-28⅓ C	17 x 24	50	160	18,870	76,000	100,000	7	6	22	0	1500	1965	885	540	380	290	230	190

Locomotives of the Forney Type are suitable for light passenger, suburban, logging and other special service. They curve readily, and can be run in either direction without turning. As the weight of the fuel and water is carried by the truck, the weight on the driving wheels is practically constant.

For remarks on tractive power, see pages 106 to 109.

$\frac{2}{40}$ and 8.



FORNEY TYPE LOCOMOTIVE

Four Coupled Locomotives

With Two-Wheeled Leading Trucks,

and Separate Tenders

Gauge, 4 Feet 8½ Inches

Fuel, Bituminous Coal or Wood

CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches.	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels — Ft.	Wheel Base: Of Driving Wheels — Ins.	Wheel Base: Total — Ft.	Wheel Base: Total — Ins.	Capacity of Tender for Water — 8⅓-lb. Gallons	Load in Tons (of 2240 Pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Medichessa....	6-11 C	9 x 14	33	150	4,380	22,000	27,000	5	0	10	8	700	470	205	125	85	60	45	35
Medicinado....	6-12 C	9 x 16	37	160	4,760	24,000	30,000	6	0	11	8½	800	515	225	135	90	65	50	40
Medicining....	6-14 C	10 x 16	37	160	5,880	27,000	34,000	6	6	12	5	1000	635	280	165	115	85	65	50
Mediciones....	6-16 C	11 x 18	42	160	7,050	31,000	40,000	6	6	13	0	1200	760	335	200	140	100	80	60
Medicone......	6-18 C	12 x 18	42	160	8,390	35,000	44,000	7	0	13	10	1400	895	395	235	165	120	95	75
Medicorum....	6-20 C	13 x 20	44	160	10,430	42,000	50,000	7	4	14	8	1600	1075	475	285	200	150	115	90
Medicosos.....	6-22 C	14 x 22	50	160	11,730	48,000	56,000	7	6	15	2	1800	1230	545	330	230	170	135	105
Medicucho.....	6-24 C	15 x 22	50	160	13,470	55,000	65,000	7	6	15	2	2000	1400	625	375	260	195	155	125
Medidagem....	6-26 C	16 x 22	50	160	15,320	65,000	75,000	7	6	15	8	2200	1665	740	450	310	235	185	150
Medideira......	6-28 C	17 x 24	56	160	16,840	71,000	84,000	7	6	15	8	2400	1815	810	485	340	255	200	160

These locomotives are suitable for light passenger, suburban and special service. They ride steadily, and easily traverse curves of short radius. The leading truck is fitted with a swing bolster and radius bar.

The total wheel base of engine and tender, varies from approximately 30 feet for Class 6-11 C, to 41 feet for Class 6-28 C. From 18 inches to 2 feet should be added to give minimum length of turn-table admissible.

For remarks on tractive power, see pages 106 to 109.

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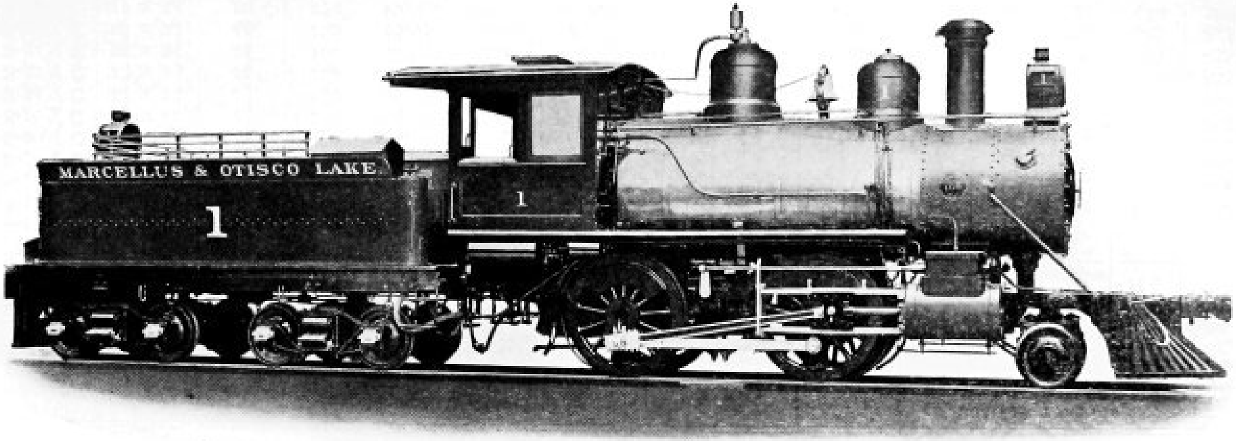


FOUR COUPLED LOCOMOTIVE WITH TWO-WHEELED LEADING TRUCK

Four Coupled Double-Ender Locomotives

With Two-Wheeled Leading and Trailing Trucks,

and Saddle or Side Tanks

Gauge, 4 Feet 8½ Inches

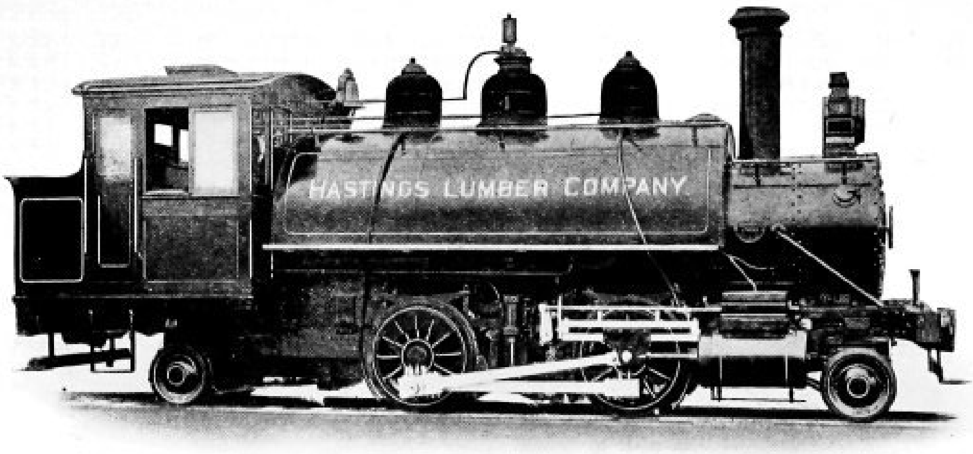
Fuel, Bituminous Coal or Wood

CODE WORD	Class	Cylinders. Diameter Stroke — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels Ft.	Wheel Base: Of Driving Wheels Ins.	Wheel Base: Total Ft.	Wheel Base: Total Ins.	Capacity of Tank for Water — 8⅓-lb. Gallons	Load in Tons (of 2240 pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Medido	8-12¼ C	9 x 16	33	160	5,340	25,000	40,000	4	9	15	2	450	580	260	155	110	80	65	50
Medidoras	8-14¼ C	10 x 16	33	160	6,590	30,000	46,000	5	0	16	5	500	715	320	195	135	100	80	65
Mediemus	8-16¼ C	11 x 16	33	160	7,970	36,000	54,000	5	6	17	3	600	870	390	235	165	125	100	80
Medietatis	8-18¼ C	12 x 18	37	160	9,520	42,000	62,000	6	0	19	4	700	1015	455	275	195	145	115	95
Mediety	8-20¼ C	13 x 20	42	160	10,930	48,000	68,000	6	0	19	11	800	1160	520	315	220	170	135	110
Medieval	8-20¼ C	13 x 22	44	160	11,480	52,000	72,000	6	0	19	11	800	1260	565	345	240	185	145	120
Medieviste	8-22¼ C	14 x 22	44	160	13,320	59,000	80,000	7	0	21	7	900	1440	645	395	280	210	165	135
Medifixe	8-22¼ C	14 x 24	44	160	14,530	64,000	88,000	7	0	21	7	1000	1550	695	425	300	225	180	145
Medikaster	8-24¼ C	15 x 24	44	160	16,690	72,000	100,000	7	0	21	7	1200	1740	785	480	335	255	205	165
Medikus	8-26¼ C	16 x 24	44	160	18,980	82,000	112,000	7	0	22	8	1400	1990	895	545	385	295	235	190
Medilunia	8-28¼ C	17 x 24	50	170	20,040	90,000	125,000	7	6	24	8	1500	2170	975	595	420	320	255	210

This type is suitable for local or suburban service, and also for logging and other special service, where a sufficient supply of fuel and water can be carried on the engine. The flexible wheel base enables the engine to readily traverse curves of short radius; and having a truck at each end, these locomotives can run equally well in either direction.

For remarks on tractive power, see pages 106 to 109.

$^{8}_{40}$ and 8, ¼ T C.



FOUR COUPLED DOUBLE-ENDER TANK LOCOMOTIVE

Four Coupled Double Ender Locomotives

With Two-Wheeled Leading and Four-Wheel Trailing Trucks, and Rear Tanks

Gauge, 4 Feet 8½ Inches

Fuel, Bituminous Coal or Wood

CODE WORD	Class	Cylinders. Diameter Stroke — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds Per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels — Ft.	Ins.	Wheel Base: Total — Ft.	Ins.	Capacity of Tank for Water — 8⅓-lb. Gallons	Load in Tons (of 2240 pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Medimni....	10-12¼ C	9 x 16	37	160	4,760	20,000	40,000	5	0	22	0	500	510	225	135	95	70	55	45
Medimnum .	10-14¼ C	10 x 16	37	160	5,880	25,000	48,000	5	6	23	0	600	635	285	170	120	90	70	55
Medinawind.	10-16¼ C	11 x 18	42	160	7,050	32,000	60,000	6	0	24	9	700	760	340	200	140	105	80	65
Medinense ..	10-18¼ C	12 x 18	42	160	8,390	38,000	70,000	6	6	25	9	800	905	405	245	170	125	100	80
Mediocral ...	10-20¼ C	13 x 20	44	160	10,430	44,000	84,000	6	6	26	3	1000	1120	500	300	210	155	120	100
Mediocre ...	10-22¼ C	14 x 22	50	160	11,730	50,000	95,000	7	0	26	7	1200	1270	565	340	235	180	140	110
Mediocrist ..	10-24¼ C	15 x 22	50	160	13,470	58,000	112,000	7	0	28	6	1500	1460	650	390	270	205	160	125
Mediocrity ..	10-26¼ C	16 x 24	56	160	14,920	62,000	118,000	7	6	28	7	1800	1580	705	425	295	220	175	140
Mediodia ...	10-28¼ C	17 x 24	56	160	16,840	68,000	130,000	7	6	30	1	2000	1735	775	465	325	245	190	150

These locomotives are suitable for local, suburban and other special service. The fuel and water are carried over the rear truck, so that the weight on the driving wheels is practically constant. As the rigid wheel base is comparatively short, these engines readily traverse curves of short radius. They run equally well in either direction.

For remarks on tractive power, see pages 106 to 109.

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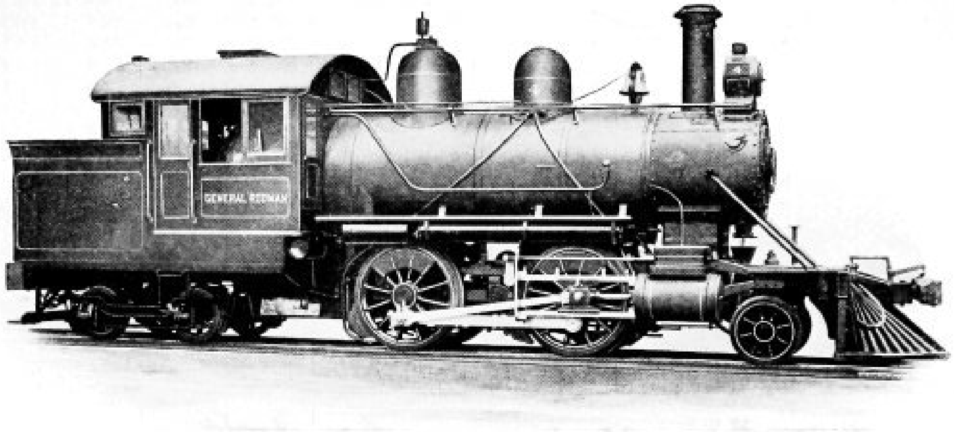

FOUR COUPLED DOUBLE-ENDER TANK LOCOMOTIVE

Six Coupled Locomotives

With Saddle or Side Tanks

Gauge, 4 Feet 8½ Inches

Fuel, Bituminous Coal or Wood

CODE WORD	Class	Cylinders. Diameter Stroke — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order — Pounds	Wheel Base — Ft.	Wheel Base — Ins.	Capacity of Tank for Water — 8⅓-lb. Gallons	Load in Tons (of 2240 Pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Mediolani........	6-12 D	9 x 16	33	160	5,340	32,000	6	9	400	580	260	160	110	85	65	55
Mediolanum......	6-14 D	10 x 16	33	160	6,590	37,000	7	7	450	720	325	195	140	105	85	70
Mediolorum......	6-16 D	11 x 16	33	160	7,970	43,000	7	0	500	875	395	240	170	130	105	85
Mediolum........	6-18 D	12 x 18	37	160	9,520	48,000	8	0	600	1050	475	290	205	155	125	105
Medionem........	6-20 D	13 x 20	42	160	10,930	54,000	8	6	700	1200	545	335	235	180	145	120
Medionnant......	6-20 D	13 x 22	44	160	11,480	58,000	8	9	750	1260	570	350	250	190	150	125
Mediopano.......	6-22 D	14 x 24	44	160	14,530	68,000	9	6	900	1600	725	445	315	245	195	160
Medioximis......	6-24 D	15 x 24	44	160	16,690	78,000	10	0	1000	1840	830	510	365	280	225	185
Medioximum.....	6-26 D	16 x 24	44	160	18,980	90,000	10	3	1200	2090	945	580	415	315	255	210
Medioxume......	6-28 D	17 x 24	50	170	20,040	100,000	10	6	1200	2210	995	610	435	330	270	225
Mediponti.......	6-30 D	18 x 24	50	170	22,460	110,000	11	0	1500	2480	1120	690	490	375	300	245
Medipontos......	6-32 D	19 x 24	50	170	25,040	120,000	11	0	1600	2760	1250	765	545	420	335	275
Medipontum.....	6-34 D	20 x 24	50	180	29,380	130,000	11	0	1600	3170	1435	885	630	485	390	320
Mediquinho......	6-34 D	20 x 26	50	180	31,810	142,000	11	0	1800	3520	1590	980	700	535	430	360
Medire..........	6-36 D	21 x 26	50	180	35,080	152,000	11	0	1800	3775	1710	1055	755	580	465	385

This type is suitable for general switching service where a separate tender is not desired, and where the necessary weight, if carried on only two pairs of driving wheels, would be greater than the rails could safely bear.

For remarks on tractive power, see pages 106 to 109

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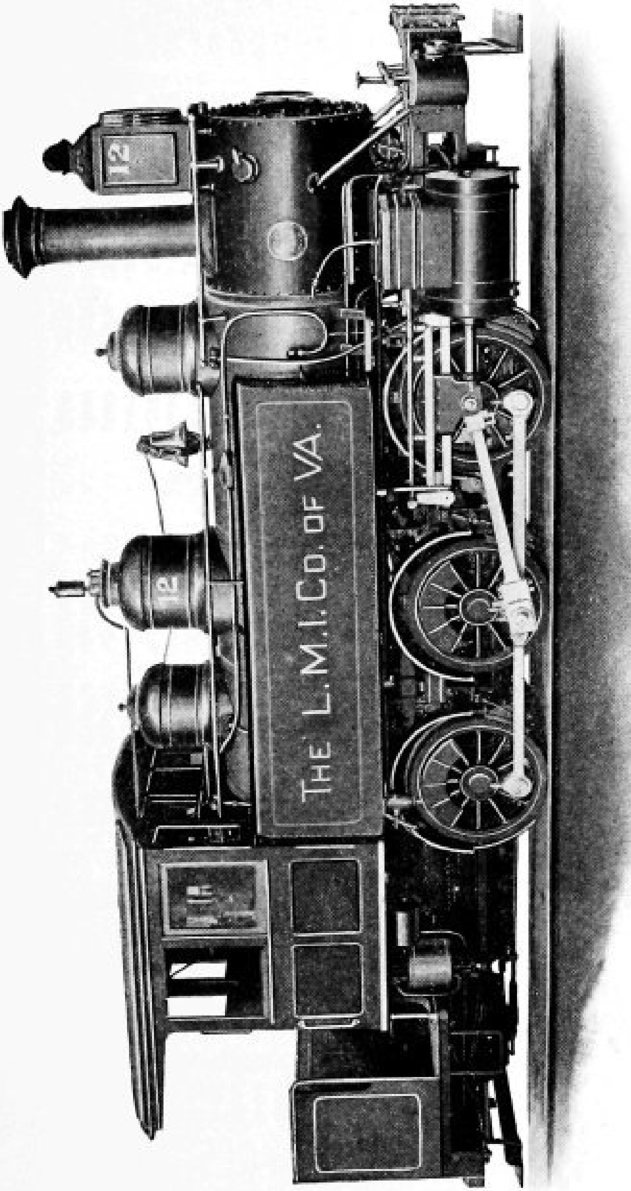

SIX COUPLED TANK LOCOMOTIVE

Six Coupled Locomotives

With Separate Tenders

Gauge, 4 Feet 8½ Inches

Fuel, Bituminous Coal or Wood

CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order. — Pounds	Wheel Base — Ft.	Wheel Base — Ins.	Capacity of Tender for Water. — 8⅓-lb. Gallons	Load in Tons (of 2240 Pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Medisance	6-12 D	9 x 16	33	160	5,340	30,000	6	9	800	580	255	150	105	80	60	50
Meditadas	6-14 D	10 x 16	33	160	6,590	35,000	7	7	1000	715	315	185	130	95	75	60
Meditador	6-16 D	11 x 16	33	160	7,970	40,000	8	0	1200	865	385	230	160	120	95	75
Meditamos	6-18 D	12 x 18	37	160	9,520	45,000	8	1	1500	1035	460	275	195	145	110	90
Meditamur	6-20 D	13 x 20	42	160	10,930	50,000	8	6	1800	1190	530	320	220	165	130	105
Meditando	6-20 D	13 x 22	44	160	11,480	54,000	8	9	2000	1250	555	335	230	175	135	110
Meditar	6-22 D	14 x 24	44	160	14,530	64,000	9	6	2200	1585	705	425	300	225	175	140
Meditarian	6-24 D	15 x 24	44	160	16,690	72,000	9	9	2400	1820	815	495	345	260	205	165
Meditative	6-26 D	16 x 24	44	160	18,980	82,000	9	9	2600	2075	925	560	395	295	235	190
Meditatore	6-28 D	17 x 24	50	170	20,040	90,000	10	6	2800	2190	975	590	415	310	245	200
Meditatura	6-30 D	18 x 24	50	170	22,460	100,000	10	6	3000	2455	1095	665	465	350	275	225
Mediteis	6-32 D	19 x 24	50	170	25,040	110,000	10	6	3500	2735	1225	740	520	390	310	250
Mediteriez	6-34 D	20 x 24	50	180	29,380	122,000	11	2	4000	3140	1405	850	600	450	355	290
Mediterreo	6-34 D	20 x 26	50	180	31,810	132,000	10	10	4000	3400	1520	925	650	490	390	315
Meditons	6-36 D	21 x 26	50	180	35,080	141,000	11	0	4000	3630	1625	990	695	525	415	340
Meditrina	6-38 D	22 x 26	50	180	38,500	154,000	11	0	4000	3970	1780	1085	765	580	460	375

This type is suitable for general switching service where a separate tender is desired, and where the necessary weight, if carried on only two pairs of driving wheels, would be greater than the rails could safely bear.

For remarks on tractive power, see pages 106 to 109.

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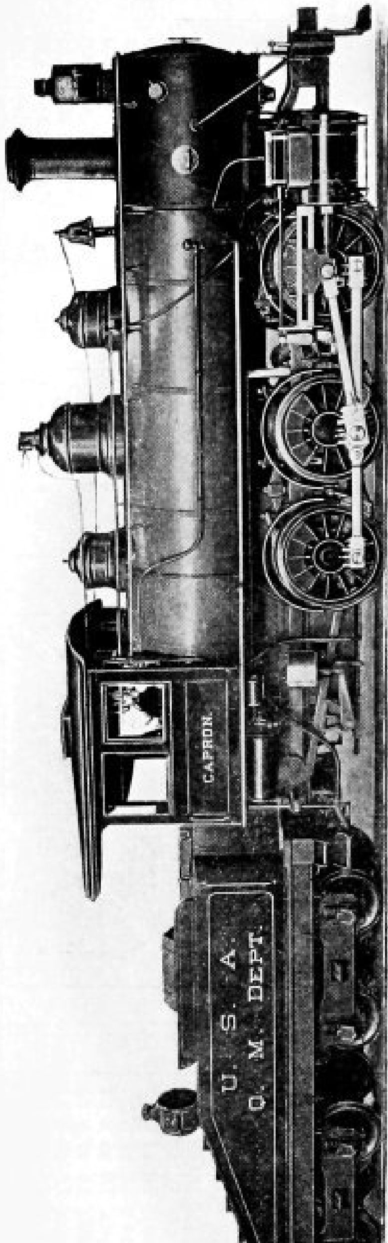


SIX COUPLED LOCOMOTIVE

Six Coupled Double-Ender Locomotives

With Two-Wheeled Leading and Trailing Trucks,

and Saddle or Side Tanks

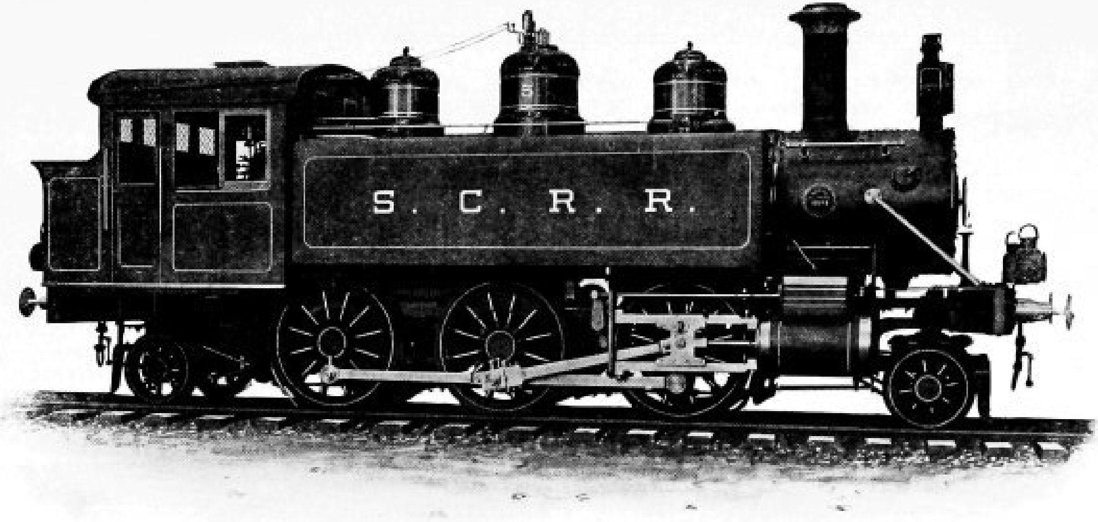
Gauge, 4 Feet 8½ Inches

Fuel, Bituminous Coal or Wood

CODE WORD	Class	Cylinders, Diameter Stroke, — Inches	Driving Wheels, Diam. — Inches	Boiler Pressure — Pounds per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order: On all Driving Wheels — Pounds	Weight in Working Order: Total — Pounds	Wheel Base: Of Driving Wheels — Ft.	Wheel Base: Of Driving Wheels — Ins.	Wheel Base: Total — Ft.	Wheel Base: Total — Ins.	Capacity of Tank for Water — 8⅓-lb. Gallons	Load in Tons (of 2240 Pounds) of Cars and Lading: On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Meditullo.....	10-18¼ D	12 x 18	37	160	9,520	43,000	62,000	8	10	21	6	800	1040	465	285	200	150	120	95
Medium......	10-20¼ D	13 x 20	42	160	10,930	50,000	70,000	9	0	22	9	900	1195	535	325	230	175	140	110
Medivalve....	10-22¼ D	14 x 22	44	160	13,320	60,000	82,000	9	0	24	0	1000	1460	655	400	280	215	170	140
Medivel......	10-24¼ D	15 x 22	44	160	15,300	72,000	94,000	9	0	24	8	1200	1675	750	460	325	245	195	160
Medizinal.....	10-26¼ D	16 x 24	44	160	18,980	82,000	109,000	10	0	25	9	1400	2040	915	560	395	300	240	195
Medjidie......	10-28¼ D	17 x 24	44	170	22,780	101,000	140,000	10	0	26	6	1700	2450	1100	670	475	360	285	235
Medley.......	10-30¼ D	18 x 24	46	180	25,870	114,000	164,000	10	0	25	3	1900	2835	1270	775	545	415	330	270
Medma.......	10-30¼ D	18 x 26	62	200	23,100	130,000	190,000	14	0	31	8	3000	2515	1115	675	470	350	275	220

This type is suitable for local or suburban service, and also for logging and other special service where a sufficient supply of fuel and water can be carried on the engine, and where the necessary adhesive weight could not be placed on two pairs of wheels without overloading the rails. The flexible wheel base enables the engine to readily traverse curves of short radius; and having trucks at each end, these locomotives can run equally well in either direction.

For remarks on tractive power, see pages 106 to 109.



SIX COUPLED DOUBLE-ENDER TANK LOCOMOTIVE

Eight Coupled Locomotives

With Separate Tenders

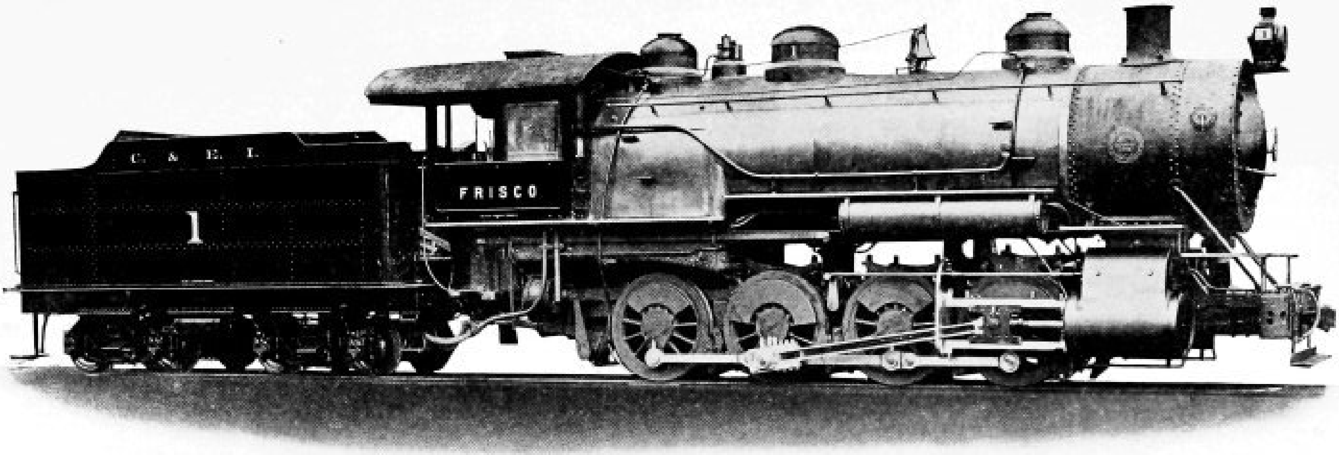
Gauge, 4 Feet 8½ Inches

Fuel, Bituminous Coal

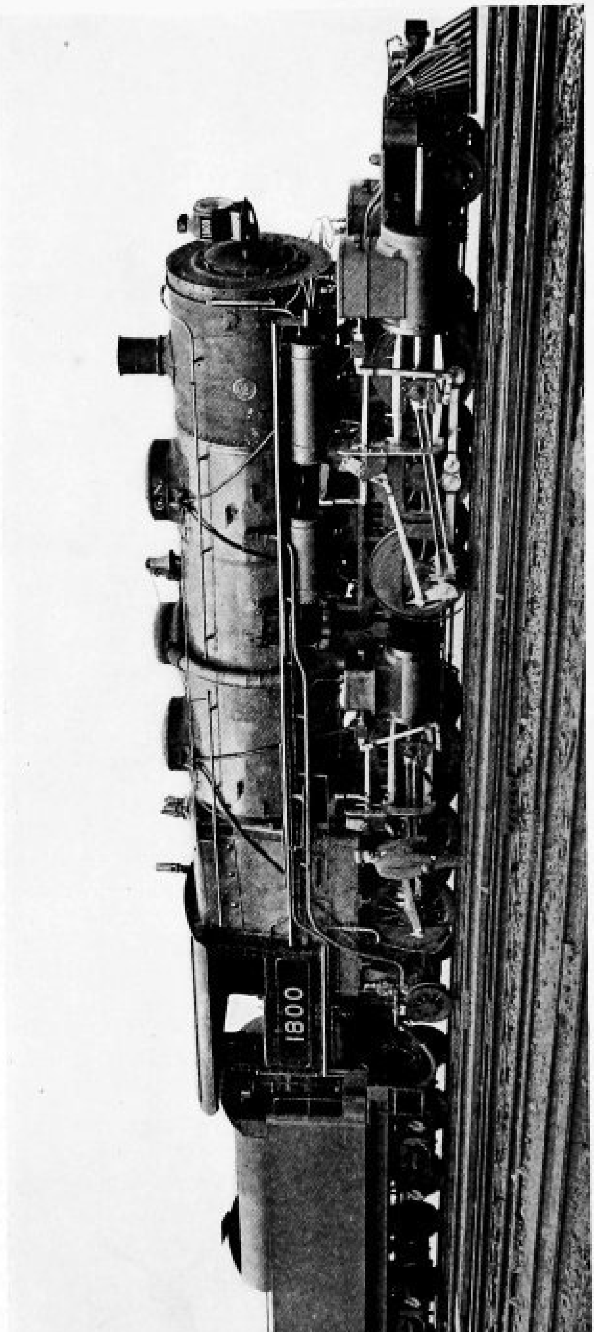
CODE WORD	Class	Cylinders. Diameter Stroke. — Inches	Driving Wheels. Diam. — Inches	Boiler Pressure — Pounds Per Sq. Inch	Cylinder Tractive Power — Pounds	Weight in Working Order. — Pounds.	Wheel Base — Ft.	Ins.	Capacity of Tender for Water. — 8⅓-lb. Gallons	LOAD IN TONS (OF 2240 POUNDS) OF CARS AND LADING — On a Level	On a Grade per Mile of 26.4 ft. or ½%	52.8 ft. or 1%	79.2 ft. or 1½%	105.6 ft. or 2%	132.0 ft. or 2½%	158.4 ft. or 3%
Medoacus........	8-34 E	20 x 26	50	200	35,370	144,000	14	0	4000	3710	1665	1010	710	540	425	350
Medobriga.......	8-36 E	21 x 28	50	200	41,980	165,000	15	4	5000	2425	1900	1155	815	615	485	395
Medonho........	8-38 E	22 x 28	50	200	46,080	194,000	15	6	5500	5000	2240	1365	960	725	575	470
Medontias.......	8-40 E	23½ x 32	57	200	52,700	224,000	16	0	6000	5775	2590	1580	1110	845	670	545

These locomotives are suitable for heavy switching service where a six coupled engine would not afford sufficient power, or where the necessary weight, if carried on only three pairs of driving wheels, would be greater than the rails could safely bear.

For remarks on tractive power, see pages 106 to 109.



EIGHT COUPLED LOCOMOTIVE



MALLET COMPOUND ARTICULATED LOCOMOTIVE

Compound Locomotives

THE primary object of applying compound cylinders to a locomotive, is to economize in fuel and water consumption. This is accomplished by expanding the steam through two cylinders, thus reducing the terminal pressure below that attained in a single-expansion locomotive, and developing more work from each pound of steam generated. The low terminal pressure results in a mild and even exhaust, which improves the draft action on the fire, especially when the engine is working at slow speed with a long cut-off. Under such circumstances, with careless handling, holes are frequently torn in the fire of a single-expansion locomotive; but this is not liable to occur on an engine equipped with compound cylinders.

The Baldwin Locomotive Works have taken an active part in the development of the compound locomotive. They are prepared to build five distinct types — the Vauclain four-cylinder compound; the two-cylinder or cross compound; the tandem compound; the balanced compound, and the Mallet articulated compound. In each of these designs the aim is to produce a locomotive free from unnecessary complications, and which can be handled as nearly as possible like a single-expansion engine. A brief description of each type follows:

The Vauclain Four-Cylinder Compound

This type of compound locomotive was introduced by the Baldwin Locomotive Works in the year 1889, since which time about 3000 have been built. These locomotives have been shipped to railways in all parts of the world. The following is a brief description of the construction of this type:

The engine is arranged with one high and one low-pressure cylinder on each side. The cylinders are placed one above the other, and the two piston rods are secured to a common crosshead. The two cylinders are cast in one piece with half the saddle, exactly as in a single-expansion locomotive.

The steam distribution to each pair of cylinders is controlled by one piston valve, which is operated by the usual link motion. A sectional view of the cylinders and steam chest is presented in the accompanying diagram.

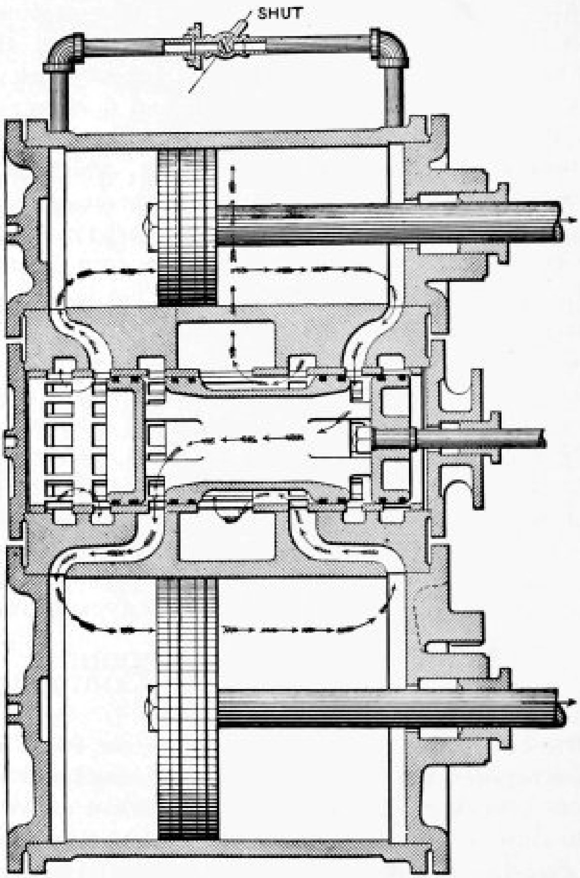


DIAGRAM OF STEAM DISTRIBUTION IN VAUCLAIN FOUR-CYLINDER COMPOUND

The arrangement of the cylinders in relation to the valve is, for convenience of reference, somewhat distorted, the valve being shown in a vertical line between the two cylinders. The valve works in a cylindrical chest located in the saddle casting, between the cylinders and the smokebox, and as close to the cylinders as convenience will permit. It is surrounded by an independent bushing, with port openings machined to exact dimensions, so that the admission of steam will be uniform under all conditions. By the use of this bushing repairs can be made from time to time, and changes effected in the port openings, without the necessity of altering the cylinder castings. The bushing is forced into place by hydraulic pressure.

The function of the valve is to control the admission and exhaust of both cylinders. Live steam enters the chest at both ends of the valve and is admitted to one end of the high-pressure cylinder. The exhaust from the high-pressure cylinder passes through the central hollow portion of the valve and supplies the low-pressure cylinder, while at the same time the steam in the opposite end of the low-pressure cylinder is allowed to escape under the valve to the final exhaust in the stack.

In order to obtain the maximum starting power in any compound locomotive it is necessary to employ some means of admitting live steam to the low-pressure cylinder. The device for this purpose in the Vauclain four-cylinder type is a by-pass valve, which is opened to allow the steam to pass from one end of the high-pressure cylinder to the other, and from thence to the low-pressure cylinder.

The Two-Cylinder Compound

In this type the high-pressure cylinder is placed on one side of the locomotive and the low-pressure on the other, the connection between the pistons and wheels being in all respects like that of a single-expansion locomotive. When working compound, steam passes from the high to the low-pressure cylinder through a receiver pipe placed in the smokebox, and after expanding, in the low-pressure cylinder it is exhausted up the stack.

It is essential, in order to start a locomotive of this type, that steam be admitted direct from the boiler to the low-pressure cylinder, and that the pressure of the steam be reduced so that the work done in the two cylinders will be approximately equal. In some cases this is accomplished by automatic devices, which start the locomotive as a single-expansion, and change it to compound as soon as the train is in motion. In the Baldwin two-cylinder type, introduced in 1898, the change from single-expansion to compound working is effected at the option of the engineer. The advantage of this arrangement lies in the fact that, when switching or working at slow speeds on heavy grades, it is sometimes desirable to operate the locomotive as a single-expansion for considerable periods of time. The mechanism for changing from single-expansion to compound is simple and positive in action, and is illustrated by the accompanying drawings.

In the diagrams, Figures 1 and 2, **A** is a double piston intercepting valve, located in the saddle casting of the high-pressure cylinder. In one direction the movement is controlled by a spiral spring, in the other by steam pressure. The function of

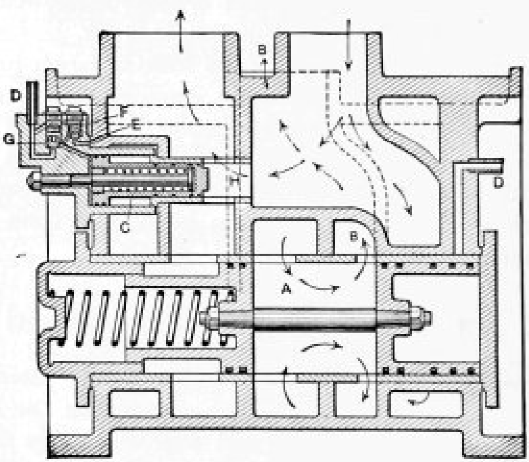


FIGURE 1
TWO-CYLINDER COMPOUND. POSITION OF VALVES WHEN WORKING SINGLE EXPANSION

the intercepting valve is to cause the exhaust steam from the high-pressure cylinder to be diverted, at the option of the engineer, either to the open air when working single-expansion, or to the receiver when working compound. **C** is a reducing valve also placed in the saddle casting of the high-pressure cylinder. Like the intercepting valve it is moved in one direction by a spiral spring, and in the opposite direction by steam pressure. The function of this valve is, in its normal position, to admit live steam into the receiver at reduced pressure while the locomotive is working single-expansion. When the locomotive is working compound, this valve automatically closes, as it is evident that there is no further need of live steam in the receiver. A further

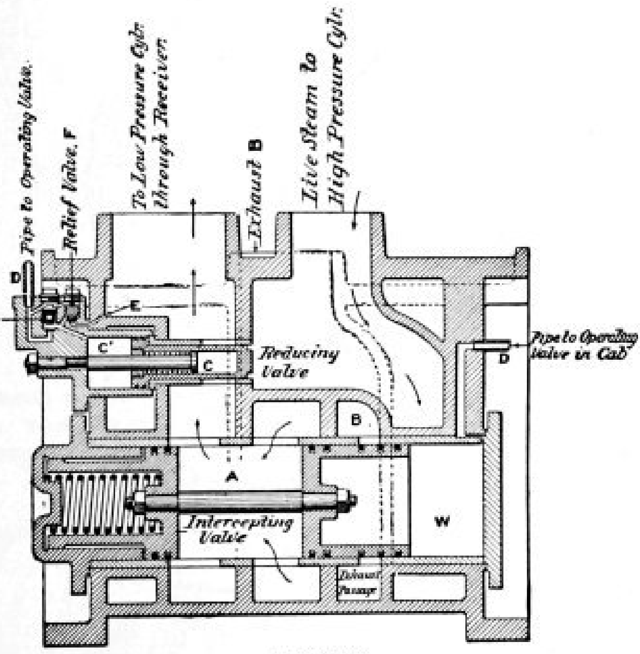


FIGURE 2
TWO-CYLINDER COMPOUND. POSITION OF VALVES WHEN WORKING COMPOUND

function of the reducing valve is to regulate the pressure in the receiver so that the total pressure on the pistons of the high and low-pressure cylinders may be equalized. The steam for controlling the operation of both intercepting and reducing valves is supplied through the pipes **D** from the operating valve in the cab.

When not permanently closed by pressure in the pipes **D**, the reducing valve **C** is operated automatically by the pressure in the receiver. To this end the port E is provided, communicating with the receiver and the space in front of the reducing valve. As the pressure rises the steam acts on the large end of the reducing valve, causing it to move backward and partially closing the passage H through which steam enters the receiver. This action prevents an excess pressure of steam in the low-

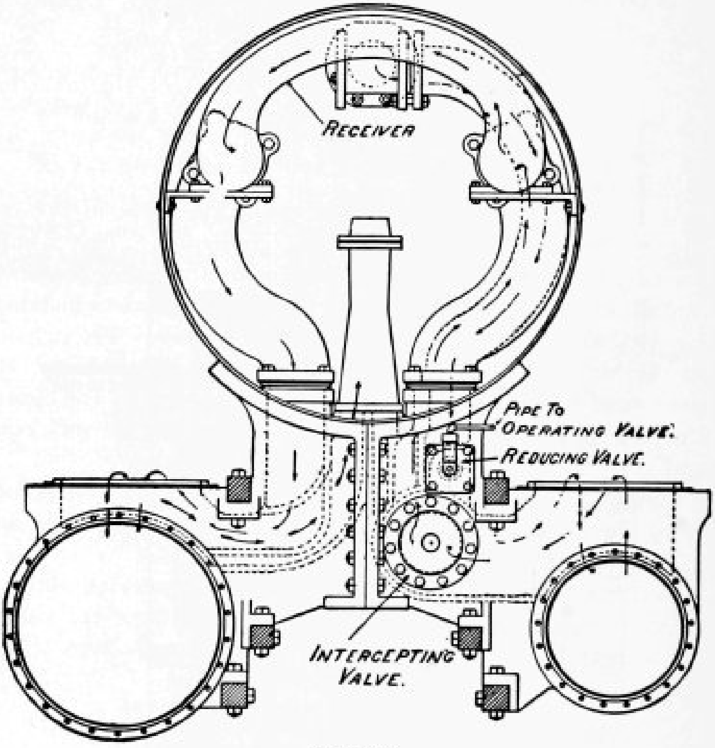


FIGURE 3
TWO-CYLINDER COMPOUND. CROSS-SECTION

pressure cylinder. Poppet valves F and G are placed in connection with the port E, one to prevent the escape of steam from the receiver to the pipe D when the locomotive is working single-expansion, and the other to close the passage from pipe D to the receiver when working compound.

Normally the lever of the operating valve in the cab is in the position marked "simple." In this position no steam is allowed to enter the pipes **D** and no pressure will be exerted on the intercepting and reducing valves in opposition to the springs, and they will assume the positions shown in Figure 1. The ports of the intercepting valve **A** stand open to receive the exhaust steam from the high-pressure cylinder and deliver it through the exhaust passage **B** to the atmosphere. The reducing valve is open, admitting live steam through passage **H** to the receiver and from thence to the low-pressure cylinder. The receiver pressure is governed by the automatic action of the reducing valve as previously explained. In this way the locomotive can be used single-expansion in making up and starting trains for switching and slow running.

At the will of the engineer the operating valve in the cab is moved to the position marked "Compound." This admits steam to the pipes **D** and through them to the valve chambers **W** and **C'**, changing the intercepting and reducing valves instantly and noiselessly to the positions shown in Figure 2. The exhaust from the high-pressure cylinder is diverted to the receiver, the admission of live steam to the receiver is stopped by the closing of the passage **H**, and the locomotive is in position to work compound.

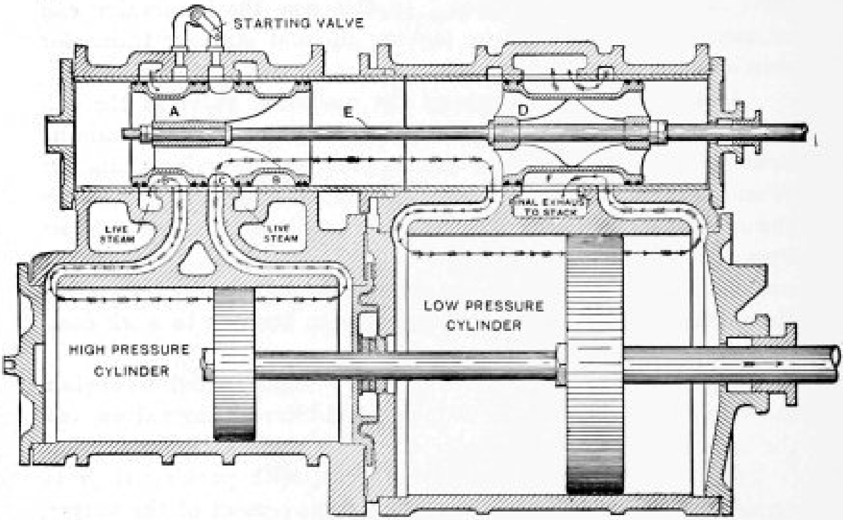
Figure 3 is a front view of the cylinders and smokebox showing the location of the reducing and intercepting valves, and the arrangement of the piping.

Both valves are of the piston type, with packing rings to prevent leakage. This insures an easy movement of the valves, and prevents the hammering action common to valves of the poppet type when automatically operated.

The Tandem Compound

In this type of locomotive, introduced in 1902, principally for heavy freight service, four cylinders are used, with a high and low-pressure cylinder and cylindrical steam chest on each side. The high-pressure cylinder is placed in front of the low-pressure, both having the same axis; that is, the center of the low-pressure cylinder extended becomes also the center of the high-pressure. With this arrangement, the guides, crossheads, and connecting rods are similar to those of a single-expansion locomotive; and the thrust imparted to the crosshead is always central, regardless of any inequality in the pressures on the two pistons.

The accompanying diagram shows a section through the cylinders and steam chests. Each cylinder with its steam chest is cast separately and is separate from the saddle. The steam connections are made by a pipe from the saddle to the high-pressure steam chest, and the final exhaust takes place through



STEAM DISTRIBUTION IN TANDEM COMPOUND CYLINDERS

an adjustable connection between the low-pressure cylinder and the saddle casting. The valve, which is double and hollow, admits steam to the high-pressure cylinder, and at the same time distributes the high-pressure exhaust from the front end of the high-pressure cylinder to the back end of the low-pressure cylinder or visa versa, as the case may be, without the necessity of crossed ports. As shown in the accompanying diagram, **A** is the high-pressure valve by which steam is conducted from the live steam openings through external cavities **B** and **B** to the high-pressure cylinder. The exhaust from the high-pressure cylinder passes through the opening **C** to the steam chest, which acts as a receiver; **D** is the low-pressure valve connected to the high-pressure valve by valve rod **E**. This valve in its operation is similar to the ordinary slide valve. The outside edges control the admission, and the exhaust takes place through the external cavity **F**. The starting valve connects the live steam ports of the high-pressure cylinder.

As shown in the drawing, a front head is provided for the low-pressure cylinder and a back head for the high-pressure. The space between the two heads is used for the reception of the packing, which is arranged to adjust itself to any slight variation in the position of the piston rod due to wear. The two cylinders are securely held together by external bolts easily accessible, and by the removal of which the high-pressure cylinder can be taken down, and the front head of the low-pressure cylinder moved forward on the piston rod, giving access to the front of the low-pressure cylinder and piston. The high and low-pressure steam chests are united by a slip joint, made tight by means of a packed gland.

This arrangement of compound cylinders has been applied to over one hundred and fifty ten coupled locomotives which are in successful operation on the Atchison, Topeka and Santa Fe Railway.

The Balanced Compound

In all two-cylinder locomotives whether single-expansion or compound, and in four-cylinder types such as the tandem and the original Vauclain compound, the reciprocating parts are counterbalanced by rotating weights in the driving wheels.

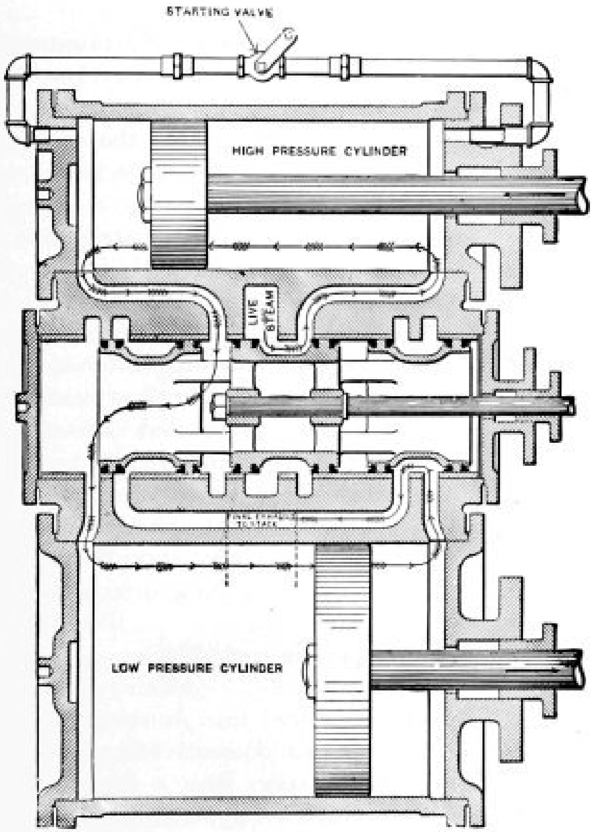
This arrangement of balance is frequently unsatisfactory, particularly for heavy locomotives when running at extremely high speeds. By balancing the reciprocating parts against each other the rotating balances in the wheels used to complement these parts can be eliminated, avoiding to a great extent the vertical shocks, and reducing the strain upon the track to that due to the weight of the locomotive only. Consequently, with a self-balanced arrangement of reciprocating parts, the weight on the driving wheels may be increased without damaging the track, and higher speed is attainable without undue strain upon the working parts of the locomotive.

The balanced compound, designed by S. M. Vauclain, and first built by the Baldwin Locomotive Works in 1902, is intended to accomplish these results and simplify, as far as possible, the arrangement of the working parts.

The cylinders are a development of the original Vauclain four-cylinder compound type, with one piston valve common to each pair. Instead of being superimposed and located outside of the locomotive frames, the cylinders are placed horizontally in line with each other, the low-pressure outside and the high-pressure inside the frames. The piston valves are placed above and between the two cylinders which they are arranged to control. A separate set of guides and connections is required for each cylinder.

As the two high-pressure cylinders are placed inside the frames, the pistons are necessarily coupled to a crank axle. The low-pressure pistons are coupled to crank pins on the outside of the driving wheels. The cranks on the axle are set at ninety degrees with each other, and at one hundred and eighty degrees with the corresponding crank pins in the wheels. The two pistons on the same side of the engine, therefore, travel in opposite directions, and the reciprocating parts act against one another and balance each other to the extent of their corresponding weights.

The distribution of steam is shown in the accompanying diagram. The live steam port in this design is centrally located between the induction ports of the high-pressure cylinder. Steam enters the high-pressure cylinder through the steam port and the central external cavity in the valve. The exhaust from the high-pressure cylinder takes place through the opposite steam port to the interior of the valve, which acts as a receiver. The outer edges of the valve control the admission of steam to the low-pressure cylinder. The steam passes from the front of the high-pressure cylinder through the valve to the front of the low-pressure cylinder, or from the back of the high-pressure to the back of the low-pressure cylinder. The exhaust from the low-pressure cylinder takes place through external cavities, under the front and back portion of the valve, which communicate with the final exhaust port. The starting valve connects the two live steam ports of the high-pressure cylinder, thus allowing the steam to pass over the piston, and thence direct to the low-pressure cylinder.



STEAM DISTRIBUTION IN BALANCED COMPOUND CYLINDERS

The arrangement of the guides and crossheads necessarily depends, to a large extent, upon the type and construction of the locomotive. It is preferable, if possible, to connect the inside main rods to the first driving axle, and this can frequently be accomplished in four and six coupled locomotives by a slight lengthening of the wheel base in order to secure the room required. If this cannot be done, the inside main rods must be connected to the second axle. In this case, the rods are either made with a loop or bifurcation, which spans the first axle, or the high-pressure cylinders are sufficiently inclined to enable the rods to pass above the axle.

The accompanying drawing shows the arrangement of the driving mechanism, as applied to an Atlantic type locomotive. In this case the inside main rods are connected to the first axle, while the outside rods are connected to the second pair of wheels. If preferred, all the main rods can be connected to the first pair of wheels in a locomotive of this type.

When these locomotives were first introduced, some objection was raised because of the necessary use of a crank axle. The design of this member has been so perfected, however, that such an objection is no longer tenable. The latest form of crank axle used by the Baldwin Locomotive Works is built up of seven pieces, with a cast steel central web. An illustration of such an axle, with wheels mounted on it, is presented herewith.

Balanced compound cylinders as described above, have been applied by the Baldwin Locomotive Works to upward of three hundred and fifty locomotives. The majority of these engines are employed in fast passenger service on railroads in the United States.

The Mallet Articulated Compound

This type has been introduced into American railroad practice, in response to a demand for a locomotive having exceptionally high tractive force in combination with a flexible wheel base. The driving wheels are divided into two groups, the rear group being driven by the high-pressure cylinders and the forward group by the low-pressure. The rear wheels are held by their frames, in rigid alignment with the boiler. The frames of the forward group of wheels are connected to the rear frames by a pin, which is placed on the center line of the locomotive between the high-pressure cylinders. The forward group of wheels swings about this pin as a center and the rigid wheel base is that of the rear group of driving wheels only. With this arrangement the engine curves as readily as a six or eight coupled locomotive of the ordinary type.

The high-pressure cylinders which are securely bolted to the rear frames, receive steam from the boiler through external rigid pipes. The connection between the high and low-pressure cylinders is made by a flexible receiver pipe which is placed on the center line of the engine and provided with ball and slip joints. A second flexible pipe conveys the exhaust steam from the low-pressure cylinders to the smokebox, whence it is discharged up the stack in the usual manner. The joints in the receiver and exhaust pipes are simple in construction and as only low-pressure steam passes through them practically no trouble is experienced from leakage.

In order to enable the locomotive to start promptly, live steam may be admitted to the receiver by opening a valve in the cab. This valve should be closed as soon as the low-pressure cylinders are receiving their full supply of steam from the high-pressure cylinders.

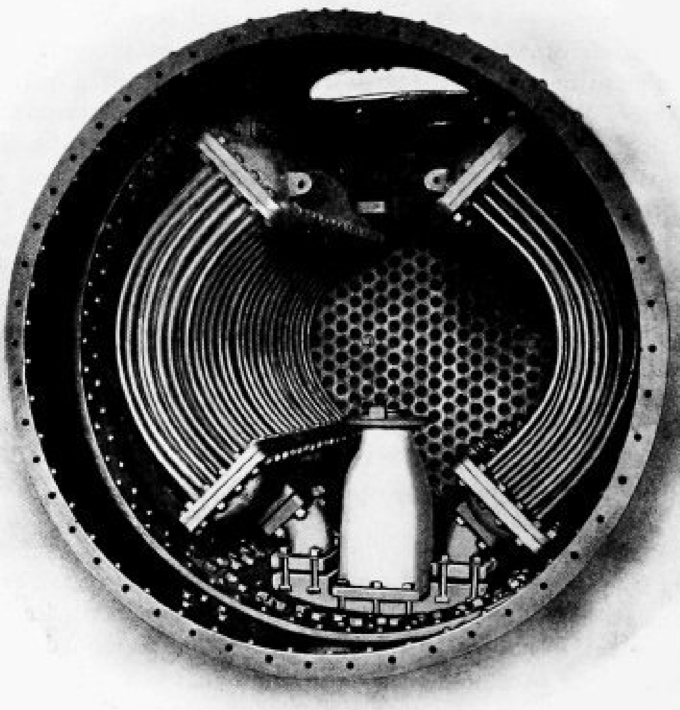
The boiler and rear frames are held in rigid alignment with one another, as previously explained. The boiler shell is supported, above the front frames, by means of a sliding bearing. A spring centering device is also provided, which assists in bringing the forward group of wheels back into line after rounding a curve.

Locomotives of this type may be arranged with either two, three or four pairs of wheels in each group. If desired leading and trailing trucks may also be provided. These trucks add to the flexibility of the wheel base and also protect the driving wheels against flange wear.

Locomotives of this type are particularly suitable for heavy freight and pushing service on mountain grades, where sharp curves must be traversed and where the development of a high tractive force is essential. Their use on American roads dates from the year 1904, and their performance has been highly satisfactory. The accompanying illustration represents an engine of this type which is in service on the Great Northern Railway.

The Vauclain Superheater

It is found, in the operation of modern locomotives, that about eighty-five per cent. of the cost of maintenance is consumed in boiler repairs, and that the proportion so consumed increases rapidly with an increase in boiler pressure. Any device, therefore, which permits a reduction of boiler pressure, while maintaining or increasing the efficiency, is an important advantage in reducing the cost of motive power. The Vauclain



superheater has been introduced with this object in view. The device, which may be more properly described as a steam dryer, is located entirely within the smokebox. It consists of an upper and lower drum on each side, the two upper drums being connected to the steam pipe cone, and the two lower drums to the live steam passages leading to the cylinders. Each upper drum communicates with the corresponding lower drum by rows of bent tubes which follow the contour of the smokebox shell. The drums are divided, by longitudinal and transverse partitions, into several compartments so that the steam in passing from the dry pipe to the cylinders flows successively through different groups of tubes and utilizes, as far as possible, the heat in the waste gases for superheating purposes.

It is not the intention, with this arrangement, to attain a high degree of superheat, such as is secured with the various forms of superheaters which have been developed in Europe. The difficulties which have been experienced in lubricating the cylinders when using highly superheated steam, would make its use prohibitive on most American roads. The Vauclain superheater gives an average of fifty-four to sixty degrees of superheat, which results in a fuel economy of about eleven per cent.; and as the temperature is not high, there is no difficulty in lubricating the valves and keeping the rod packing tight.

The superheater is proving of special value on heavy locomotives, which when using saturated steam, are worked at high boiler pressure. In applying it the pressure is reduced, and the cylinders are enlarged in order to maintain the tractive force desired. The device can thus be used on any of the locomotives described in this catalogue.

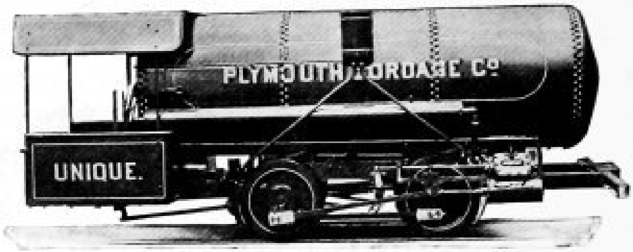
Compressed Air Locomotives

LOCOMOTIVES particularly adapted for mine haulage were first used in the United States about the year 1870. These early locomotives were operated by steam, and proved vastly more efficient and economical than the prevailing system of hauling by animal power. Their use, however, was limited to the main gangways of well-ventilated mines on account of the danger and inconvenience from fire and escaping steam and gases. In order to overcome the difficulties attending the use of steam, compressed air was substituted. A reservoir was provided for the reception of the air, to take the place of the steam boiler, making no material change in the arrangement of the machinery. In this way the efficiency derived from the use of the locomotive was retained and danger avoided.

In common with all gases the atmosphere possesses the property of perfect elasticity, and is capable of giving back in work all the stored energy, subject only to the losses due to the process of compression and the frictional resistances of the compressing machinery. Compressed air, therefore, affords a valuable and convenient source of motive power for general use when the conditions are such as to preclude the use of steam or electricity. It will be readily seen that locomotives actuated by compressed air can exert only so much power as has previously been stored within them, and when this power has been exhausted it can only be restored from without. It is necessary, therefore, to provide tanks or reservoirs of sufficient capacity to supply the total power demanded for the entire run, or from one charging station to another.

In view of the large quantity of free air required to propel a locomotive when drawing any considerable load, it is of the greatest importance to consider carefully the storage capacity, and utilize any means which will economize the air or increase its efficiency as this directly affects the capacity of the locomotive both for hauling power and for length of run.

When air is expanded in the locomotive a drop in temperature is experienced, reaching far below that of the atmosphere; this has a marked effect on the final volume of the air used in the cylinders. An increase in economy and efficiency will, therefore, be obtained by restoring to the air some of its lost heat. An efficient system



FOUR COUPLED LOCOMOTIVE FOR THE PLYMOUTH CORDAGE COMPANY

of reheating would be highly desirable were it not for the complication involved, and the fact that for mine service the process of reheating brings with it the very danger which the use of the compressed air locomotive is intended to avoid. It should be borne in mind, however, that the temperature of the expanding air reaches far below that of the surrounding atmosphere, which under these conditions acts as a reheating medium by contact with the outer surfaces of the tanks and cylinders similar to the process of heat absorption in an ordinary furnace. Any increase in the amount of surface of tanks or cylinders exposed to the atmosphere is a direct gain. In view of this fact the outer surfaces of the cylinders are corrugated, causing them to present a greater area for absorption.

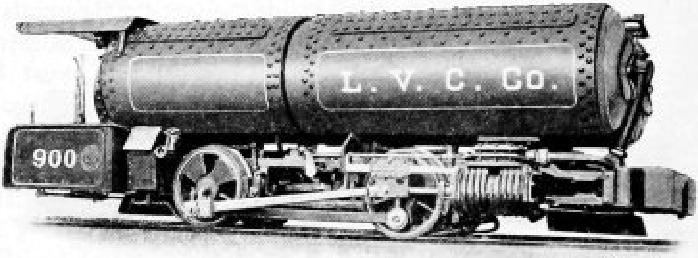
Within certain limits compressed air is preferable to steam or electricity for mine haulage. Compressed air locomotives, as compared with those using steam, differ but slightly so far as the machinery is concerned. The steam generating apparatus is however entirely eliminated, simplifying the construction and doing away with the part of the locomotive which requires the greater amount of skill to operate. As long as the air supply is maintained, compressed air locomotives are capable of handling the same load in proportion to their tractive power as locomotives operated by steam, and have the advantage of being entirely free from fire, gas or vapor.

With electricity, especially for large units, the trolley system is the only one ordinarily available, and the locomotive is confined in its range to the trolley and bonded track, except in some instances where its scope is increased by the installation of a gathering reel and cable. With compressed air, however, the locomotive is at liberty to run in any direction on any available track to the limit of its charge. The cost of installation for compressed air compares favorably with that for electricity. A study of the conditions governing each individual case should be made to determine which system is advisable. The use of compressed air, in mines where animals are used to supplement the locomotive, avoids accidents to these animals, often experienced with electric power. With an electric installation the generators must be operated at a constant speed sufficient to overcome the aggregate maximum resistances of the locomotives. With compressed air each unit or locomotive carries its own stored maximum power, which is available at any time without special demand upon the source of supply represented by the compressor plant. This plant can, therefore, be operated at an average speed and with a minimum expenditure of power, being independent of any fluctuation in the power required by the moving trains. If the output is reduced or fewer and lighter trains are run, which would tend to cause an excess pressure in the receiver, the compressor is so arranged as to automatically slow down when the maximum pressure is reached, thus reducing the expenditure of fuel. The equipment is simple and does not require specially educated experts to keep it in repair.

Equipment

For the installation of a compressed air plant it is first necessary to determine the requisite number of locomotives of the proper size and power to adequately handle the output. An air compressor of suitable design can then be provided, having a capacity sufficient to supply the locomotives with air at the required pressure, which under ordinary conditions is from 600 to 800 pounds per square inch.

It is possible to charge the locomotive direct from the compressor, but this system, although economical in some respects, would necessitate an increase in size of both the compressor and the locomotive. It is preferable, therefore, to provide stationary reservoirs at convenient points in the mine from which a supply of air can be readily drawn to recharge the locomotive tanks. This enables the compressor to be run continuously and restore the depleted reservoirs to their normal pressure while the locomotive is doing its work. Where the system requires a considerable length of piping the pipe line in itself will supply sufficient capacity without the necessity of extra stationary reservoirs.



FOUR COUPLED LOCOMOTIVE FOR THE LEHIGH VALLEY COAL COMPANY

In order to insure the requisite storage pressure in a locomotive tank, a somewhat higher pressure must be maintained in the charging reservoirs or pipe line. The relative size and volume of the storage and locomotive tanks may be expressed approximately as follows:

$Vp + GF = (V + G) P$ in which

V=Volume of locomotive storage tanks.

P=Absolute initial pressure in locomotive tanks.

p=Absolute final pressure in locomotive tanks usually corresponding to cylinder working pressure.

G=Volume of stationary storage tank or pipe line.

F=Absolute pressure in storage tank or pipe line to give initial pressure in locomotive tanks.

To find the volume required in the stationary storage tank, to at once fill the locomotive tank to a given pressure, the storage pressure of the stationary tank must be assumed, or the pressure may be ascertained by assuming a certain volume.

$$\text{The volume } G = \frac{V(P-p)}{F-P} \text{ or the pressure } F = \frac{P(V+G)-Vp}{G}$$

Assuming the locomotive storage pressure to be 800 pounds and the volume of the locomotive tank to be 150 cubic feet, with a final pressure of 140 pounds left in the tank at the time of recharging, and also assuming that the pipe line or stationary storage tank has a pressure above the atmosphere of 1000 pounds, then $\frac{150\ (815-155)}{1015-815}=495$ cubic feet required volume of pipe line or stationary reservoir.

To find the pressure necessary for the pipe line (for convenience assuming 495 cubic feet for the volume and working the same problem inversely), then

$$\frac{815\ (150+495)-150\times 155}{495}=1015 \text{ absolute pressure.}$$

From this subtract 15 pounds for atmospheric pressure, and the result will be 1000 pounds gauge pressure necessary to give 800 pounds in the locomotive tanks.

Charging Stations

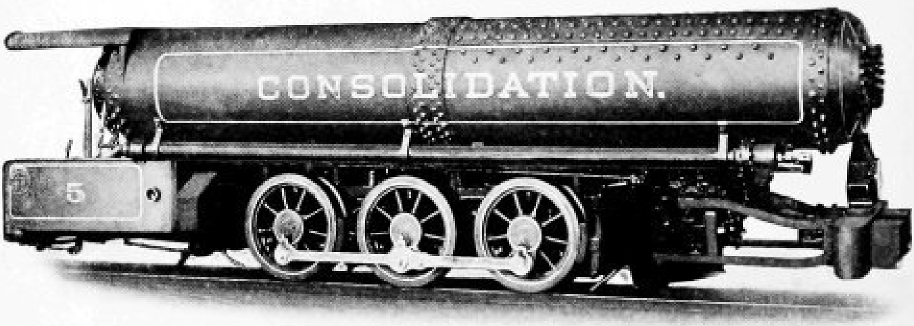
The charging stations should be located at convenient points, preferably at the ends of the run or where the locomotive is, for other reasons, required to stop. This will economize the air by avoiding the necessity of running the engine any considerable distance simply for the purpose of recharging. The connection and stop valves for the charging stations are arranged with a view to ready adjustment and speedy supply, in order that the locomotives may not be detained longer than is absolutely necessary while receiving their charge. After becoming familiar with the operation, the time required for making connections and recharging is ordinarily less than one minute.

Curves

The resistance due to curves is influenced to such an extent by the construction of the road bed and various other conditions of service that it is practically impossible to give an exact rule applicable in all cases.

In ordinary surface railroad practice the resistance due to curvature is taken at about five-tenths pounds per ton per degree of curvature. If this is expressed as a percentage of the weight, or co-efficient, it equals .00025; and the total resistance due to curvature alone equals weight × .00025 × degree of curvature. This is approximately correct for the average truck wheel base of about six feet, and when wheels are fixed on axles.

The above co-efficient, however, should evidently be a function of the angle between the wheel and rail, and this angle is dependent upon the relation existing between the wheel base and the radius of curvature.



SIX COUPLED INSIDE CONNECTED LOCOMOTIVE FOR THE CONSOLIDATION COAL COMPANY

As the above expression does not embody the wheel base, it is not sufficiently comprehensive for all combinations, and when applied to short wheel bases of about two feet, commonly used on mine cars, it is found to give results greatly in excess of the actual curve resistance.

To determine an approximate value for this co-efficient a series of tests was made at the mines of the Consolidation Coal Company, near Frostburg, Md. The cars were three feet gauge, two feet wheel base, with loose wheels eighteen inches in diameter, and were selected at random from the run of the mine. The average co-efficient was found to be about twenty per cent. of the sine of the angle made between the front wheel and the rail; or as the back axle assumes a radial position, the average co-efficient=

$$.20 \times \frac{\text{Wheel Base}}{\text{Radius of Curve.}}$$

Hence, the resistance due to curvature alone of loose wheeled cars=

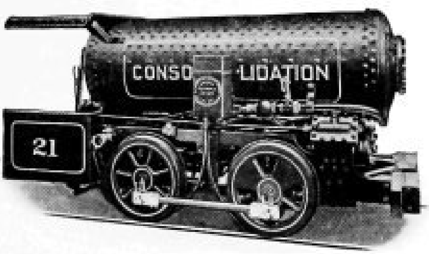
$$.20 \times \frac{\text{Wheel Base}}{\text{Radius of Curve}} \times \text{weight.}$$

Assuming for example, a wheel base of two feet; radius of curvature, fifty feet; weight, 2000 pounds. The resistance due to curvature alone=

$$.20 \times \frac{2}{50} \times 2000 = 16 \text{ pounds.}$$

This should be added to the frictional and grade resistance to find the total resistance.

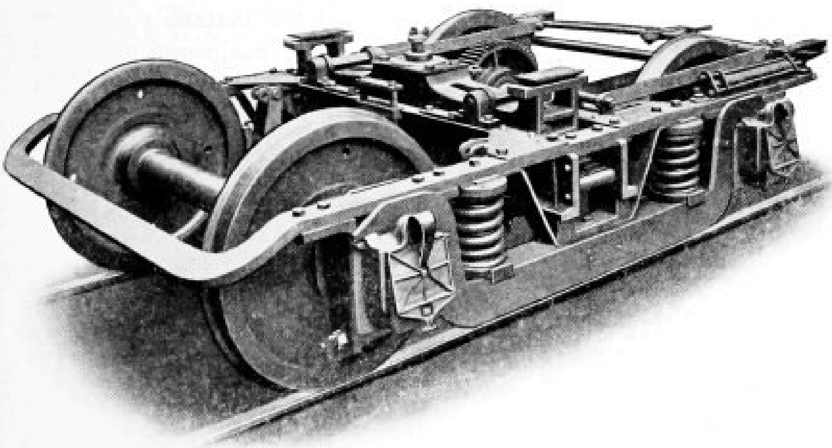
The gauge of track does not appear in the above as a factor because the wheels are loose and all longitudinal slipping is eliminated.



FOUR COUPLED LOCOMOTIVE FOR THE CONSOLIDATION COAL COMPANY

Electric Motor and Trailer Trucks

IN general design the Baldwin Electric Truck is constructed on the lines of the Master Car Builders' Standard trucks for steam railroads. It is believed that this design, resulting from many years of study and experiment represents the best knowledge on the subject, and this belief is confirmed by the experience of fifteen years in the manufacture of electric trucks.



ELECTRIC MOTOR TRUCK

Designs will, however, be prepared and submitted when desired to meet special conditions or trucks will be built to customer's specifications.

The requirements of modern electric street and interurban railways with heavy cars and motors and high speeds are fully as severe as the requirements of steam railroads. Particularly is this true of trucks, for upon the excellence of their design, workmanship, and material, depends not only the safety of passengers, but also an economical maintenance of the car and road bed, and a minimum expenditure of power. The Baldwin trucks are designed to combine with the Master Car Builders' running gear the characteristics of a Baldwin locomotive. The strains due to the weight and torque of the motors are provided for by a stronger construction and different distribution of weight, but the Master Car Builders' method of equalization of the load, swing bolster construction and general features are retained. From the standpoint of the operating engineer, as well as theoretically, Baldwin trucks have shown themselves to be strong, easy riding and low in maintenance cost.

All of the trucks built by the Baldwin Locomotive Works are assembled in accordance with standards of workmanship set for the construction of locomotives and the materials used are the best of their respective kinds. Workmanship and materials must conform rigidly to the specifications drawn from data acquired in more than seventy-five years of locomotive construction.

Locomotive Details

EACH locomotive has the builder's number plate attached to sides of smokebox directly over steam chests, except in small engines of special designs, when it is placed on smokebox door, or in some other conspicuous position. This plate contains the name of the manufacturers, the consecutive construction number of the engine, and the year in which constructed.

In ordering parts, in all cases where it is possible to do so this construction number should be given, and when this cannot be obtained, the original road number or name should be supplied. This information will assist in ready reference to original records of construction and facilitate the work of renewals.

The locomotive details and code words herein given can be used with reference to either broad or narrow-gauge locomotives.

Instructions for Cabling

The cable address of these Works is, **"Baldwin, Philadelphia."** All code words relating to duplicate parts begin with the letter "E."

Each of the tables accompanying the plates in this book has in large heavy letters opposite the plate number a code word, the use of which indicates that all the parts shown on the plate are required; and each of the items has opposite it a code word in small heavy letters indicating that only that particular piece is needed.

In all cases it is understood that a set or enough for one locomotive will be sent unless specific instructions to the contrary are given.

On pages, 261-269 a list will be found of duplicate parts in groups, such as are generally ordered, with a code word corresponding to each group.

In answering inquiries for prices, the cost is made for delivery f.o.b. vessel in Philadelphia or New York unless otherwise indicated.

The construction or consecutive number of the locomotive should be used in cabling and in writing orders. This is shown on the builder's plates, which are generally on the smokebox above the cylinders. Code words corresponding to construction numbers will be found in the tables herewith (pages 243-251), which range from 1 to 45,000 (from 1 to 1,000 inclusive proceeding by units, and from 1000 to 45,000 proceeding by thousands).

Words consisting of more than ten letters are counted as two words. When the name of a railway or firm embraces two or more words containing ten letters or less in all, they can be cabled as one: for instance, **"Costarica** Railway" (two words), meaning Costa Rica Railway.

It is a rule of all telegraph companies that in cabling, three figures count as one word. Therefore, any construction number can be cabled in two words: for instance, 13 975 (13975), which would be counted two words. Inasmuch, however, as figures are more apt to be improperly transmitted than words, a table has been prepared (see page 243) by the use of which construction numbers can still be given in two words and some of them in one, these words being less liable to misconstruction than the figures.

Messages should be written very plainly, so that there can be no doubt as to the word used, and no possibility of the division of one word into two.

Upon application a code word will be assigned, representing the name of any railroad company or firm desiring to do business by cable with the Baldwin Locomotive Works.

Example: The construction number 6000 would be one word, "Eenlobbig;" while 6020 would be "Eenlobbig Earthworms," and 12540 "Eensgezind Ecofora" ("Eensgezind" standing for 12,000 and "Ecofora" for 540). 6020 could also be 6 020, and 12540 be 12 540; but the word method is preferable.

Example: if it be desired to cable for a boiler complete, as shown on Plate 1, for engine 13978, to be shipped by steamer to Havana, Cuba, the message would read as follows (the signature should be the name of the company ordering or its code word).

HAVANA, January 10, 1905.

BALDWIN, Philadelphia.

Eerekrans
Encotyle
Eerewoord
Eensklaps
Eenbladig

(Signed) (Code name or actual name of Company)

Translation:

HAVANA, January 10, 1905.

BALDWIN, Philadelphia.

Eerekrans . . Please ship by steamer as soon as possible duplicate parts covered by code word.

Encotyle . . Boiler and all parts on Plate 1.

Eerewoord . For one locomotive, construction number

Eensklaps .
Eenbladig . } 13978.

(Name of Company)

But if a set of tubes were wanted, the message would read:

HAVANA, January 10, 1905.

BALDWIN, Philadelphia.

Eerekrans
Encravacao
Eerewoord
Eensklaps
Eenbladig

(Signed) (Code name or actual name of Company)

Translation:

HAVANA, January 10, 1905.

BALDWIN, Philadelphia.

Eerekrans . . Please ship by steamer as soon as possible duplicate parts covered by code word.
Encravacao . Boiler tubes.
Eerewoord . . For one locomotive, construction number
Eensklaps . } 13978.
Eenbladig . }

(Name of Company)

If three sets of tubes were wanted for the same locomotive, or for locomotives of the same dimensions, the message would read:

HAVANA, January 10, 1905.

BALDWIN, Philadelphia.

Eerekrans
Encravacao
Eergierig
Eensklaps
Eenbladig

(Signed) (Code name or actual name of Company)

Translation:

HAVANA, January 10, 1905.

BALDWIN, Philadelphia.

Eerekrans Please ship by steamer as soon as possible duplicate parts covered by code word.

Encravacao Boiler tubes.

Eergierig . . For three locomotives, construction number

Eensklaps
Eenbladig } 13978.

(Name of Company)

To order a pair of cylinders from Rio de Janeiro, Brazil, with parts attached, a message would read:

RIO, March 1, 1905.

BALDWIN, Philadelphia.

Eerekroon
Effricatum (See page 261.)
Eensdeels
Eddaic

(Signed) (Code name or actual name of Company)

Translation:

RIO, March 1, 1905.

BALDWIN, Philadelphia.

Eerekroon . . Please ship by steamer as soon as possible duplicate parts covered by code word (see*) for locomotive, construction number (see**).

Effricatum . *1 pair cylinders with heads, covers, chests, caps, casings, glands, valves, yokes and pistons, painted and varnished.

Eensdeels
Eddaic . . } **11743.

(Name of Company)

A cable message from Yokohama, Japan, for a crosshead for left side of locomotive 14126, would read as follows:

YOKOHAMA, March 22, 1905.

BALDWIN, Philadelphia.

Eeredienst
Endosmic
Eeretomben
Eensnarig
Eboueuses

(Signed) (Code name or actual name of Company)

Translation:

YOKOHAMA, March 22, 1905.

BALDWIN, Philadelphia.

Eeredienst . Please ship by quickest freight route as soon as possible duplicate parts covered by code word.

Endosmic . . Crosshead.

Eeretomben For left hand side of one locomotive, construction number

Eensnarig
Eboueuses } 14126.

(Name of Company)

To order an eccentric strap from Rio de Janeiro, Brazil, for locomotive 10055, a message would read:

RIO, March 1, 1905.

BALDWIN, Philadelphia.

Eerekrans
Endrudge
Eeresabels
Eenschalig
Ebaucheras
Eerstdaags

(Signed) (Code name or actual name of Company)

Translation:

RIO, March 1, 1905.

BALDWIN, Philadelphia.

Eerekrans . Please ship by steamer as soon as possible duplicate parts covered by code word.

Endrudge . . Eccentric Strap.

Eeresabels For right hand side of one locomotive, construction number

Eenschalig
Ebaucheras } 10055.

Eerstdaags . . Backward motion.

(Name of Company)

Cable Code Numbers

1 Eachwhere
2 Eactarius
3 Eadbert
4 Eadburge
5 Eadwin
6 Eager
7 Eagerly
8 Eagerness
9 Eagrass
10 Eanred
11 Eapse
12 Earinus
13 Earshrift
14 Earthiness
15 Earthling
16 Earthly
17 Earthquake
18 Earthward
19 Earthwork
20 Earthworms
21 Earwig
22 Earwort
23 Easeful
24 Easels
25 Easily
26 Easiness
27 Easium
28 Easterling
29 Easterly
30 Eastward
31 Eatable
32 Eatage
33 Eauzan
34 Eavagier
35 Ebahi
36 Ebalacon
37 Ebalette
38 Ebanacee
39 Ebanista
40 Ebanizar
41 Ebankers
42 Ebano
43 Ebanoyer
44 Ebaque
45 Ebarbement
46 Ebarbeuse
47 Ebarboir
48 Ebaroui
49 Ebattons
50 Ebattriez
51 Ebattront
52 Ebattu
53 Ebaubi
54 Ebauchage
55 Ebaucheras
56 Ebauchiez
57 Ebauchoir
58 Ebbeanker
59 Ebbeboom
60 Ebbene
61 Ebbenhout
62 Ebbero
63 Ebbestrom
64 Ebbezeit
65 Ebbing
66 Ebbrezza
67 Ebbrieta
68 Ebbrioso
69 Ebdomada
70 Ebelians
71 Ebenaceo
72 Ebenastre
73 Ebenbild
74 Ebeneous
75 Ebenezer
76 Ebenfalls
77 Ebenheit
78 Ebeni
79 Ebenier
80 Ebenistes
81 Ebenmass
82 Ebenoxyle
83 Ebenrecht
84 Ebensohle
85 Ebenspiel
86 Ebenuz
87 Ebenwage
88 Eberesche
89 Ebergement
90 Eberhard
91 Eberhirsch
92 Eberlue
93 Eberulf
94 Ebetazione
95 Ebetement
96 Ebeto
97 Ebeurrer
98 Ebeylieres
99 Ebiasaph
100 Ebionisme
101 Ebiscum
102 Ebisele

103 Eblana
104 Eblandior
105 Eblanditus
106 Eblanine
107 Eblouimes
108 Eblouir
109 Eblouiras
110 Eblouired
111 Eblouiront
112 Eblouisses
113 Eboda
114 Ebonist
115 Ebonite
116 Ebonized
117 Eboraci
118 Eboracum
119 Eborarios
120 Eborense
121 Eborgnage
122 Eboribus
123 Ebosia
124 Ebouage
125 Eboueur
126 Eboueuses
127 Ebouffer
128 Ebouiger
129 Ebouilli
130 Eboulait
131 Eboulee
132 Eboulement
133 Ebouleront
134 Ebouleux
135 Ebouqueter
136 Ebouriffe
137 Ebouisine
138 Ebouter
139 Ebouture
140 Ebraiche
141 Ebraico
142 Ebraismo
143 Ebraisoir
144 Ebraizzano
145 Ebraizzare
146 Ebraizzava
147 Ebraizzo
148 Ebrancadas
149 Ebrancado
150 Ebranchait
151 Ebranchiez
152 Ebranchons
153 Ebranlait
154 Ebranler
155 Ebranliez
156 Ebranlions
157 Ebrasure
158 Ebreche
159 Ebreneur
160 Ebria
161 Ebriacus
162 Ebriation
163 Ebriativo
164 Ebriato
165 Ebriavisti
166 Ebriedad
167 Ebrietas
168 Ebriety
169 Ebrieux
170 Ebrillade
171 Ebriosa
172 Ebriosidad
173 Ebriositas
174 Ebriosos
175 Ebrious
176 Ebriulatus
177 Ebrodunum
178 Ebroin
179 Ebromagi
180 Ebromagus
181 Ebrondeur
182 Ebrosser
183 Ebrouait
184 Ebrouement
185 Ebruiter
186 Ebruiteras
187 Ebruitiez
188 Ebruitons
189 Ebrulpho
190 Ebucheter
191 Ebudae
192 Ebulinus
193 Ebulliate
194 Ebullicao
195 Ebulliency
196 Ebullition
197 Ebulo
198 Eburacum
199 Eburatus
200 Eburinorum
201 Eburiphore
202 Eburnation
203 Eburnean
204 Eburneos
205 Eburninae
206 Eburobriga
207 Eburodunum
208 Eburon
209 Eburones
210 Eburovices
211 Ebusus
212 Ecabochage
213 Ecabocher
214 Ecachement
215 Ecaffer
216 Ecafignon
217 Ecaflote
218 Ecagne
219 Ecaillage
220 Ecaillaire
221 Ecaille
222 Ecaillette
223 Ecalcarate
224 Ecaler
225 Ecalisseur
226 Ecalyptre
227 Ecangage
228 Ecanguer

229 Ecaqueur
230 Ecarasse
231 Ecarquille
232 Ecarrure
233 Ecart
234 Ecartais
235 Ecartasses
236 Ecartelait
237 Ecarteler
238 Ecartement
239 Ecarterais
240 Ecarteriez
241 Ecarteur
242 Ecartons
243 Ecatissage
244 Ecaude
245 Ecauvage
246 Ecbalion
247 Ecballium
248 Ecbasis
249 Ecbatic
250 Ecbibi
251 Ecbibitum
252 Ecbirsoma
253 Ecbolade
254 Ecbolique
255 Ecbyrsome
256 Eccanthis
257 Eccedemmo
258 Eccedendo
259 Eccedenza
260 Eccederai
261 Eccedero
262 Eccedessi
263 Eccedevamo
264 Eccedevate
265 Eccediate
266 Eccedo
267 Eccehomo
268 Ecceite
269 Eccentric
270 Eccentros
271 Eccessivo
272 Eccettuano
273 Eccettuare
274 Eccettuava
275 Eccheuma
276 Ecchymose
277 Ecchymosis
278 Eccillum
279 Eccitammo
280 Eccitando
281 Eccitarla
282 Eccitarono
283 Eccitassi
284 Eccitata
285 Eccitativo
286 Eccitatore
287 Eccitavamo
288 Eccitavate
289 Ecciterai
290 Eccitero
291 Eccitolla
292 Ecclesia
293 Ecclesians
294 Ecclesiola
295 Ecclinuse
296 Eccopeur
297 Eccrisis
298 Eccycleme
299 Ecderon
300 Ecdicus
301 Ecdippa
302 Ecdique
303 Ecdore
304 Ecdurorum
305 Ecdysies
306 Ecelenore
307 Ecepper
308 Ecerner
309 Ecerveler
310 Ecetera
311 Ecfisa
312 Ecfisesi
313 Ecfonesi
314 Ecfrassi
315 Ecgonine
316 Echacantos
317 Echacorvos
318 Echadico
319 Echadores
320 Echaduras
321 Echafaud
322 Echafauder
323 Echaillon
324 Echalas
325 Echalasser
326 Echamiento
327 Echampeau
328 Echampi
329 Echamplure
330 Echancrais
331 Echancrant
332 Echancrure
333 Echando
334 Echandole
335 Echanges
336 Echangiez
337 Echangions
338 Echangiste
339 Echapellas
340 Echapoter
341 Echappade
342 Echappiez
343 Echappons
344 Echarbon
345 Echarnoir
346 Echarpes
347 Echarseter
348 Echauboule
349 Echaudoir
350 Echauffer
351 Echauffure
352 Echaulant
353 Echaux
354 Echazones

355 Echeable
356 Echeancier
357 Echebulus
358 Echeclea
359 Echecrates
360 Echecs
361 Echedamia
362 Echeggia
363 Echeggiano
364 Echeggiare
365 Echeggiava
366 Echelades
367 Echelaos
368 Echelidae
369 Echelonner
370 Echeneide
371 Echeneidis
372 Echeniller
373 Echephron
374 Echepolis
375 Echeveria
376 Echevinage
377 Echidna
378 Echidnine
379 Echidorus
380 Echignole
381 Echimyd
382 Echimyside
383 Echinacee
384 Echinaria
385 Echinated
386 Echinidae
387 Echinidans
388 Echinipede
389 Echinital
390 Echinite
391 Echinocere
392 Echinoderm
393 Echinodore
394 Echinogale
395 Echinogyne
396 Echinoide
397 Echinome
398 Echinomys
399 Echinopo
400 Echinopode
401 Echinorhin
402 Echinozoa
403 Echinulate
404 Echinus
405 Echinussa
406 Echionides
407 Echiopsis
408 Echiquete
409 Echite
410 Echiuride
411 Echkendji
412 Echmagoras
413 Echnomos
414 Echoes
415 Echoicus
416 Echoing
417 Echome
418 Echometer
419 Echometria
420 Echometro
421 Echonele
422 Echopolus
423 Echoppage
424 Echoppe
425 Echoton
426 Echouage
427 Echouais
428 Echouasses
429 Echouer
430 Echouerais
431 Echoueriez
432 Echoueront
433 Echouiez
434 Echouons
435 Echrefite
436 Echsenbrut
437 Echsenei
438 Echtbreken
439 Echtbreuk
440 Echteband
441 Echtebed
442 Echtelijk
443 Echtgareel
444 Echtgenoot
445 Echtheit
446 Echthre
447 Echting
448 Echtkoets
449 Echtwort
450 Echura
451 Ecidine
452 Ecimable
453 Eckard
454 Eckband
455 Eckbert
456 Eckehard
457 Eckelhaft
458 Eckeln
459 Eckenhalm
460 Eckenzahl
461 Eckerganz
462 Eckermast
463 Eckhaus
464 Eckkegel
465 Ecklade
466 Ecklonie
467 Eckplatz
468 Ecksaal
469 Ecksaeulen
470 Eckschuh
471 Eckstamm
472 Eckstein
473 Eckthor
474 Ecktisch
475 Eckzahn
476 Eclactisme
477 Eclaffer
478 Eclair
479 Eclairage
480 Eclairais

481 Eclairci
482 Eclaircise
483 Eclairons
484 Eclampsy
485 Eclanche
486 Eclandre
487 Eclapsia
488 Eclapside
489 Eclatable
490 Eclatais
491 Eclateriez
492 Eclatons
493 Ecleche
494 Eclecticos
495 Eclectique
496 Eclectiser
497 Eclectisme
498 Eclectizar
499 Eclegma
500 Eclepsis
501 Eclesiarca
502 Eclettismo
503 Eclidon
504 Ecligmata
505 Ecligmatis
506 Ecligmatum
507 Eclingure
508 Eclipsable
509 Eclipsais
510 Eclipsar
511 Eclipsaron
512 Eclipse
513 Eclipsons
514 Eclipticus
515 Eclissage
516 Eclissammo
517 Eclissando
518 Eclissassi
519 Eclissava
520 Eclisser
521 Eclisso
522 Eclittica
523 Eclogarius
524 Eclogarum
525 Eclopper
526 Eclore
527 Ecloses
528 Eclosion
529 Eclusa
530 Eclusement
531 Ecmatyrie
532 Ecmelia
533 Ecnephias
534 Ecnomus
535 Ecobuer
536 Ecochelage
537 Ecocheler
538 Ecoeurant
539 Ecoeurer
540 Ecofora
541 Ecofrai
542 Ecoica
543 Ecoicos
544 Ecoincon
545 Ecolage
546 Ecole
547 Ecolerer
548 Ecoliers
549 Ecometria
550 Ecometro
551 Econduirai
552 Economat
553 Economicas
554 Economico
555 Economique
556 Economist
557 Economizar
558 Economize
559 Econtrario
560 Econverso
561 Ecoper
562 Ecoperche
563 Ecoquer
564 Ecorcage
565 Ecorchant
566 Ecorchasse
567 Ecorcheler
568 Ecorchiez
569 Ecorcons
570 Ecornifle
571 Ecossain
572 Ecossaises
573 Ecossoneux
574 Ecotado
575 Ecotant
576 Ecotard
577 Ecouailles
578 Ecouanette
579 Ecouchures
580 Ecoulard
581 Ecoulera
582 Ecoulerait
583 Ecourgee
584 Ecourgeon
585 Ecourtant
586 Ecoussage
587 Ecoutames
588 Ecoutasses
589 Ecouterais
590 Ecouterons
591 Ecouteur
592 Ecoutille
593 Ecoutillon
594 Ecoutoir
595 Ecouvette
596 Ecphasis
597 Ecphlysis
598 Ecphoneme
599 Ecphonesis
600 Ecphora
601 Ecphorarum
602 Ecphoris
603 Ecphorome
604 Ecphractic
605 Ecphraste
606 Ecphyma

607 Ecphymote
608 Ecphyse
609 Ecphysese
610 Ecpiema
611 Ecpiesme
612 Ecpleope
613 Ecplerome
614 Ecplessia
615 Ecplexie
616 Ecpnoe
617 Ecpyeme
618 Ecpyesis
619 Ecpyetique
620 Ecpyrosis
621 Ecqui
622 Ecquod
623 Ecrabouir
624 Ecrache
625 Ecraigne
626 Ecrainier
627 Ecrapette
628 Ecrasable
629 Ecrasais
630 Ecraser
631 Ecraserais
632 Ecraseriez
633 Ecrasiez
634 Ecrasure
635 Ecremaison
636 Ecremer
637 Ecremillon
638 Ecremoire
639 Ecrevisse
640 Ecrhexis
641 Ecriames
642 Ecrieront
643 Ecrille
644 Ecrirons
645 Ecrise
646 Ecriteau
647 Ecritmo
648 Ecritoire
649 Ecriturer
650 Ecrivaille
651 Ecrivimes
652 Ecroe
653 Ecroistre
654 Ecrouellet
655 Ecrouir
656 Ecroutage
657 Ecrysie
658 Ecsarcome
659 Ecstacy
660 Ecstasize
661 Ecstatic
662 Ecstatical
663 Ectadion
664 Ectatique
665 Ectatops
666 Ectenes
667 Ecthese
668 Ecthesien
669 Ecthlimme
670 Ecthlipse
671 Ecthlipsis
672 Ecthyma
673 Ecthymose
674 Ecthymosis
675 Ectilotici
676 Ectimosi
677 Ectipo
678 Ectobie
679 Ectoblast
680 Ectocarpe
681 Ectocyste
682 Ectoderme
683 Ectogramma
684 Ectolitro
685 Ectometro
686 Ectonstero
687 Ectopage
688 Ectopagia
689 Ectophyte
690 Ectopia
691 Ectopogono
692 Ectopones
693 Ectosarc
694 Ectosmie
695 Ectozoa
696 Ectrogenie
697 Ectromata
698 Ectromatis
699 Ectrome
700 Ectroparum
701 Ectropical
702 Ectropio
703 Ectrotico
704 Ectrotique
705 Ectylotic
706 Ectypal
707 Ectype
708 Ectypique
709 Ectyporum
710 Ecuable
711 Ecuacion
712 Ecuanteur
713 Ecubier
714 Ecueil
715 Ecuiage
716 Eculeo
717 Ecumais
718 Ecumant
719 Ecumenical
720 Ecumenico
721 Ecumeresse
722 Ecumeront
723 Ecumeux
724 Ecumions
725 Ecumoire
726 Ecunemica
727 Ecunemicos
728 Ecuorea
729 Ecuoreos
730 Ecureuil
731 Ecusson
732 Ecussonne

733 Ecvolorum
734 Ecvolus
735 Eczematous
736 Edacidade
737 Edacious
738 Edaciously
739 Edacissimo
740 Edacitatis
741 Edacite
742 Edaphodont
743 Eddaic
744 Eddas
745 Eddered
746 Eddering
747 Eddoes
748 Edealogia
749 Edeatros
750 Edecan
751 Edecanes
752 Edecimamus
753 Edecimatum
754 Edecimavi
755 Edelaardig
756 Edeldame
757 Edelerde
758 Edelfest
759 Edelfink
760 Edelfisch
761 Edelfrau
762 Edelfuchs
763 Edelgarbe
764 Edelhengst
765 Edelhof
766 Edelknabe
767 Edelknecht
768 Edelkrebs
769 Edellehen
770 Edelmann
771 Edelmarder
772 Edelmass
773 Edelmoedig
774 Edelmogend
775 Edelmuth
776 Edelopal
777 Edelraut
778 Edelreis
779 Edelrose
780 Edelschoen
781 Edelsinn
782 Edelsinnig
783 Edelstahl
784 Edelstolz
785 Edelthat
786 Edelthier
787 Edelvrouw
788 Edelweiss
789 Edematico
790 Edematoso
791 Edematous
792 Edemera
793 Edenique
794 Edenisch
795 Edenize
796 Edenizing
797 Edenruine
798 Edental
799 Edentalous
800 Edentamus
801 Edentation
802 Edento
803 Edentula
804 Edentulus
805 Edeopalmo
806 Edepoe
807 Edera
808 Ederaceo
809 Ederaceus
810 Ederato
811 Ederoso
812 Edesio
813 Edesseno
814 Edessenus
815 Edesside
816 Edetana
817 Edetanos
818 Edgar
819 Edgeless
820 Edgewise
821 Edgythe
822 Edharz
823 Edhemite
824 Edibility
825 Edible
826 Edibleness
827 Edicaria
828 Edicendum
829 Edichio
830 Edicola
831 Edictabam
832 Edictabis
833 Edictalium
834 Edictamus
835 Edictarem
836 Edictavi
837 Edictione
838 Edictionis
839 Edictorum
840 Edicule
841 Ediderunt
842 Edidici
843 Edidicimus
844 Edidisti
845 Edifiant
846 Edificaban
847 Edificacao
848 Edificada
849 Edificados
850 Edificao
851 Edifice
852 Edificios
853 Edifiement
854 Edifieras
855 Edifieriez
856 Edifieront
857 Edifiques
858 Edifizio

859 Edify
860 Edifying
861 Edifyingly
862 Edikt
863 Edilberto
864 Edileship
865 Edilicio
866 Edilidade
867 Edilita
868 Edilitaire
869 Ediografia
870 Ediologia
871 Ediosmo
872 Ediotide
873 Ediotomia
874 Edisaro
875 Edisma
876 Edisseris
877 Edisserto
878 Editeur
879 Editicia
880 Editioned
881 Editioning
882 Editor
883 Editores
884 Editorial
885 Editoribus
886 Editorship
887 Editress
888 Editresses
889 Edituate
890 Edituating
891 Edixerimus
892 Edixi
893 Ediximus
894 Edixissem
895 Edizione
896 Edmondie
897 Edmundo
898 Edoardo
899 Edocenter
900 Edocephale
901 Edoctum
902 Edocuerunt
903 Edocui
904 Edocuisti
905 Edolandi
906 Edolandos
907 Edolandum
908 Edolatorum
909 Edolatum
910 Edolavisti
911 Edolien
912 Edomitas
913 Edomitavi
914 Edomiter
915 Edoner
916 Edonio
917 Edonismo
918 Edonorum
919 Edormisco
920 Edossage
921 Edostome
922 Edredon
923 Edredones
924 Edris
925 Edrisiden
926 Edrum
927 Educacao
928 Educadores
929 Educados
930 Educaremus
931 Educate
932 Educateur
933 Educative
934 Educatore
935 Educatrix
936 Educatum
937 Educaturi
938 Educaturos
939 Educaturum
940 Educavano
941 Educavisti
942 Educavit
943 Educeret
944 Educeretis
945 Educhiamo
946 Eductor
947 Edulcare
948 Edulcorado
949 Edulcorant
950 Edulcoreis
951 Edulica
952 Edulious
953 Edulis
954 Edumia
955 Eduquant
956 Eduquemos
957 Eduques
958 Edurescis
959 Edurorum
960 Edwardsie
961 Edwarsite
962 Edwig
963 Edyllium
964 Edzard
965 Eedbrekers
966 Eedbreuk
967 Eedgespan
968 Eegaas
969 Eekhakker
970 Eekhandel
971 Eekhoren
972 Eelbuck
973 Eelpot
974 Eelspear
975 Eeltachtig
976 Eelterig
977 Eeltzweer
978 Eenbladig
979 Eenbloemig
980 Eendebout
981 Eendenei
982 Eendenhok
983 Eendenkom
984 Eendenkooi

985	Eendennest
986	Eendenroer
987	Eender
988	Eendeveder
989	Eendjes
990	Eendracht
991	Eendvogels
992	Eengrepig
993	Eenhandig
994	Eenheid
995	Eenhelmig
996	Eenhoekig
997	Eenhoofdig
998	Eenhoorn
999	Eenhoornig
1,000	Eenhuizig
2,000	Eenigerlei
3,000	Eeniglijk
4,000	Eenkennig
5,000	Eenkleurig
6,000	Eenlobbig
7,000	Eenoog
8,000	Eenoogig
9,000	Eenrijm
10,000	Eenschalig
11,000	Eensdeels
12,000	Eensgezind
13,000	Eensklaps
14,000	Eensnarig
15,000	Eenspan
16,000	Eenstemmig
17,000	Eenstijlig
18,000	Eenvakkig
19,000	Eenvervig
20,000	Eenvinnig
21,000	Eenvoetig
22,000	Eenvoud
23,000	Eenvoudig
24,000	Eenwijvig
25,000	Eenzaam
26,000	Eenzabing
27,000	Eenzabors
28,000	Eenzaceom
29,000	Eenzadare
30,000	Eenzal
31,000	Eenzalums
32,000	Eenzarium
33,000	Eenzatu
34,000	Eenzbacite
35,000	Eenzbacon
36,000	Eenzbacpar
37,000	Eenzbdaic
38,000	Eenzbdas
39,000	Eenzbdered
40,000	Eenzbdoes
41,000	Eenzbecan
42,000	Eenzcatum
43,000	Eenzcole
44,000	Eenzdake
45,000	Eenzdime
46,000	Eenzdurium
47,000	Eenzear
48,000	Eenzeabat
49,000	Eenzeatum
50,000	Eenzedite

Useful Sentences for Cabling for Parts of Locomotives

Eenzelvig . . At what price and how soon can you ship duplicate parts covered by code word . . . . . ?

Eenzijdig . How soon can you ship duplicate parts covered by code word . . . . . ?

Eeotomous Please ship by express as soon as possible duplicate parts covered by code word . . . . . .

Eerambt . Please ship by express as soon as possible duplicate parts covered by code word . . . . . for locomotive, construction number . . .

Eerbetoon . Please ship by freight as soon as possible duplicate parts covered by code word . . . .

Eereblijk . . Please ship by freight as soon as possible duplicate parts covered by code word . . . for locomotive, construction number . . . . . .

Eereboog . Please ship overland as soon as possible duplicate parts covered by code word . . . .

Eeredegen . Please ship overland as soon as possible duplicate parts covered by code word . . . for locomotive, construction number . . .

Eeredienst . Please ship by quickest freight route as soon as possible duplicate parts covered by code word . . . . .

Eeregraf . Please ship by quickest freight route as soon as possible duplicate parts covered by code word . . . . . . for locomotive, construction number . . . . .

Eerekrans . . Please ship by steamer as soon as possible duplicate parts covered by code word . . . .

Eerekroon . . Please ship by steamer as soon as possible duplicate parts covered by code word . . . . . for locomotive, construction number . . .

Eeremantel . Please ship by sailing vessel as soon as possible duplicate parts covered by code word . . . . .

Eereplaats . . Please ship by sailing vessel as soon as possible duplicate parts covered by code word . . . . . for locomotive, construction number . . . . .

Eerepoort . . Please ship by steamer as soon as possible duplicate parts to the value of $ . . . . .

Eerepost . . Please ship by steamer as soon as possible duplicate parts to the value of $ . . . . . for locomotive, construction number . . . . .

Eereposten . Please ship by sailing vessel as soon as possible duplicate parts to the value of $ . . . . .

Eereprijs . . Please ship by sailing vessel as soon as possible duplicate parts to the value of $ . . . . . for locomotive, construction number . . . . .

Eeresabels . For right hand side of one locomotive, construction number . . . . .

Eereschot . . For right hand side of two locomotives, construction number . . . . .

Eerestoel . . For right hand side of three locomotives, construction number . . . . .

Eeretempel . For right hand side of four locomotives, construction number . . . . .

Eeretitels . . For right hand side of five locomotives, construction number . . . . .

Eeretomben . For left hand side of one locomotive, construction number . . . . .

Eeretrap . . For left hand side of two locomotives, construction number

Eerewacht . . For left hand side of three locomotives, construction number . . . . .

Eerewapen . For left hand side of four locomotives, construction number . . . . .

Eerewijn . . . For left hand side of five locomotives, construction number . . . . .

Eerewoord . . For one locomotive, construction number . . . . .

Eergevoel . . For two locomotives, construction number . . . . .

Eergierig . . For three locomotives, construction number . . . . .

Eerlijk . . . For four locomotives, construction number . . . . .

Eerlijker . . For five locomotives, construction number . . . . .

Eerloozer . . For six locomotives, construction number . . . . .

Eermetaal . . For seven locomotives, construction number . . . . .

Eernamen . . For eight locomotives, construction number . . . . .

Eerpenning . For nine locomotives, construction number . . . . .

Eerroof . . . For ten locomotives, construction number . . . .
Eerroovend Hold order of . . . . until you receive further instructions.
Eershalve . Forward motion.
Eerstdaags . Backward motion.
Eertijds . .
Eervol . . . .
Eervoller . .
Eerwaarde .
Eerwaardig .
Eerzamer . .
Eerzucht . .
Eerzuchtig . .
Eesting . . .
Eestmout . .
Eetbak . . .
Eethuis . . .
Eethuizen . .
Eetion . . . .
Eetionem . .
Eetkamers . .
Eetlepels . .
Eetlust . . .
Eetmalen . .
Eetplaats .
Eetregel . . .
Eetsters . . .
Eettafel . . .
Eetwaar . . .
Eetzaal . .
Eeuwen . . .
Eeuwenoud .
Eeuwfeest . .
Eeuwjaar . .
Eeuwspel . .
Eeuwzang . .
Eeuwzangen .
Efantel . . .
Efaufile . .
Efectuado . .
Efectuamos .
Efectuaron .

Efectuases . .
Efectueis . .
Efedra .
Efemerides .
Efemerie . .
Efesias . . .
Efesio . . . .
Efestite . .
Efetico . .
Effable . . .
Effacable . .
Effacage . .
Effacais . . .
Effacasses . .
Effacerais . .
Effaceriez . .
Effacerons
Effacest . .
Effacing . . .
Effacons .
Effaecata .
Effaecatus . .
Effaner . .
Effanures
Effarcimus
Effarcio . .
Effarciunt . .
Effarement
Effarvatte . .
Effatio . .
Effatione .
Effatorum . .
Effauce .
Effaumer . .
Effeccao . . .
Effecerim . .
Effecissem .
Effectible . .
Effectif . . .
Effectione . .
Effectivo .
Effectivus

Effectless . .
Effectrix . .
Effectuais . .
Effectuar . .
Effectuose . .
Effecundo . .
Effeiance . .
Effeito . .
Effeituoso . .
Effelure . . .
Effeminar . .
Effeminava . .
Effeminize . .
Effendi . . .
Effenende . .
Effenheid . .
Effening . . .
Efferascis . .
Efferasco . .
Efferatio . . .
Efferatus . .
Efferous . . .
Effersimus . .
Effersisti . . .
Effervens . .
Efferveo . . .
Effervesce . .
Effestria . . .
Effestuer . .
Effete . .
Effettore . . .
Effettrice . .
Effettuato . .
Effettuavi . .
Effeuiller . .
Effezione . . .
Efficacia . .
Efficaz . . .
Efficiency . .
Efficient . . .
Efficienza . .
Efficta . . .

Effictorum . .
Effictum . .
Effierced . .
Effiercing . .
Effigiado . .
Effigiar . .
Effigiassi . .
Effigiava . .
Effigie . .
Effigierai . .
Effiloche . .
Effiloquer . .
Effimero . .
Effindere . .
Efflagitas . .
Efflagito . .
Efflammans .
Efflanque . .
Efflation . .
Efflatos . .
Effleurais . .
Effleure . .
Efflevisti . .
Efflictim . .
Effloreo . .
Effloremus .
Effloresce . .
Efflorui . .
Efflower . .
Effluencia . .
Effluente . .
Effluescis . .
Effluvial . .
Effluvio . .
Effluvioso . .
Effluxed . .
Effluxing . .
Effluxorum .
Effocare . .
Effoderunt .
Effodimus . .
Effodisti . .

Effoedis . . .
Effoedo . . .
Effondrait . .
Effondront . .
Effor . .
Efforcais . .
Efforcant . .
Efforcing . .
Efforcions . .
Efforeria . .
Efformed . .
Efformier . .
Effortless . .
Effossioni . .
Effossum . .

Groups of Duplicate Parts with Code Words

[In some cases it will be more convenient to order parts by using these group words; in others by a reference to the plates. To find part needed, see index at the back of the book.]

Effouage	1	Boiler with Tubes, Double Cone, Dry Pipe, Throttle work complete, including Stuffing Box and Gland, Dome Cap and Safety Valves, Smokebox Front and Door, Fire Door with Liner and Frame and Cleaning Plugs, tested and primed.
Effoueil	1	Boiler with Tubes and Cleaning Plugs only, tested and primed.
Effractor	1	Firebox.
Effracture	1	Set Boiler Tubes.
Effrange	1	Set Boiler Tube Ferrules.
Effrayable	1	Double Cone.
Effrayer	1	Set Steam Pipes.
Effrayeras	1	Throttle Valve, Box, Pipe, Elbow, Crank, and Rod.
Effrayiez	1	Smokebox Front and Door.
Effrayons	1	Fire Door with Frame and Liner.
Effreement	1	Set Cleaning Plugs.
Effrenatio	1	Set Fusible Plugs.
Effrenatus	1	Set Boiler Lagging.
Effrenibus	1	Set Boiler Jacket.
Effrenis	1	Set Boiler Jacket Bands.
Effricare	1	Set Safety Valves, complete.
Effricatum	1	Pair Cylinders with Heads, Covers, Chests, Caps, Casings, Glands, Valves, Yokes and Pistons, painted and varnished.
Effrico	1	Pair Finished Cylinders, bolted together, without any fittings.
Effrique	1	Set Front Cylinder Heads.
Effriter	1	Set Back Cylinder Heads.
Effrixisti	1	Set Front Cylinder Covers.
Effroisser	1	Set Back Cylinder Covers.
Effruitant	1	Set Cylinder Glands and Bottom Rings.

Effrutico . . . 1 Set Metallic Packing complete, for Piston Rods and Valve Stems.
Effugio . . . 1 Set Composition Rings for Metallic Packing of Piston Rods and Valve Stems.
Effugisti . . . 1 Set Cylinder Casings.
Effugitos . . . 1 Set Steam Chests.
Effugiunt . . . 1 Set Steam Chest Caps or Lids.
Effulcrate . . 1 Set Steam Chest Glands and Bottom Rings.
Effulge . . . 1 Set Steam Chest Casings.
Effulgence . . 1 Set Steam Chest Casing Covers.
Effulgent . . 1 Set Steam Chest Valves.
Effulgetis . . 1 Set Steam Chest Valve Yokes.
Effulsio . . . 1 Set Steam Chest Relief Valves.
Effulsioni . . 1 Set Pistons with Rods and Packing.
Effultorum . . 1 Set Piston Rods.
Effultus . . . 1 Set Piston Packing.
Effumable . . 1 Pair Cylinders with Heads, Covers, Casings, Valves, Stems, Pistons, Metallic Piston Rod and Valve Stem Packing, complete (Vauclain Compound System).
Effumant . . 1 Pair Finished Cylinders with Bushings, bolted together, but without other fittings (Vauclain Compound System).
Effumigare . . 1 Set Front Cylinder Heads, High Pressure (Vauclain Compound System).
Effuming . . . 1 Set Back Cylinder Heads, High Pressure (Vauclain Compound System).
Effundica . . 1 Set Front Cylinder Head Casing Covers, High Pressure (Vauclain Compound System).
Effundir . . . 1 Set Back Cylinder Head Casing Covers, High Pressure (Vauclain Compound System).
Effundo . . . 1 Set Front Cylinder Heads, Low Pressure (Vauclain Compound System).
Effusion . . . 1 Set Back Cylinder Heads, Low Pressure (Vauclain Compound System).
Effusive . . . 1 Set Front Cylinder Head Casing Covers, Low Pressure (Vauclain Compound System).
Effusively . . 1 Set Back Cylinder Head Casing Covers, Low Pressure (Vauclain Compound System).
Effusoris . . . 1 Set Front Valve Chamber Heads (Vauclain Compound System).

Effusorum . . 1 Set Back Valve Chamber Heads (Vauclain Compound System).
Effuticius . . 1 Set Front Valve Chamber Head Casing Covers (Vauclain Compound System).
Effutile . . . 1 Set Back Valve Chamber Head Casing Covers (Vauclain Compound System).
Effutilis . 1 Set Valve Chamber Bushings (Vauclain Compound System).
Effutilium . . 1 Set Main Piston Valves with Rings (Vauclain Compound System).
Efialte . . 1 Set Main Piston Valves with Rings and Stems (Vauclain Compound System).
Eficiencia . . 1 Set Main Piston Valve Rings (Vauclain Compound System).
Efigies . . . 1 Set Pistons with Rods and Packing, High Pressure (Vauclain Compound System).
Eflagelle . . . 1 Set Pistons with Rods and Packing, Low Pressure (Vauclain Compound System).
Efourceau . 1 Set Piston Packing Rings, High Pressure (Vauclain Compound System).
Efraimo . . . 1 Set Piston Packing Rings, Low Pressure (Vauclain Compound System).
Efusal . . . 1 Set Piston Rods (Vauclain Compound System).
Egagre . . . 2 Starting Valves (Vauclain Compound System).
Egagropilo 4 Cylinder Cocks (Vauclain Compound System).
Egailler . . . 1 Set Cylinder Relief Valves (Vauclain Compound System).
Egalement 1 Set Frames without Fittings.
Egalisage . . 1 Set Frame Front Rails.
Egaliser . . . 1 Set Frame Pedestal Caps.
Egaliseras . . 1 Set Pedestal Wedges.
Egalisons . 1 Set Pedestal Wedge Bolts.
Egalitaire . . 1 Set Pedestal Gibs.
Egalite . 1 Set Driving Wheels complete, on Axles with Eccentrics, Eccentric Straps, and Boxes, painted and varnished.
Egancette . . 1 Set Driving Tires.
Egarerais . 1 Set Wrist Pins.
Egareriez . 1 Set Driving Axles.
Egareront 1 Set Eccentrics.
Egariez 1 Set Eccentric Straps.
Egarons . . 1 Set Guides with Filling Pieces.

Egarrotte . . 1 Set Crossheads.
Egauler . . . 1 Set Crosshead Gibs.
Egayantes . . 1 Set Crosshead Filling Pieces.
Egayasses . . 1 Set Crosshead Pins.
Egayer . . . 1 Set Rods complete, except Oil Cups.
Egayeras . . 1 Set Rod Brasses.
Egayions . . 1 Set Rod Straps.
Egberto . . . 1 Set Rod Keys.
Egdauama . . 1 Set Rod Straps with Brasses, Keys, Bolts and Set Screws.
Egeenne . . . 1 Set Links complete, with Blocks, Lifters, Eccentric Rods and all Pins.
Egeirino . . . 1 Reverse Shaft.
Egelamus . . 1 Set Reverse Shaft Bearings.
Egelantier . . 1 Set Rock Shafts.
Egelbeere . . 1 Set Rocker Boxes.
Egelgras . . . 1 Set Valve Rods.
Egelidamus . . 1 Counterbalance Spring.
Egelidas . . . 1 Pump complete.
Egelkruid . . 1 Pump Plunger.
Egelochus . . 1 Pump Feed Cock.
Egentium . . 1 Pump Check complete.
Egenulorum . 1 Complete Set of Springs.
Egerane . . . 1 Set Driving Springs.
Egermage . . 1 Set Driving Spring Links.
Egersimon . . 1 Set Engine Truck Springs.
Egesaretus . . 1 Set Tender Springs.
Egesippe . . . 1 Forward Equalizing Beam.
Egestas . . . 1 Forward Equalizing Beam Fulcrum.
Egestione . . 1 Set Equalizing Beams.
Egestionis . . 1 Set Equalizing Beam Fulcrums.
Egestorum . . 1 Bell with Clapper and Tongue.
Egestosi . . . 1 Bell with Clapper and Tongue, Frame, Yoke and Crank.
Egestosus . . 1 Sand Box complete.
Egestuum . . 1 Smoke-stack complete with Base.
Eggaree . . . 1 Smoke-stack Base complete.
Eggebalken . . 1 Smoke-stack Cone.
Eggehaken . . 1 Smoke-stack Netting.
Eggement . . 1 Set Grate Bars.
Eggen . . . . 1 Set Grate Frames or Holders.
Eggerigst . . 1 Set Rocking Grates, with all Fixtures.

Eggerling	1	Set Engine Truck Boxes with Brasses and Cellars.
Eggiger	1	Set Engine Truck Box Brasses.
Eggigheid	1	Set Engine Truck Box Cellars.
Eghiazar	1	Set Driving Boxes with Brasses and Cellars.
Egialus	1	Set Driving Box Brasses.
Egidarmato	1	Set Driving Box Cellars.
Egidio	1	Set Tender Boxes with Lids, Wedges and Brasses.
Egifila	1	Set Tender Boxes with Lids.
Egignere	1	Set Tender Box Wedges.
Egilopical	1	Set Tender Box Brasses.
Eginetique	1	Engine Truck complete, with Wheels, Boxes, etc., painted and varnished.
Eginopside	1	Engine Truck complete, except Wheels and Boxes.
Egiochus	1	Engine Truck Center Pin.
Egipciana	1	Engine Truck Swing Bolster.
Egipcios	1	Engine Truck Frame.
Egipiro	2	Engine Truck Wheels without Axles, bored.
Egiptologo	1	Pair Engine Truck Wheels on Axles, painted and varnished.
Egirine	1	Pilot.
Egissent	1	Pilot Bull Nose.
Egiziache	1	Pilot Draw Bar.
Egiziaco	1	Engine Front Draw Casting.
Eglecopala	1	Water Gauge, complete.
Egloga	12	Water Gauge Glasses.
Eglogiste	1	Water Gauge Lamp.
Egloguista	1	Injector.
Eglon	1	Injector Steam Valve.
Egmond	1	Injector Feed Cock.
Egnatia	1	Injector Check.
Egnatius	1	Steam Gauge.
Egoarico	1	Steam Gauge Stand.
Egoasinha	1	Steam Gauge Lamp.
Egobole	12	Steam Gauge Lamp Globes.
Egobuer	1	Steam Gauge Lamp Stand.
Egofonia	1	Blower Valve.
Egoger	1	Heater Valve.
Egohine	1	Steam Brake Valve for Engineer.
Egoical	1	Steam Brake Stop Valve.
Egoismar	1	Blow-off Cock.
Egoismo	1	Set Gauge Cocks.
Egoistical	1	Set Cylinder Cocks.

Egoistique . . 1 Sight Feed Cylinder Lubricator.
Egoity . . . 1 Set Cab Cylinder Oilers, B. L. W. Style.
Egoletro . . 1 Set Condensing Steam Chest Oil Cups.
Egologie . . 1 Set Rod Oil Cups.
Egologique . 1 Set Guide Oil Cups.
Egomet . . . 1 Set Rock Shaft Oil Cups.
Egomiste . . 1 Set Eccentric Strap Oil Cups.
Egophone . . 1 Whistle.
Egopodio . . 1 Headlight.
Egopogono . 1 Throttle Lever complete, with Quadrant, Latch, Link, Stud, Handle and Spring.
Egoprico . . 1 Reverse Lever complete.
Egoprosope . 1 Reverse Lever Rod, or Reach Rod.
Egorgement . 1 Set Cab Brackets.
Egorgeoir . . 1 Set Cab Bracket Plates.
Egorgeront . 1 Foot Plate.
Egorgille . . 1 Tender Wedge.
Egosiller . . 1 Tender Wedge Box.
Egotheism . . 1 Engine Back Draw Bar.
Egothele . . 1 Exhaust Nozzle and Thimbles.
Egotism . . . 1 Set Exhaust Nozzle Thimbles.
Egotistic . . 1 Set Smokebox Netting.
Egotize . . . 1 Spark Ejector.
Egotizing . . 1 Spark Ejector Valve.
Egout . . . . 1 Set Smokebox Cleaning Holes and Caps.
Egoutier . . . 1 Set Driving Brake Shoes.
Egouttage . . 1 Set Driving Brake Heads.
Egraffigne . . 1 Set Brake Cylinders complete, with Pistons and Rods.
Egrageure . . 1 Set Driving Brake Cams.
Egrainage . . 1 Tank with Funnel and Lid, Valves, Lugs and Handles, painted and varnished.
Egrainoir . . 1 Tank Funnel and Lid.
Egramente . 1 Tank Cock.
Egraminer . . 1 Tender, complete on Wheels, painted and varnished.
Egrappage . . 1 Tender Chafing Casting.
Egrapper . . 1 Tender Front Draw Casting.
Egratigner . . 1 Tender Back Draw Casting.
Egravoir . . 1 Set Tender Frame Center Pins.
Egregiat . . . 1 Set Tender Pedestals.
Egregiorum . 1 Set Tender Trucks complete, with Wheels, painted and varnished.

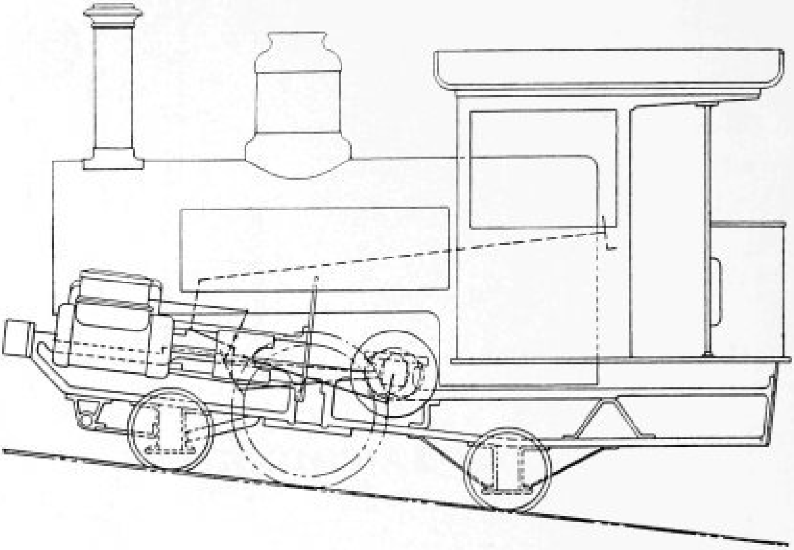
Egregious . . 1 Tender Truck complete, with Wheels, painted and varnished.
Egregores . . 1 Set Tender Trucks complete, without Wheels and Boxes.
Egrenement . 1 Tender Truck complete, without Wheels and Boxes.
Egressao . . 1 Set Tender Truck Center Plates.
Egressed . . 1 Set Tender Wheels on Axles, painted and varnished.
Egressing . . 1 Pair Tender Wheels on Axle, painted and varnished.
Egribos . . . 1 Set Tender Wheels without Axles.
Egrillard . . 1 Set Tender Brake Shoes.
Egriot . . . 1 Set Tender Brake Heads.
Egrisage . . 1 Cab.
Egritude . . .
Egrotant . . .
Egsmeden . .
Egsmederij .
Egsmid . . .
Egtand . . .
Egtanden . .
Egualendo . .
Egualezza . .
Egualimmo .
Egualirai . .
Egualisco . .
Egualissi . .
Egualito . . .
Egueille . .
Eguerunt . .
Eguilles . . .
Eguimus . . .
Eguisier . . .
Eguisti . .
Egularum . .
Egurgito . . .
Egypciaco . .
Egypius . . .
Egyptiaque .
Egyptien . .
Egyptology .
Ehamote . .
Ehebett .
Ehebruch .

Ehebund . .
Ehefrau . . .
Ehegatte . .
Ehegeld . . .
Ehegemahl
Ehegenosse .
Ehegericht .
Ehegespons
Ehegestern .
Ehehaelfte .
Ehejoch . . .
Eheklage . .
Eheleben. . .
Eheleute . .
Eheliebe . .
Ehelos . . .
Ehemals . .
Ehemann . .
Eheordnung .
Ehepaar . .
Ehepfand . .
Eherecht. . .
Ehering . .
Eheringen .
Ehern . . .
Eheschatz . .
Eheschmied
Eheschuld .
Ehesegen . .
Ehestifter . .
Ehestunde .
Ehevater. . .
Ehevogt . .
Eheweib . .
Ehewunsch .
Ehodum . . .
Ehontement .
Ehoupper . .
Ehrbarer. . .
Ehrenamt . .
Ehrenbahn. .
Ehrenbett . .

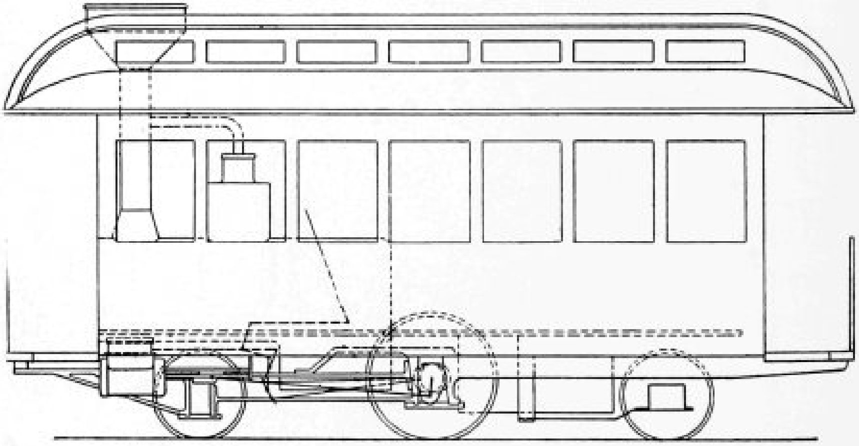
Ehrenbild
Ehrenbogen
Ehrengabe
Ehrengift
Ehrengrab
Ehrengruss
Ehrenhaft
Ehrenkampf
Ehrenkerze
Ehrenkette
Ehrenkranz
Ehrenkreuz
Ehrenkrone
Ehrenlied
Ehrenlohn
Ehrenluege
Ehrenmahl
Ehrenmann
Ehrenmusik
Ehrenpaar
Ehrenplatz
Ehrenpreis
Ehrenpunkt
Ehrenrauch
Ehrenrecht
Ehrenreim
Ehrenrock

Types of Locomotives

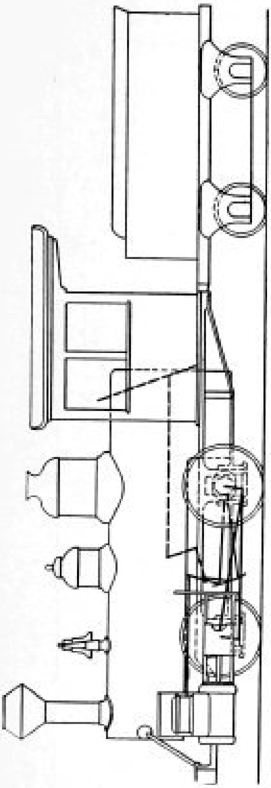
IN order to aid in understanding the class designations more readily, the different types of engines manufactured at these Works, with the class designations of each type, and the kind of service for which they are specially designed or adapted, are shown by line illustrations, in the following pages.



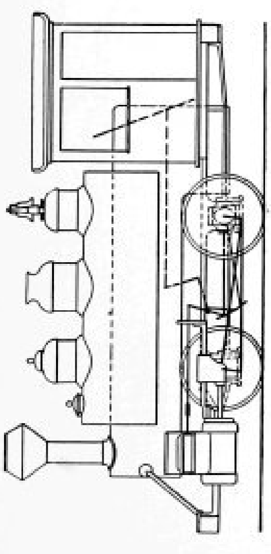
5 A (RACK RAIL TYPE)
MOUNTAIN SERVICE



6 B
INSPECTION SERVICE

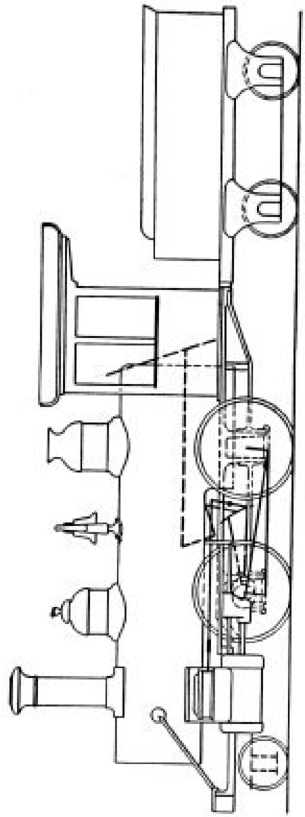


4 C WITH TENDER

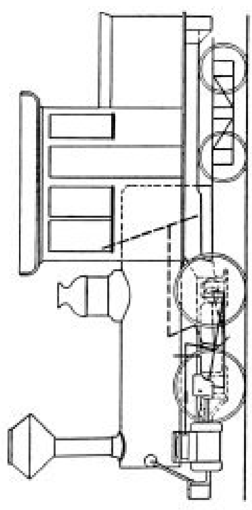


4 C TANK ON BOILER

SWITCHING SERVICE

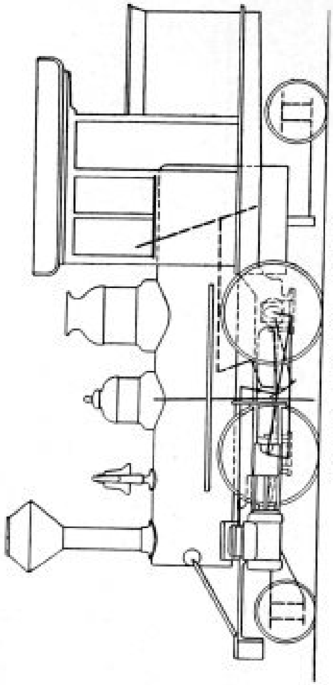


6 C WITH TENDER

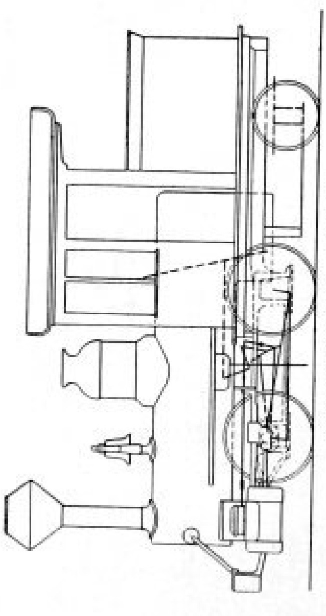


8⅓ C TANK BACK

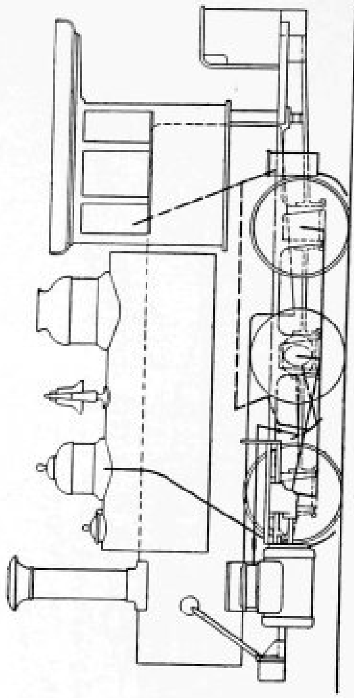
SWITCHING AND LOCAL SERVICE



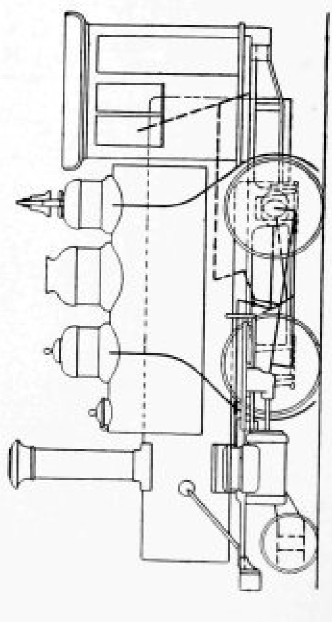
8¼ C TANK BACK
SWITCHING AND LOCAL PASSENGER SERVICE



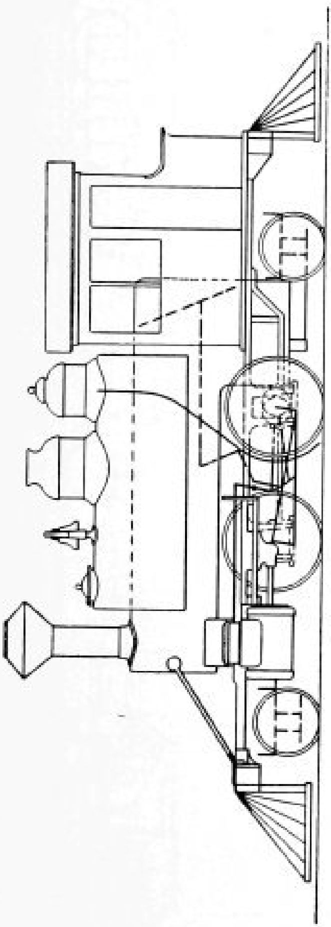
6⅓ C TANK BACK
SWITCHING SERVICE



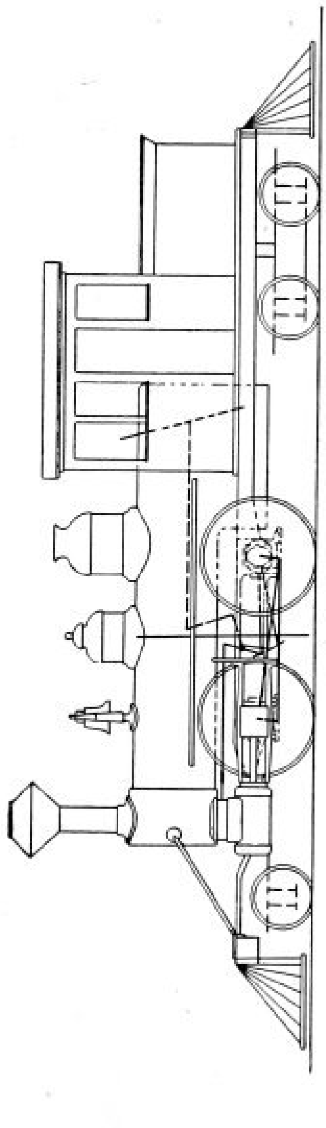
6 D TANK ON BOILER
HEAVY SWITCHING



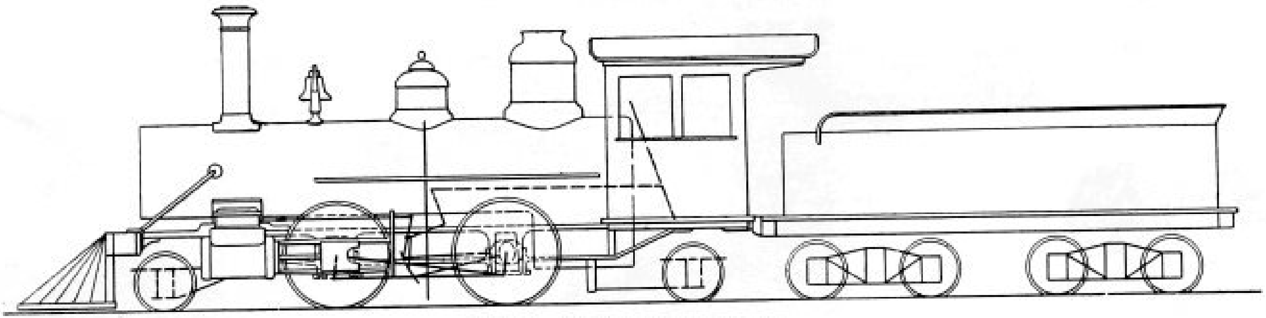
6 C TANK ON BOILER
SWITCHING AND LOCAL SERVICE



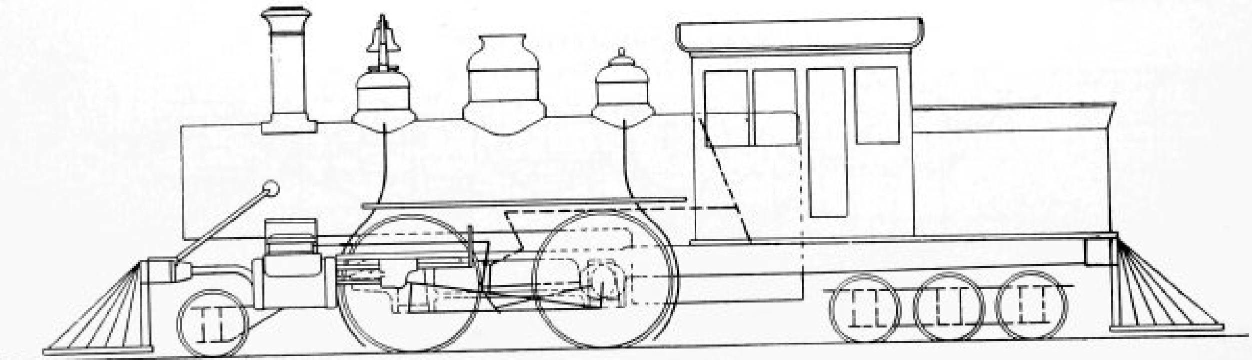
8¼ C TANK ON BOILER
LOCAL PASSENGER SERVICE



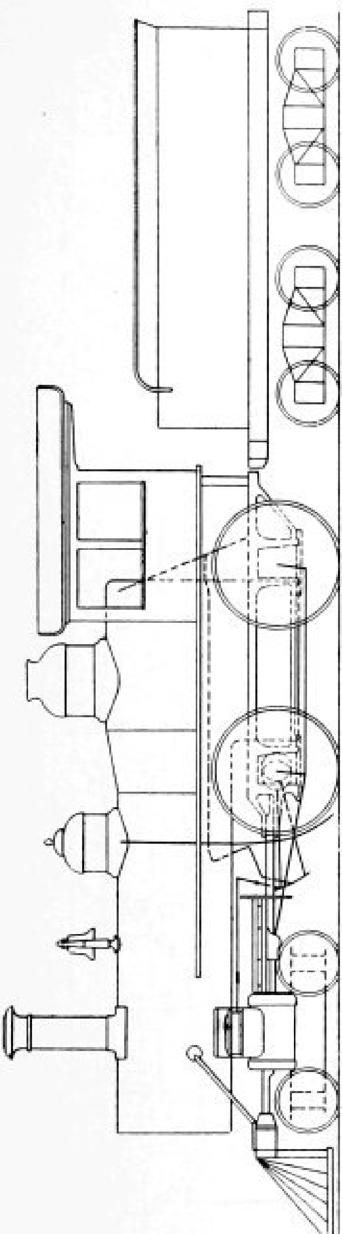
10¼ C TANK BACK
LOCAL PASSENGER SERVICE



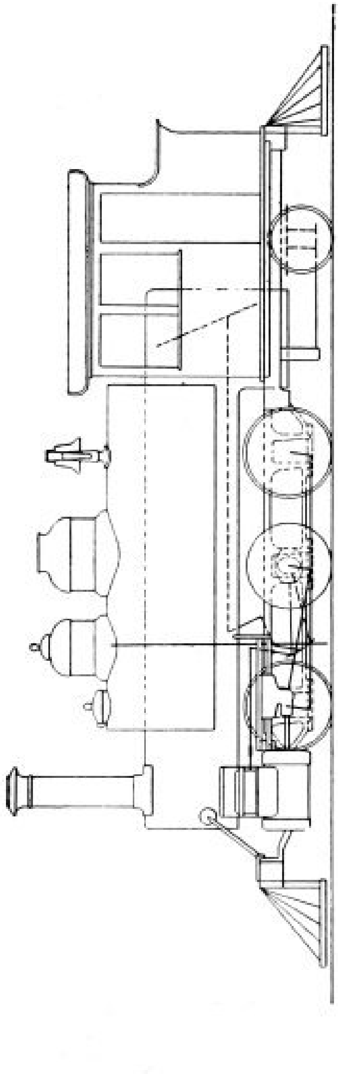
8¼ C WITH TENDER
EXPRESS PASSENGER SERVICE



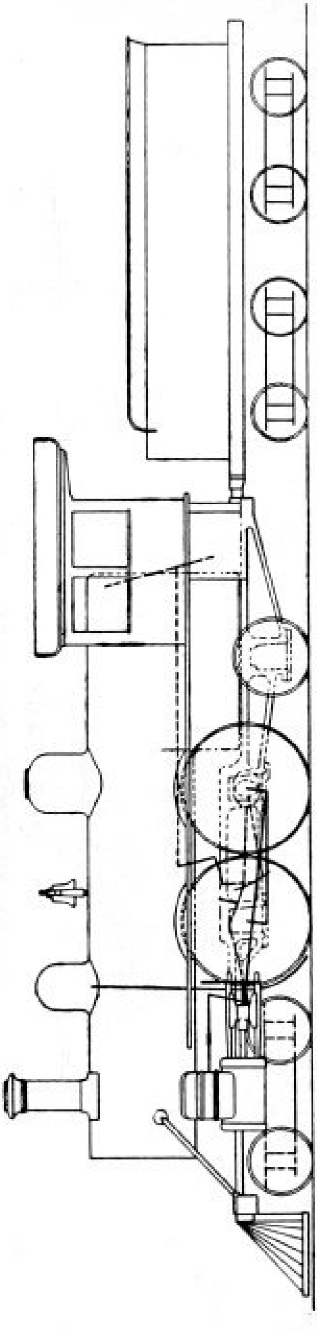
12¼ C TANK BACK
LOCAL PASSENGER SERVICE



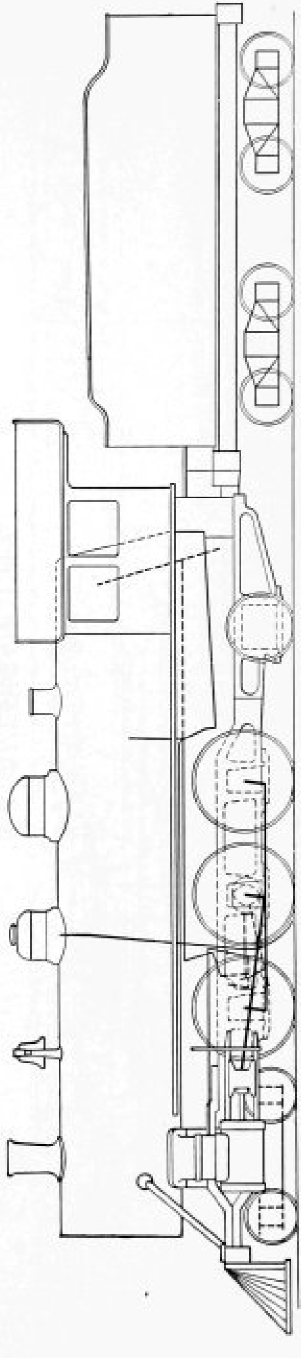
8 C AMERICAN TYPE
EXPRESS PASSENGER SERVICE



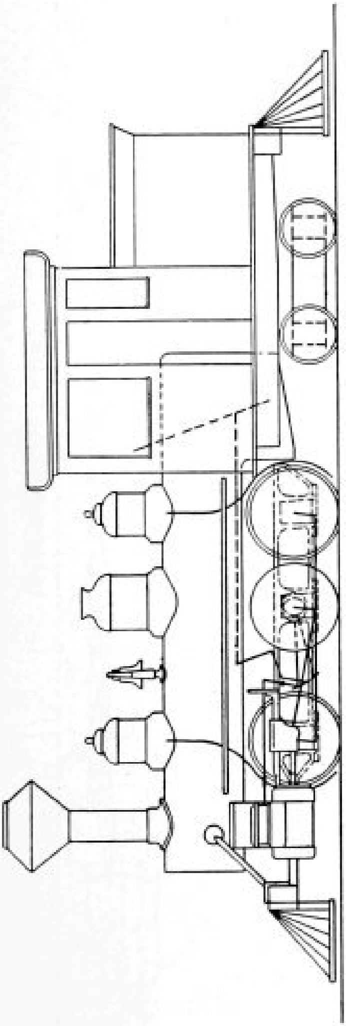
8½ D TANK ON BOILER
HEAVY SWITCHING AND LOCAL FREIGHT SERVICE



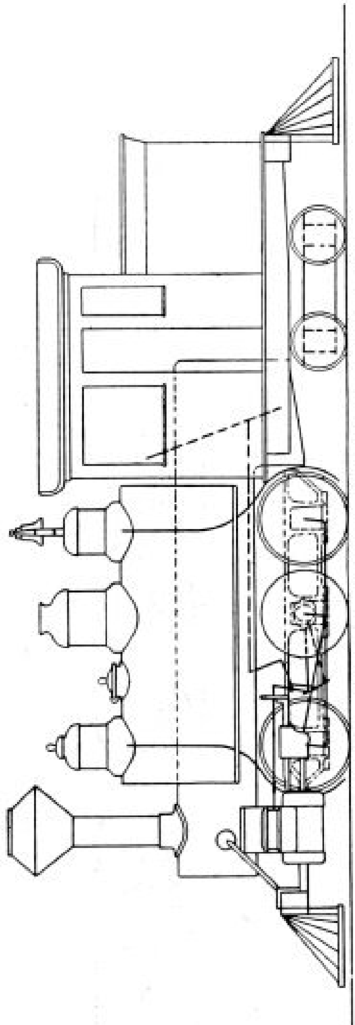
10¼ C (ATLANTIC TYPE)
HIGH SPEED PASSENGER SERVICE



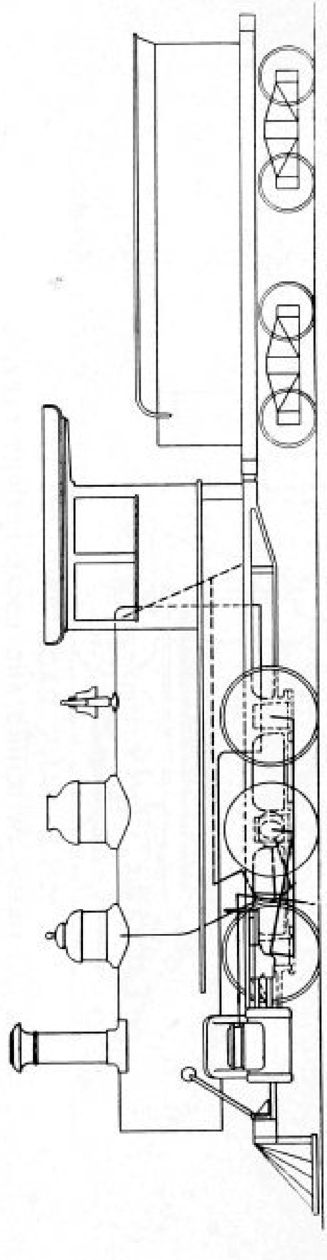
12¼ D (PACIFIC TYPE)
HEAVY PASSENGER SERVICE



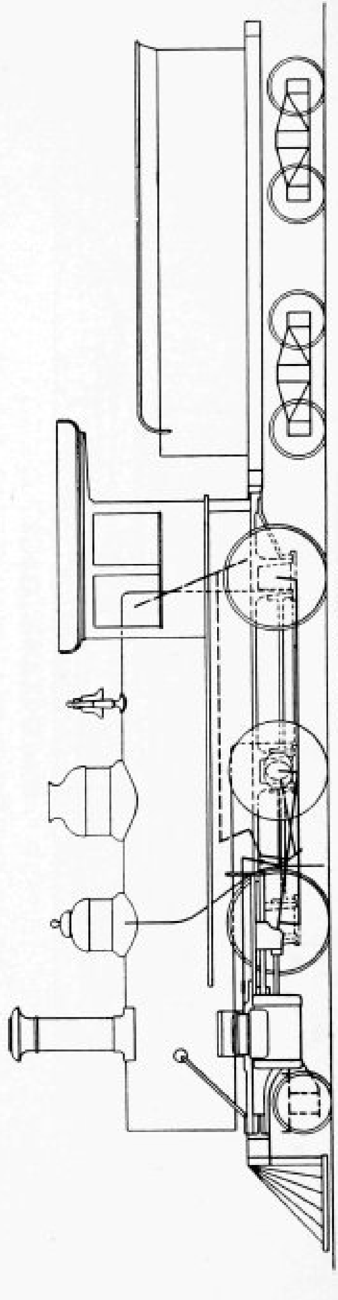
10½ D TANK BACK
HEAVY SWITCHING AND LOCAL FREIGHT SERVICE



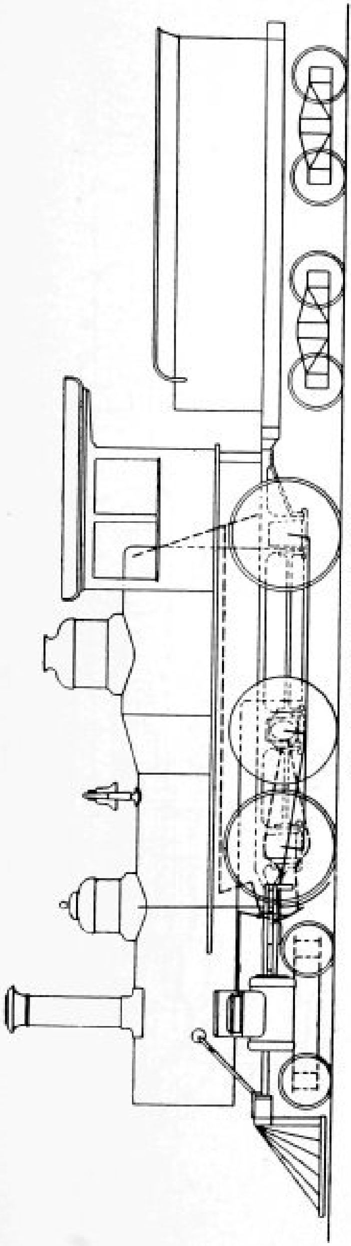
10½ D TANK BACK AND ON BOILER
HEAVY SWITCHING AND LOCAL FREIGHT SERVICE



6 D WITH TENDER
HEAVY SWITCHING SERVICE

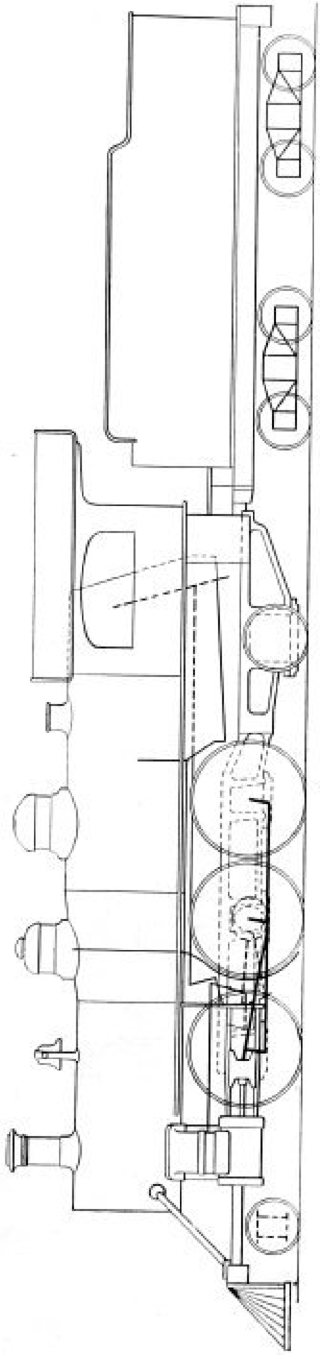


8 D MOGUL
FREIGHT SERVICE



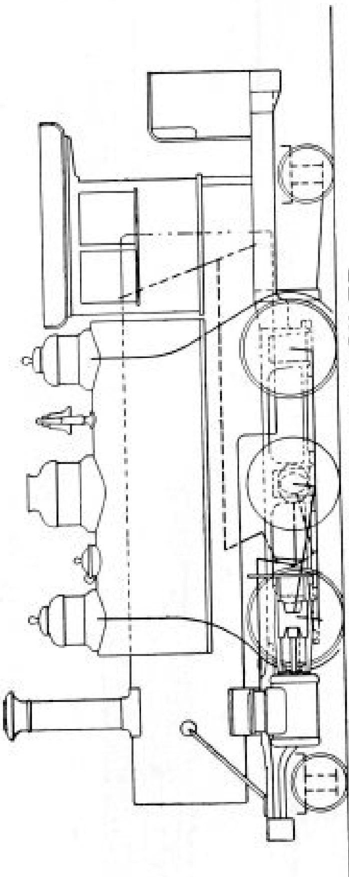
10 D TEN-WHEELER

FAST FREIGHT AND PASSENGER SERVICE

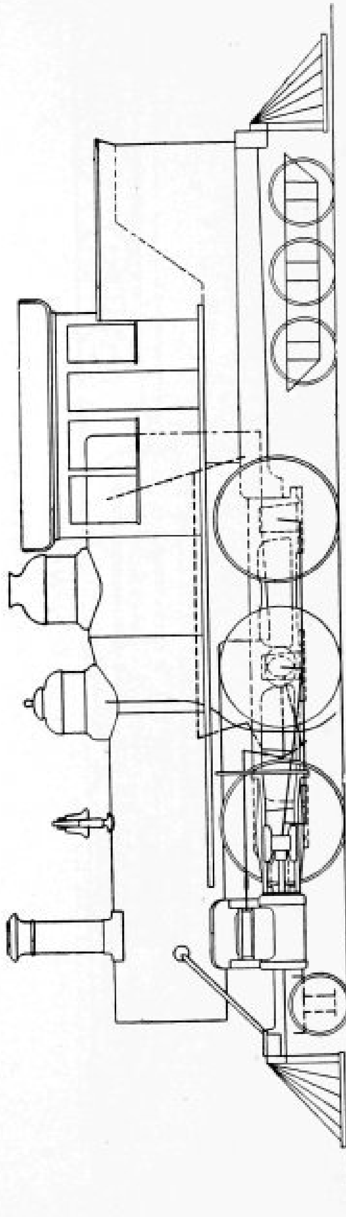


10½ D PRAIRIE TYPE

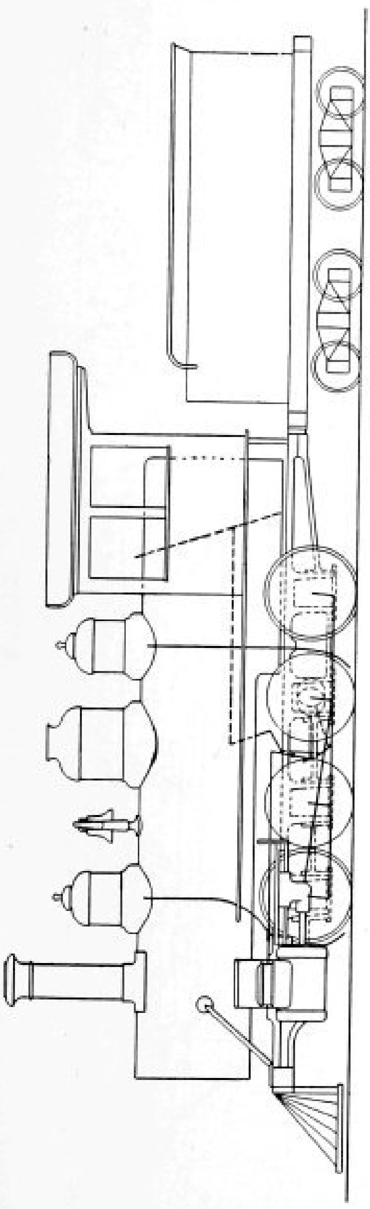
PASSENGER AND FREIGHT SERVICE



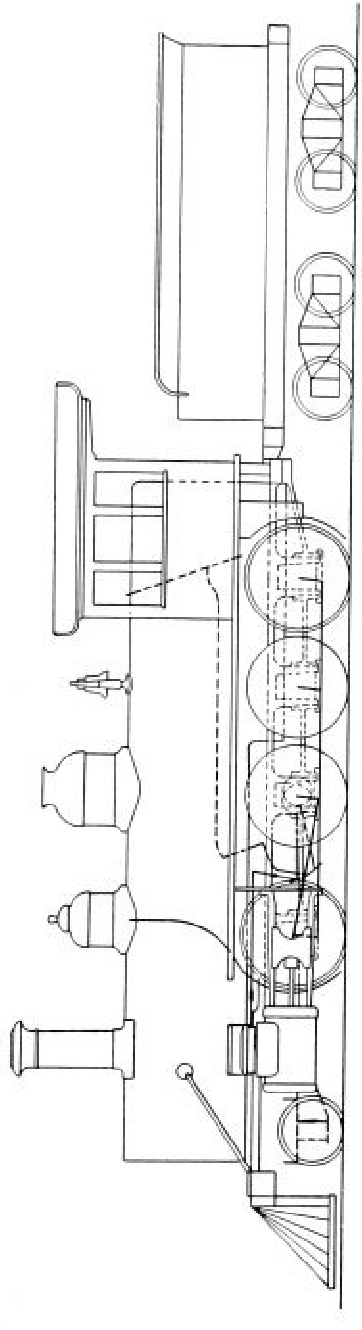
10¼ D TANK ON BOILER
HEAVY SWITCHING SERVICE



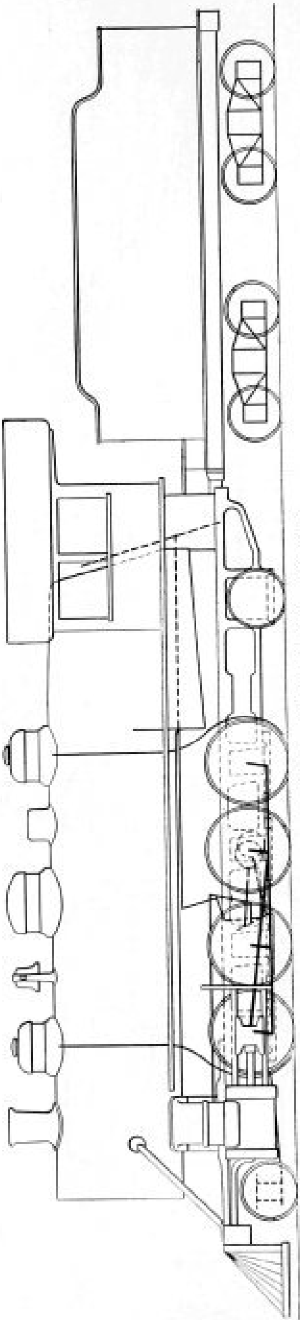
14¼ D TANK BACK
LOCAL PASSENGER SERVICE



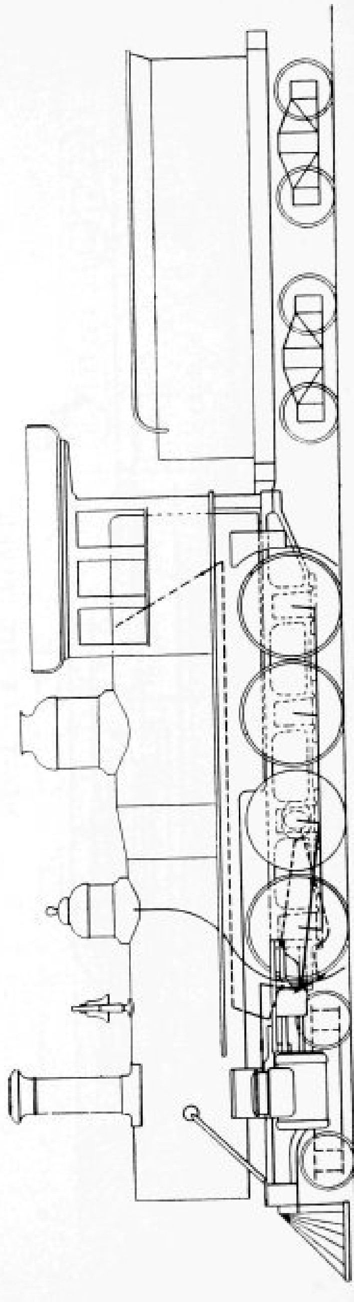
8 E
HEAVY FREIGHT SERVICE



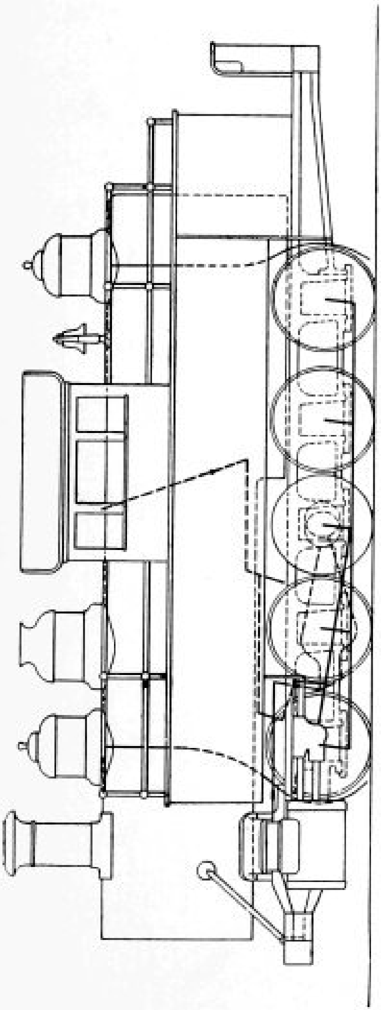
10 E CONSOLIDATION
HEAVY FREIGHT SERVICE



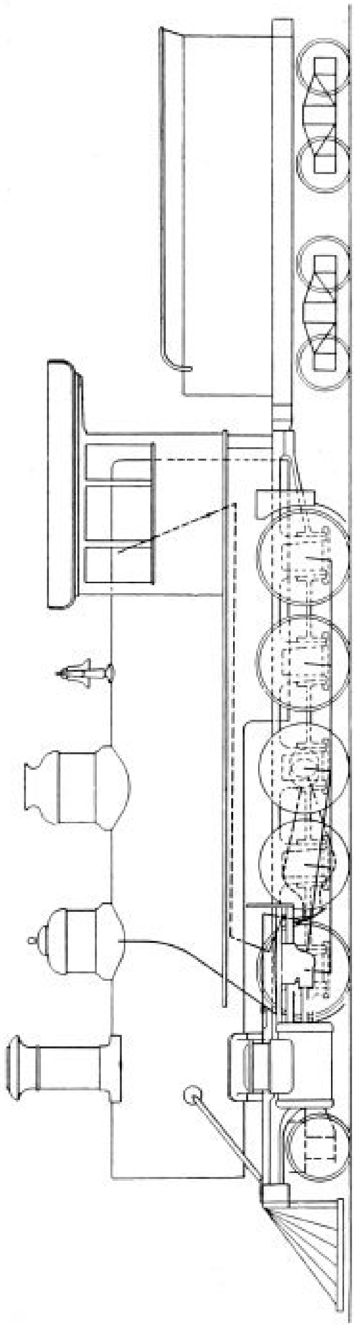
12¼ E MIKADO TYPE
HEAVY FREIGHT SERVICE



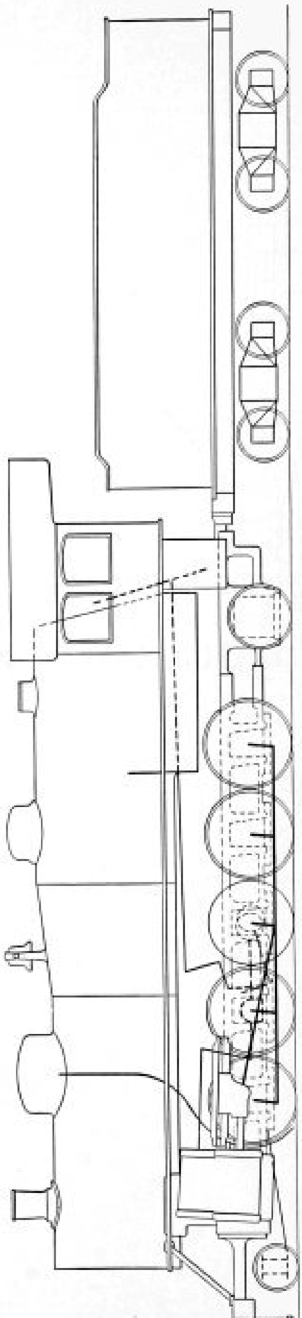
12 E
HEAVY FREIGHT SERVICE



10 F TANK ON BOILER
HEAVY SWITCHING SERVICE



12 F DECAPOD
HEAVY FREIGHT SERVICE

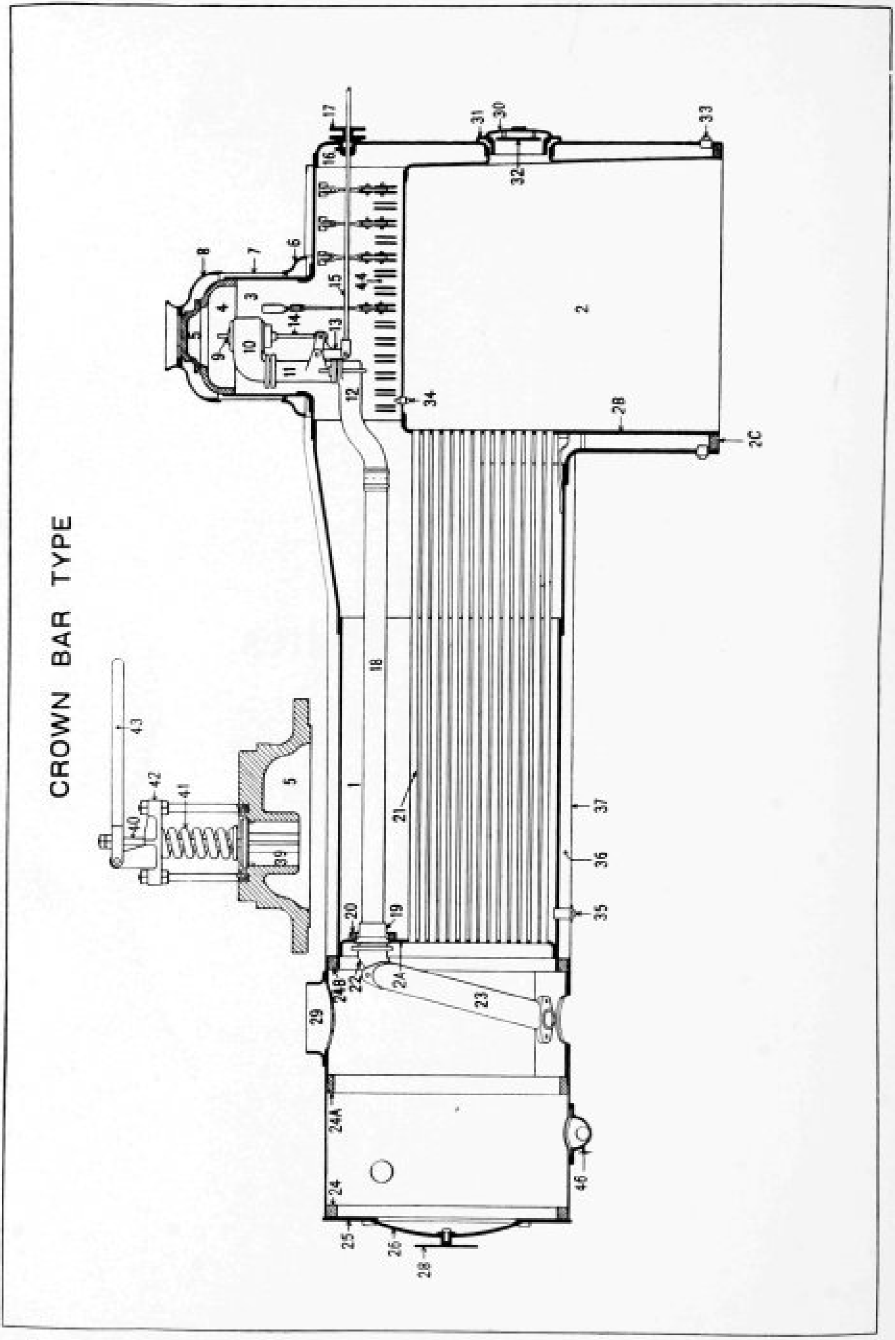


14¼ F SANTA FE TYPE

HEAVY FREIGHT SERVICE

Illustrated Plates

Plate 1


CROWN BAR TYPE
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2B
2C
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24A
24B
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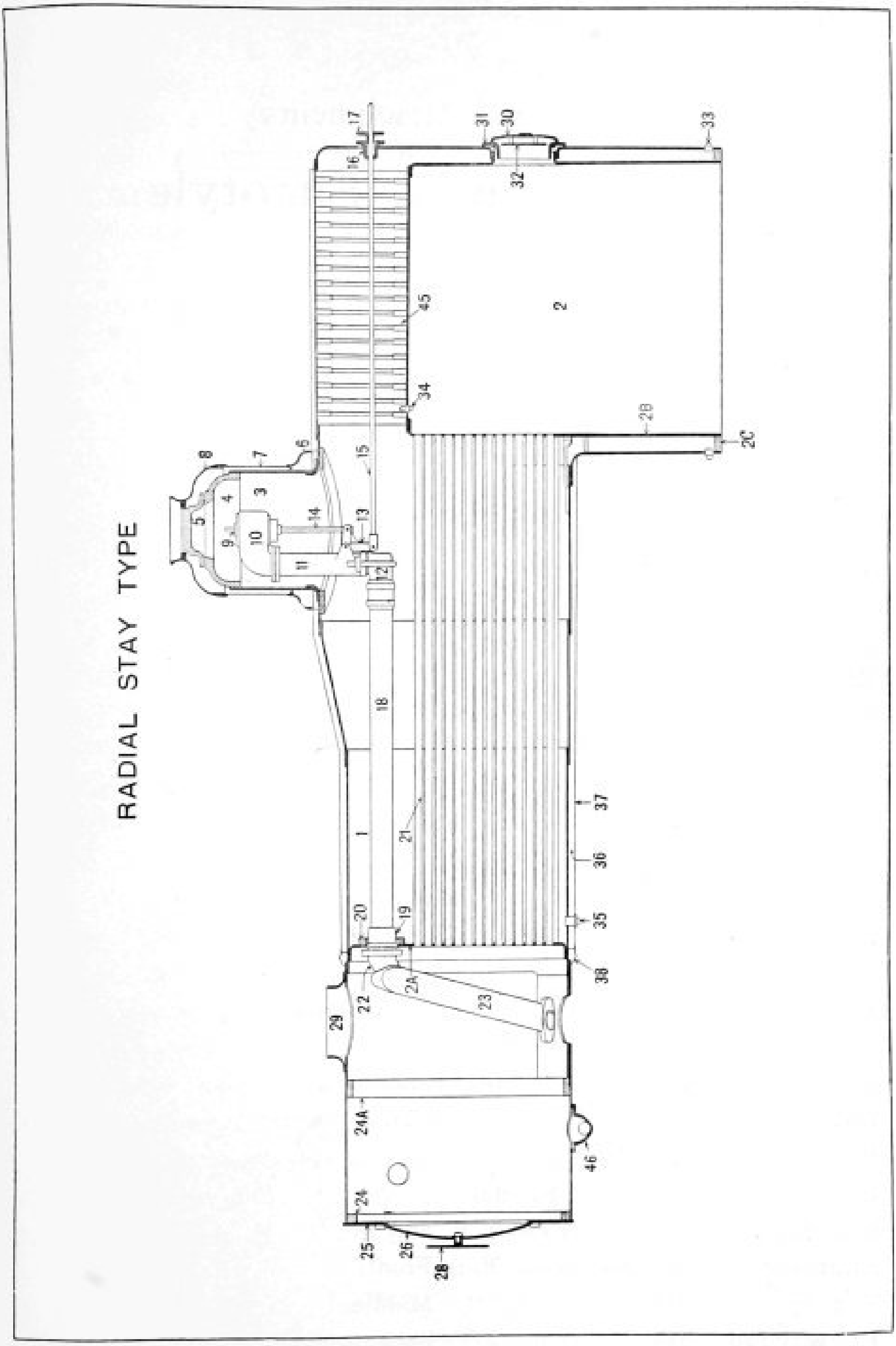
Plate 2


RADIAL STAY TYPE
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24
24A
25
26
28
29
2A
2B
2C
30
31
32
33
34
35
36
37
38
45
46

Boiler and Attachments

Plates 1 and 2. Encotyle

Encouardi	1.	Boiler.
Encoubert	2.	Firebox.
Encoudam	2A.	Front Tube Sheet.
Encoufer	2B.	Firebox " "
Encougard	2C.	Water Space Frame.
Encouloir	3.	Dome.
Encounters	4.	" Ring.
Encourager	5.	" Cap.
Encourais	6.	" Base.
Encourar	7.	" Casing.
Encouriez	8.	" Cover.
Encourons	9.	Throttle Valve.
Encourront	10.	" " Box.
Encourumes	11.	" Pipe.
Encouteiro	12.	" " Elbow.
Encouto	13.	" Valve Crank.
Encouturer	14.	" " Rod.
Encradle	15.	" " Stem.
Encradling	16.	" Stuffing Box.
Encranio	17.	" " " Gland.
Encrasser	18.	Dry Pipe.
Encratitas	19.	" Front End.
Encratiti	20.	" Ring on Tube Sheet.
Encravacao	21.	Tubes.
Encravar	22.	Double Cone.
Encravo	23.	Steam Pipes, R. and L.
Encreases	24.	Smokebox Ring Front.
Encrepe	24A.	" " Middle.
Encrespado	24B.	" " Back.

Encrespar	25.	Smokebox Front.
Encrespeis	26.	" Door.
Encrespo	27.	" " Liner.
Encresta	28.	Number Plate.
Encrestada	29.	Smoke-stack Base.
Encrimson	30.	Firedoor.
Encrinic	31.	" " Frame.
Encrinital	32.	" " Liner.
Encrisped	33.	Corner Plug.
Encristado	34.	Fusible "
Encrivore	35.	Waist "
Encroach	36.	Lagging.
Encroached	37.	Jacket.
Encroise	38.	Smokebox Band.
Encrotter	39.	Safety Valve.
Encroutant	40.	" " Stem.
Encruar	41.	" " Spring.
Encruecer	42.	" " " Cap.
Encruzado	43.	Relief Lever.
Encuaderno	44.	Crown Bar.
Encubabais	45.	Staybolt.
Encubado	46.	Spark Ejector.

In ordering steam pipes (No. 23), it will be necessary to specify the side, if both are not wanted.

Smoke-stack base (No. 29), while shown in one piece on this plate, is frequently made in two parts, as shown on Plate 38, and either part can be had by referring to the latter plate. See Plate 4 for steel base.

Jacket bands are not given a number in this list, as they are easily designated without.

In many cases patented valves are used instead of the safety valve shown on this plate. In ordering, state whether valve is wanted with or without relief lever.

Plate 3

Fig. 1

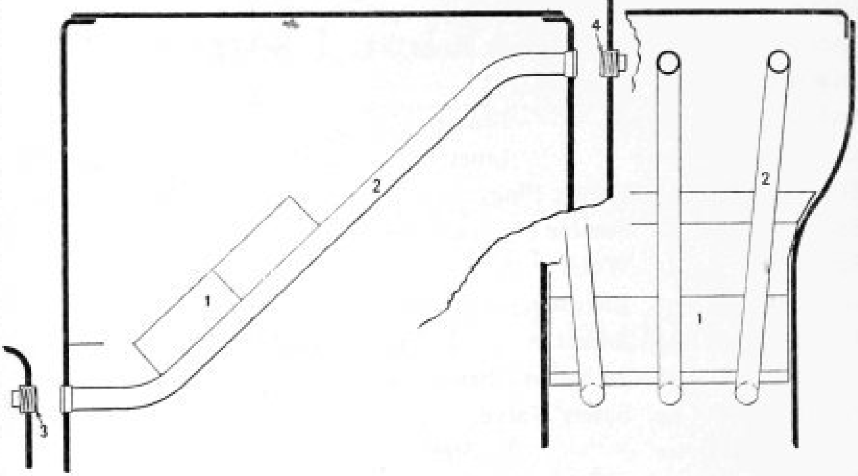
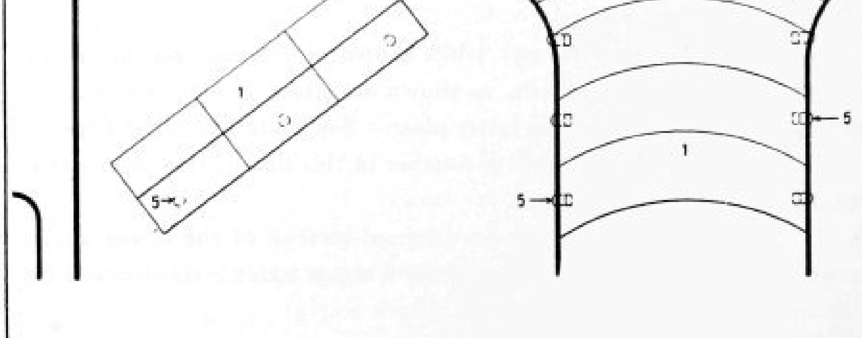


Fig. 2



Arrangement of Fire Bricks in Firebox

Plate 3. Encubamos

FIGURE 1.—Bricks supported on Tubes.

Encubar . . 1. Fire Brick.

Encubarian 2. " " Tube.

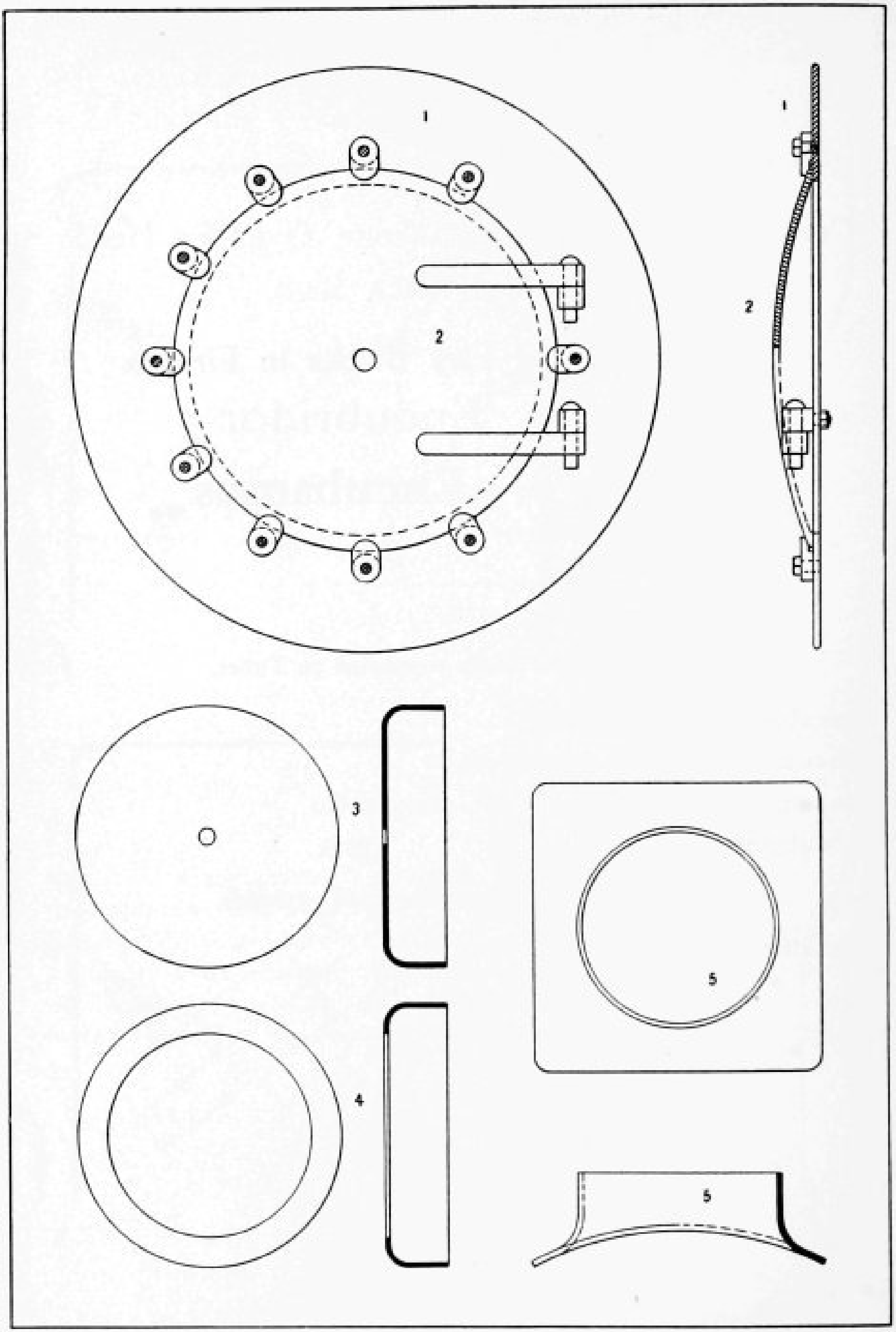
Encubaron . 3. " " " Plug, Front.

Encubertar . 4. " " " " Back.

FIGURE 2.—Bricks supported on Studs.

Encubierta . 5. Fire Brick Stud.

Plate 4



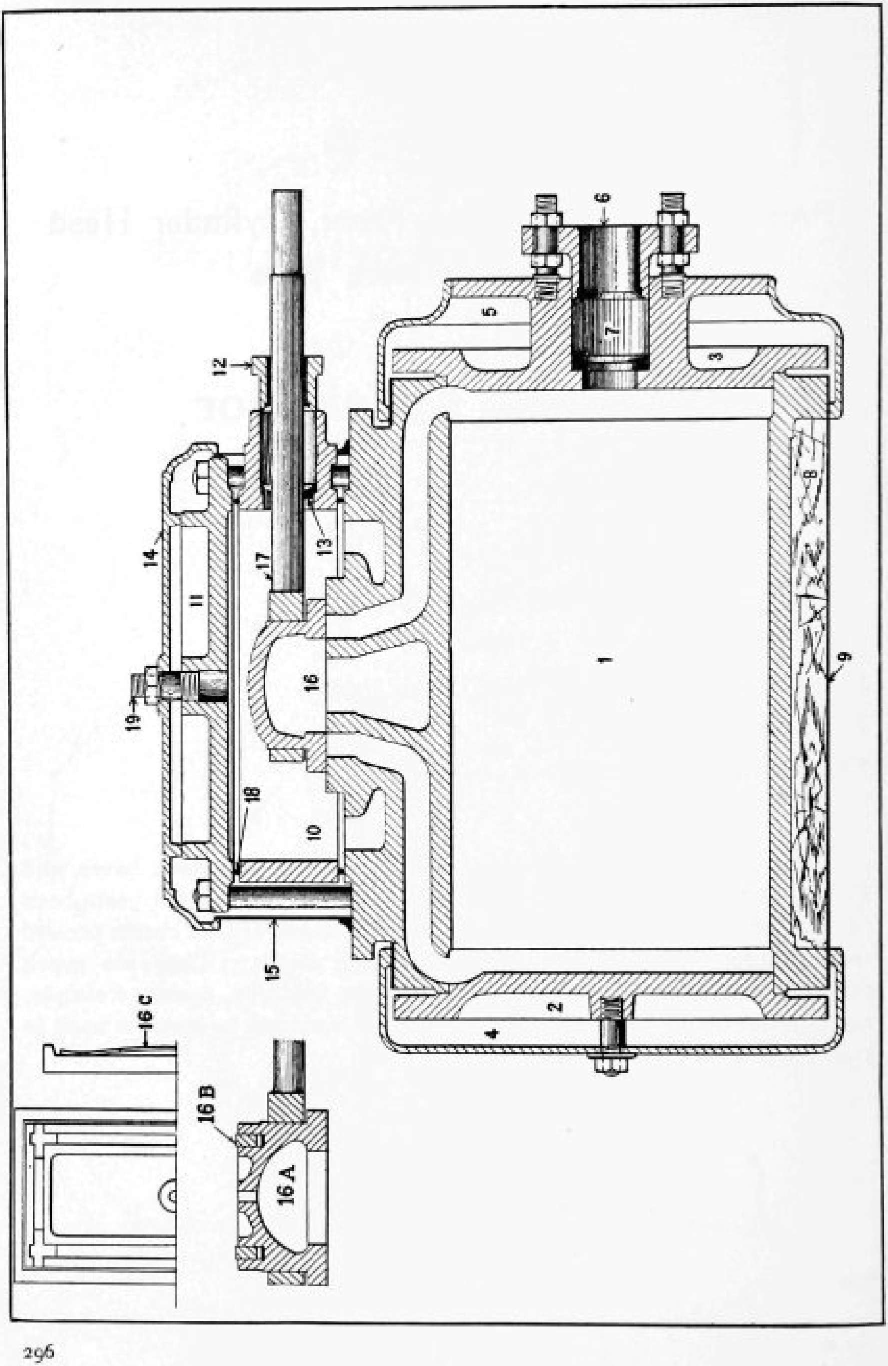
Pressed Steel Smokebox Front, Cylinder Head Cover, and Stack Base

Plate 4. Encubridor

Encubrimos 1. Smokebox Front.
Encubrir . 2. " Door.
Encubriras . 3. Cylinder Head Cover, Front.
Encubriria . 4. " " " Back.
Encuentras . 5. Stack Base.

Plates 1 and 2 show cast iron smokebox fronts and stack bases, and Plate 5 cast iron cylinder head covers. These have in recent years been superseded on many railroads by similar parts made of steel sheets pressed while hot in dies giving them the required forms. They are much stronger, and consequently more durable than cast iron, present a simple, neat appearance, and in many cases when injured can be brought back to their original shape.

Plate 5



Single-Expansion Cylinder, Steam Chest and Attachments

Plate 5. Encuentro

Encuerda	1.	Cylinder.
Encugentar	2.	Front Head.
Encuirer	3.	Back "
Enculasse	4.	Front Casing Cover.
Encumber	5.	Back " "
Encumbraba	6.	Cylinder Gland, R. and L.
Encumbrar	7.	" " Bottom Ring.
Encumbreis	8.	Wood Lagging.
Encumbro	9.	Casing.
Encumear	10.	Steam Chest.
Encunare	11.	" " Cap.
Encunasen	12.	" " Gland.
Encurralar	13.	" " " Bottom Ring.
Encurtador	14.	" " Casing Cover.
Encurtain	15.	" " Casing.
Encurtamos	16.	" " Valve.
Encurtidos	16A.	" " " Balanced Pattern.
Encurtiera	16B.	" " " Packing Strips.
Encurtir	16C.	" " " " Springs.
Encurtiras	17.	" " " Yoke.
Encuvage	18.	" " Joint.
Encyanthe	19.	" " Oil Pipe Stem.

If a single cylinder, head, gland, or steam chest is ordered, the side required for should be specified.

Plate 6

FIG. 1

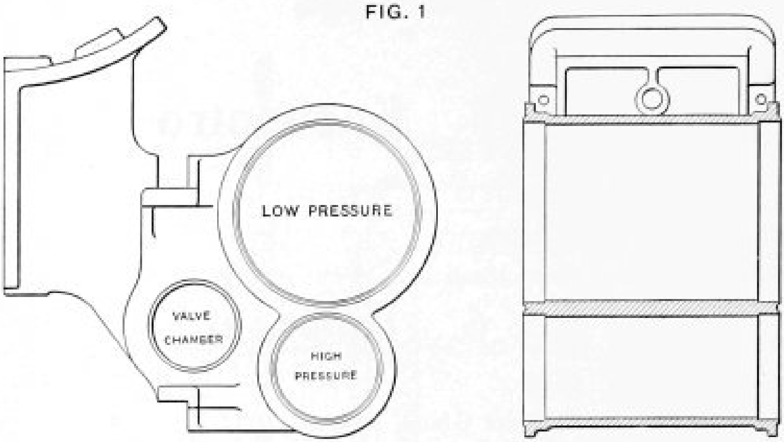
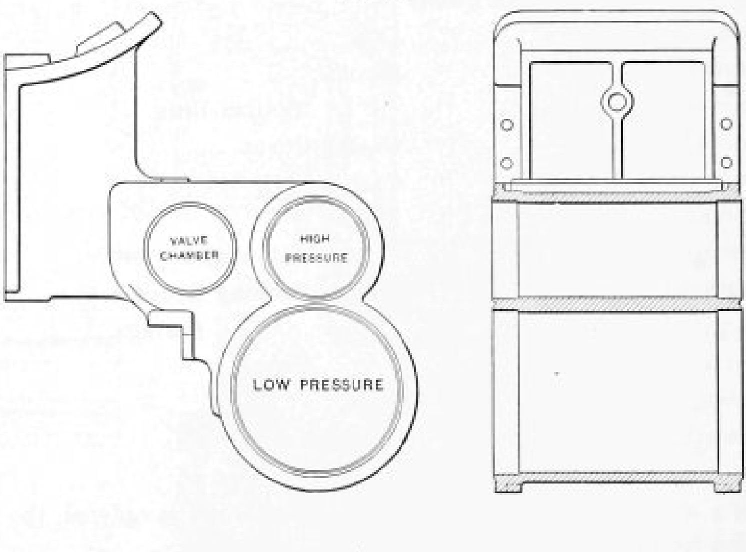


FIG. 2



Baldwin Compound Cylinders (Four Cylinder, Vauclain System)

Plate 6. Encycle

FIGURE 1.

Baldwin Compound Cylinders with Low-Pressure Cylinder above High-Pressure, showing one side of locomotive.

FIGURE 2.

Baldwin Compound Cylinders with High-Pressure Cylinder above Low-Pressure, showing one side of locomotive.

The High- and Low-Pressure Cylinders are cast in one piece.

Plate 7

DIAGRAM SHOWING COURSE OF STEAM
IN
FOUR CYLINDER COMPOUND LOCOMOTIVE

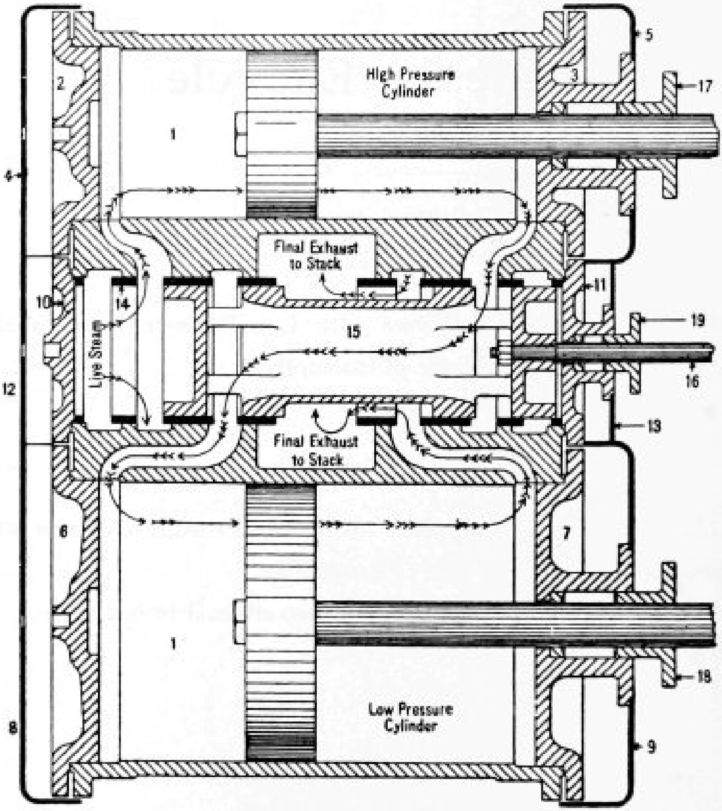


Diagram of Baldwin Compound Cylinders (Vauclain System), Showing the Course of Steam in the Cylinders and Valve Chamber

Plate 7. Encycleme

Encyclia	1.	Cylinder.				
Encyclical	2.	High-Pressure	Front	Cylinder	Head.	
Encyclios	3.	"	Back	"	"	
Encyclique	4.	"	Front	"	"	Casing Cover.
Encyclon	5.	"	Back	"	"	" "
Encymon	6.	Low-Pressure	Front	"	"	
Encyoneme	7.	"	Back	"	"	
Encyrte	8.	"	Front	"	"	Casing Cover.
Encyrtite	9.	"	Back	"	"	" "
Encystment	10.	Front Valve Chamber Head.				
Encytis	11.	Back " " "				
Encyto	12.	Front " " " Casing Cover.				
Endacin	13.	Back " " " " "				
Endagrie	14.	Valve Chamber Bushing. (See Plate 13).				
Endamage	15.	Piston Valve. " "				
Endamaging	16.	" " Stem. " "				
Endamenes	17.	*High-Pressure Cylinder Gland.				
Endanger	18.	*Low-Pressure " "				
Endangered	19.	*Valve Chamber Gland.				

If a single cylinder, head, casing cover, bushing, valve, stem, or gland is ordered, the side required for should be specified.

*Metallic Packing is used in all Stuffing Boxes of Compound Cylinders. (See Plates 91 and 92).

Plate 8

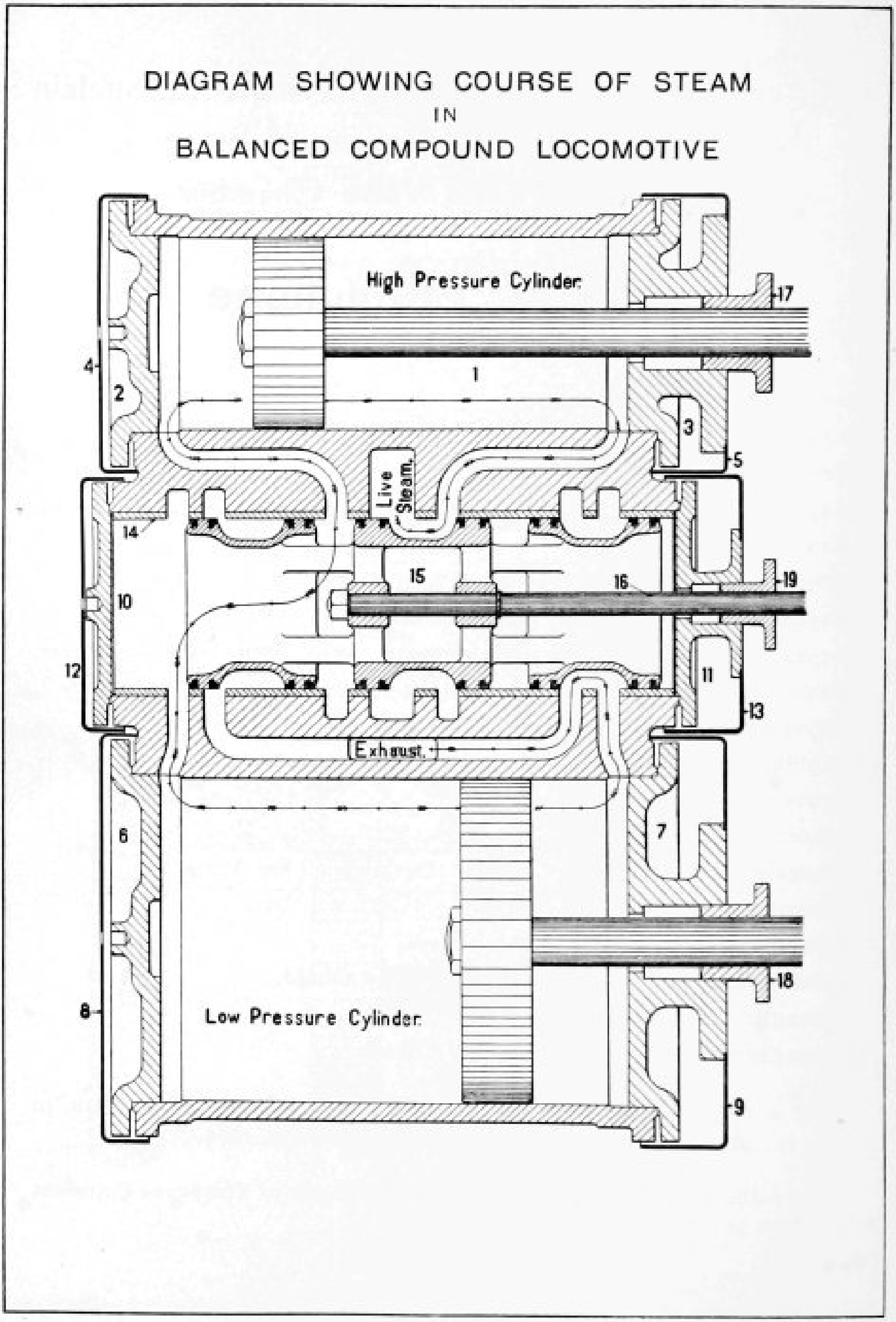


DIAGRAM SHOWING COURSE OF STEAM
IN
BALANCED COMPOUND LOCOMOTIVE
High Pressure Cylinder.
Live Steam.
15
16
Exhaust.
Low Pressure Cylinder.
1
2
3
4
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6
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18
19

Diagram of Baldwin Balanced Compound Cylinders Showing the Course of Steam in the Cylinders and Valve Chamber

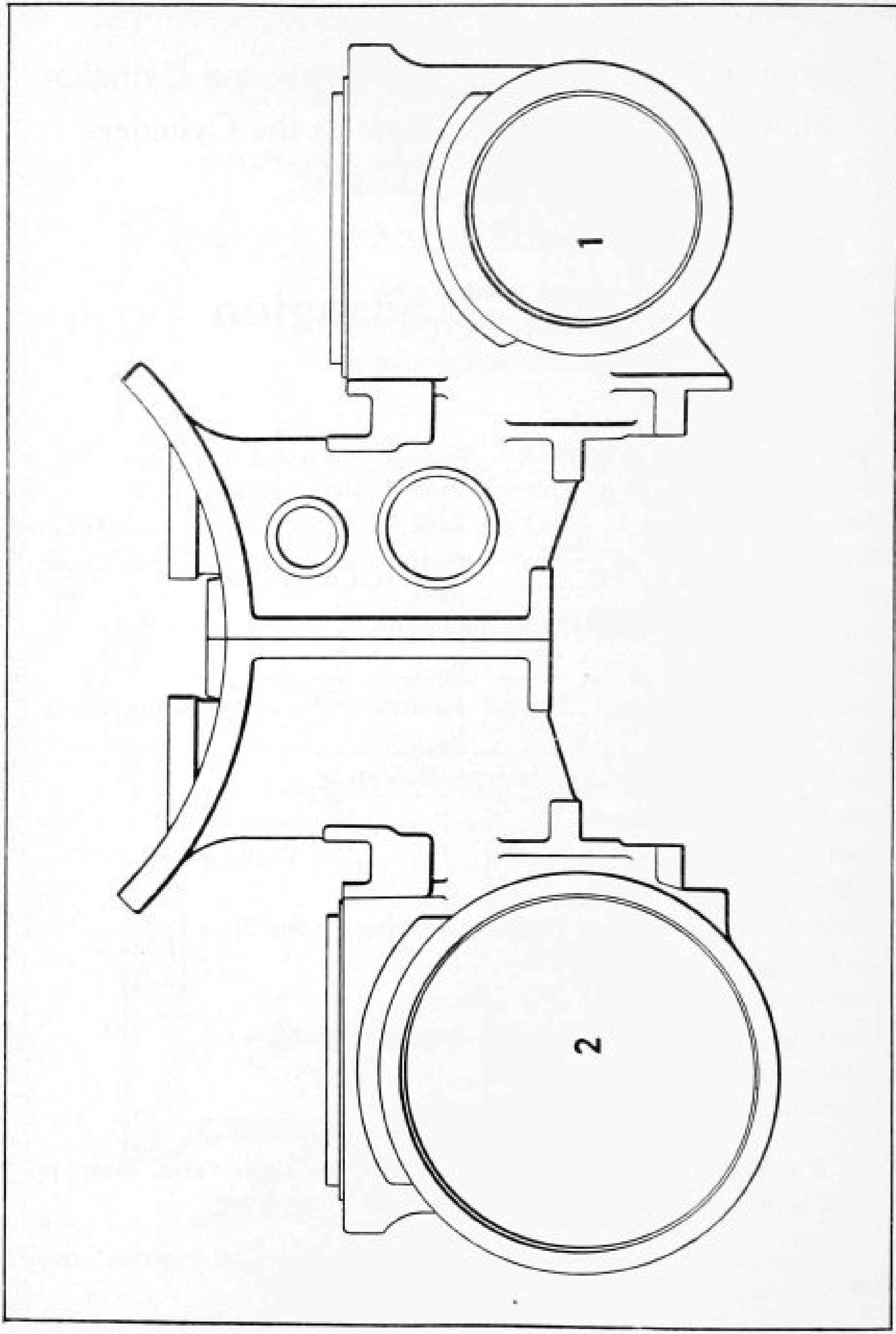
Plate 8. Endangion

Endark	1.	Cylinder.
Endarken	2.	High-Pressure Front Cylinder Head.
Endarkened	3.	" " Back " "
Endarking	4.	" " Front " " Casing Cover.
Endaubage	5.	" " Back " " " "
Endaubeur	6.	Low-Pressure Front " "
Endazeh	7.	" " Back " "
Endearedly	8.	" " Front " " Casing Cover.
Endearment	9.	" " Back " " " "
Endeavour	10.	Front Valve Chamber Head.
Endebles	11.	Back " " "
Endeblezes	12.	Front " " " Casing Cover.
Endecader	13.	Back " " " " "
Endecaedro	14.	Valve Chamber Bushing. (See Plate 13.)
Endecagono	15.	Piston Valve. " "
Endechador	16.	" " Stem. " "
Endechamos	17.	*High-Pressure Cylinder Gland.
Endechando	18.	*Low-Pressure " "
Endechar	19.	*Valve Chamber Gland.

If a single cylinder, head, casing cover, bushing, valve, stem, or gland is ordered, the side required for should be specified.

*Metallic Packing is used in all Stuffing Boxes of Compound Cylinders. (See Plates 91 and 92).

Plate 9



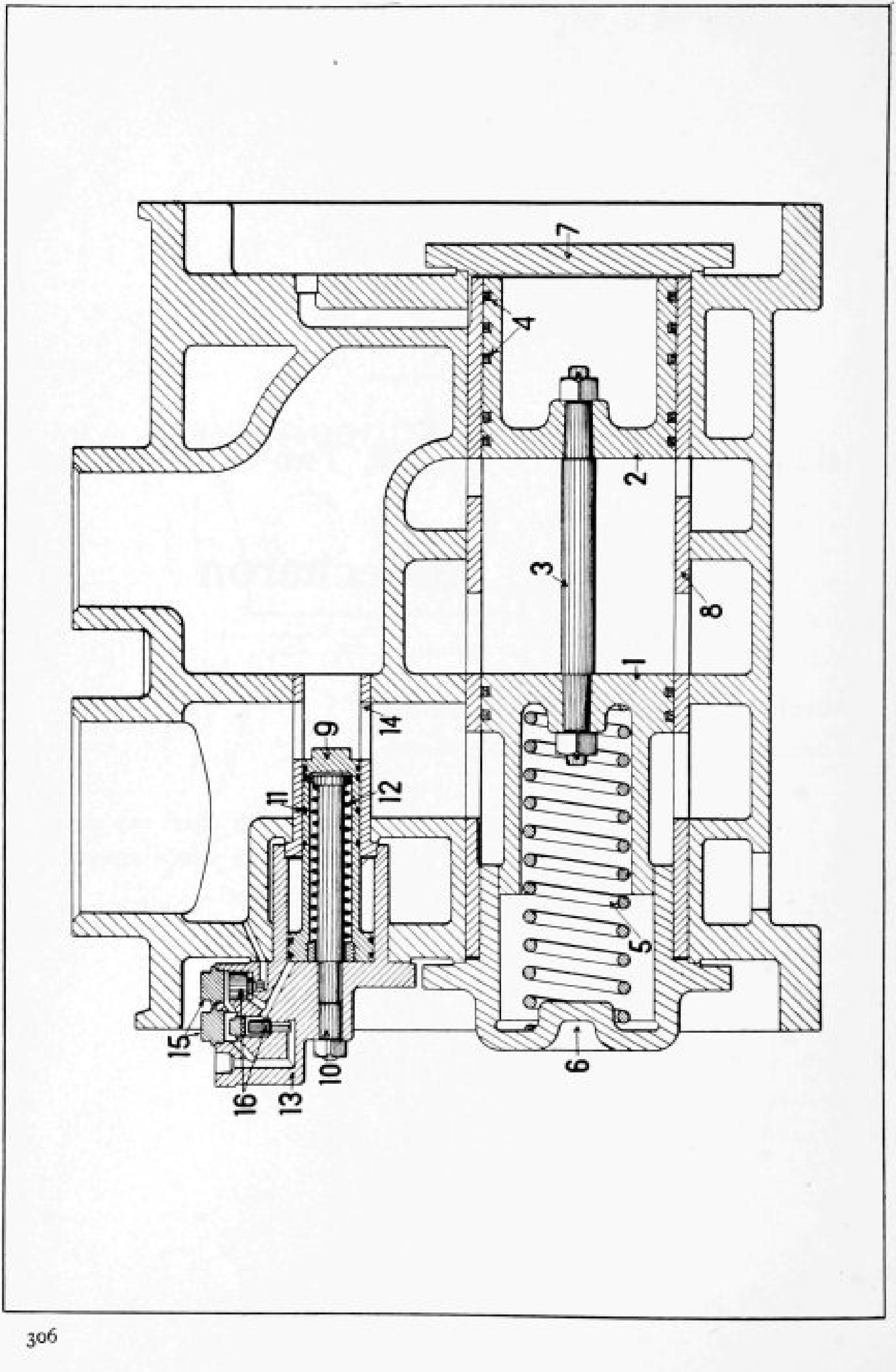
Baldwin Compound Cylinders, Two-Cylinder Type

Plate 9. Endecharon

Endechases . 1. High-Pressure Cylinder.
Endecheis . . 2. Low-Pressure Cylinder.

In ordering steam chest, steam chest valve, steam chest cap or casing, cylinder heads or cylinder head covers, use code words shown on Plate 5, specifying for which side the parts are required.

Plate 10

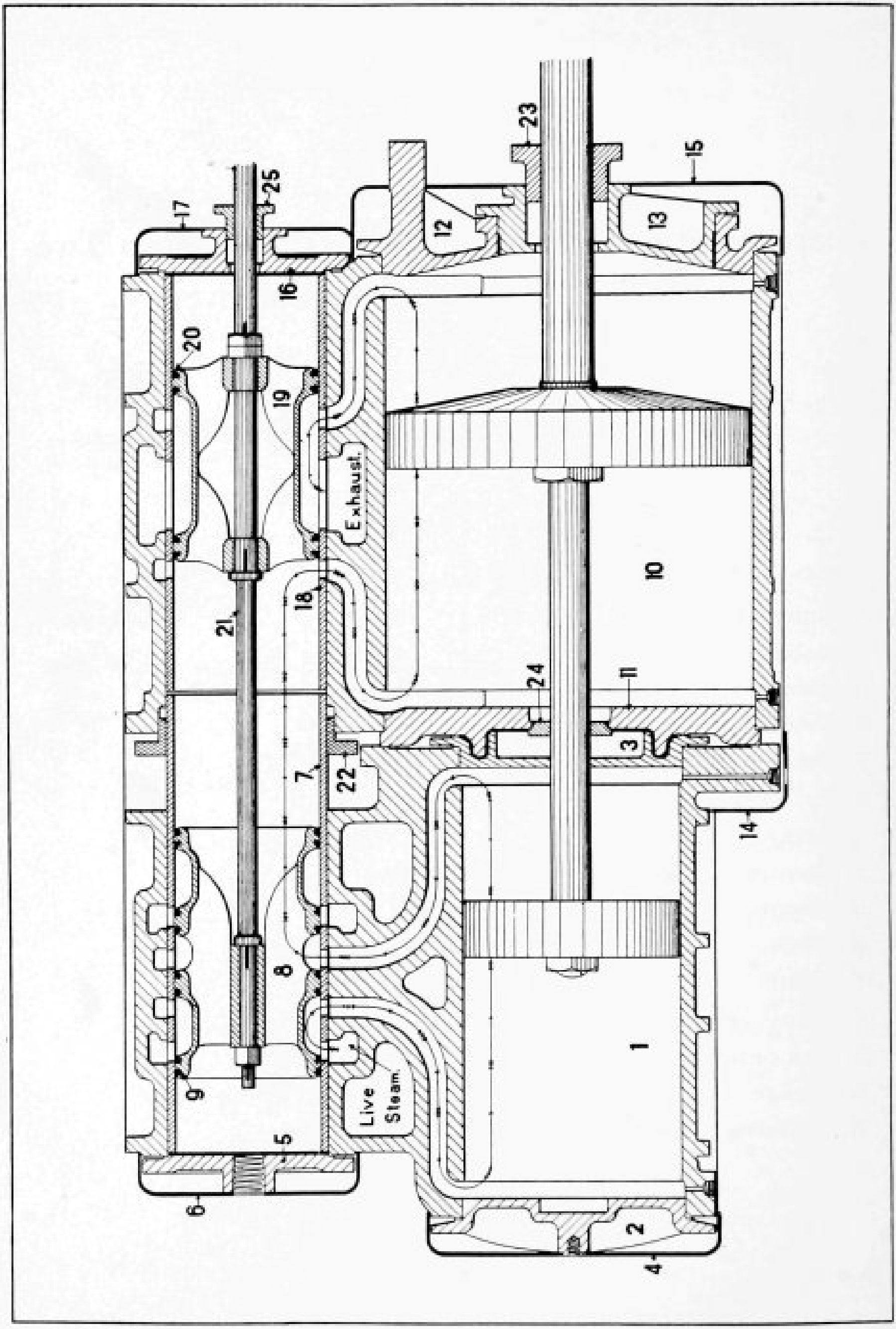


Intercepting and Reducing Valves for Baldwin Two-Cylinder Compound Locomotives

Plate 10. Endechoso

Endehesado	1.	Intercepting Valve Front.
Endehesais	2.	" " Back.
Endehesar	3.	" " Distance Bar.
Endeictic	4.	" " Packing Ring.
Endeixis	5.	" " Spring.
Endelechia	6.	" " Front Head.
Endellione	7.	" " Back "
Endelsy	8.	" " Bushing.
Endemial	9.	Reducing Valve Piston.
Endemicite	10.	" " Rod.
Endemico	11.	" " Packing Ring.
Endemie	12.	" " Spring.
Endemique	13.	" " Head.
Endemoniar	14.	" " Bushing.
Endenize	15.	" " Plugs.
Endenizing	16.	" " Poppet Valves.

Plate 11



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23
24
25
Exhaust
Live Steam

Diagram of Tandem Compound Cylinders, Showing the Course of Steam in the Cylinders and Valve Chamber

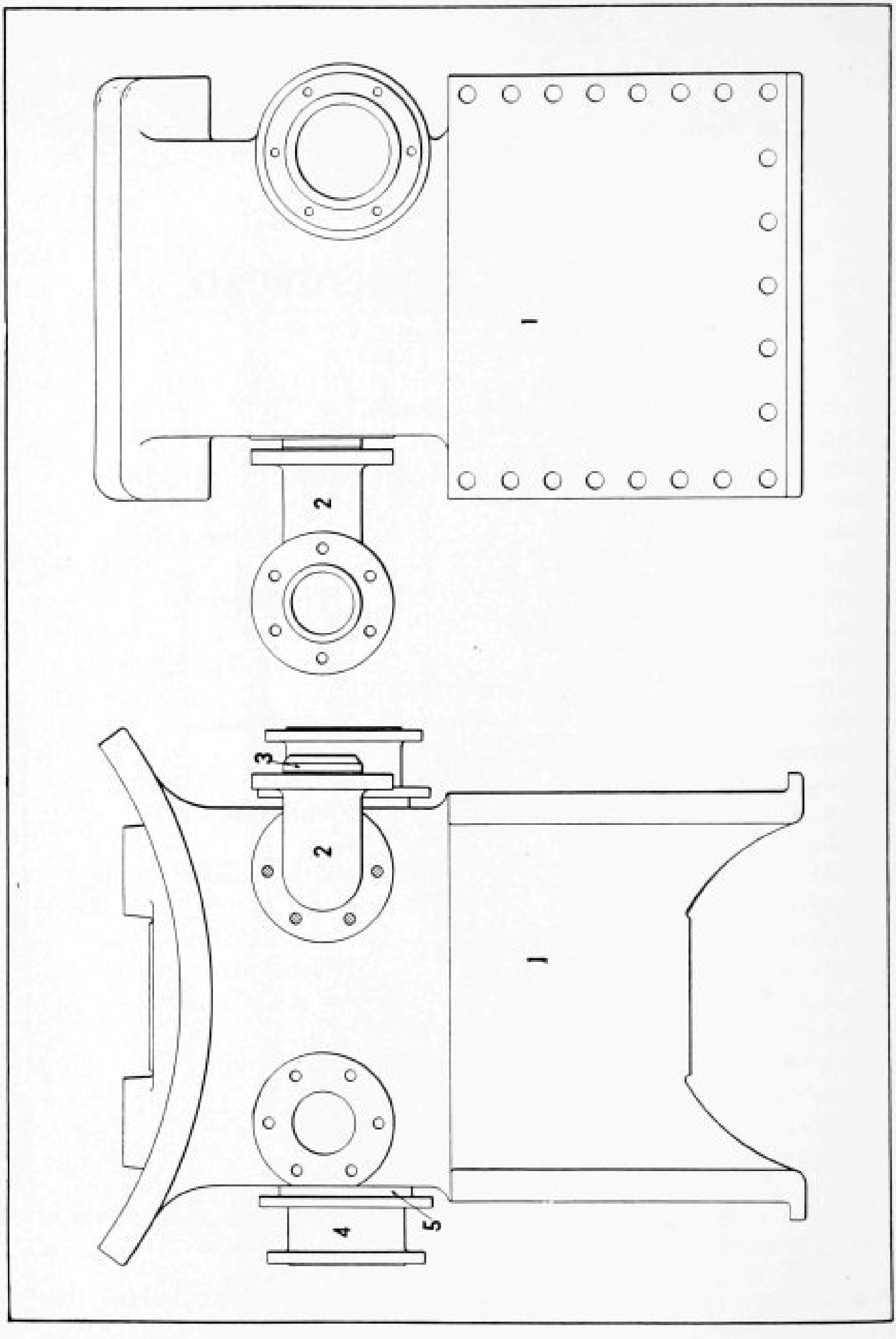
Plate 11. Endentacao

Endentadas	1.	High-Pressure Cylinder.				
Endentado	2.	"	"	Front Head.		
Endentamos	3.	"	"	Back "		
Endentaron	4.	"	"	Front " Cover.		
Endentecer	5.	"	"	Valve Chamber Head.		
Endenteis . .	6.	"	"	" " " Cover.		
Endentezco	7.	"	"	" Bushing.		
Endenture .	8.	"	"	Piston Valve.		
Endeonose	9.	"	"	" " Rings.		
Endeosar .	10.	Low-Pressure Cylinder.				
Endeque . .	11.	"	"	Front Head.		
Enderecar . .	12.	"	"	Back "		
Endereco .	13.	"	"	" " (Central).		
Enderezado	14.	"	"	Front Head Cover.		
Enderezeis .	15.	"	"	Back " "		
Endermatic .	16.	"	"	Valve Chamber Head.		
Endermic . .	17.	"	"	" " " Cover.		
Enderon	18.	"	"	" Bushing.		
Enderum .	19.	"	"	Piston Valve.		
Endetteras	20.	"	"	" " Rings.		
Endettiez .	21.	Valve Stem.				
Endettons .	22.	Intermediate Valve Chamber Gland.				
Endever . .	23.	*Low-Pressure Cylinder Gland.				
Endexa . .	24.	*Intermediate Cylinder Gland.				
Endgueltig	25.	*Valve Chamber Gland.				

If a single cylinder, head, casing cover, bushing, valve, stem or gland is ordered, the side required for should be specified.

*Metallic Packing is used in all Stuffing Boxes of Compound Cylinders. (See Plates 91 and 92).

Plate 12

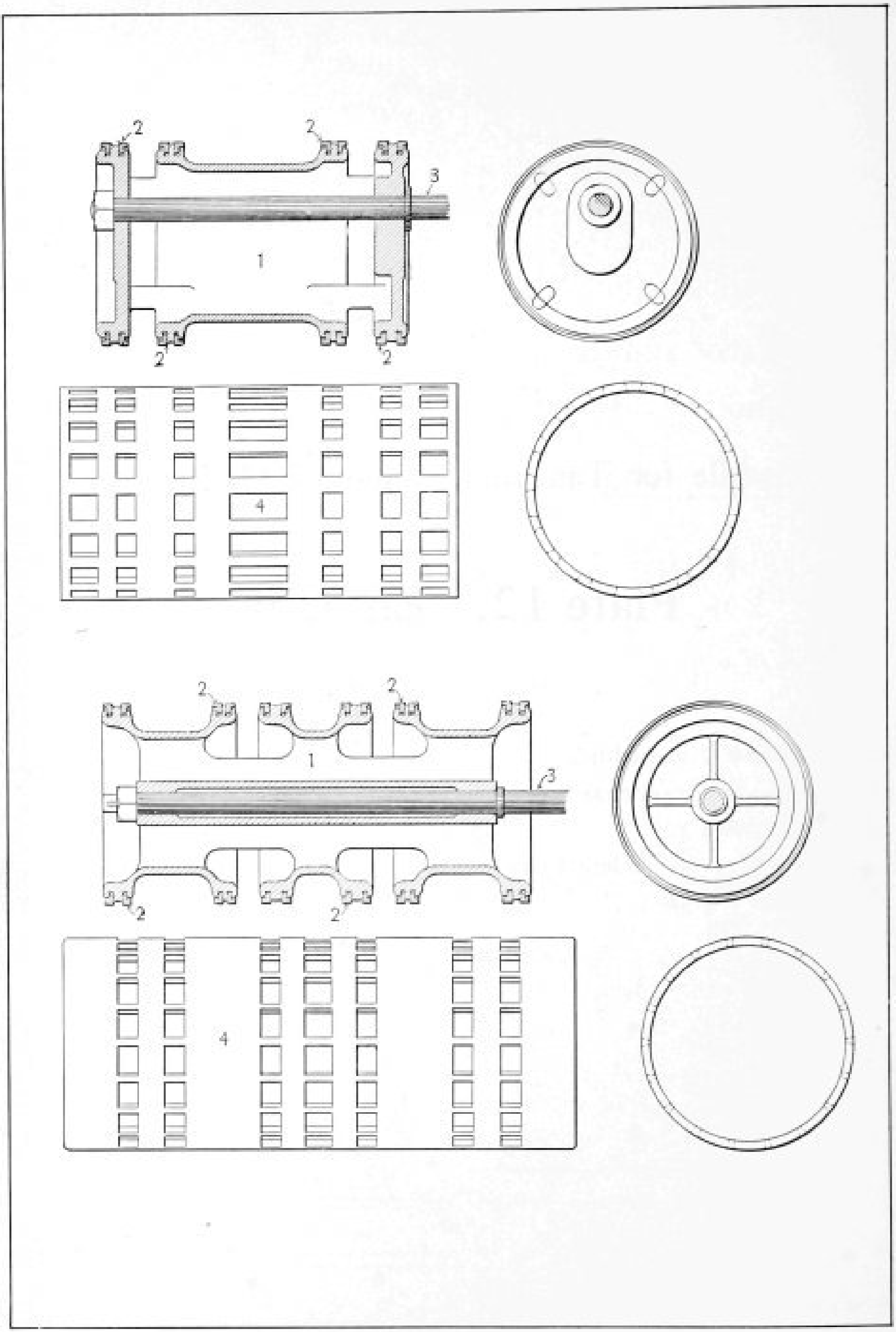


Saddle for Tandem Compound Cylinders

Plate 12. Endiable

Endiabrado	1.	Saddle.
Endiaco . .	2.	Steam Pipe.
Endiamante .	3.	" " Ring.
Endiandre .	4.	Exhaust Connection.
Endiaper . .	5.	" " Gland.

Plate 13



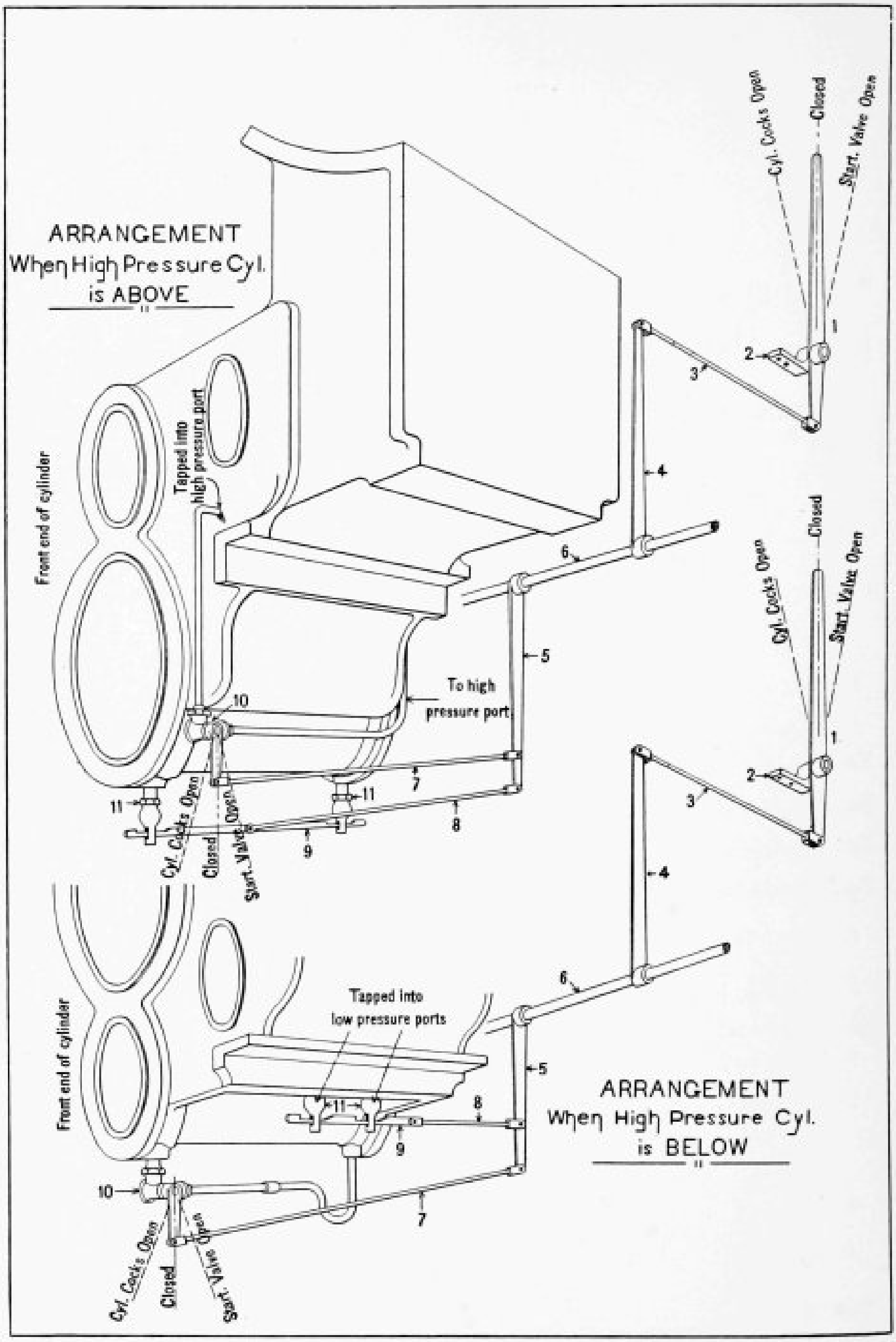
Piston Valve and Bushing for Baldwin Compound Locomotives (Vauclain and Balanced Systems)

Plate 13. Endiapered

Endica	1.	Piston Valve.	
Endicuzza .	2.	" "	Packing Ring.
Endigue . .	3.	" "	Stem.
Endilgada . .	4.	Valve Chamber Bushing.	

If a single valve, stem, or bushing is ordered, the side required for should be specified.

Plate 14



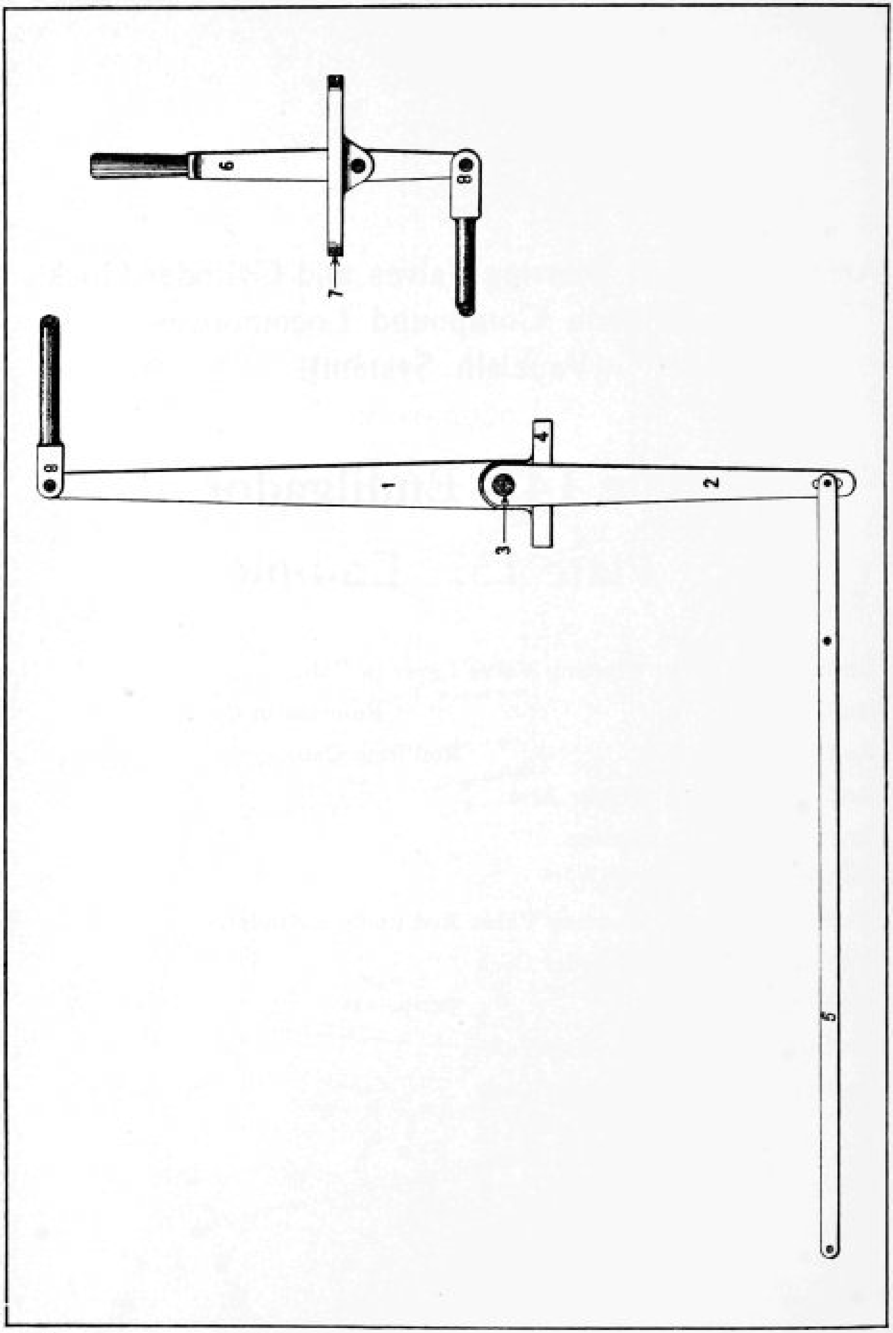
ARRANGEMENT
When High Pressure Cyl.
is ABOVE
Front end of cylinder
Tapped into
high pressure port
To high
pressure port
Cyl. Cocks Open
Closed
Start. Valve Open
1
2
3
4
5
6
7
8
9
10
11
Front end of cylinder
Tapped into
low pressure ports
ARRANGEMENT
When High Pressure Cyl.
is BELOW

Arrangement of Starting Valves and Cylinder Cocks for Baldwin Compound Locomotives (Vauclain System)

Plate 14. Endilgador

Endilgamos	1.	Starting Valve Lever in Cab.
Endilgar . .	2.	" " " Fulcrum in Cab.
Endilgaron	3.	" " Rod from Cab.
Endilgases	4.	Upper Arm.
Endilgueis .	5.	Lower "
Endimanche	6.	Shaft.
Endiosado .	7.	Starting Valve Rod under Cylinder.
Endiosamos .	8.	Cylinder Cock " " "
Endiosaron .	9.	" " Strip.
Endiosases	10.	Starting Valve.
Endioseis .	11.	Cylinder Cock.

Plate 15

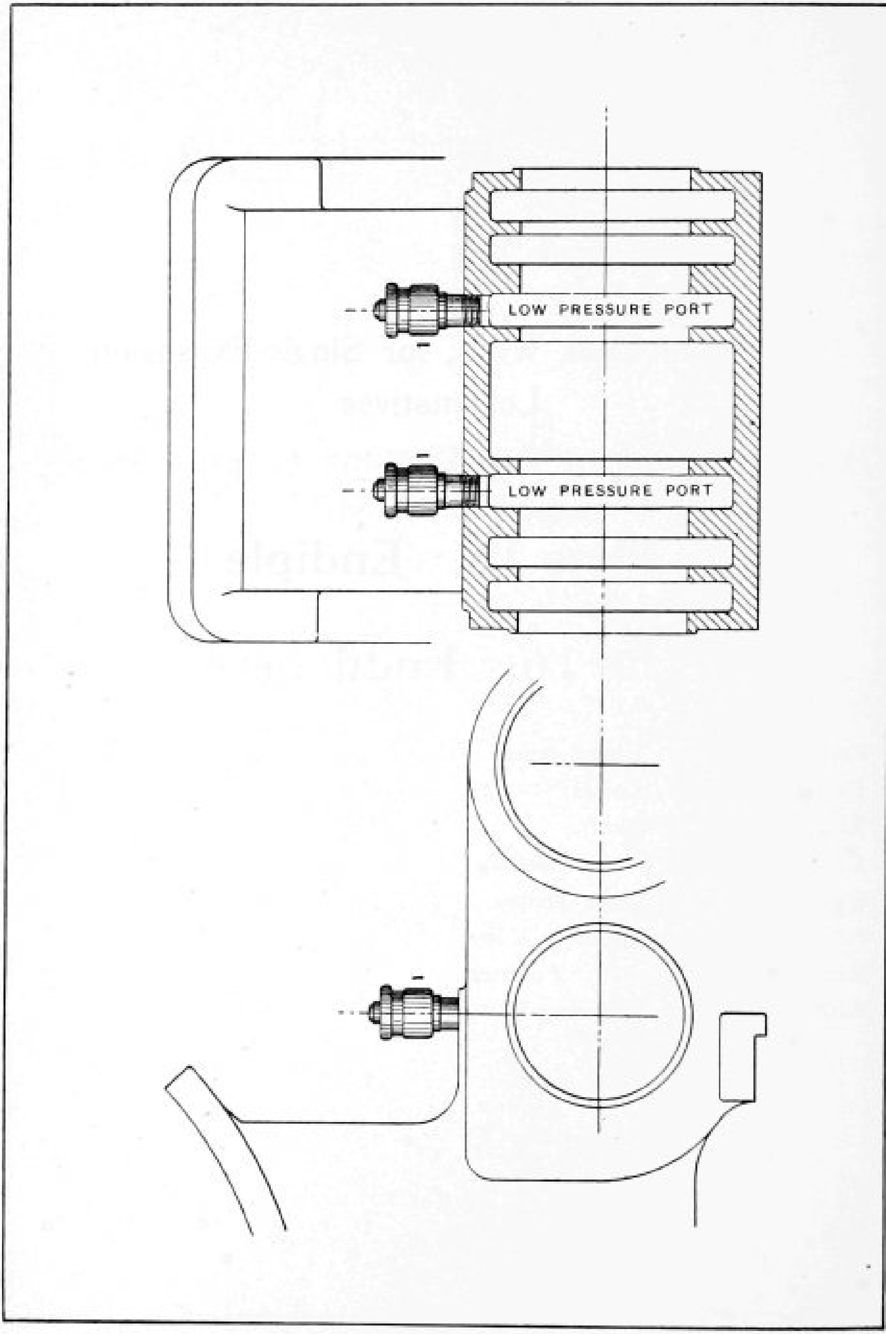


Cylinder Cock Work, for Single-Expansion Locomotives

Plate 15. Endiple

Endireitar . .	1. Upper Arm.
Endive . . .	2. Lower "
Endivia . . .	3. Shaft.
Endknospe .	4. " Bearing.
Endkopf . .	5. Cock Strips.
Endless . .	6. Lever in Cab.
Endlessly . .	7. " Fulcrum.
Endlich . .	8. Coupling Rod Jaws.

Plate 16

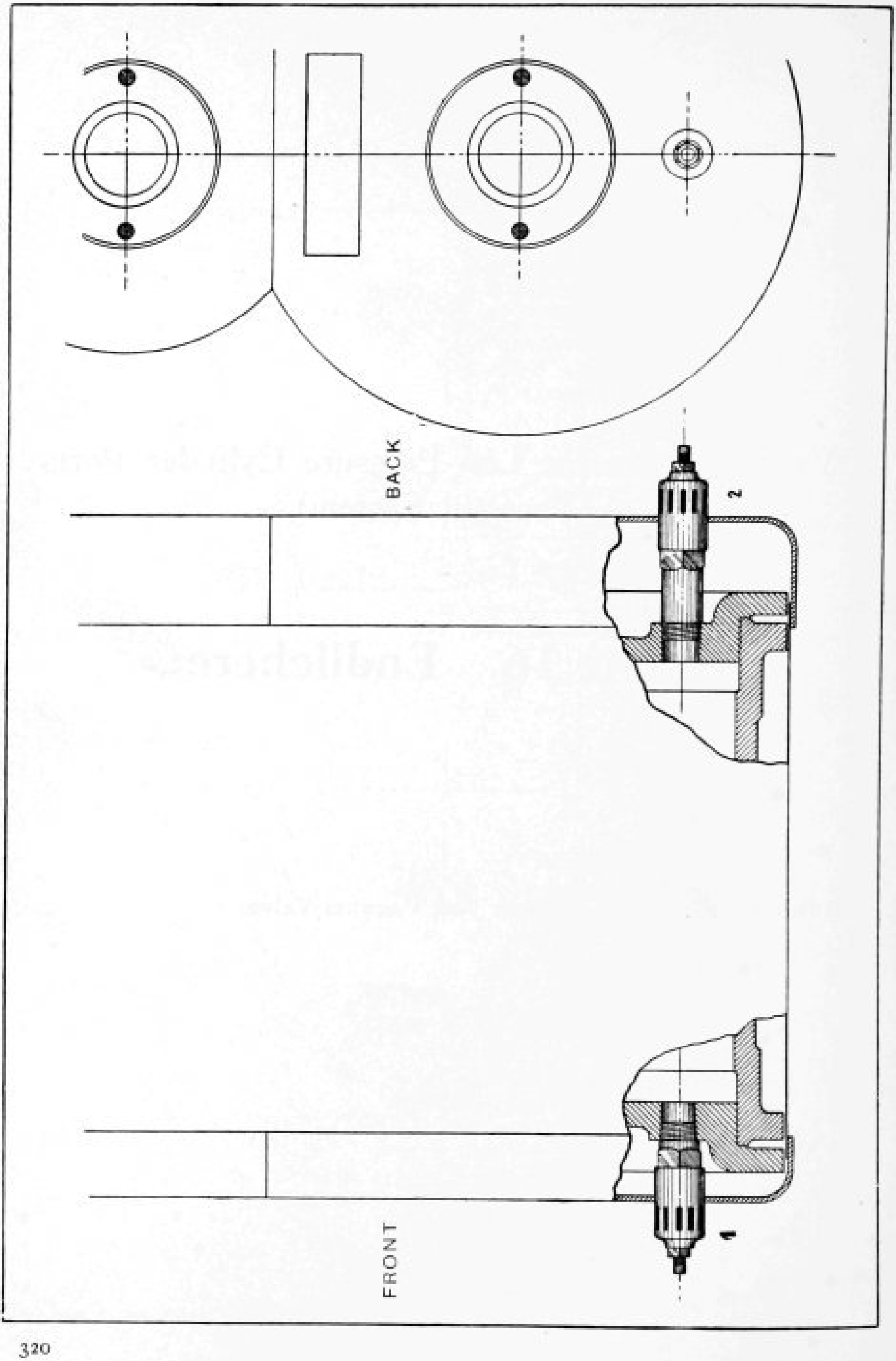


Vacuum Valve for Low-Pressure Cylinder Ports (Vauclain System)

Plate 16. Endlichere

Endlong . 1 Low-Pressure Port Vacuum Valve.

Plate 17



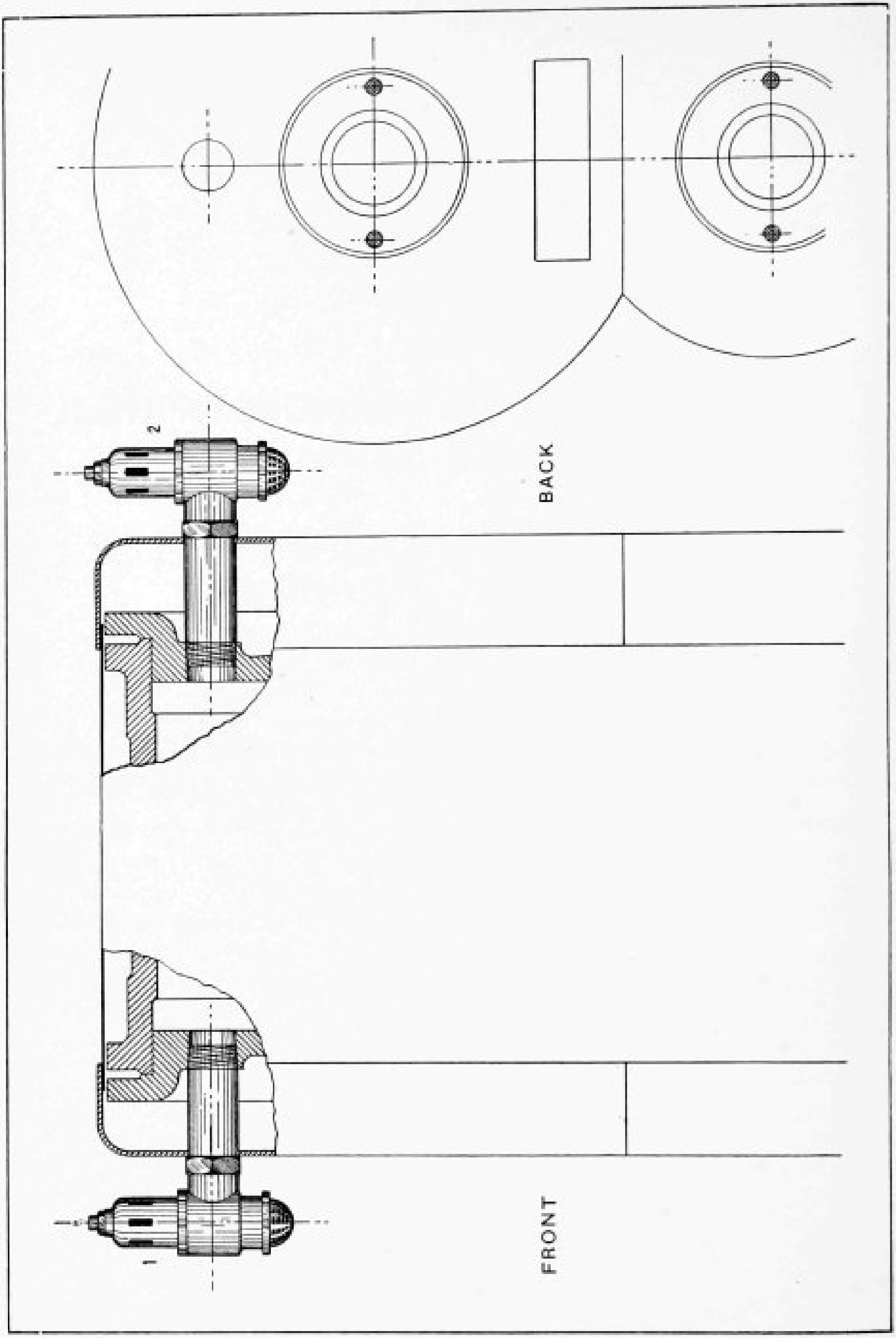
Relief Valve for Low-Pressure Cylinder Heads (Vaulclain System)

Plate 17. Endmost

Endoblado	1.	Low-Pressure Cylinder Head Relief Valve, Front.
Endocardio	2.	" " " " " Back.

In ordering a single valve, state whether it is wanted for front or back cylinder head.

Plate 18



Combined Relief and Vacuum Valve for Low-Pressure Cylinder Heads (Vauclain System)

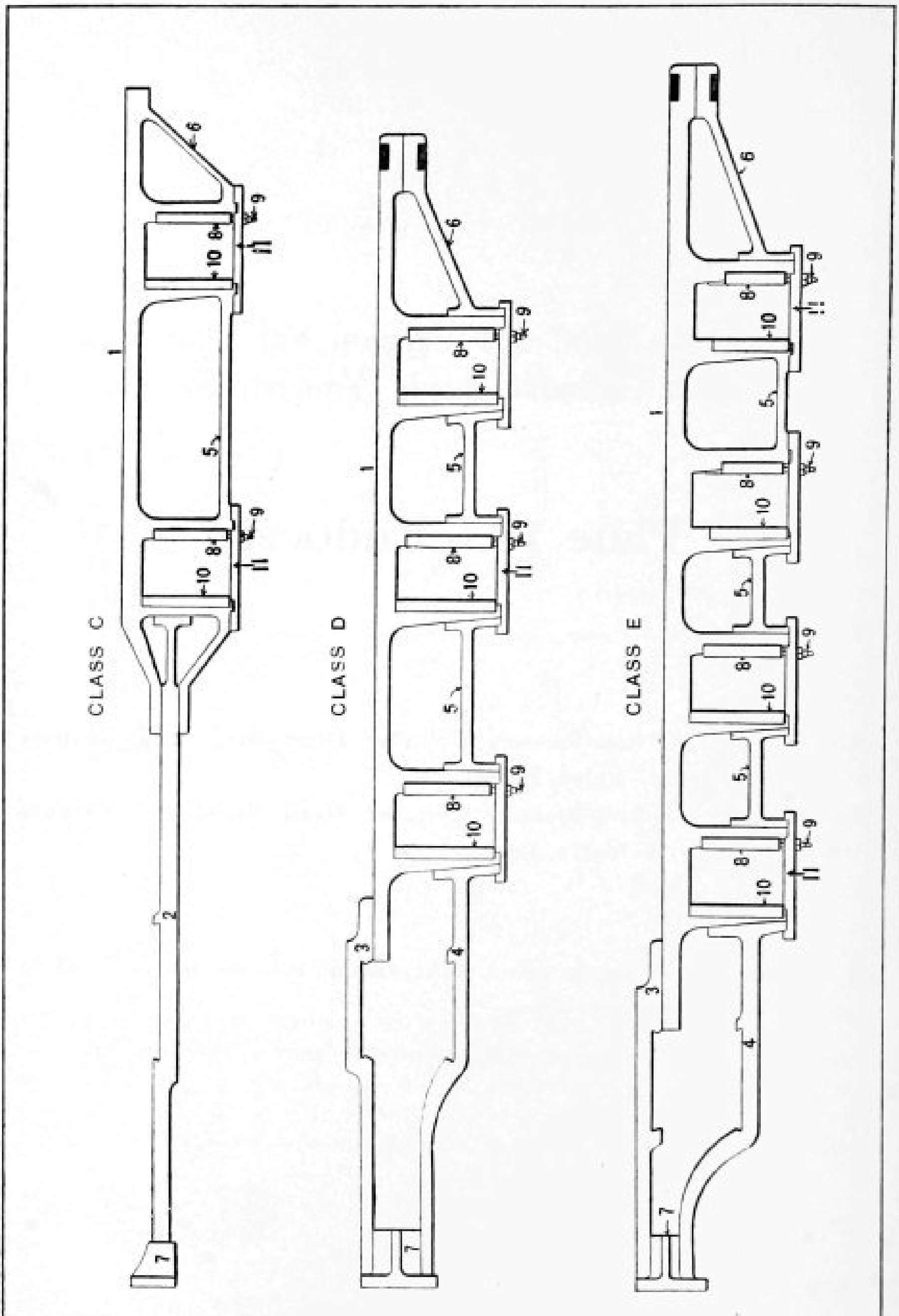
Plate 18. Endocarp

Endocarpei . 1. Low-Pressure Cylinder Head Relief and Vacuum Valve, Front.

Endocarpon . 2. Low-Pressure Cylinder Head Relief and Vacuum Valve, Back.

In ordering a single valve, state whether it is wanted for front or back cylinder head.

Plate 19



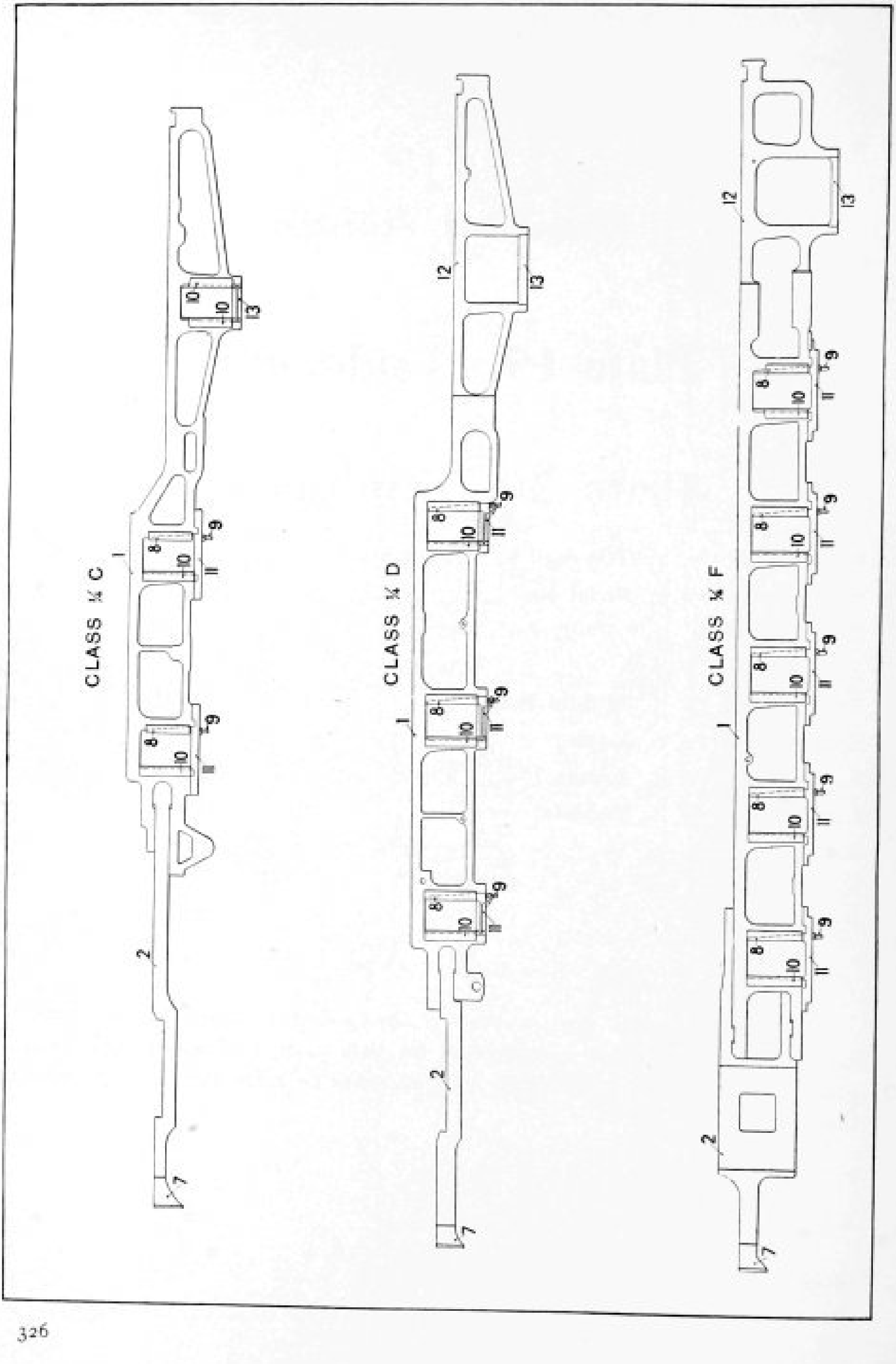
Frames and Pedestals

Plate 19. Endoceras

Endochroa	1.	Top Rail and Pedestals.
Endochromo	2.	Front Rail.
Endocladie	3.	" " Top.
Endocrane	4.	" " Bottom.
Endoctorer	5.	Middle Brace.
Endoctrine	6.	Back "
Endocus	7.	Frame Filling Piece.
Endocyme	8.	Pedestal Wedge.
Endocyst	9.	" " Bolt.
Endodaque	10.	" Gib.
Endomyque	11.	" Cap.

While this plate does not show the pedestal bolted to the frame rail, engines have been constructed on this plan, and when ordering a pedestal to replace, it will only be necessary to refer to its position on the frame.

Plate 20

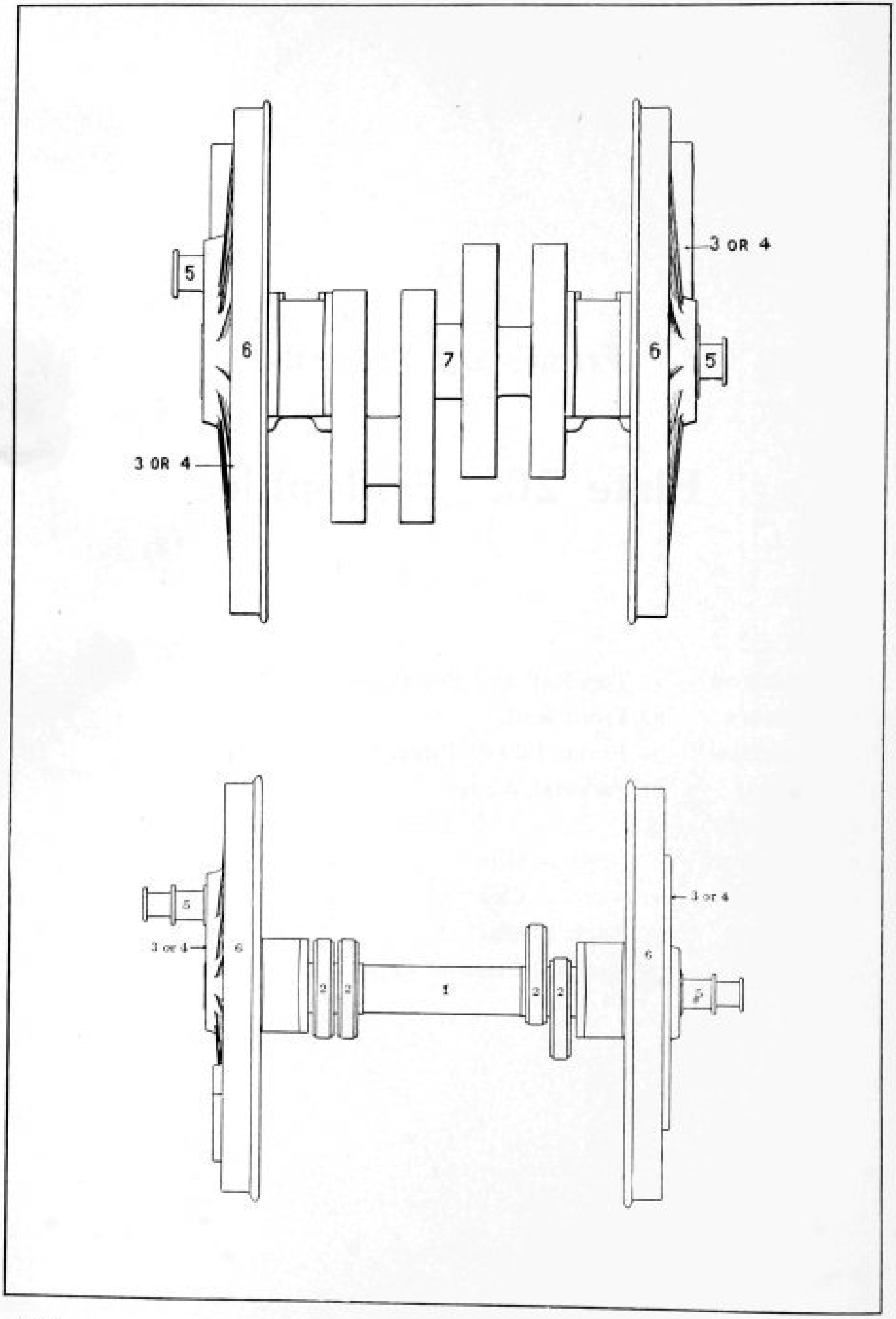


Frames and Pedestals

Plate 20. Endophlee

Endophleon	1.	Top Rail and Pedestals.
Endophore .	2.	Front Rail.
Endophylle	7.	Frame Filling Piece.
Endoplast . .	8.	Pedestal Wedge.
Endopleura	9.	" " Bolt.
Endopodite	10.	" Gib.
Endopogon	11.	" Cap.
Endoptere .	12.	Back Frame.
Endoptilo . .	13.	Trailing Pedestal Cap.

Plate 21



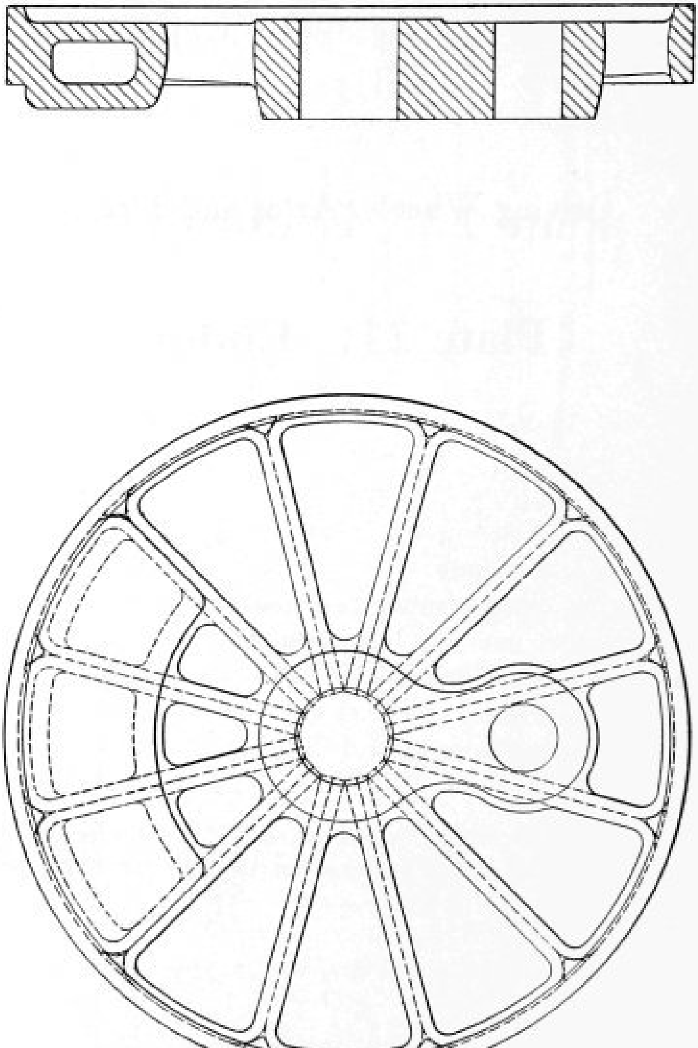
Driving Wheels, Axles and Tires

Plate 21. Endor

Endorhizal	1.	Axle.
Endorhizo	2.	Eccentric.
Endormais	3.	Wheel Center (Cast Iron).
Endormant	4.	" " (Cast Steel).
Endormeur	5.	Wrist Pin.
Endormez	6.	Tire.
Endormi	7.	Crank Axle.

Orders for wheels or their parts, when not in full sets, should indicate particular pair of wheels required, or the pair for which parts are needed.

Plate 22



Wrought Iron Driving Wheel Center (Vauclain Type)

Plate 22. Endormions

Endormiras . . Driving Wheel Center.

For many years cast iron has been used in this country for driving wheel centers. Lately, however, on account of the increased severity of locomotive service, a demand has arisen for stronger wheels, and this has been met by the wrought iron center here described.

The method of manufacture is plainly shown by the drawing. The parts are forged separately under drop and steam hammers and a hydraulic machine, and assembled as shown by the dotted lines. They are then brought to a welding heat and placed between steel dies of suitable dimensions, the upper one being connected to the piston rod of a powerful steam hammer. A few blows then weld the parts together, making a homogeneous, solid forging.

These wheels possess great strength, lightness, and beauty of design. The counterbalance is filled with lead when necessary to bring it to the required weight.

For clearer illustration of method of manufacture, (See Plate 23 Figure 1).

Plate 23

fig. 1

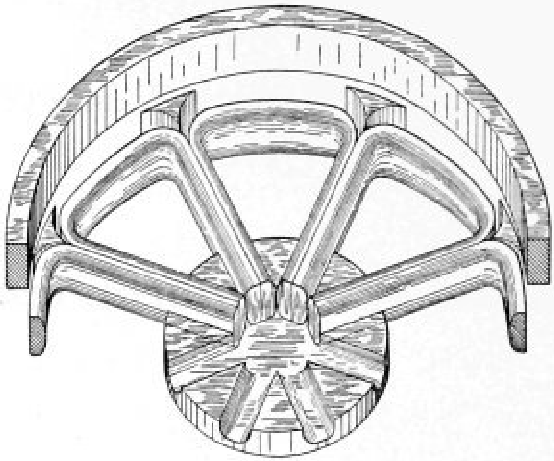
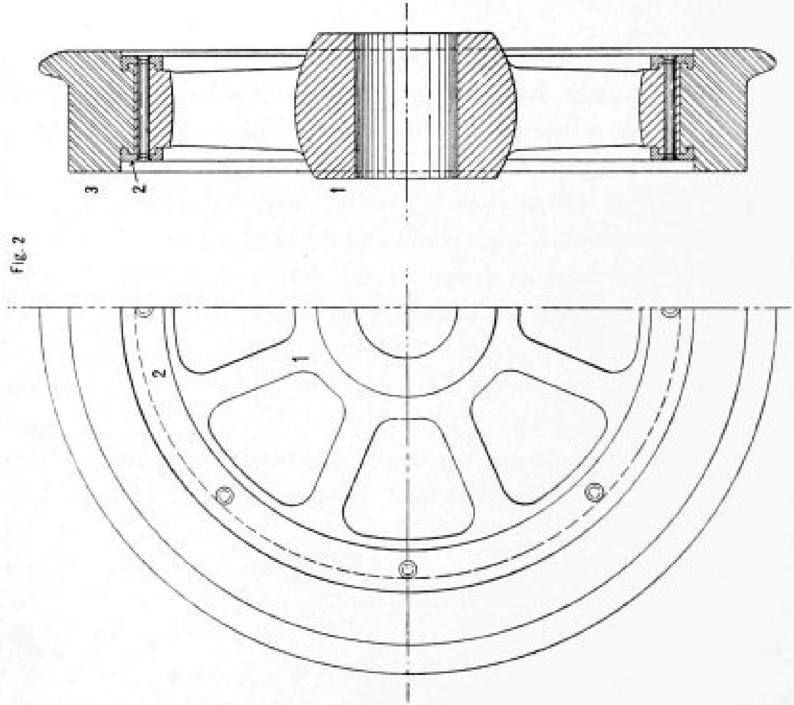


fig. 2



Wrought Iron Engine Truck and Tender Wheel (Vauclain Type)

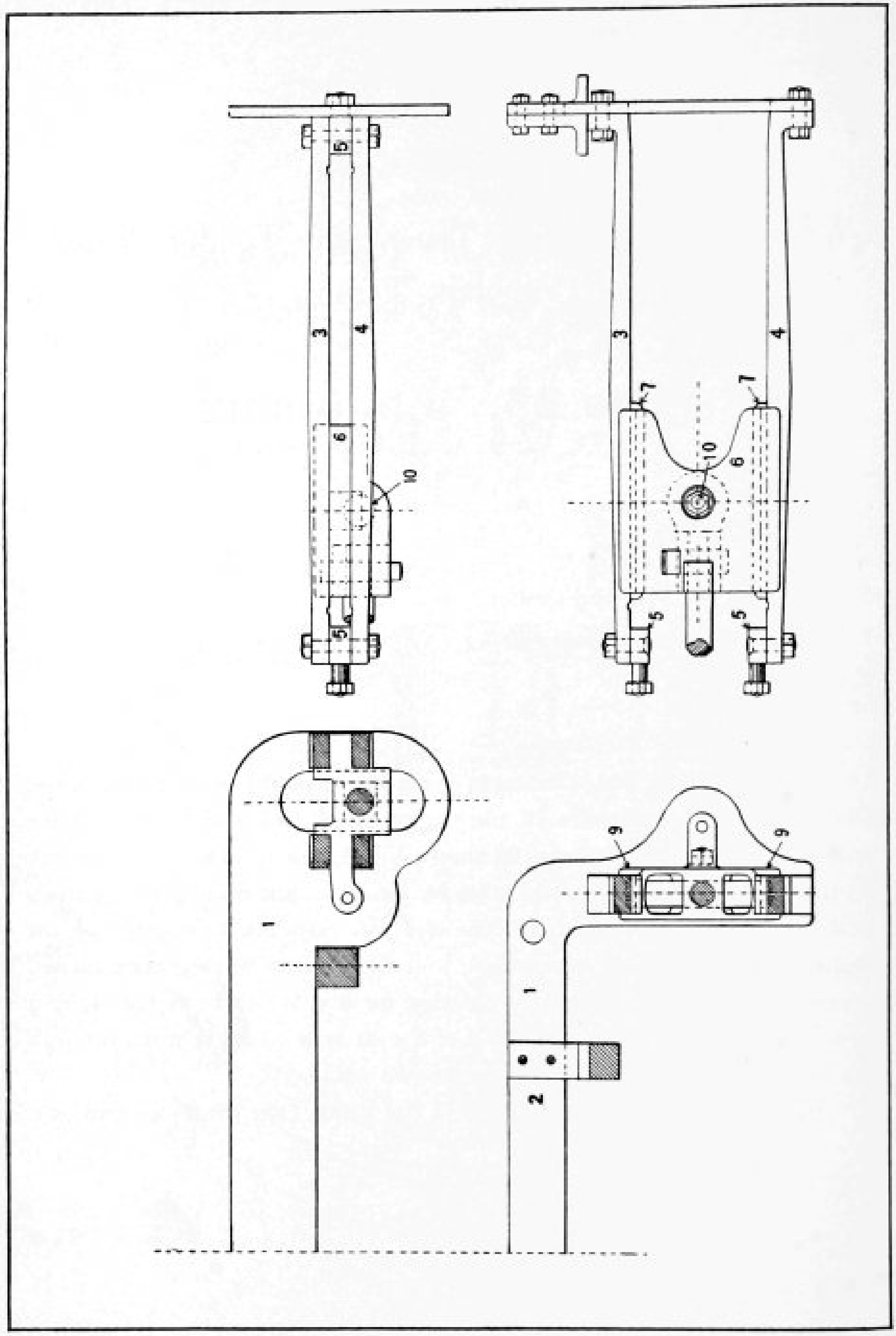
Plate 23. Endorsing

Endosados . 1. Wheel Center.
Endosarc . 2. Retaining Ring.
Endosareis . 3. Tire.

The conditions which brought forth the wrought iron driving wheel have caused the existence of the engine truck and tender wheel of the same type. The construction is shown by Figure 1. The tire is shrunk on the center and is further secured by two wrought iron retaining rings held by rivets (see Figure 2). The steel tire lasts much longer than the chilled tread of a cast iron wheel, and when, after having been turned several times, it is finally worn too thin for use, it can be replaced by a new one; whereas, when the tread of a cast iron wheel is worn through the chill, the whole wheel must be thrown away.

For the position of these wheels in the truck, (see Plates 42 and 72).

Plate 24



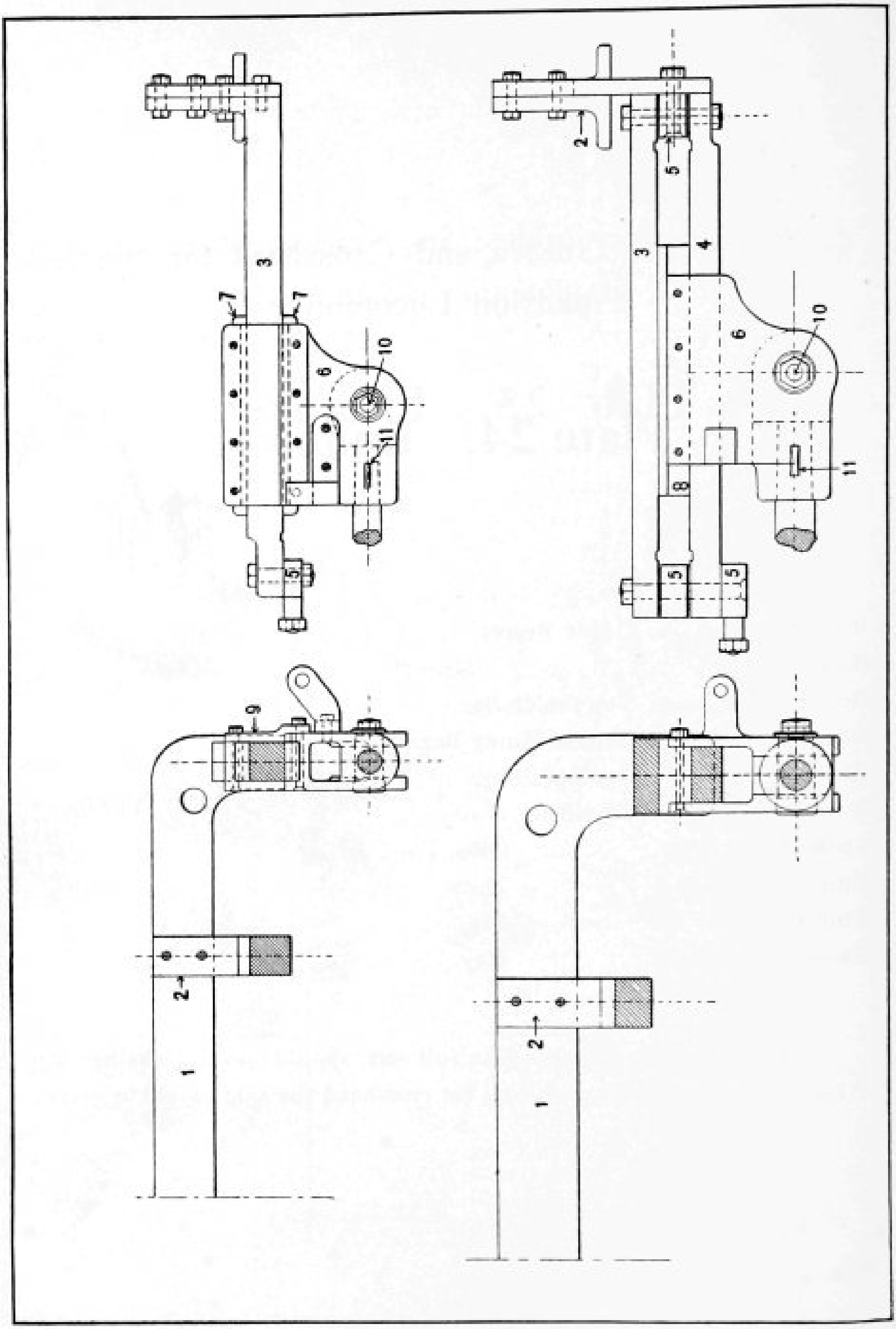
Guide Bearer, Guides, and Crosshead for Single-Expansion Locomotives

Plate 24. Endosas

Endoscopie	1.	Guide Bearer.
Endoselado	2.	" " Knee.
Endoselar	3.	Top Guide Bar.
Endosimon	4.	Bottom Guide Bar.
Endosiphie	5.	Guide Fillings.
Endosmic	6.	Crosshead.
Endosmose	7.	" Gibs.
Endosmosis	9.	" Plate.
Endosmotic	10.	" Pin.
Endosperma	11.	" Key.

Orders for guides, when not in full sets, should specify whether top or bottom guides are wanted, and for crosshead the side should be given.

Plate 25



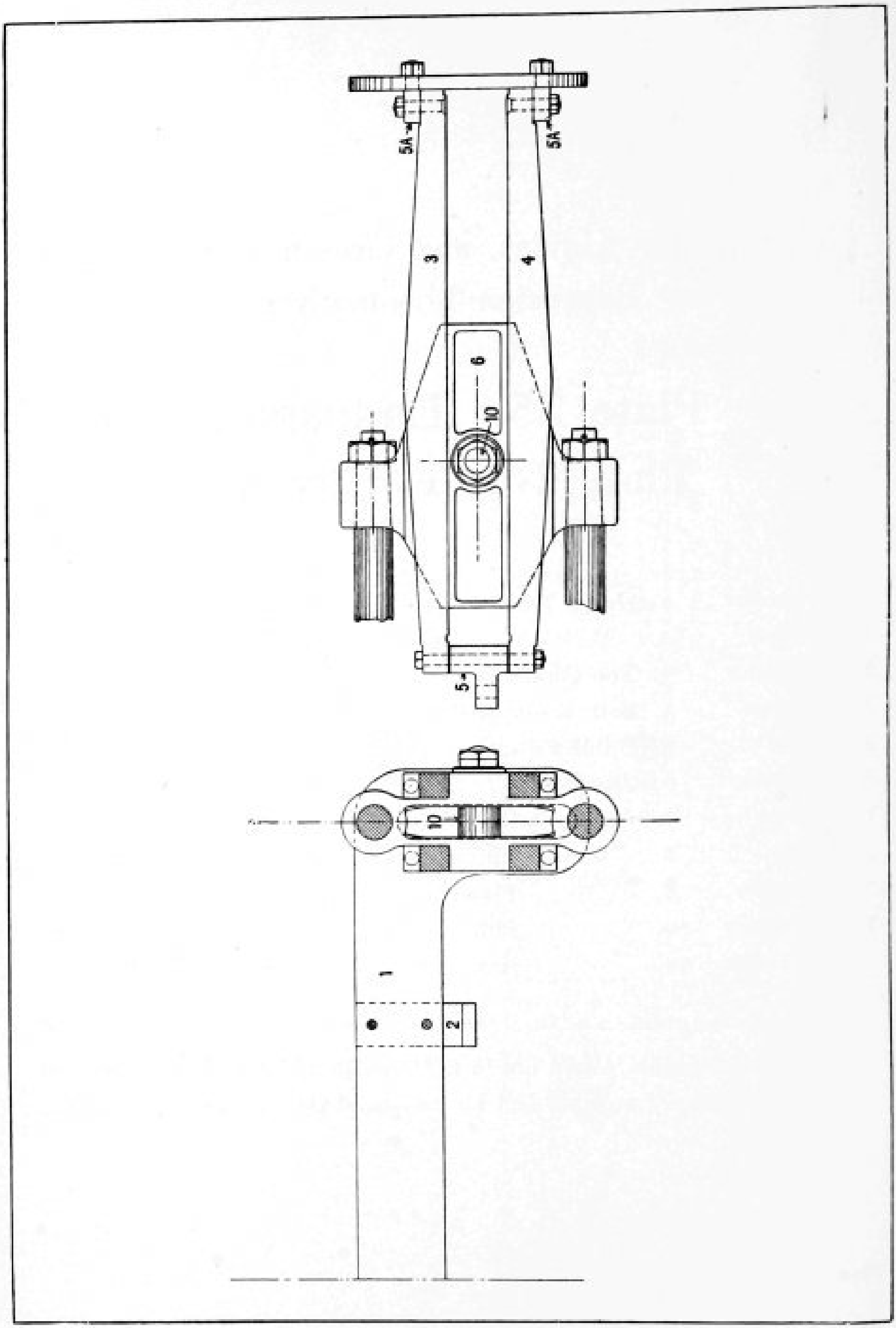
Guide Bearer, Guides, and Crosshead for Single-Expansion Locomotives

Plate 25. Endospore

Endossador	1.	Guide Bearer.
Endossed	2.	" " Knee.
Endosseras	3.	Top Guide Bar.
Endossiez	4.	Bottom Guide Bar.
Endosso	5.	Guide Fillings.
Endostomo	6.	Crosshead.
Endotheque	7.	" Gibs.
Endotric	8.	" Filling Piece.
Endotropis	9.	" Plate.
Endoudecer	10.	" Pin.
Endouzaine	11.	" Key.

Orders for guides, when not in full sets, should specify whether top or bottom guides are wanted, and for crosshead the side should be given.

Plate 26



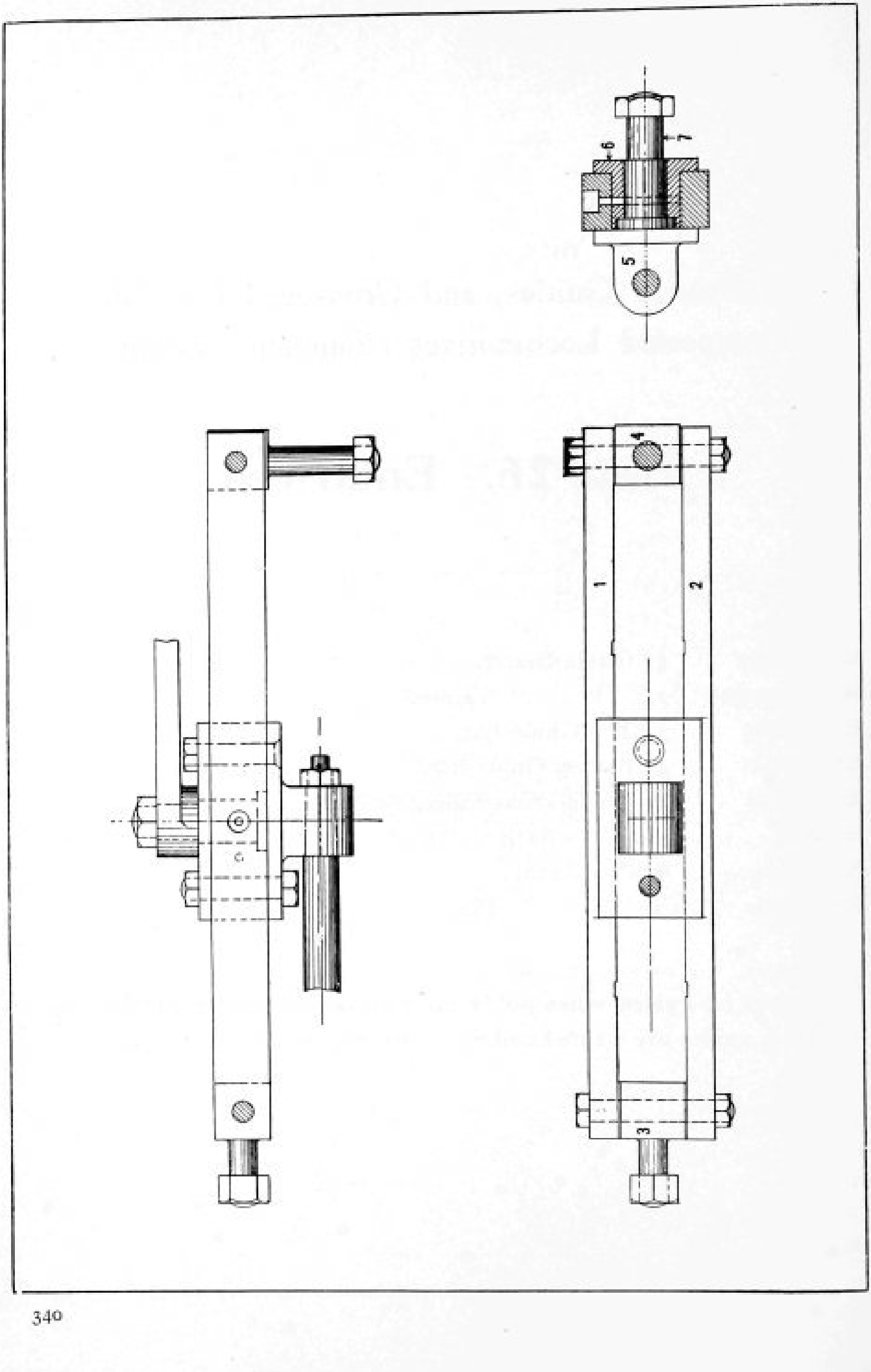
Guide Bearer, Guides, and Crosshead for Baldwin Compound Locomotives (Vauclain System)

Plate 26. Endowed

Endowing . .	1.	Guide Bearer.
Endowment	2.	" " Knee.
Endplatte	3.	Top Guide Bar.
Endpunkt	4.	Bottom Guide Bar.
Endracco	5.	Guide Front Filling or Block.
Endrao . . .	5A.	" Back " " "
Endreim .	6.	Crosshead.
Endressie . .	10.	" Pin.

Orders for guides, when not in full sets, should specify whether top or bottom guides are wanted and for crosshead the side should be given.

Plate 27



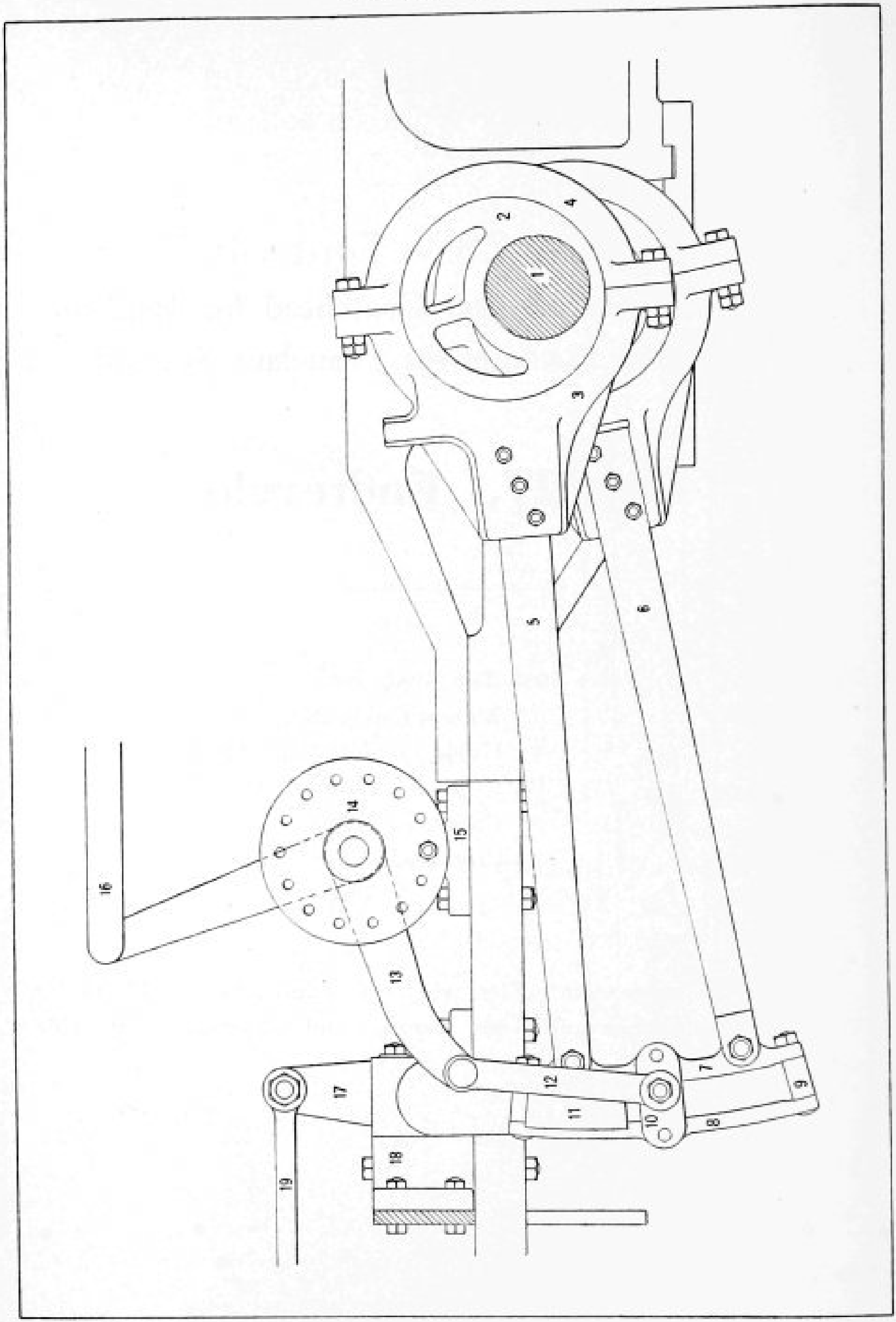
Valve Stem Guides and Crosshead for Baldwin Compound Locomotives (Vauclain System)

Plate 27. Endrevelo

Endriago	1.	Valve Stem Top Guide Bar.
Endrinales	2.	" " Bottom Guide Bar.
Endrinas	3.	" " Guide Front Filling or Block.
Endrispe	4.	" " " Back " " "
Endrivet	5.	" " Crosshead Lug.
Endroguant	6.	" " Crosshead.
Endroguet	7.	" " " Pin.

Orders for valve stem guides, when not in full sets, should specify whether top or bottom guides are wanted; and for crosshead the side should be given.

Plate 28



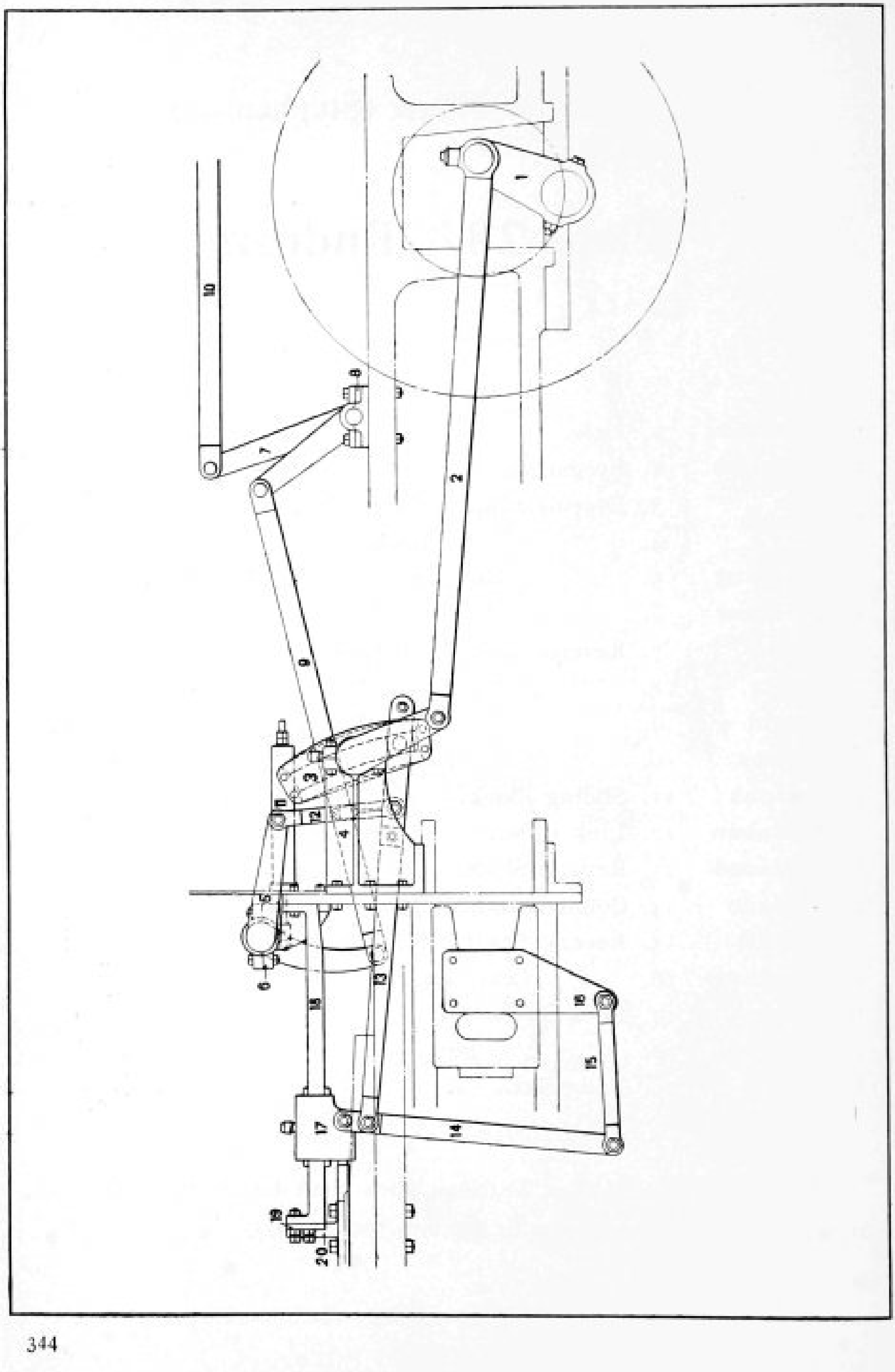
Valve Motion Work (Stephenson)

Plate 28. Endroit

Endromide	1.	Axle.
Endromidis	2.	Eccentrics.
Endrudge	{ 3.	Eccentric Strap, Front Half.
	{ 4.	" " Back "
Endrudging	5.	" Rod, Inside (Forward Motion).
Endschloss	6.	" " Outside (Back ").
Endsilbe . .	7.	Reverse Link, Back Half.
Endspitz	8.	" " Front "
Endstuhl	9.	" " Filling Piece.
Enduisiez . .	10.	" " Saddle.
Enduisons . .	11.	Sliding Block.
Endulzaban .	12.	Link Lifter.
Endulzadas	13.	Reverse Shaft.
Endulzado	14.	Counterbalance Spring.
Endulzais . .	15.	Reverse Shaft Bearing.
Endulzemos	16.	" Lever Rod.
Endulzo .	17.	Rock Shaft.
Endurable . .	18.	" " Box.
Endurais	19.	Valve Rod.

Orders for reverse shaft bearings, rock shaft boxes, and link work, when not in sets, should specify the side required for.

Plate 29



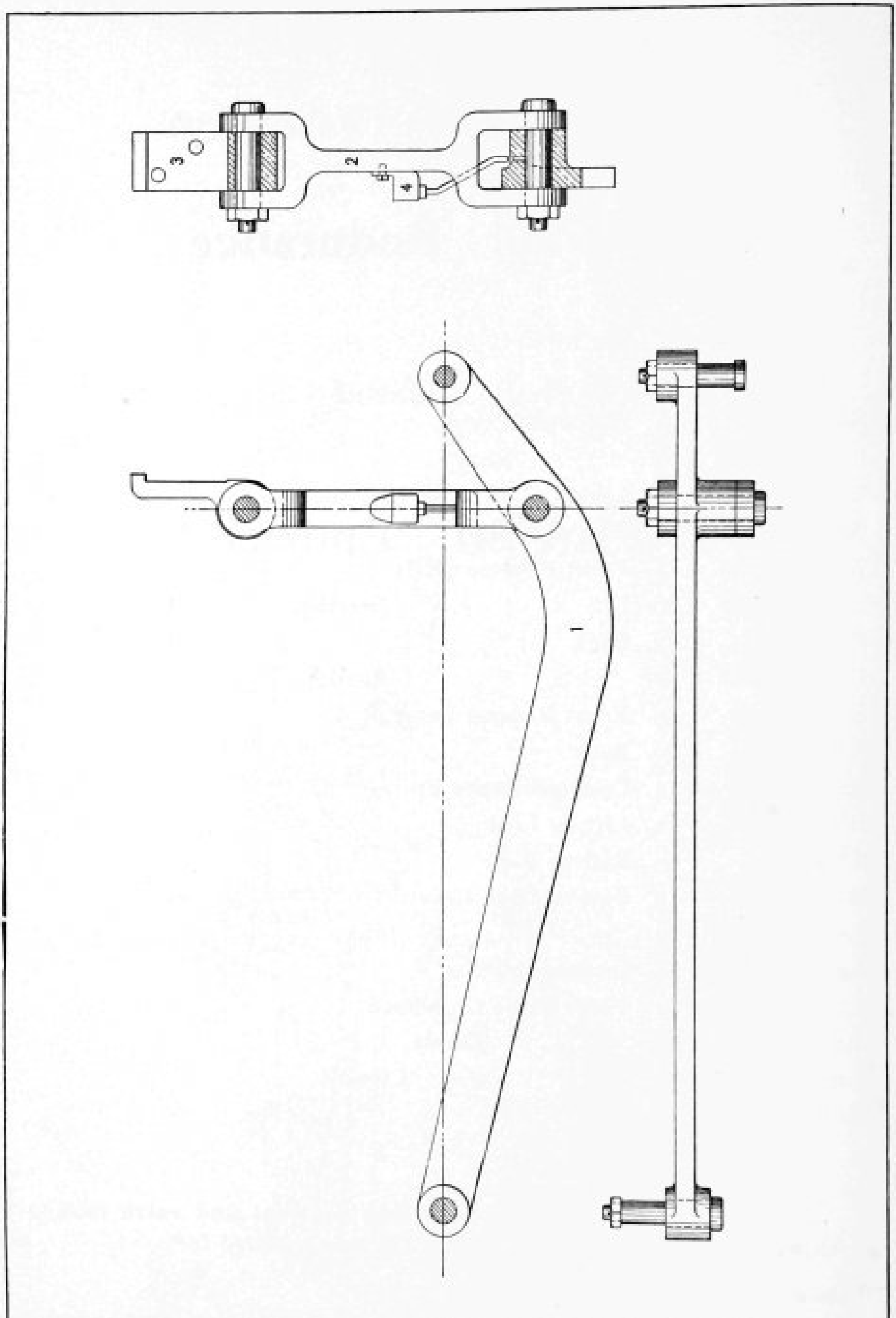
Valve Motion Work (Walschaerts)

Plate 29. Endurance

Endurant	1.	Eccentric Crank.
Endurcimes	2.	" Rod.
Endurciras	3.	Link.
Endurecias	4.	" Bearing.
Endurecido	5.	Front Reverse Shaft.
Endurentar	6.	" " " Bearing.
Endurer	7.	Back " "
Endurezcas	8.	" " " Bearing.
Endurezco	9.	Front Reverse Lever Rod.
Enduring	10.	Back " " "
Enduringly	11.	Counterbalance Spring.
Endurons	12.	Lifting Link.
Endways	13.	Radius Rod.
Endwise	14.	Combination Lever.
Endyalite	15.	" " Link.
Endymion	16.	Crosshead Plate.
Endymionem	17.	Valve Yoke Crosshead.
Endymionis	18.	" " Guide.
Endytis	19.	" " " Crosstie.
Endzapfen	20.	" " " " Knee.

Orders for reverse shaft bearings, link bearings and valve motion work, when not in sets, should specify the side required for.

Plate 30



Rock Shaft Rod and Hanger

Plate 30. Endziel

Endzweck .	1.	Rock Shaft Rod.
Eneacordio	2.	" " " Hanger.
Eneadas .	3.	" " " " Bearing.
Eneaginias	4.	" " " Oil Cup.

Orders for rock shaft rods, hangers, and bearings, when not in sets should specify the side required for.

Plate 31

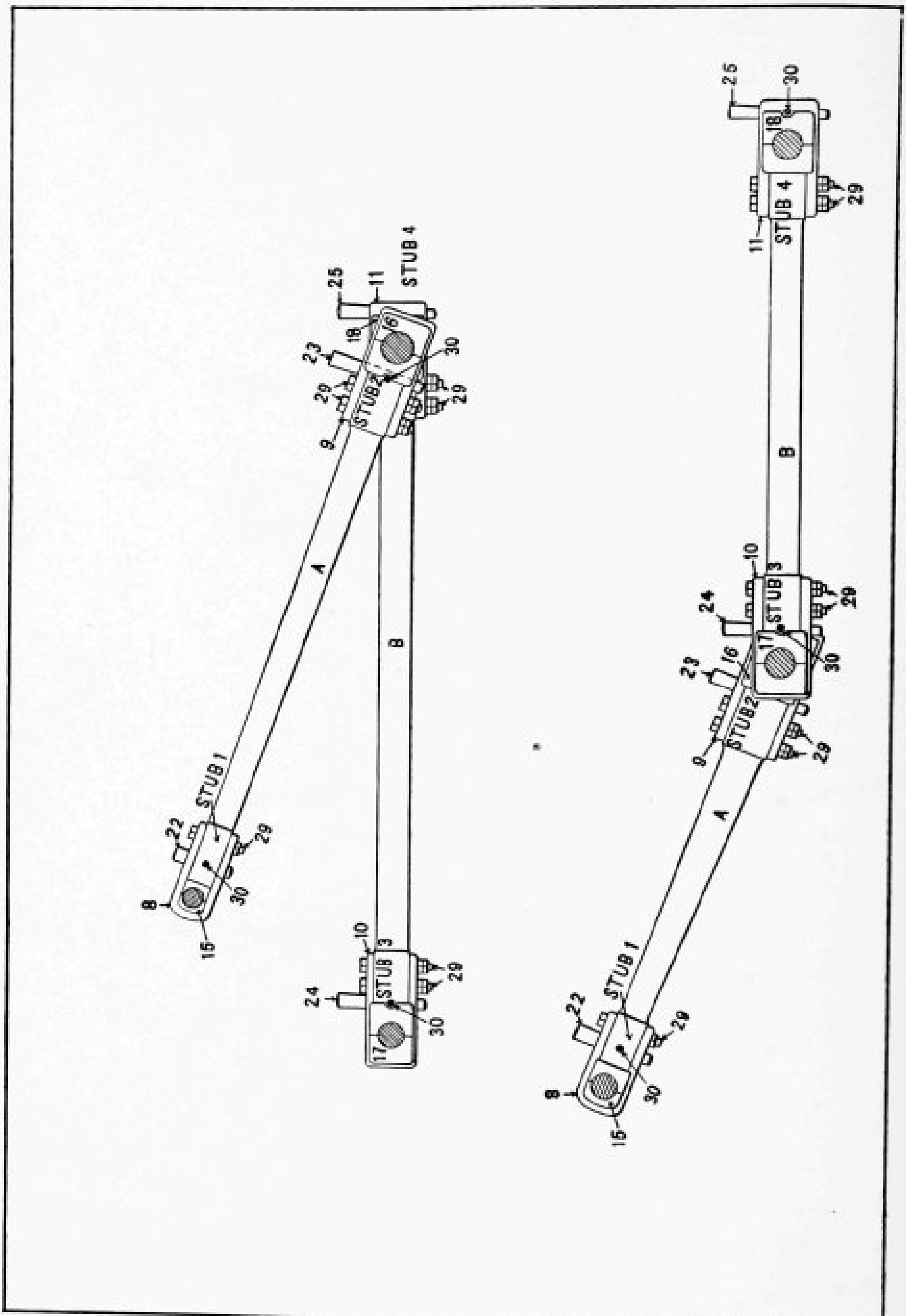
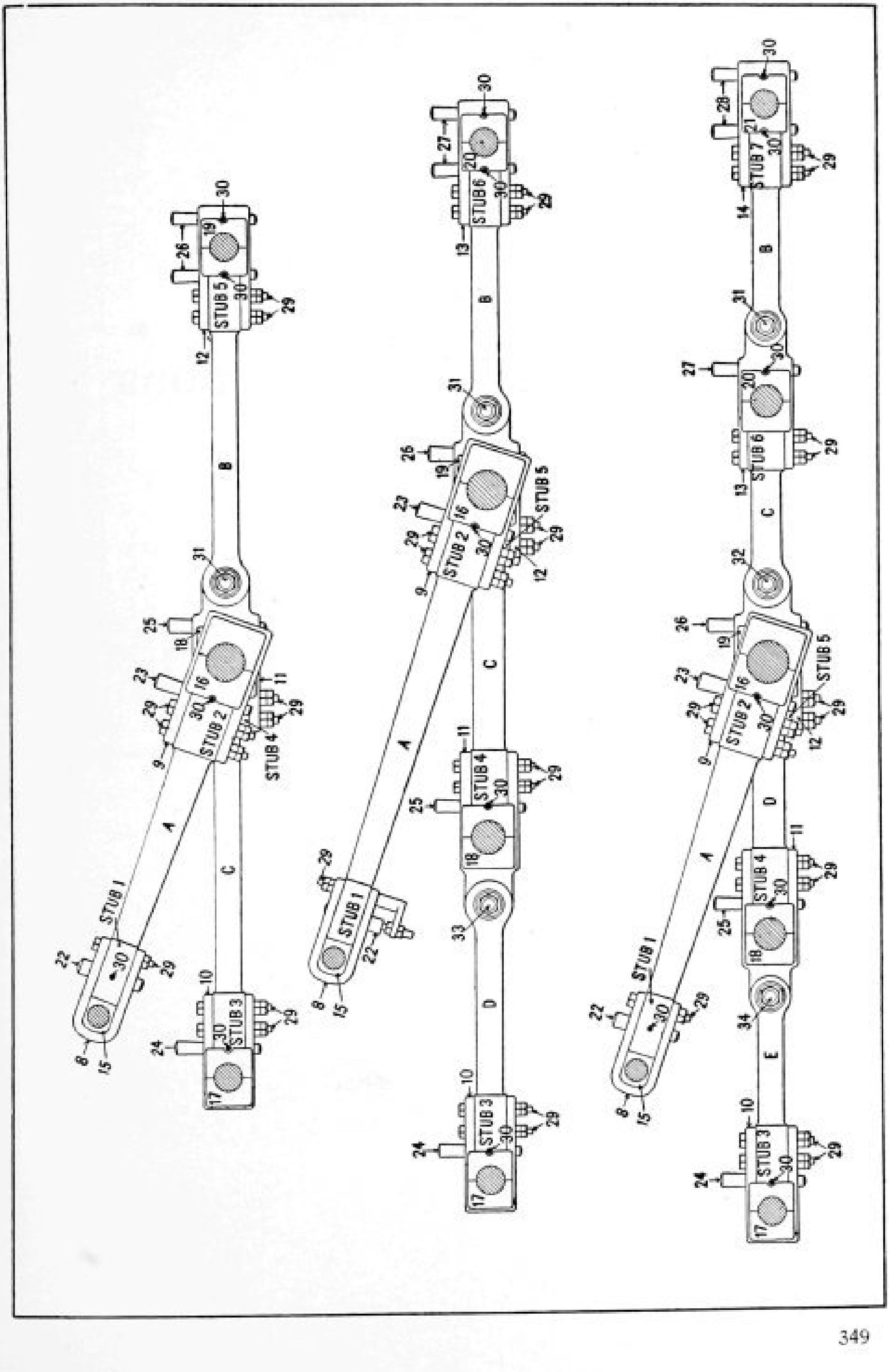


Plate 32



Rods, Straps and Brasses

Plates 31 and 32. Eneagona

Eneagonos	A.	Main Rod.
Eneandria	B.	Back Parallel or Side Rod.
Enebral	C.	Second " " "
Enebrinas	D.	Third " " "
Enebros	E.	Fourth " " "

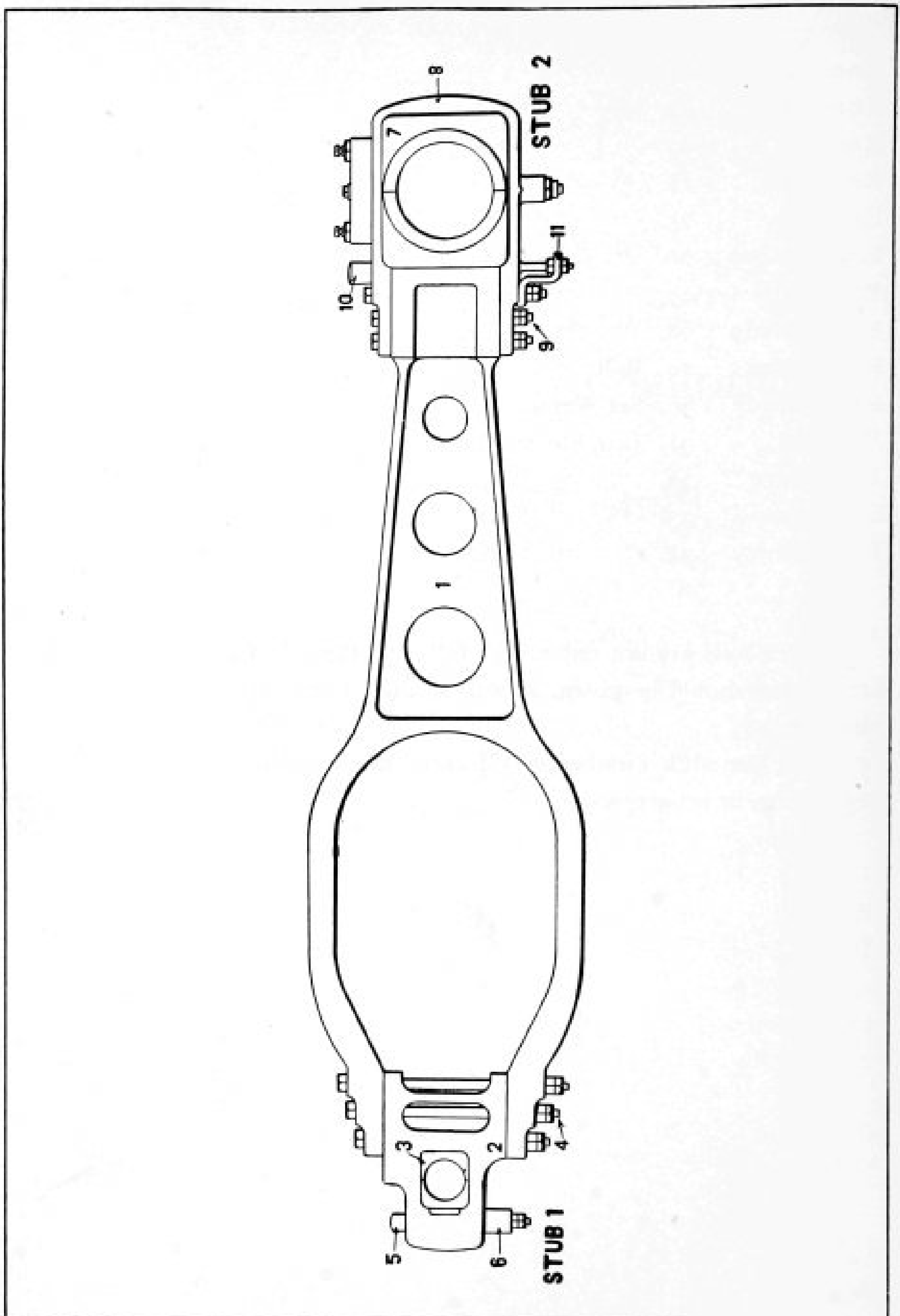
Enecabamus	8.	Strap of Stub 1.
Enecandos	9.	" " " 2.
Enecantium	10.	" " " 3.
Enecaremus	11.	" " " 4.
Enecate	12.	" " " 5.
Enecating	13.	" " " 6.
Enecatrici	14.	" " " 7.
Enecatrix	15.	Brass " " 1.
Enecia	16.	" " " 2.
Enecturam	17.	" " " 3.
Enecturi	18.	" " " 4.
Enecturos	19.	" " " 5.

Enecuero	20.	Brass of Stub 6.
Enecuerunt	21.	" " " 7.
Enedreyte	22.	Key " " 1.
Eneida	23.	" " " 2.
Eneldos	24.	" " " 3.
Eneleo	25.	" " " 4.
Enematibus	26.	" " " 5.
Enemion	27.	" " " 6.
Enemistado	28.	" " " 7.
Enemistas	29.	Bolt.
Enemitique	30.	Set Screw.
Enenkel	31.	Jaw Pin for B.
Eneoptere	32.	" " " C.
Eneorema	33.	" " " D.
Energema	34.	" " " E.

When rods are not ordered in full sets, the side for which the parts are wanted should be given, as well as the letter of the rod and the stub number.

Give the stub number in all cases when ordering straps, brasses, keys, bolts, or set screws.

Plate 33

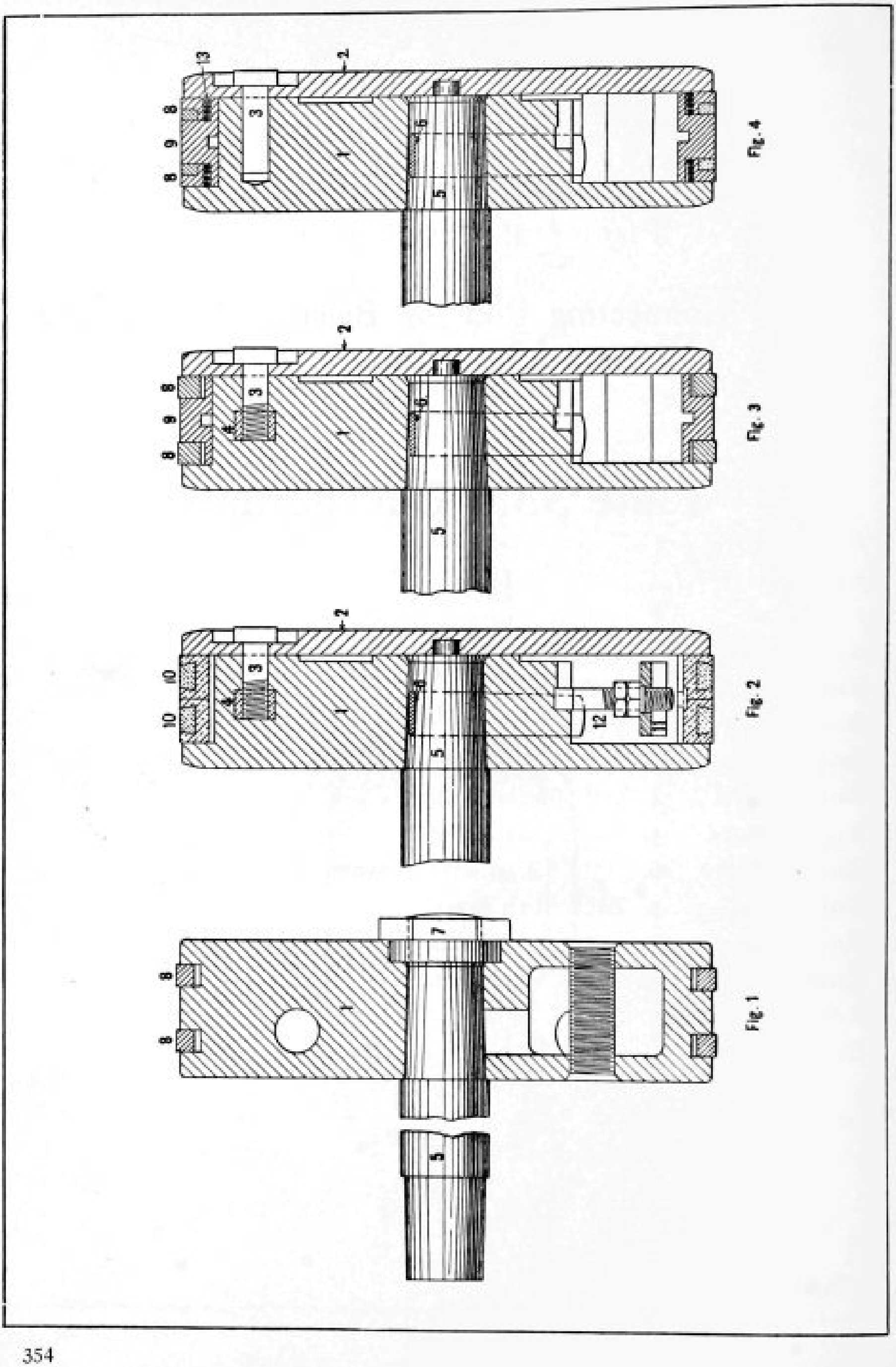


Inside Connecting Rod for Balanced Compound Locomotives

Plate 33. Energemati

Energetico	1.	Rod Body.
Energical	2.	Front Stub.
Energiche	3.	" " Brass.
Energizar	4.	" " Bolts.
Energizing	5.	" " Key.
Energumeno	6.	" " " Washer.
Energy	7.	Back Stub Brass.
Enero	8.	" " Strap.
Enervabais	9.	" " Bolts.
Enervabunt	10.	" " Key
Enervacao	11.	" " " Holder.

Plate 34



Pistons and Packing Rings

Plate 34. Enervador

Enervais	1.	Piston Head.	
Enervamos	2.	"	Follower.
Enervant	3.	"	" Bolts.
Enervaron	4.	"	" Bolt Nuts.
Enervasses	5.	"	Rod.
Enervative	6.	"	" Key.
Enervaturo	7.	"	" Nut.
Enervavero	8.	"	Spring Rings (Cast Iron).
Enervement	9.	"	T Ring (Cast Iron).
Enerverais	10.	"	Brass and Composition Rings.
Enerveront	11.	"	Spring.
Enervibus	12.	"	" Studs and Nuts.
Enerviez	13.	"	Wire Springs.

This plate indicates four kinds of packing generally used, and customers can readily refer to the particular pieces by the number of the piece, as well as the figure number.

Plate 35

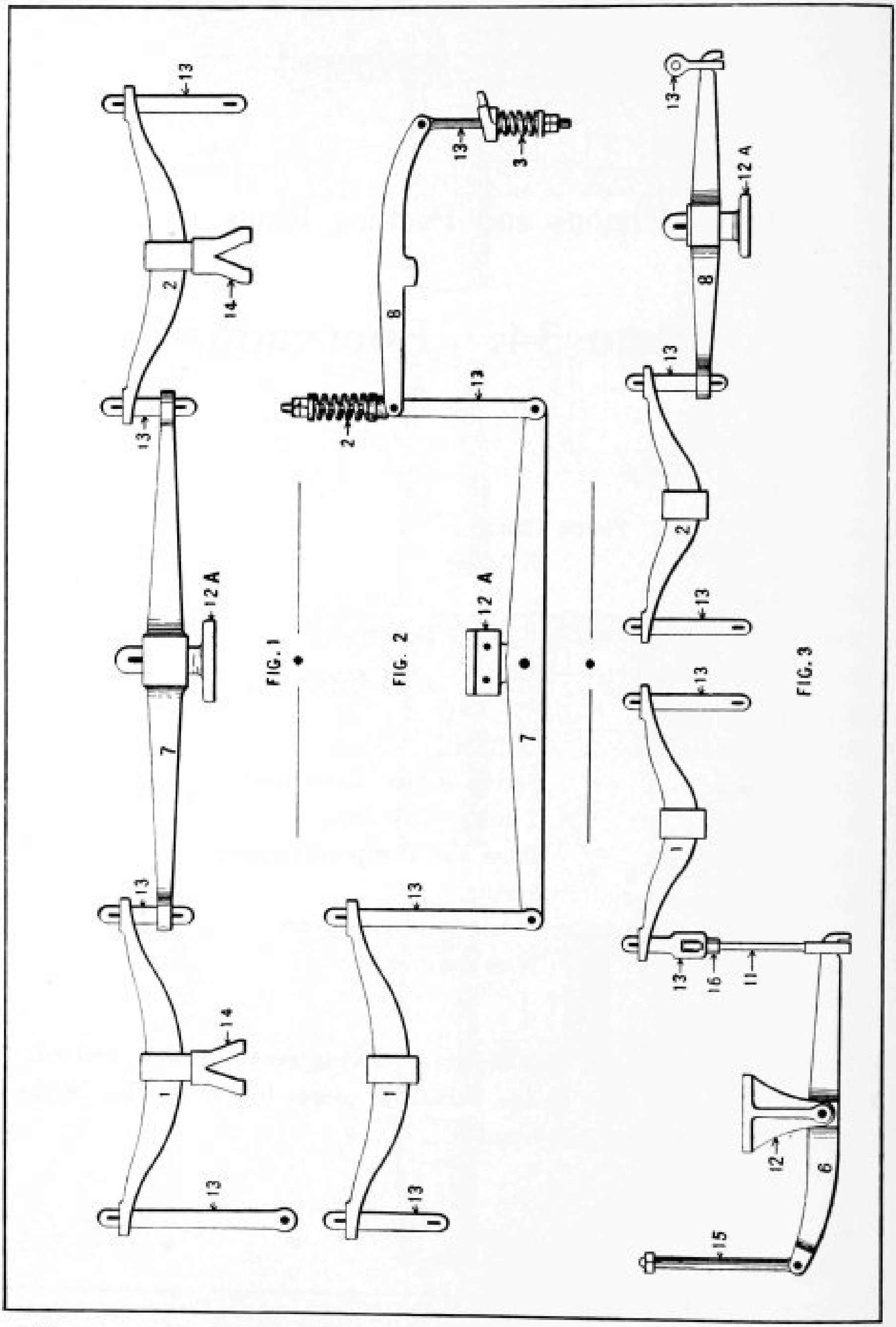


Plate 36

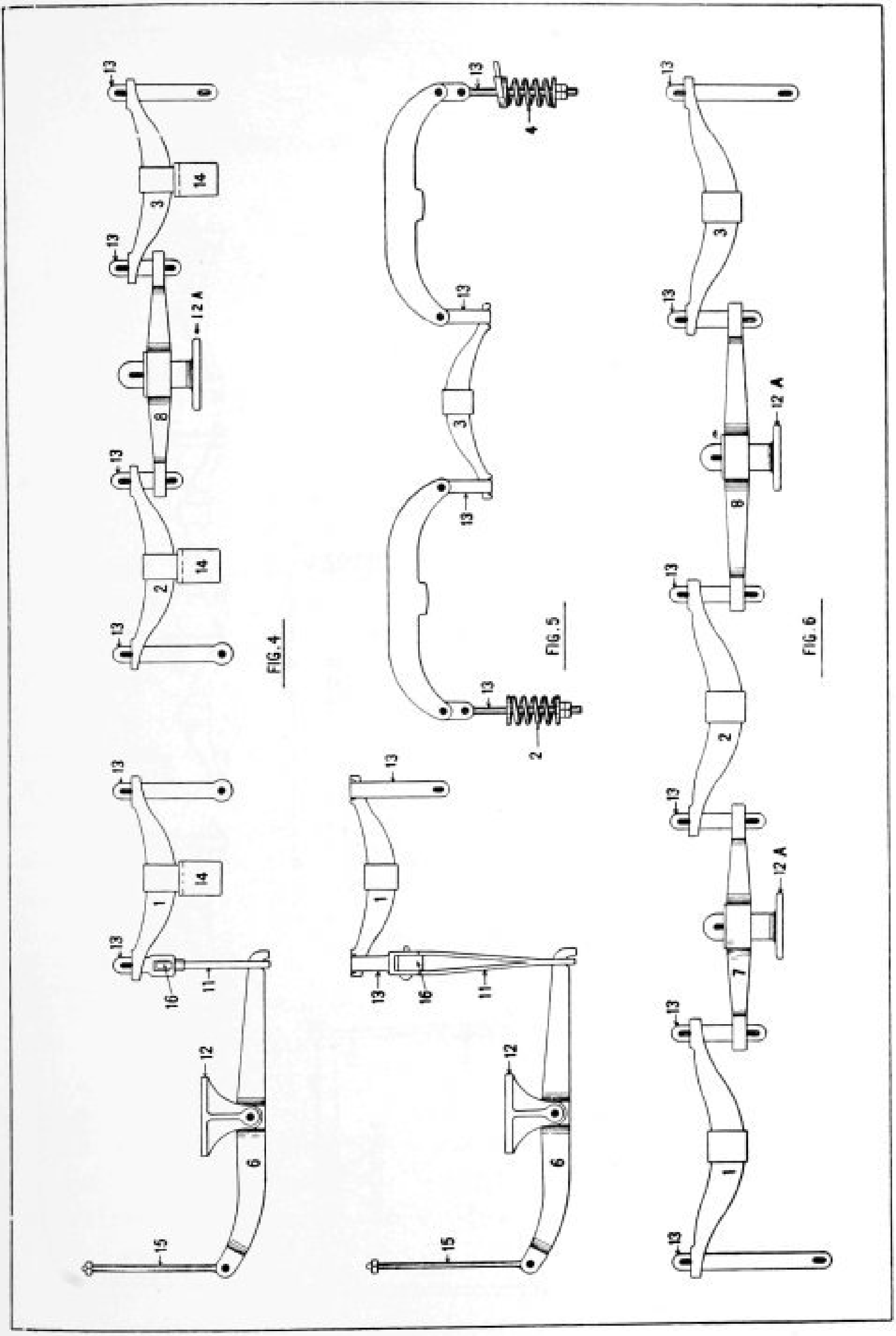
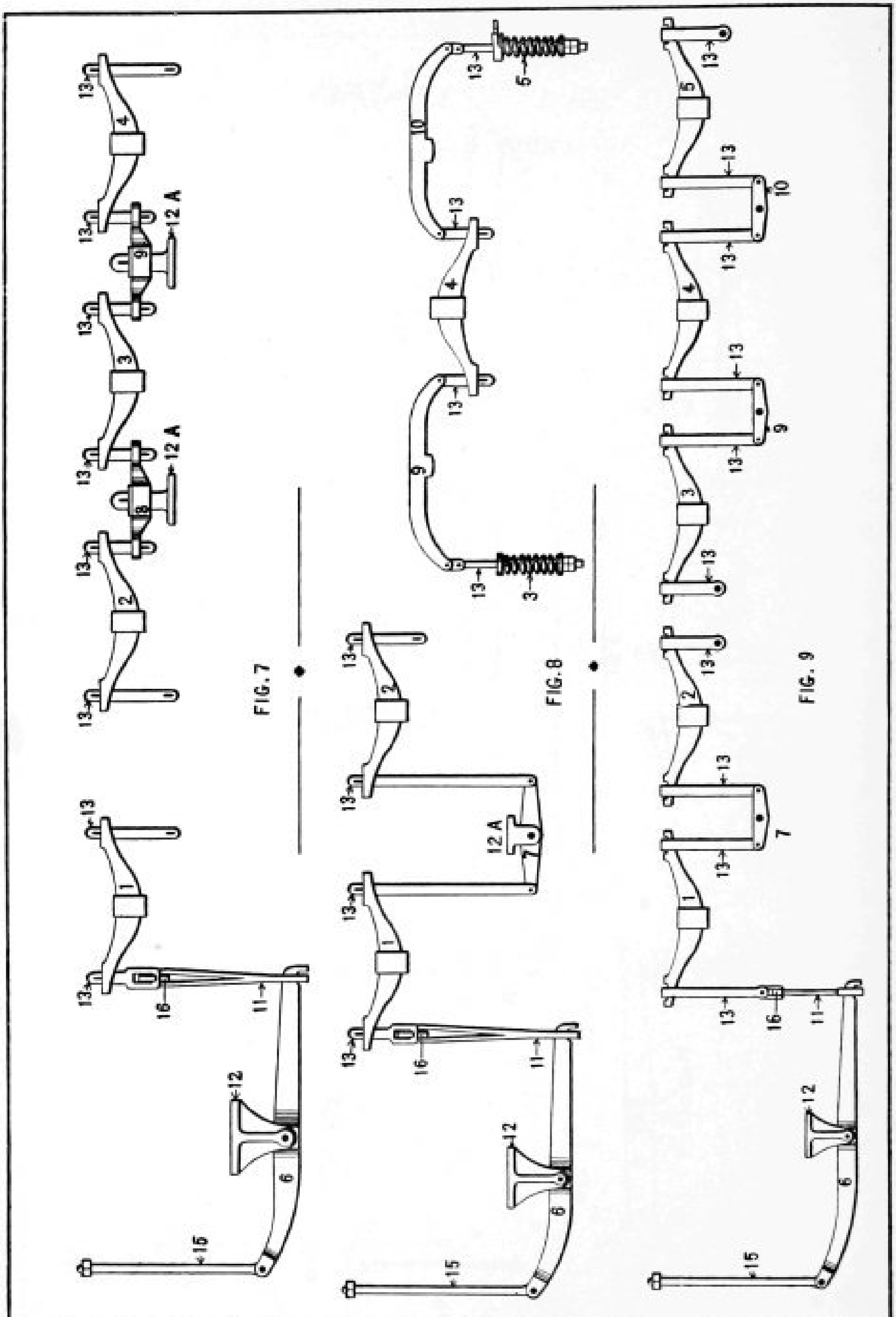


Plate 37



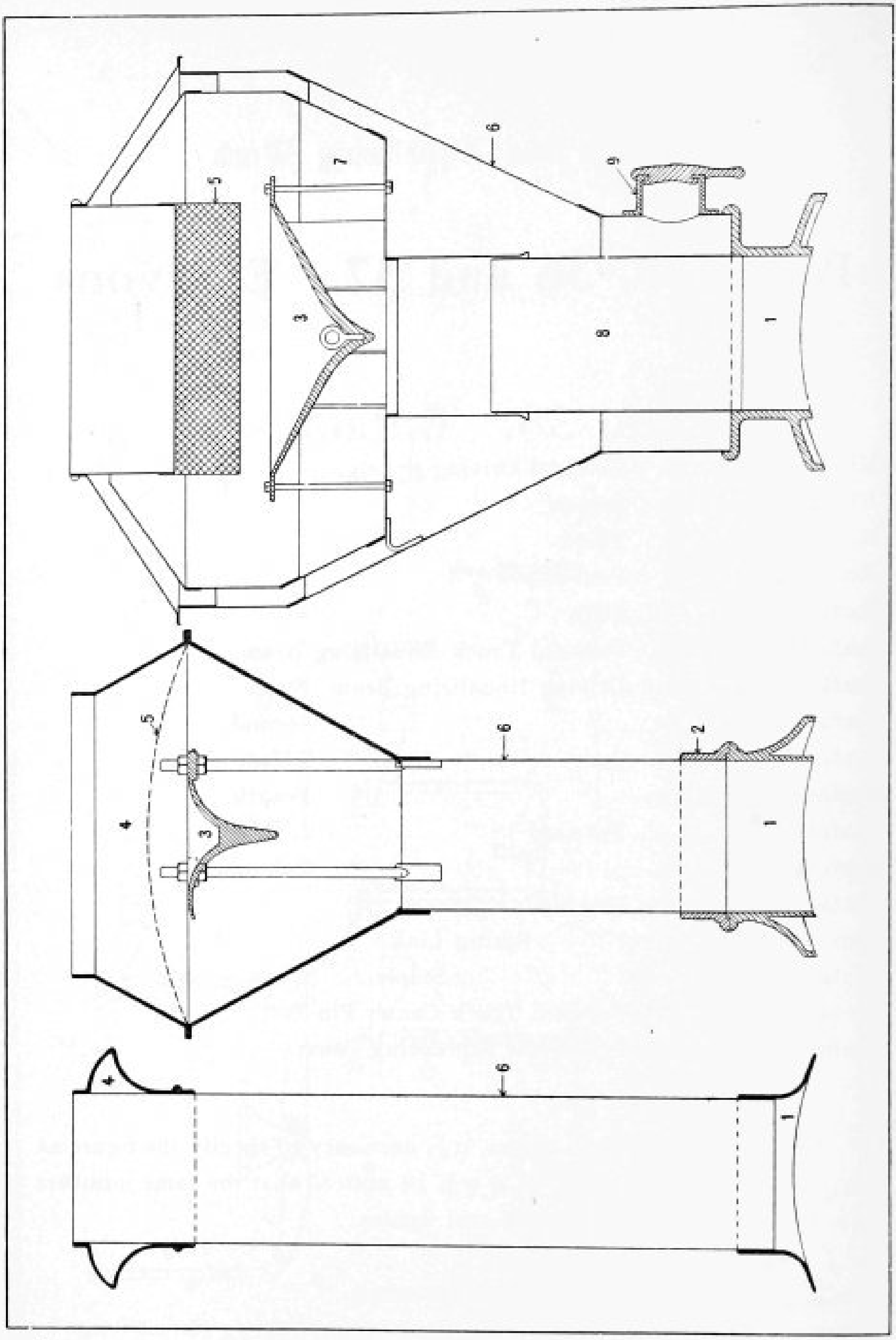
Springs and Equalizing Work

Plates 35, 36 and 37. Enervons

Enervorum .	1.	Forward Driving Spring.
Eneti .	2.	Second " "
Eneyer	3.	Third " "
Enfadadas .	4.	Fourth " "
Enfadadico	5.	Fifth " "
Enfadando	6.	Forward Truck Equalizing Beam.
Enfadarian	7.	Driving Equalizing Beam, First.
Enfadeis .	8.	" " " Second.
Enfadonho	9.	" " " Third.
Enfagoter	. 10.	" " " Fourth.
Enfaixar	. . 11.	Forward " " Link.
Enfaldada .	. 12.	" " " Fulcrum.
Enfaldador	. 12A.	Driving " " "
Enfaldamos	. 13.	" Spring Link
Enfaldare	14.	" " Staple.
Enfaldaron	15.	Forward Truck Center Pin Bolt.
Enfamar	. . 16.	Transverse Equalizing Beam.

In ordering from these plates, it is necessary to specify the figure as well as the number of piece, as it will be noticed that the same numbers have different shapes on the different figures.

Plate 38



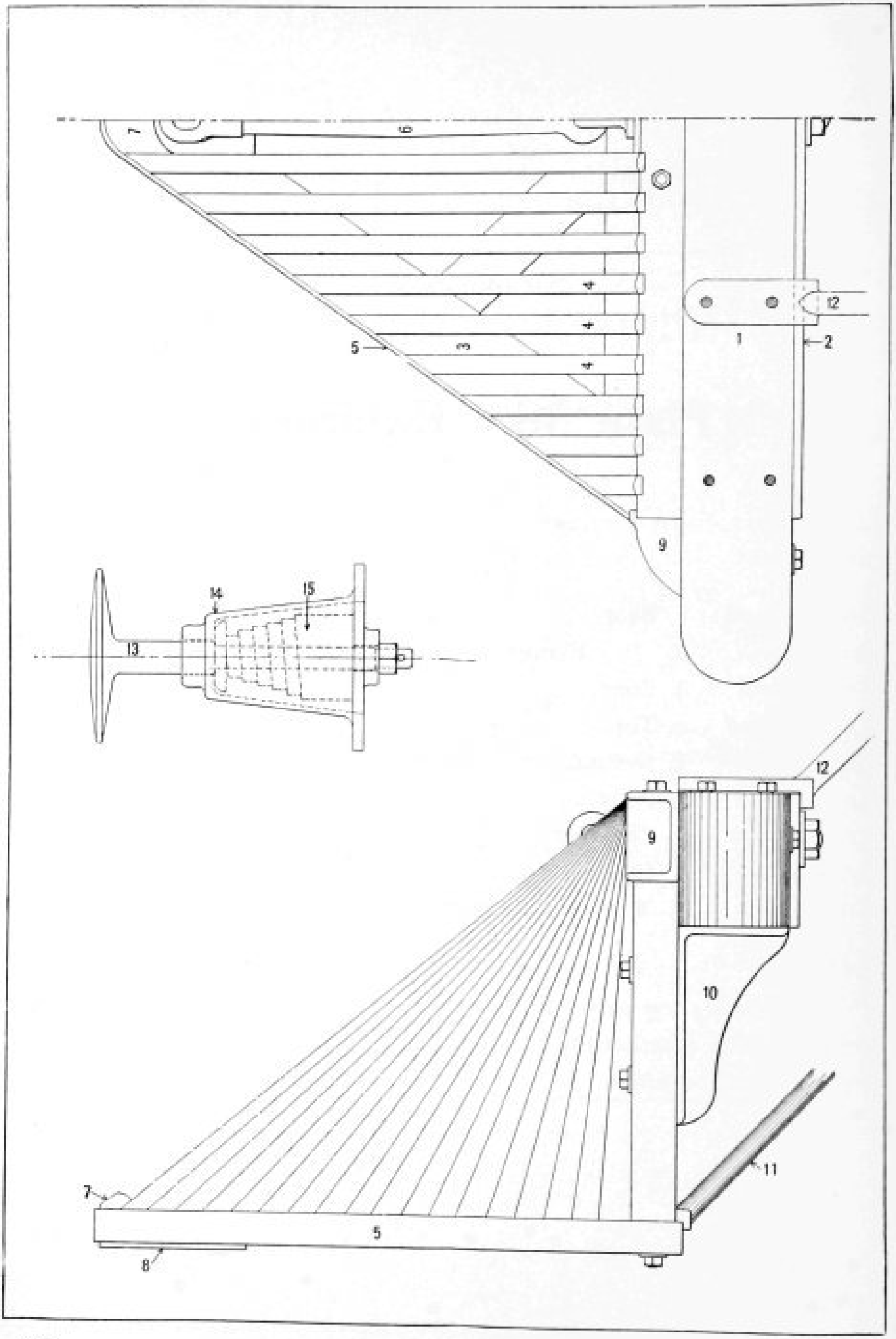
Smoke-Stacks

Plate 38. Enfamined

Enfamished	1. Base.
Enfancon .	2. " Flange.
Enfangada	3. Cone.
Enfangados	4. Top.
Enfangueis	5. Netting.
Enfardaras	6. Body.
Enfardasen	7. Chamber.
Enfardelo .	. 8. Inside Pipe.
Enfarelar	9. Hand Hole and Plate.

In ordering top parts of "Diamond" plan of stack, the order should always specify whether top or bottom part of No. 4 is wanted when both pieces are not required.

Plate 39



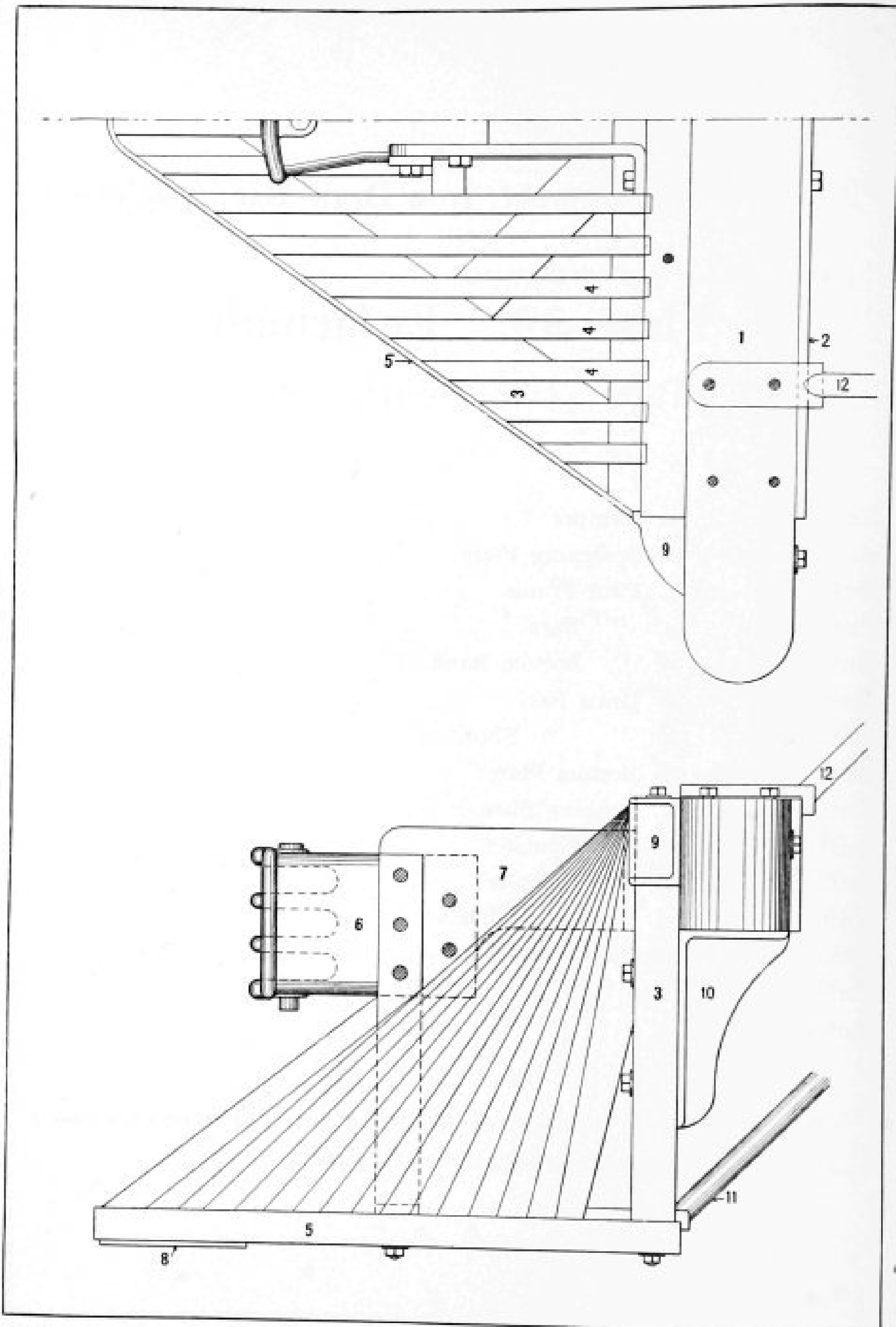
Pilot and Front Bumper, Iron Draw Bar Attachment

Plate 39. Enfarinait

Enfarinhar	1.	Bumper.
Enfarinons	2.	Stiffening Plate.
Enfascie	3.	Pilot Frame.
Enfastiado	4.	" Bars.
Enfatiche	5.	" Bottom Band.
Enfatico	6.	Draw Bar.
Enfatilhar	7.	" " Shoe.
Enfects	8.	Bottom Plate.
Enfeeble	9.	Pushing Shoe.
Enfeebling	10.	Pilot Bracket.
Enfeeblish	11.	Middle Brace.
Enfeitador	12.	Smoke-box Brace.
Enfeiticar	13.	Spring Buffer.
Enfelon	14.	" " Case.
Enfeloned	15.	" " Spring.

The bracket No. 10 is made right and left, and when only one is wanted the side required for should be specified.

Plate 40



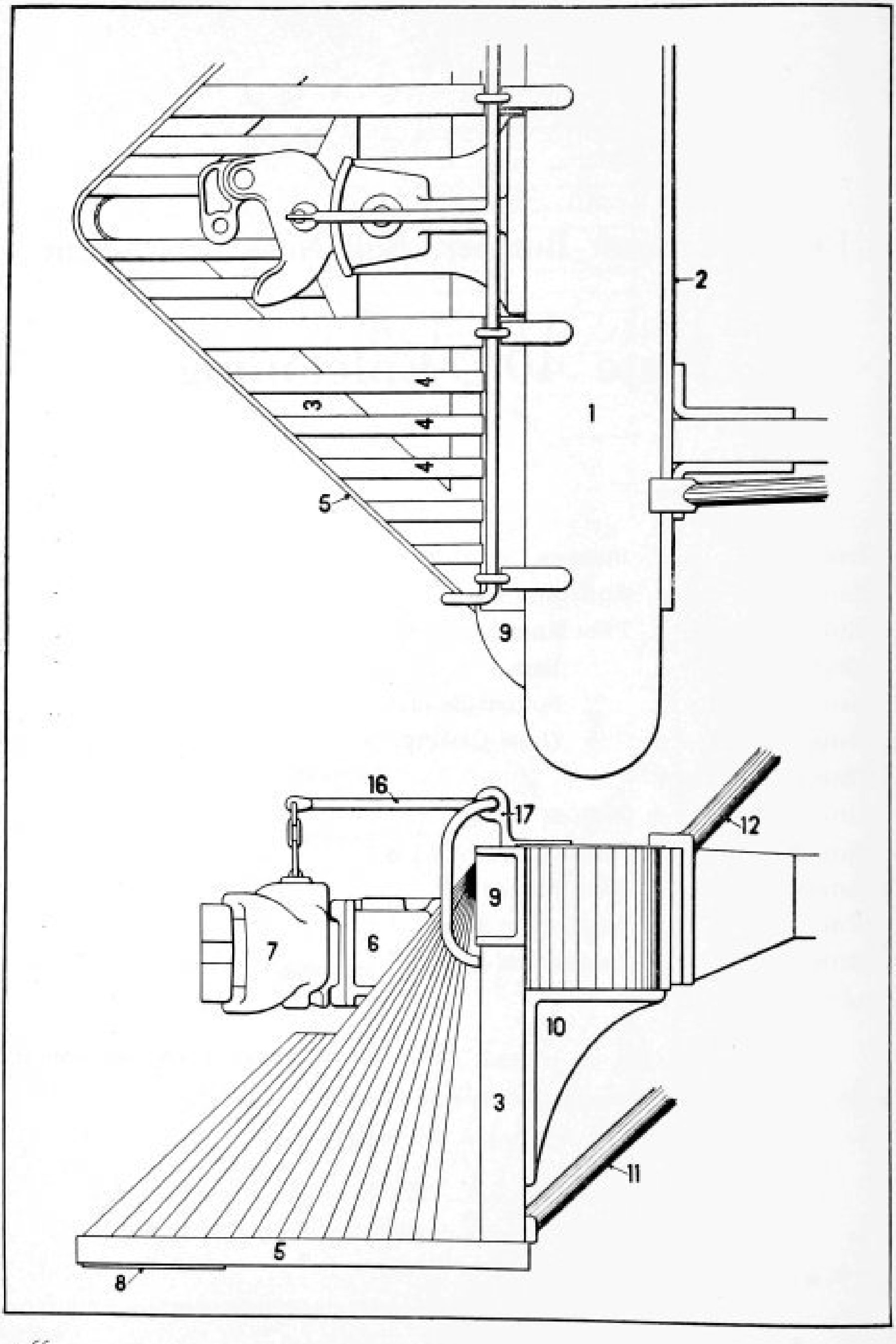
Pilot and Front Bumper, Bull Nose Attachment

Plate 40. Enfeloning

Enfelujar	1.	Bumper.
Enfeoff	2.	Stiffening Plate.
Enfeoffed	3.	Pilot Frame.
Enfeoffing	4.	" Bars.
Enfermaban	5.	" Bottom Band.
Enfermados	6.	" Draw Casting.
Enfermames	7.	" " " Support.
Enfermar	8.	Bottom Plate.
Enfermaria	9.	Pushing Shoe.
Enfermedad	10.	Pilot Bracket.
Enfermeiro	11.	Middle Brace.
Enfermiez	12.	Smoke-box Brace.

The bracket No. 10 is made right and left, and when only one is wanted the side required for should be specified.

Plate 41



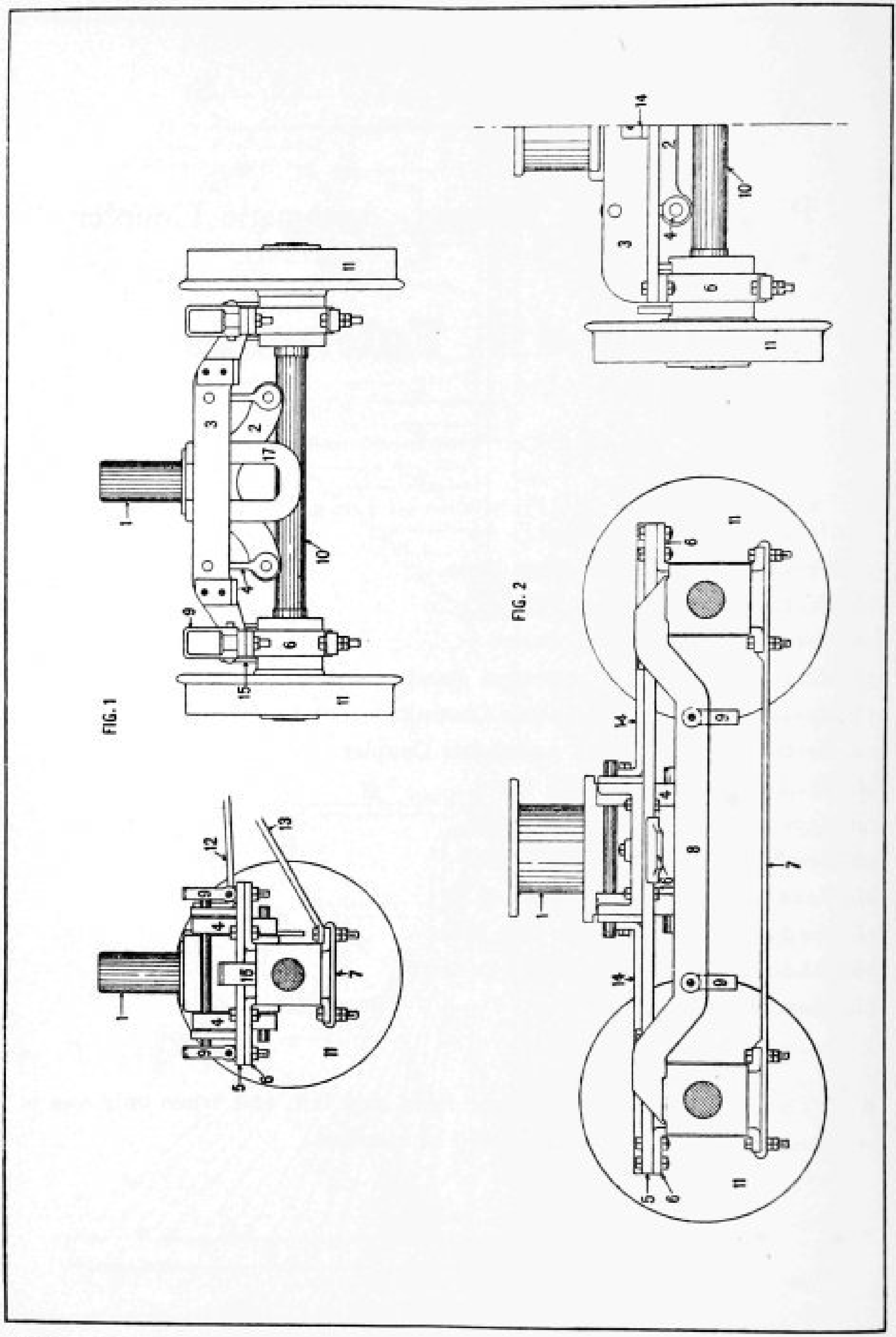
Pilot and Front Bumper, Automatic Coupler

Plate 41. Enfermizas

Enfermizo	1.	Bumper.
Enfermons	2.	Stiffening Plate.
Enfernizar	3.	Pilot Frame.
Enferonner	4.	" Bars.
Enferrure	5.	" Bottom Band.
Enfesta	6.	" Draw Casting.
Enfettered	7.	Pilot Automatic Coupler.
Enfeudacao	8.	Bottom Plate.
Enfevered	9.	Pushing Shoe.
Enfevering	10.	Pilot Bracket.
Enfezado	11.	Middle Brace.
Enfiada	12.	Smoke-box Brace.
Enfiadura	16.	Coupling Pin Lifter.
Enfiamento	17.	" " " Bearing.

The bracket No. 10 is made right and left, and when only one is wanted the side required for should be specified.

Plate 42



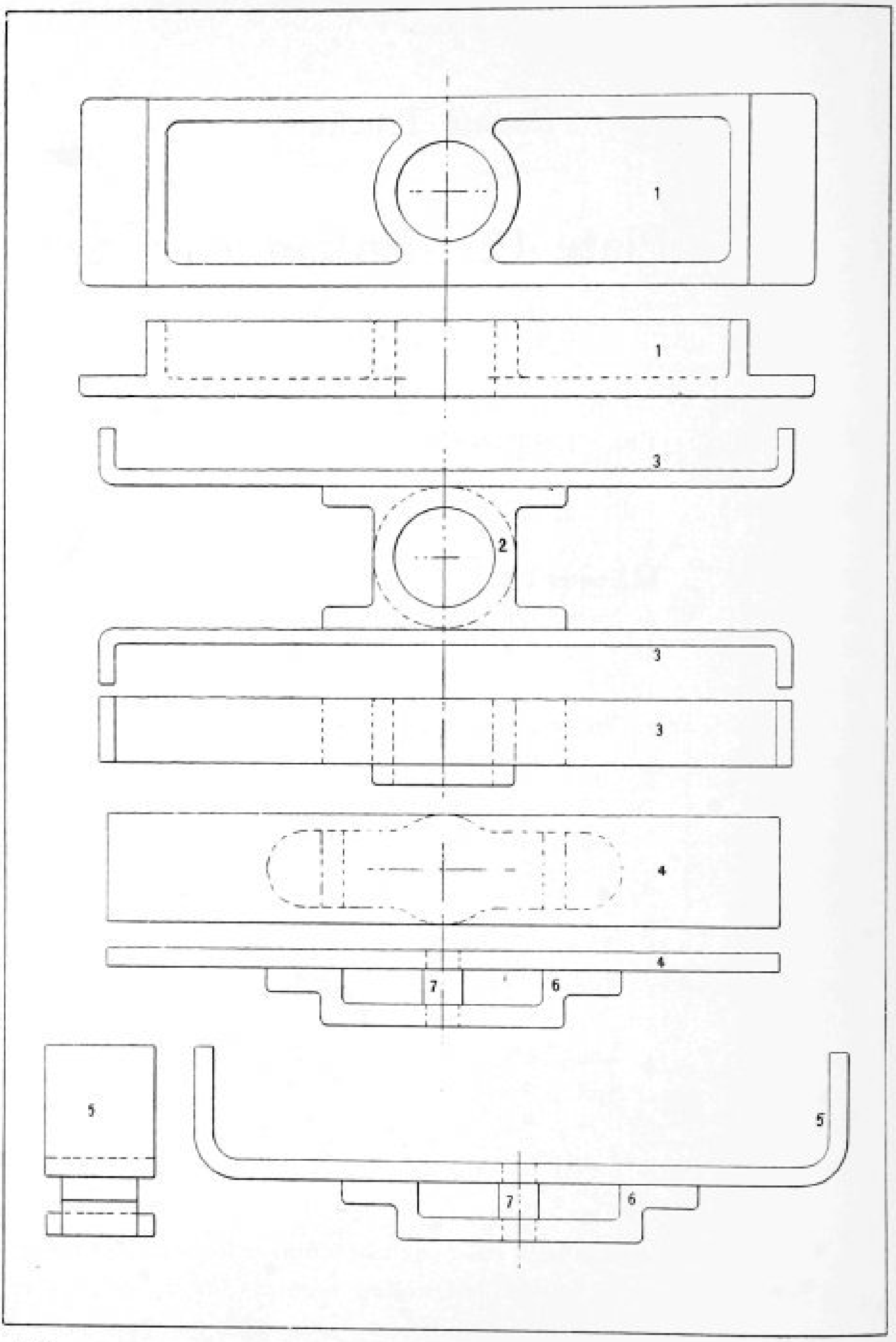
Engine Trucks

Plate 42. Enfiando

Enfiarono	Fig.	**1.**—Two-wheeled or Pony Truck.
Enfiassimo	Fig.	**2.**—Four-wheeled Truck.
Enfiatello	1.	Center Pin.
Enfiativo	2.	Swing Bolster.
Enfiatuzzo	3.	" " Crosstie.
Enfiavamo	4.	" " Link.
Enfiavate	5.	Truck Frame.
Enfiazione	6.	" Pedestal.
Enficeler	7.	" " Cap.
Enfieranno	8.	Equalizing Beam.
Enfierced	9.	Spring Link.
Enfiercing	10.	Axle.
Enfierebbe	11.	Wheel.
Enfieremo	12.	Radius Bar.
Enfieresti	13.	" " Brace.
Enfiero	14.	Longitudinal "
Enfievrait	15.	Spring Staple.
Enfievriez	16.	" Seat.
Enfievront	17.	Safety Strap.

This plate embodies both the pony and ordinary four-wheeled truck, and in ordering parts by the designating numbers the figure number should first be given.

Plate 43

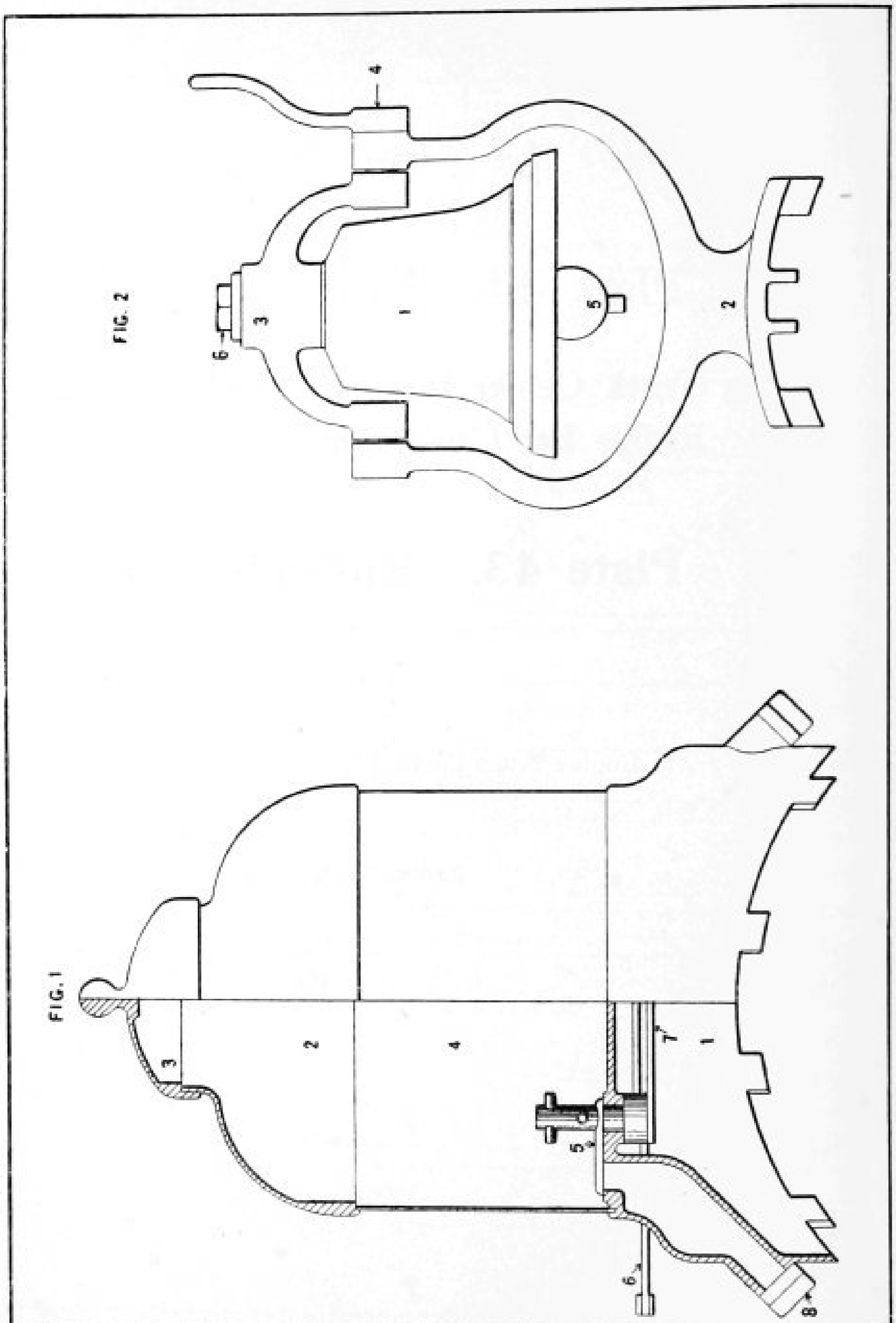


Engine Truck Center Pin Guide and Crosstie, Radius Bar Crosstie and Clamp

Plate 43. Enfiladed

Enfilading . .	1.	Engine Truck Center Pin Guide.
Enfilado . . .	2.	" " " " "
Enfilais . . .	3.	" " " " " Crosstie.
Enfilamos . .	4.	" " Radius Bar Crosstie.
Enfilant . . .	5.	" " " " "
Enfilasses . .	6.	" " " " Clamp.
Enfileirar . .	7.	" " " " Pin.

Plate 44



Sand Box and Bell Work

Plate 44. Enfilerais

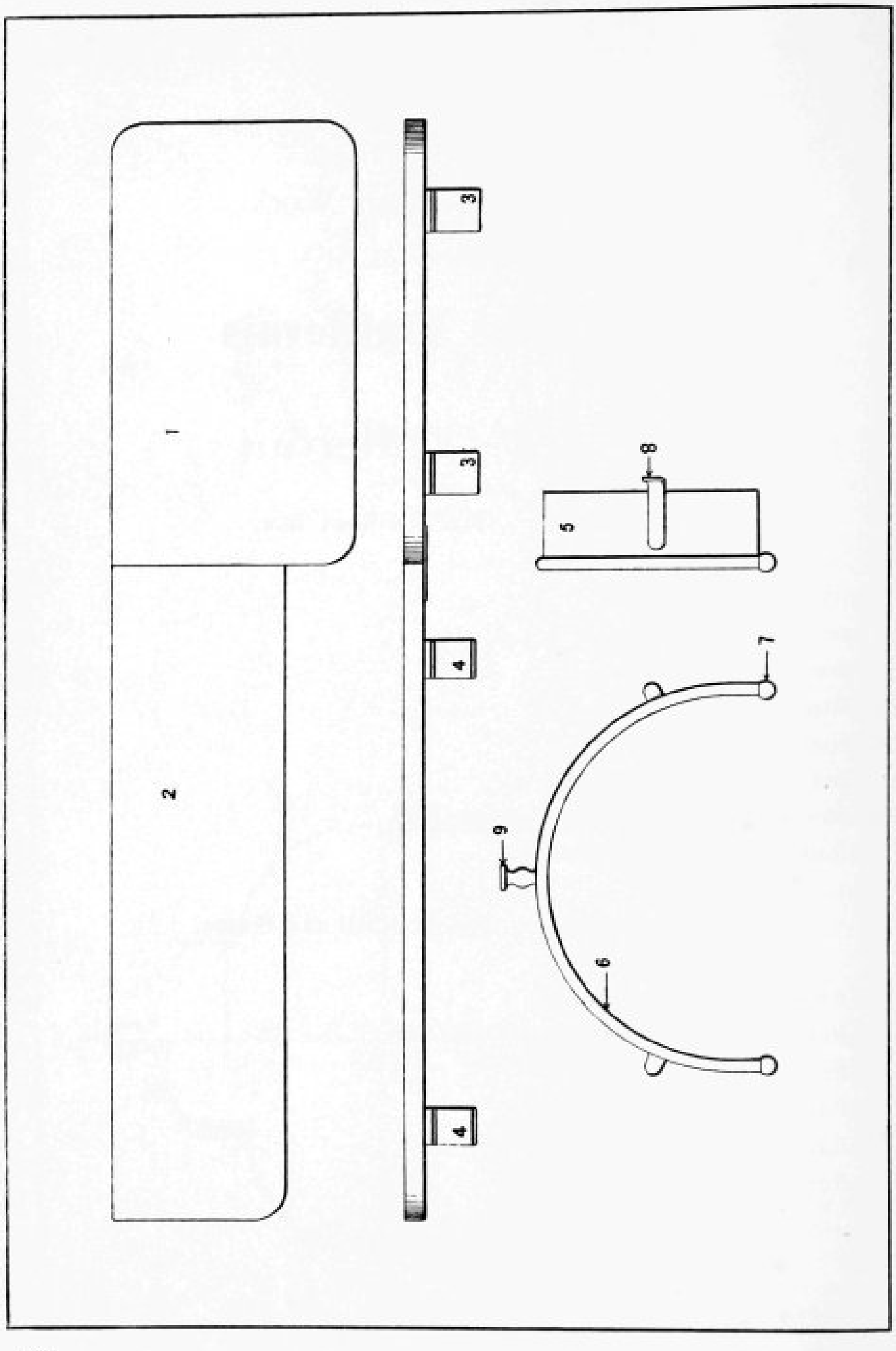
Enfiliez . . . FIG. 1.—Sand Box.

Enfilons . . 1. Base.
Enfiring . . 2. Top.
Enfisema . . 3. Lid.
Enfitar . . . 4. Body.
Enfiteusis . 5. Valve.
Enfiteuta . 6. Lever.
Enfivelar . 7. Valve Connecting Rod.
Enflais . . 8. Pipe Flange.

Enflammait . . FIG. 2.—Bell and Frame.

Enflaquer . 1. Bell.
Enflautado . 2. Frame.
Enflautar . 3. Yoke.
Enflauteis . 4. Crank.
Enflauto . 5. Tongue.
Enflerez . 6. Acorn.

Plate 45



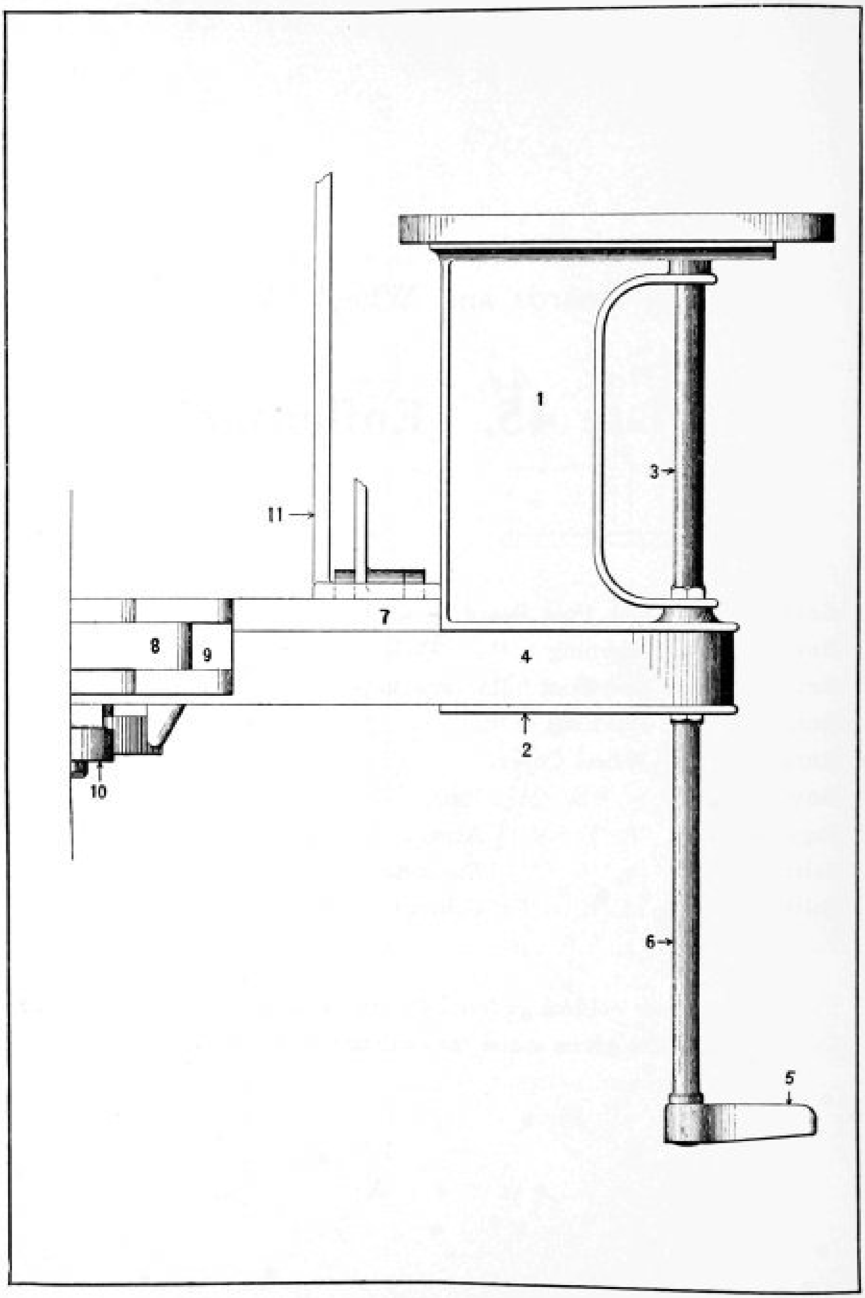
Foot Boards and Wheel Covers

Plate 45. Enfleront

Enfleshed	1.	Cab Foot Board.		
Enfleshing	2.	Running	"	
Enfleurant	3.	Cab Foot	"	Brackets.
Enfleuri	4.	Running	"	"
Enflorar	5.	Wheel Cover.		
Enflowered	6.	"	"	Pipe.
Enfogado	7.	"	"	Acorn.
Enfoliates	8.	"	"	Bracket.
Enfolier	9.	"	"	Column.

These parts are seldom ordered except in full sets, and the side wanted for should be given when they are not so ordered.

Plate 46



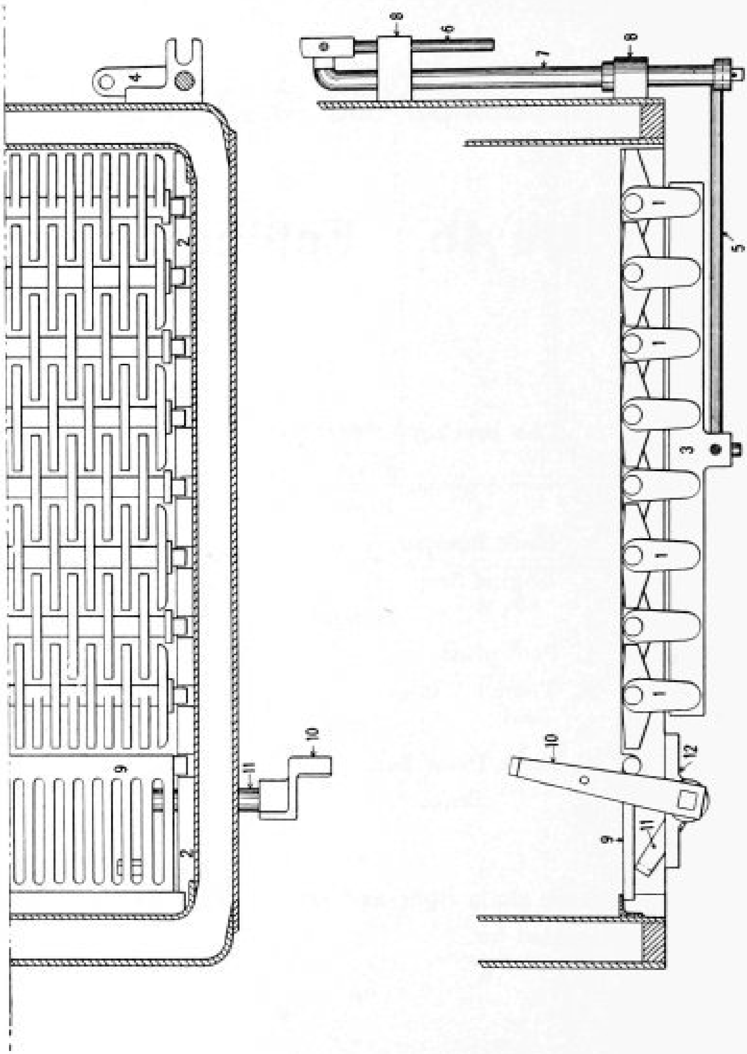
Back Bumper and Attachments

Plate 46. Enfoncage

Enfoncais	1.	Cab Bracket.
Enfonceur	2.	" " Plate.
Enforcedly	3.	" " Pipe.
Enforcing	4.	Back Bumper.
Enforciras	5.	Engine Step.
Enforcive	6.	" " Hanger.
Enformacao	7.	Foot-plate.
Enforms	8.	Tender Wedge.
Enfortuned	9.	" " Box.
Enfouimes	10.	Back Draw Bar.
Enfouining	11.	" Brace.

Cab brackets are made right and left. Orders for single brackets should give side wanted for.

Plate 47



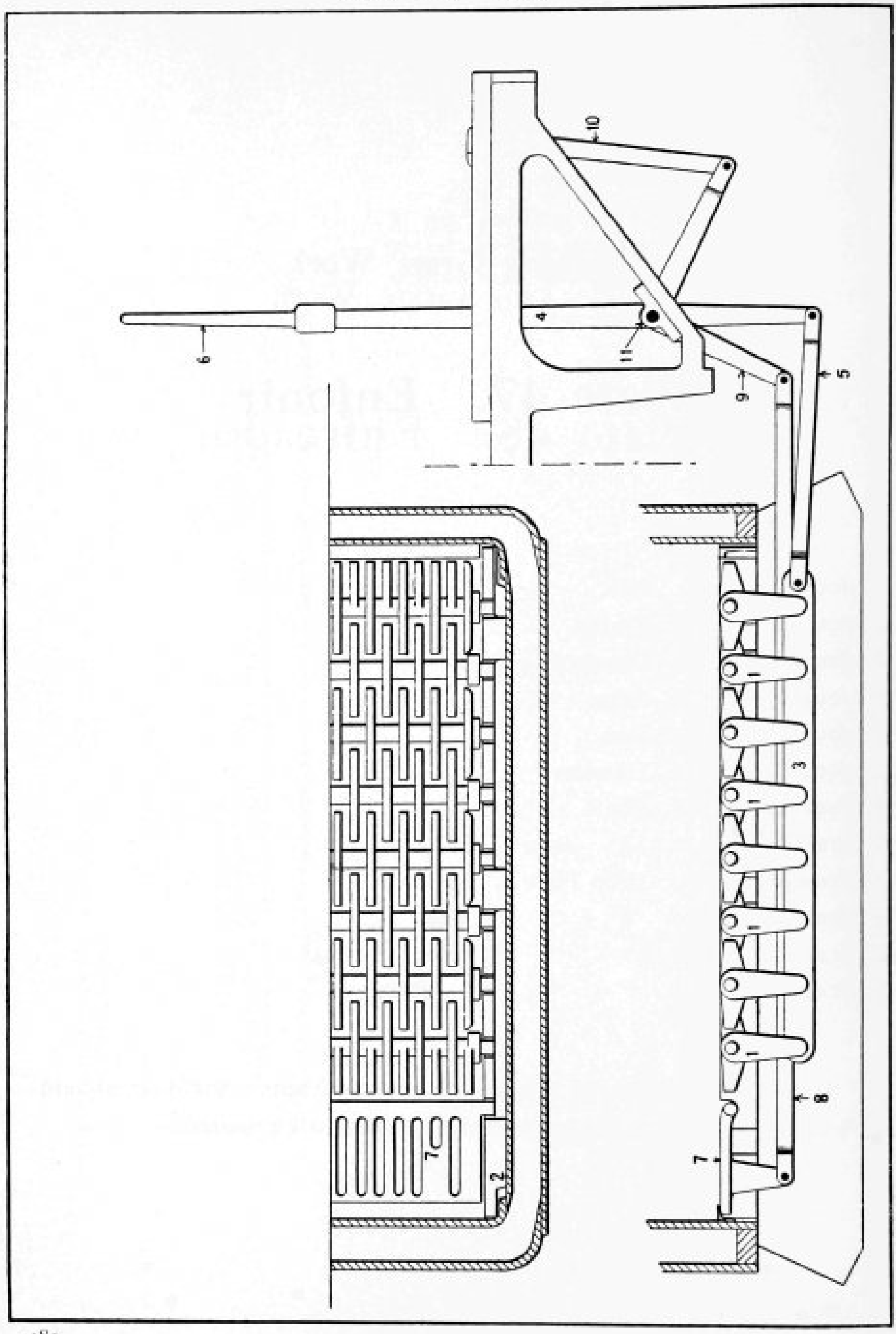
Rocking Grate Work

Plate 47. Enfouir

Enfouiras	1.	Bar.
Enfouiriez	2.	Frame.
Enfouiront	3.	Connecting Bar.
Enfourchi	4.	Arm.
Enfournait	5.	Rod.
Enfournons	6.	Handle.
Enfourrer	7.	Shaft.
Enfraile	8.	" Bearings.
Enfranger	9.	Drop Plate.
Enfrasques	10.	" " Handle.
Enfrassia	11.	" " Shaft.
Enfratico	12.	" " " Bearing.

When complete sets of these bars are not wanted, the order should give the position from the front of the bars that are required.

Plate 48



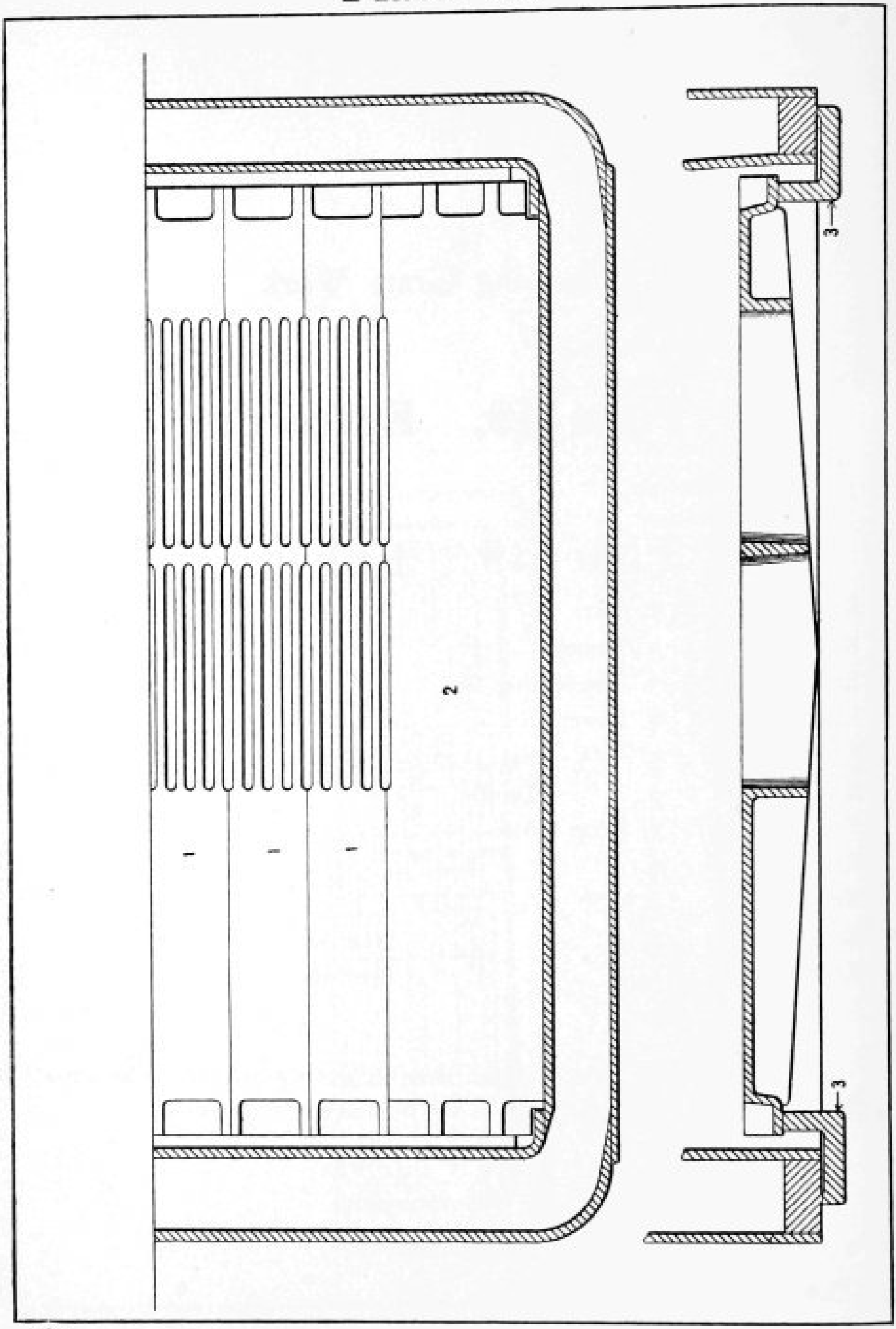
Rocking Grate Work

Plate 48. Enfreador

Enfrear	1.	Bar.
Enfreedom	2.	Frame.
Enfrenaba	3.	Connecting Bar.
Enfrenases	4.	Lever.
Enfrestado	5.	" Rod.
Enfriabais	6.	" Handle.
Enfriadera	7.	Drop Plate.
Enfriado	8.	" " Rod.
Enfriamos	9.	" " Crank.
Enfriarian	10.	" " " Handle.
Enfriaron	11.	" " " Bearing.

When complete sets of these bars are not wanted, the order should give the position from the front of the bars that are required.

Plate 49



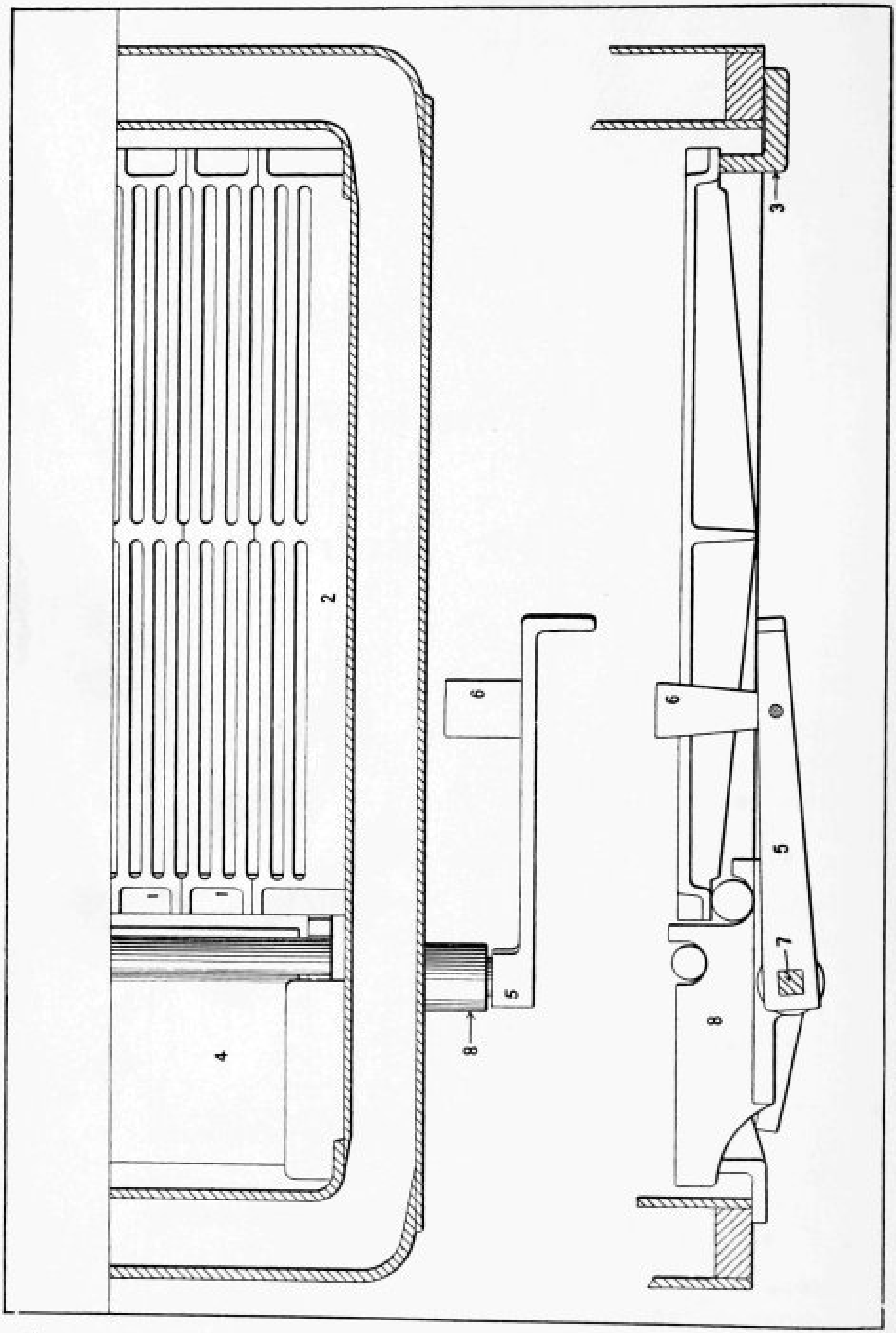
Plain Grate for Wood

Plate 49. Enfronhar

Enfroquer . 1. Bar.
Enfroward 2. Dead Plate.
Enfueirar . 3. End Holder.

For this plan of grate it will be necessary to specify for which side dead plate is required when not in full sets.

Plate 50



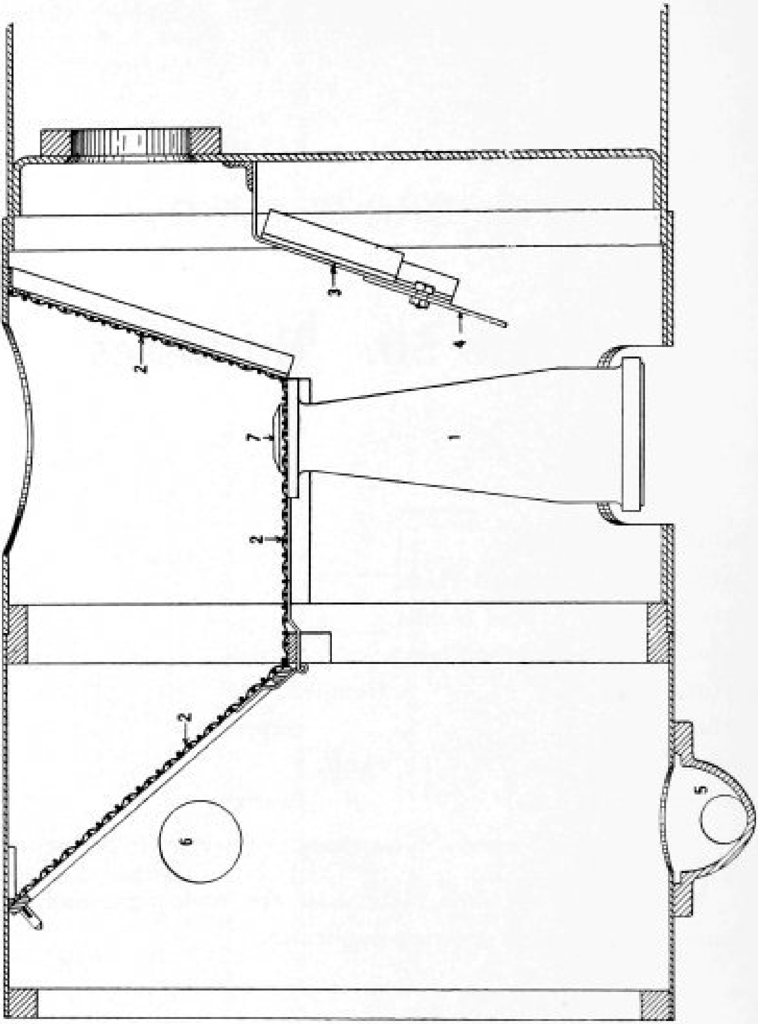
Plain Grate for Soft Coal

Plate 50. Enfuisses

Enfumado	1.	Bar.
Enfumar	2.	Dead Plate.
Enfumoirs	3.	End Holder.
Enfundadas	4.	Drop Plate.
Enfundado	5.	" " Handle.
Enfundamos	6.	" " " Support.
Enfundaron	7.	" " Shaft.
Enfundeis	8.	" " " Bearing.

The bearings for drop plate shaft are made right and left. This should be observed in ordering duplicates.

Plate 51



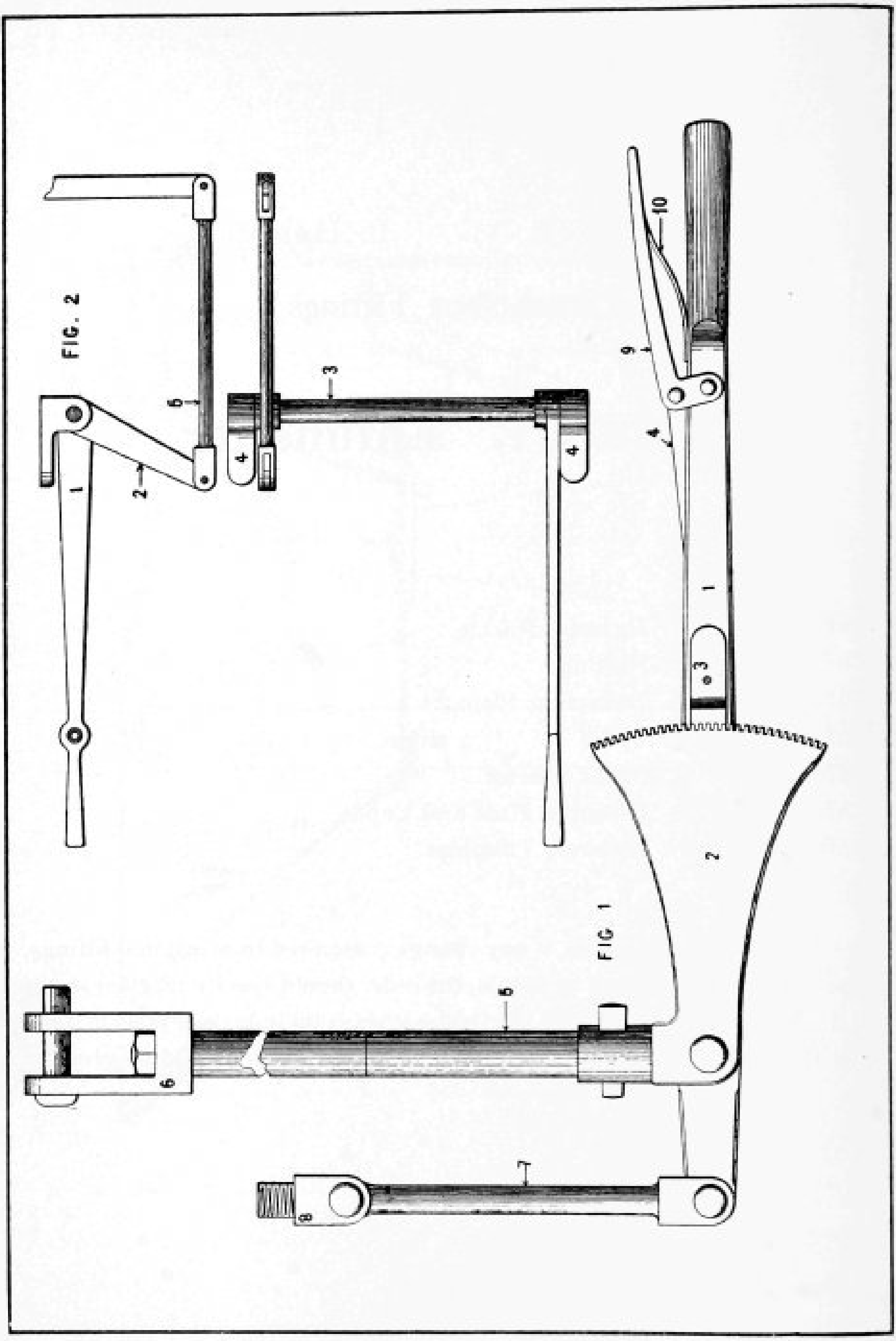
Smoke-box Fittings

Plate 51. Enfunester

Enfunilado	1.	Exhaust Nozzle.
Enfunilar	2.	Netting.
Enfurece . .	3.	Deflecting Plate.
Enfurecida	4.	" " Slide.
Enfurecio .	5.	Spark Ejector.
Enfurezca . .	6.	Cleaning Hole and Cap.
Enfuriar . . .	7.	Exhaust Thimbles.

In ordering these parts, if any change is required from original fittings, especially with reference to nozzle, the order should specify whether single or double opening is wanted. Thimbles always include three sizes to a set, and the particular size wanted, when not in full sets, should be given.

Plate 52



Throttle and Whistle Work

Plate 52. Enfusa

Enfuscado FIGURE 1.—Throttle Work.

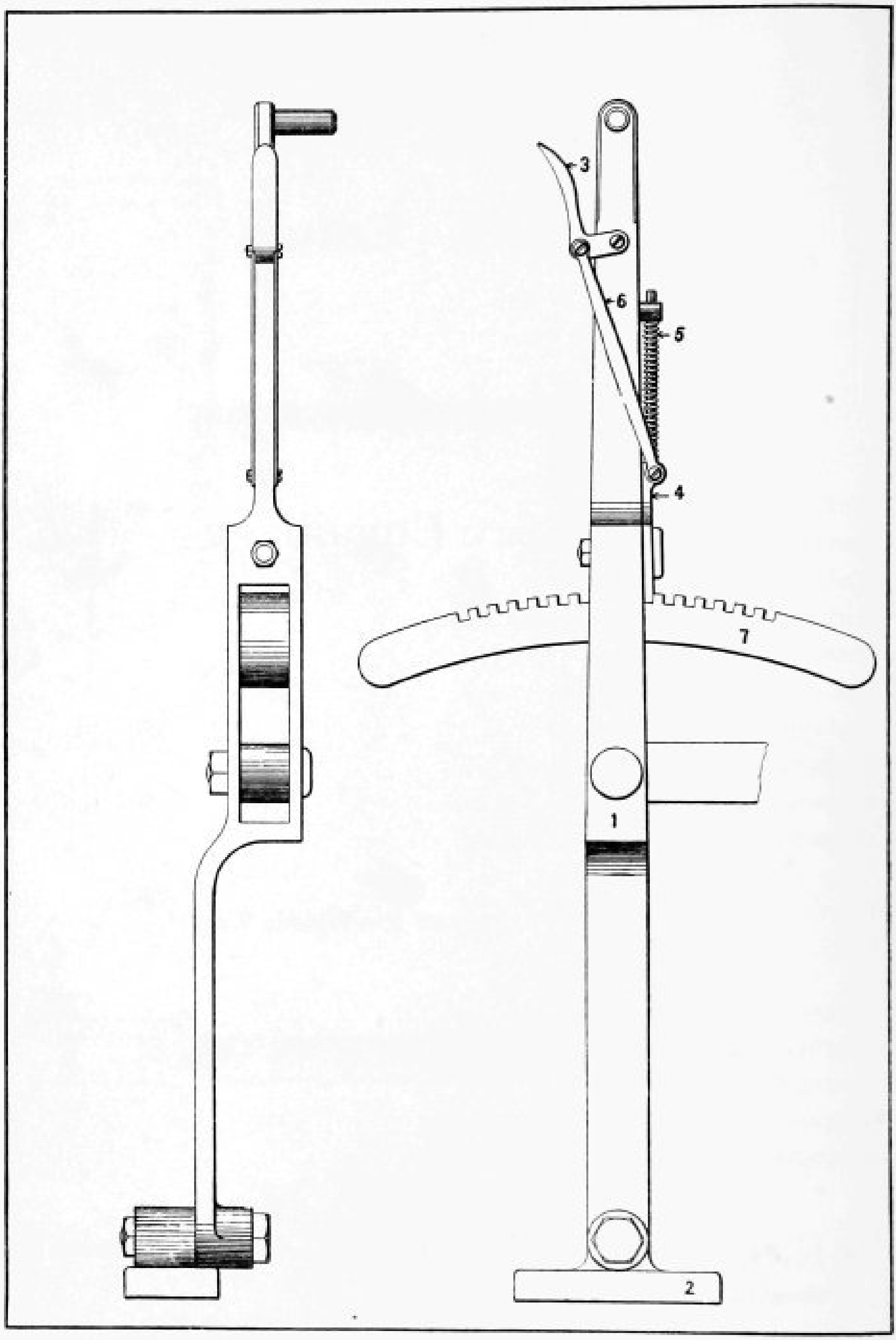
Enfuscar	1.	Lever.
Enfuster	2.	Quadrant.
Enfutage	3.	Latch.
Enfuyais	4.	" Link.
Enfuyant	5.	Rod.
Enfuyiez	6.	Jaw.
Enfuyons	7.	Link.
Engabanado	8.	" Stud.
Engabelar	9.	Handle.
Engacar	10.	" Spring.

Engachsig FIGURE 2.—Whistle Work.

Engaco	1.	Lever.
Engageais	2.	Arm or Crank.
Engageante	3.	Shaft.
Engagedly	4.	" Bearing.
Engagiste	5.	Link.

In ordering Link No. 5, Figure 2, the distance from center to center of jaw should be given.

Plate 53

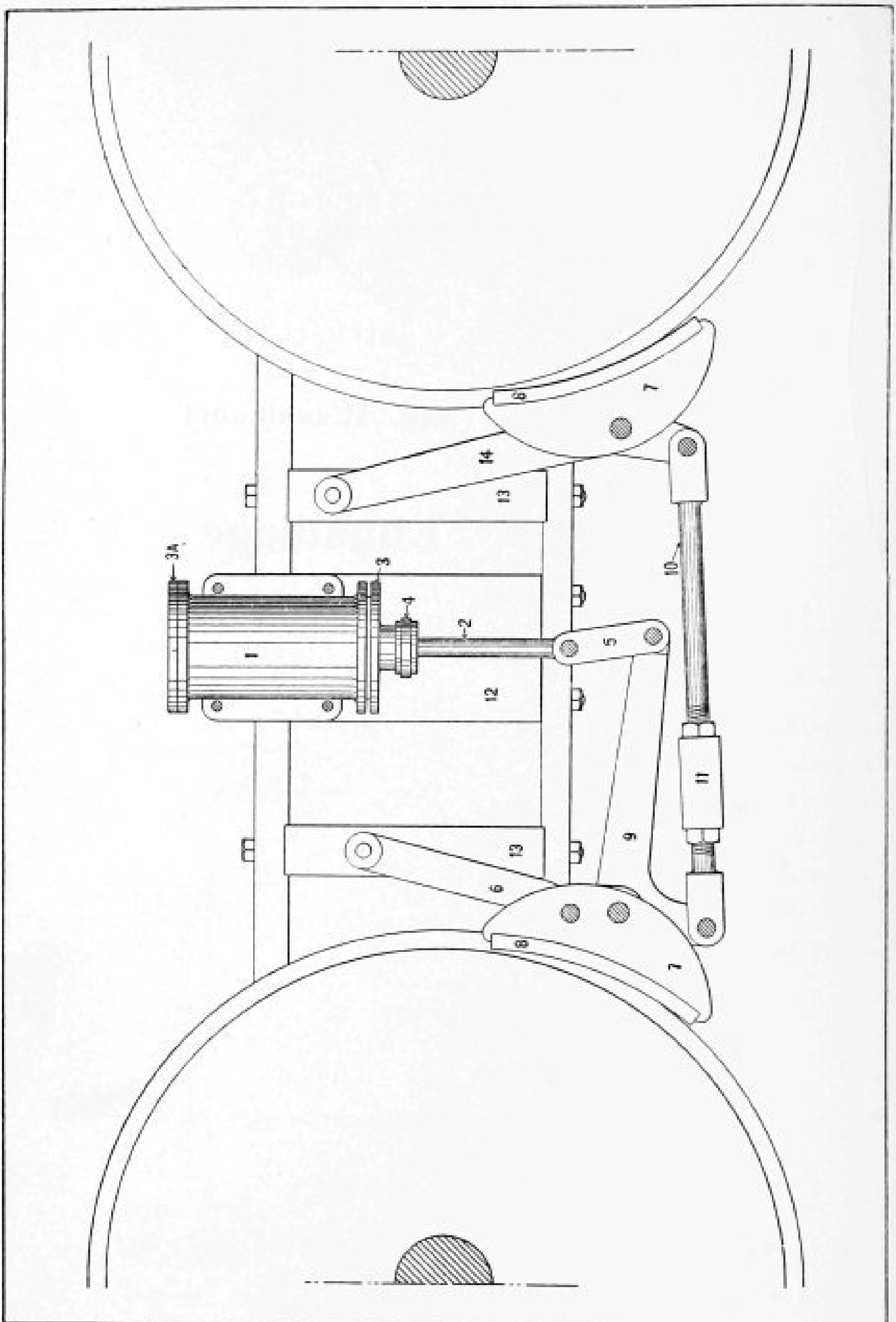


Reverse Lever and Attachments

Plate 53. Engaillage

Engainant . .	1. Lever.
Engaineras	2. Fulcrum.
Engainiez	3. Handle.
Engainons . .	4. Latch.
Engaiolar . .	5. " Spring.
Engaitadas .	6. " Rod.
Engaitado . .	7. Catch.

Plate 54



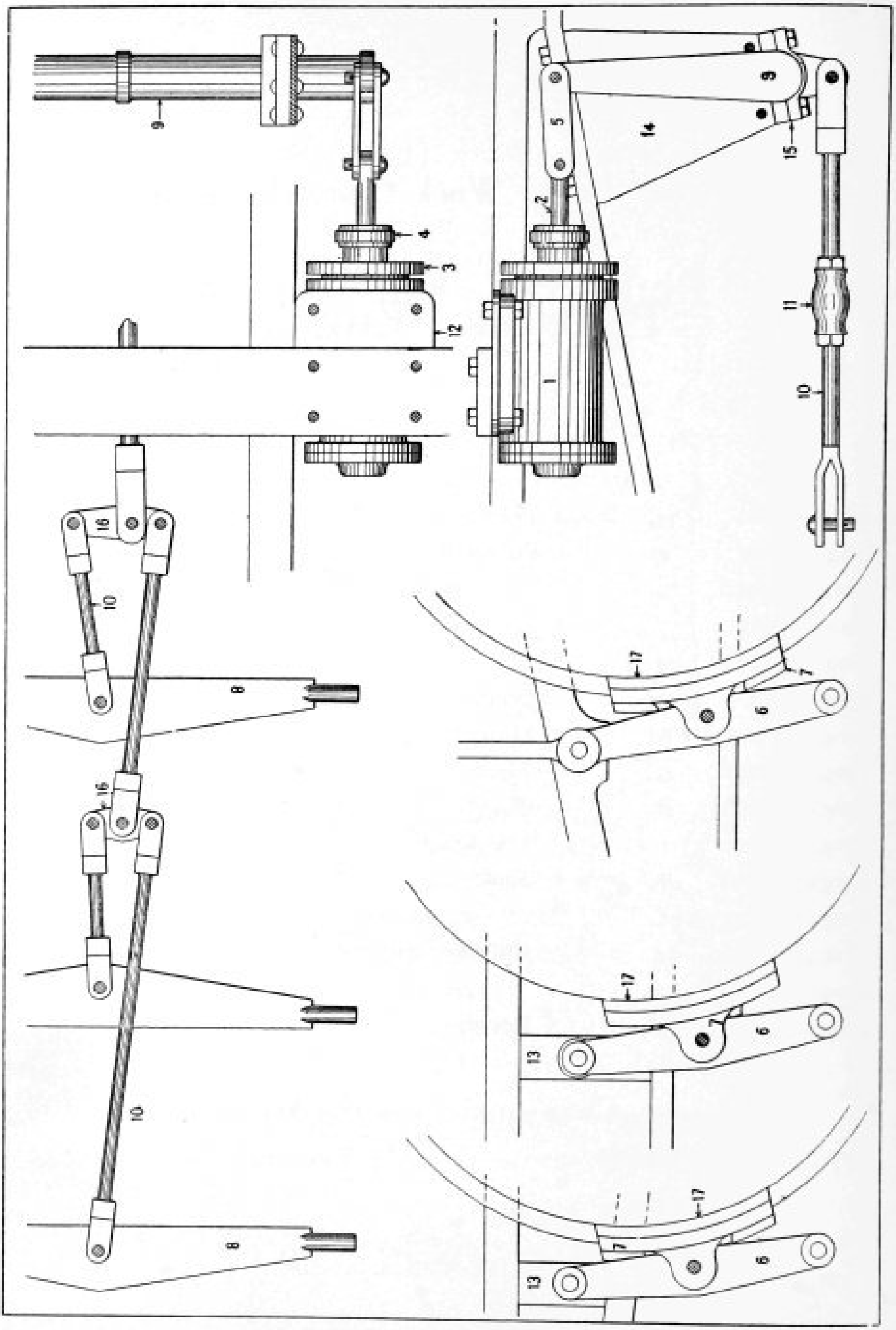
Steam Brake Work (Spread Style)

Plate 54. Engajar

Engalado	1.	Brake Cylinder.
Engalanar	2.	" Piston Rod.
Engalgaban	3.	" Cylinder Head, Bottom.
Engalgada	3A.	" " " Top.
Engalgados	4.	" " Stuffing Box Nut.
Engalla	5.	" Connecting Link.
Engallador	6.	" Hanger Link.
Engallarse	7.	" Head.
Enganabais	8.	" Shoe.
Enganadico	9.	" Bell Crank.
Enganamos	10.	" Rod.
Enganaron	11.	" " Adjusting Nut.
Enganchado	12.	" Cylinder Support.
Engancheis	13.	" Hanger "
Engancho	14.	" Lever.

Separate catalogues of patented power brakes may be obtained by applying to the makers.

Plate 55



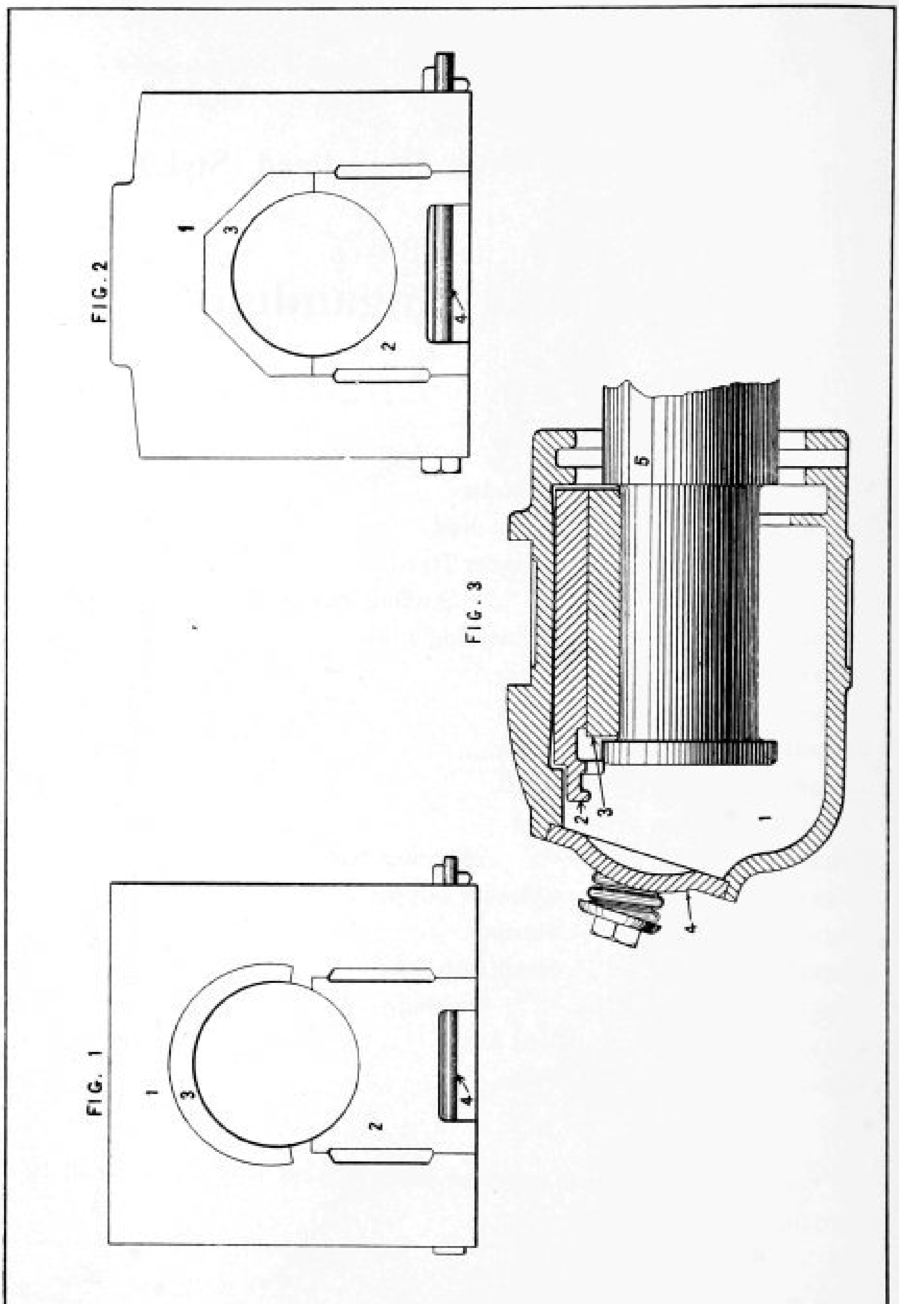
Steam Brake Work (Equalized Style)

Plate 55. Engandujo

Enganeis	1.	Brake Cylinder.
Engangento	2.	" Piston Rod.
Enganifa	3.	" Cylinder Head.
Enganosas	4.	" " Stuffing Box Nut.
Enganoso	5.	" Connecting Link.
Engantant	6.	" Lever.
Enganzar	7.	" Head.
Engaols	8.	" Beam.
Engarabato	9.	" Shaft.
Engaraire	10.	" Rod.
Engarampar	11.	" " Adjusting Nut.
Engarbaba	12.	" Cylinder Support.
Engarbadas	13.	" Hanger.
Engarboil	14.	" Shaft Support.
Engarce	15.	" " Bearing.
Engaritado	16.	" Rod Lever.
Engariteis	17.	" Shoe.

Separate catalogues of patented power brakes may be obtained by applying to the makers.

Plate 56



Journal Boxes

Plate 56. Engarland

Engarrafar . FIGURE 1.—Driving Box.

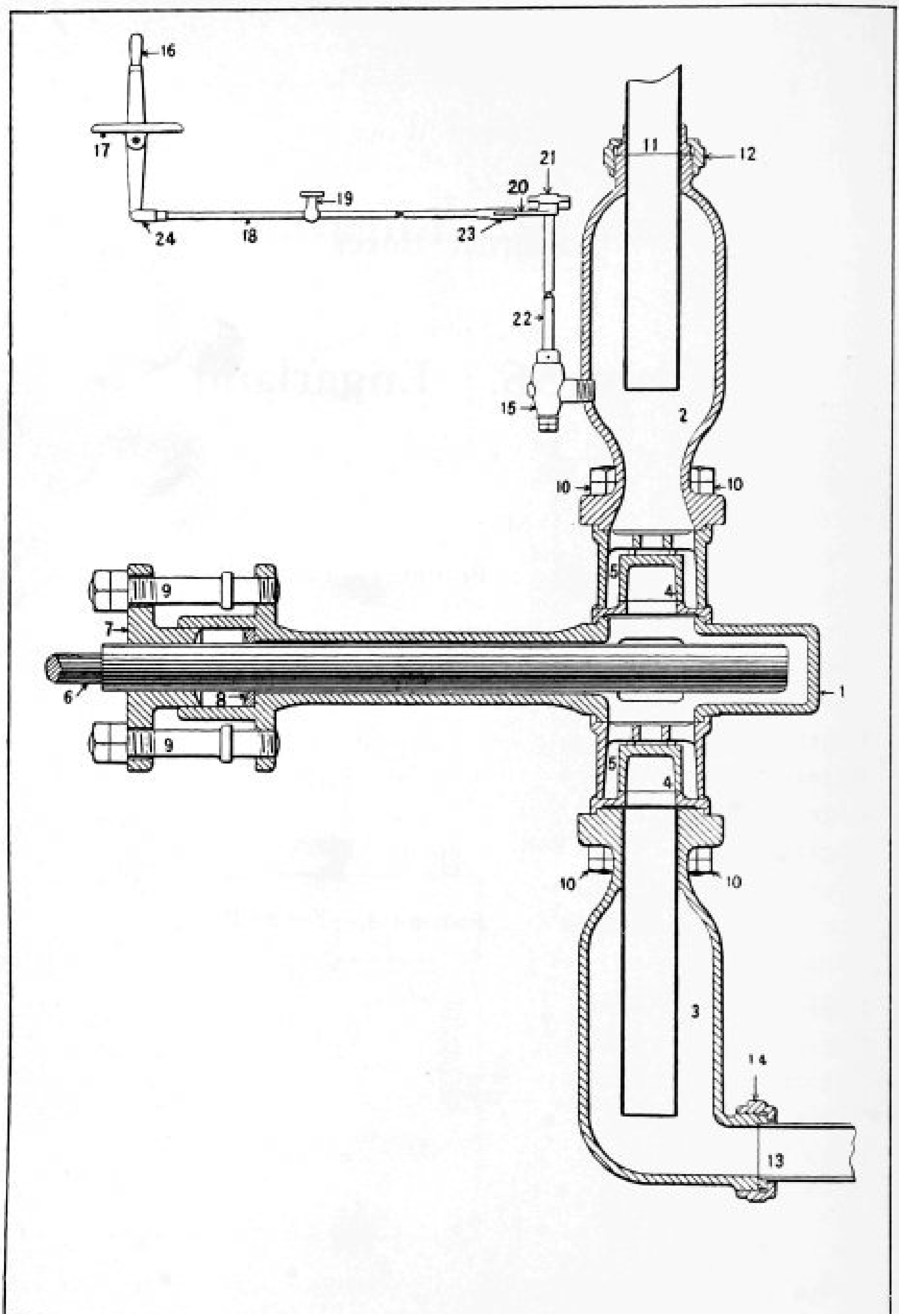
Engarrafo . FIGURE 2.—Truck Box.

Engarrison . 1. Box.
Engarzamos 2. Cellar.
Engarzaron . 3. Brass.
Engarzases 4. Cellar Bolt.

Engarzeis . . FIGURE 3.—Tender Box.

Engarzo . . . 1. Box.
Engasgado 2. Wedge.
Engastaban 3. Brass.
Engastada 4. Lid.
Engasto 5. Axle.

Plate 57



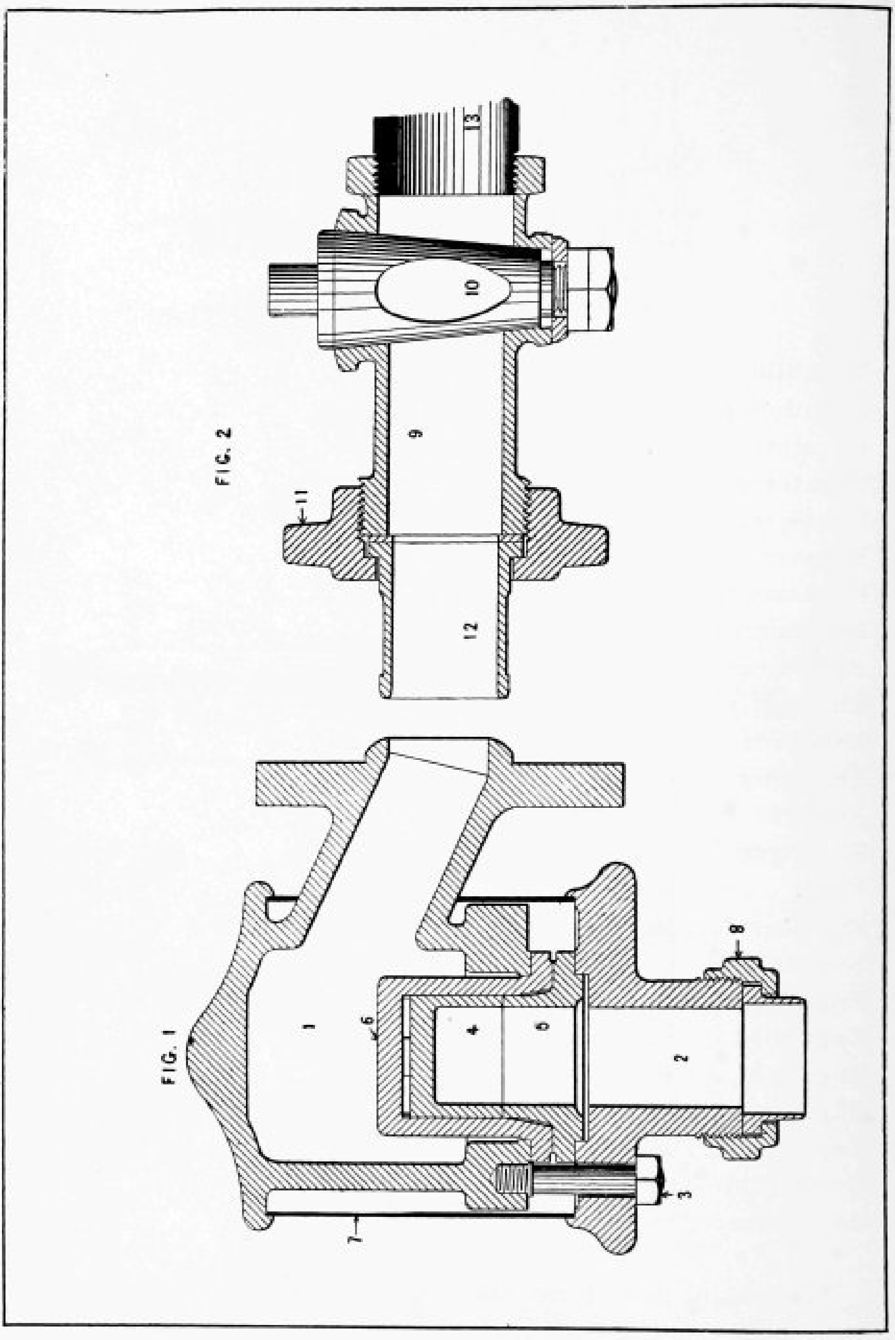
Pump Work

Plate 57. Engathmig

Engatillo	1.	Pump Barrel.
Engatinhar	2.	Top Chamber.
Engatusado	3.	Bottom Chamber.
Engatusar	4.	Valve.
Engatuseis	5.	" Cage.
Engaver	6.	Plunger.
Engazonner	7.	Gland.
Engbloem	8.	" Bottom Ring.
Engbloemen	9.	" Studs.
Engborstig	10.	Chamber Studs.
Engeance	11.	Check Pipe.
Engeigner	12.	" " Coupling Nut.
Engeira	13.	Feed Pipe.
Engeitado	14.	" " Coupling Nut.
Engel	15.	Pet Cock.
Engelbert	16.	" " Lever in Cab.
Engelbild	17.	" " " Fulcrum.
Engelblume	18.	" " " Rod.
Engelfried	19.	" " " " Guide.
Engelgras	20.	" " Crank.
Engelhar	21.	" " " Hanger.
Engelknabe	22.	" " " Rod.
Engelkruid	23.	" " " Jaw.
Engelmesse	24.	" " Lever "

In ordering pump barrel, the side wanted for should be indicated in the order.

Plate 58



Pump Check and Feed Cock

Plate 58. Engelmiene

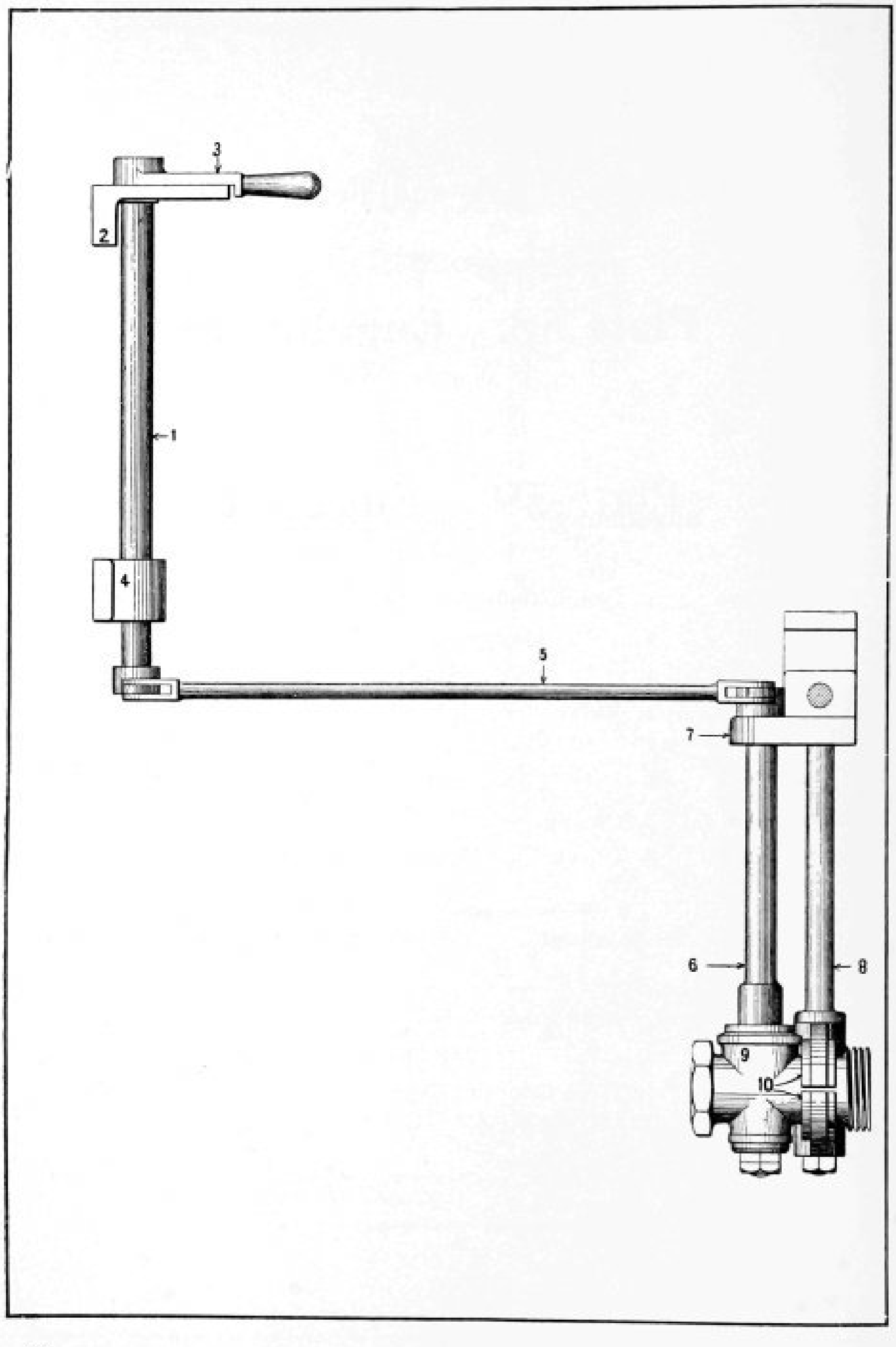
Engelmund . . FIGURE 1.—Pump Check.

Engelname . 1. Check Body.
Engelrein . 2. " Flange.
Engelroche . 3. " " Studs.
Engelsauge . 4. Valve.
Engelsch . 5. " Seat.
Engelschar . 6. " Cage.
Engelseele . 7. Casing.
Engelskind . 8. Check Pipe Coupling Nut.

Engelskopf . . FIGURE 2.—Feed Cock.

Engelstand . 9. Feed Cock Body.
Engelstill . . 10. " " Plug and Nut.
Engelsweib . 11. Hose Coupling Nut.
Engelthal . 12. " Swivel.
Engeltrude 13. Feed Pipe.

Plate 59

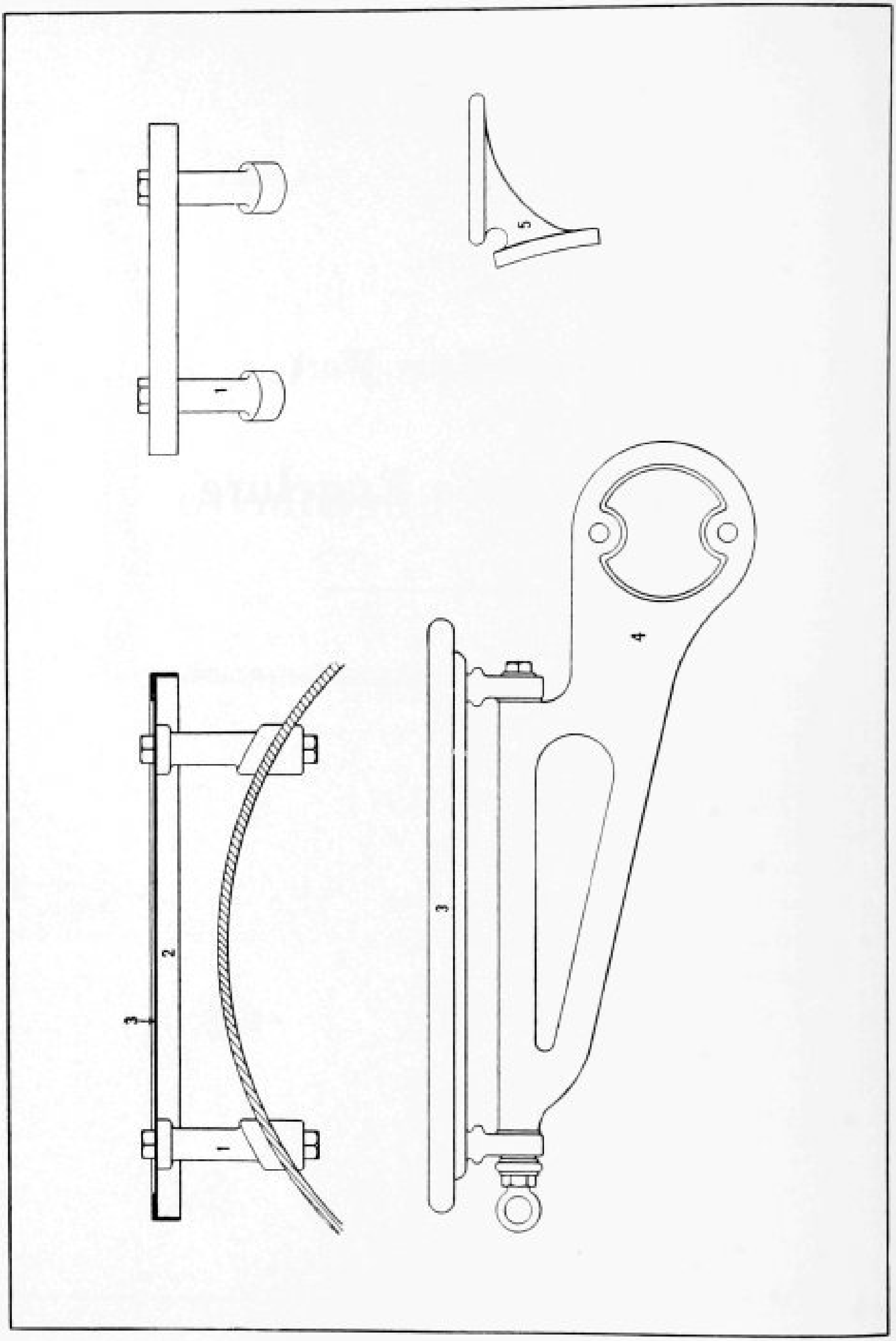


Feed Water Work

Plate 59. Engelure

Engelwelt	1.	Shaft.
Engelzoet . .	2.	" Quadrant.
Engenceant	3.	" Handle.
Engendered	4.	" Hanger.
Engendrais	5.	" Rod.
Engendrer . .	6.	Cock Shaft.
Engendriez	7.	" " Bearing.
Engendront	8.	" Hanger.
Engenhador .	9.	Cock.
Engenharia	10.	Pipe Clamp.

Plate 60



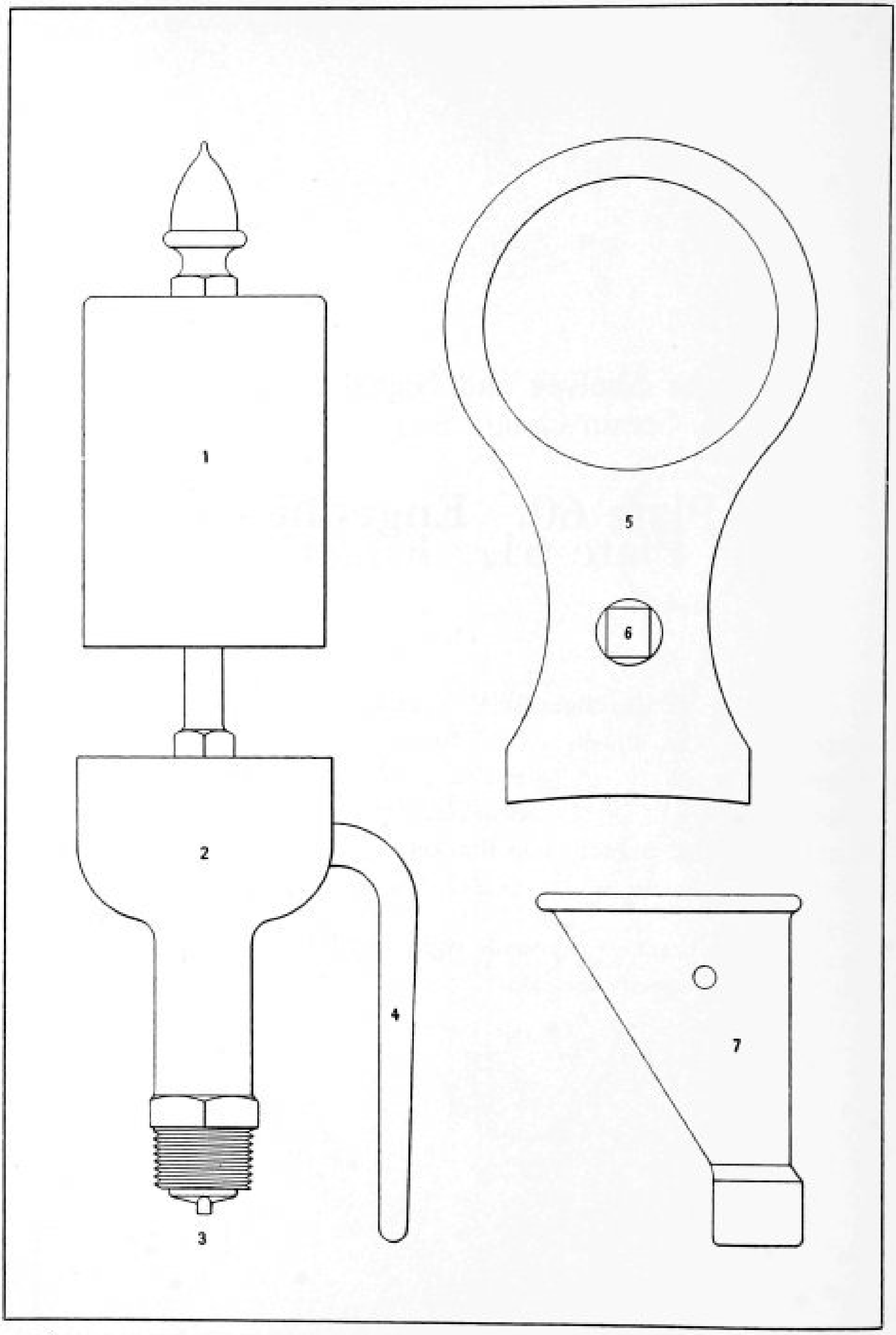
Headlight Shelves and Signal Light Bracket

Plate 60. Engenheiro

Engenho	1.	Headlight Shelf Column.
Engenhoso	2.	" " Edge.
Engeoleur	3.	" Shelf.
Engeray	4.	" Bracket.
Engerbage	5.	Signal Light Bracket.

Headlight brackets are made right and left, and orders for single brackets should specify the side.

Plate 61

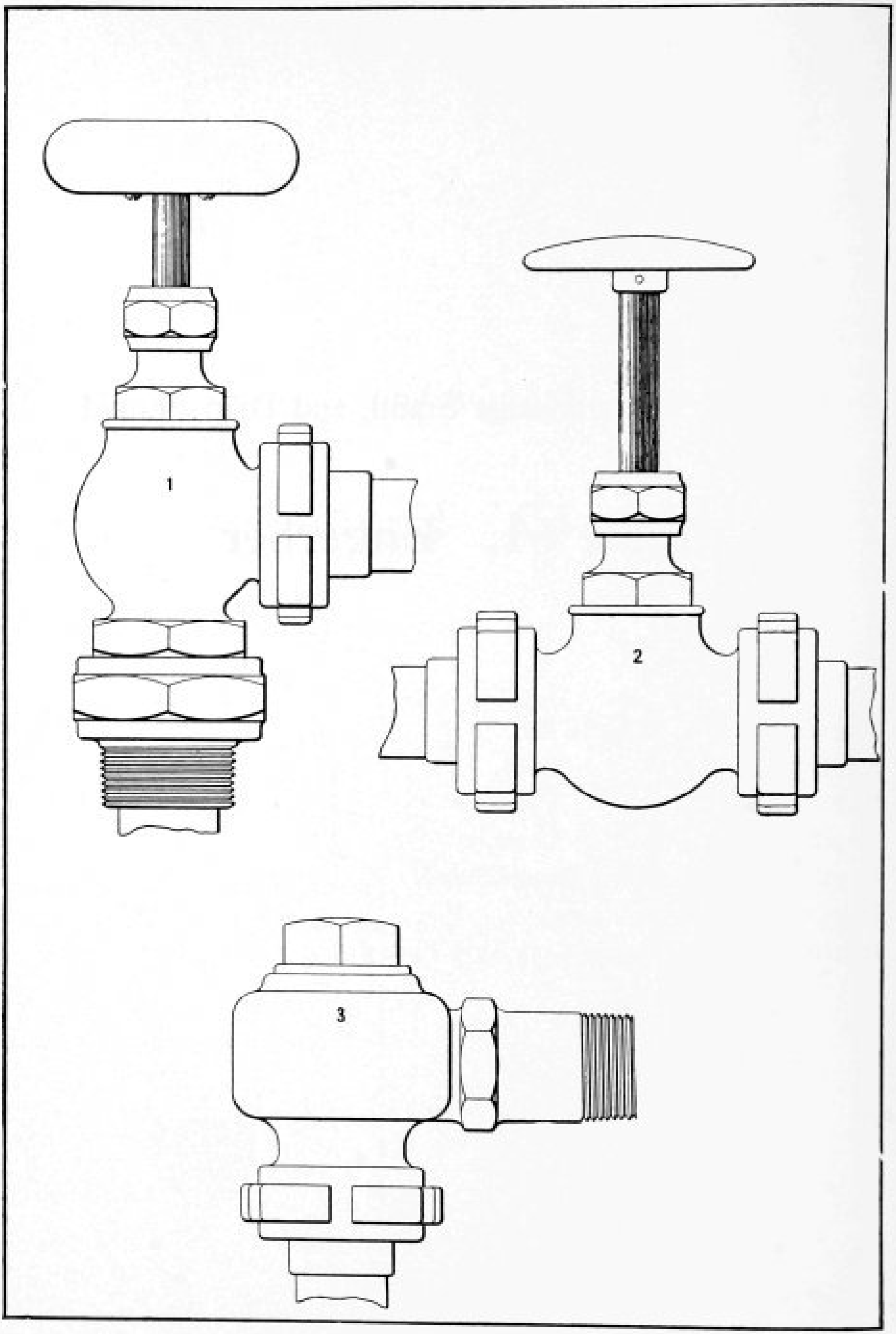


Whistle, Steam Gauge Stand, and Drip Funnel

Plate 61. Engerber

Engessar	. . 1.	Whistle Bell.
Enggasse	. . 2.	" Bowl.
Engherzig	. . 3.	" Valve.
Engibate	. . 4.	" Lever.
Engibatis	. . 5.	Steam Gauge Stand.
Engihoul	. . 6.	Cab Lamp "
Engimelgar	7.	Gauge Cock Drip Funnel.

Plate 62



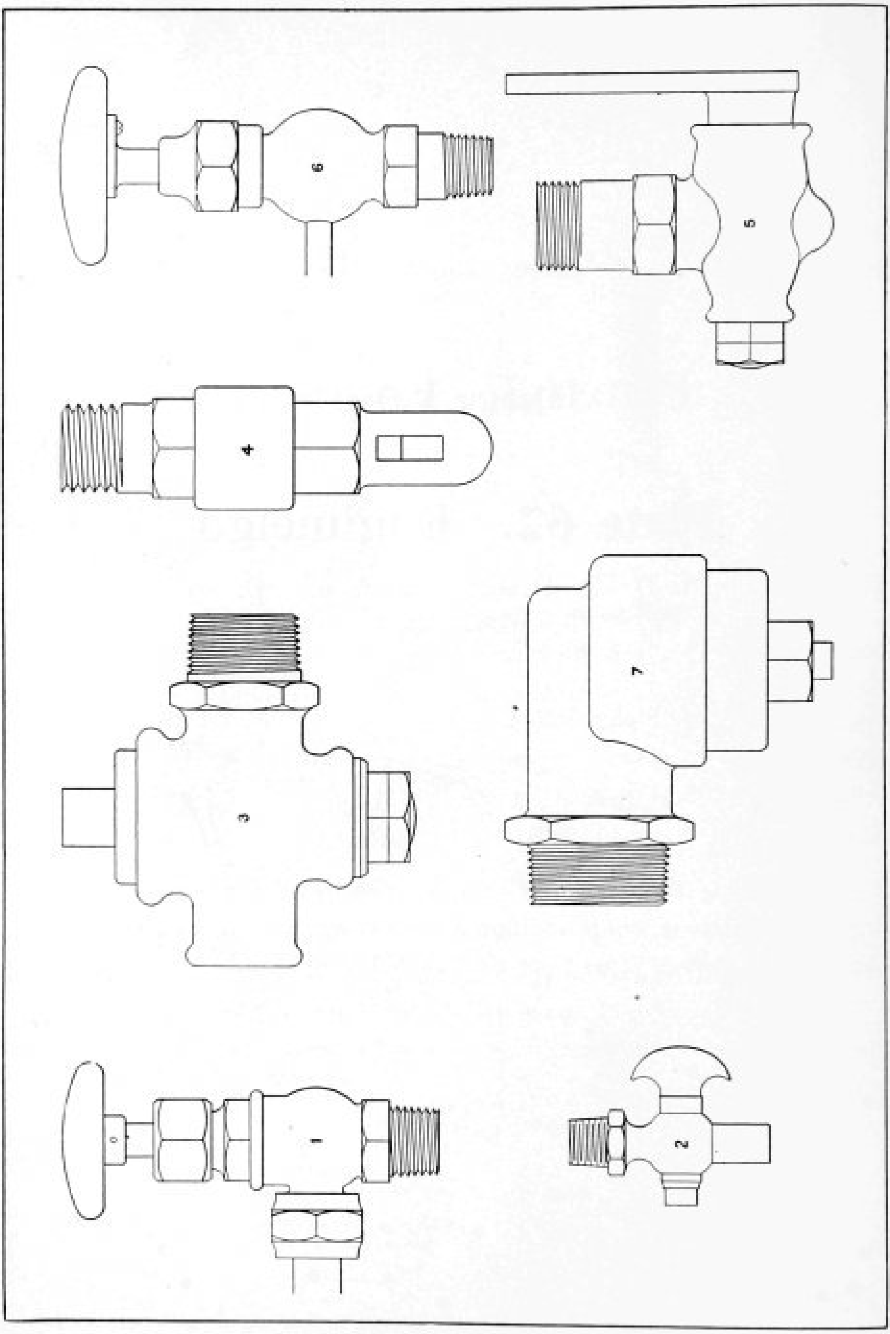
Injector Valves

Plate 62. Engimelgo

Enginadure	1. Steam Valve.
Engineers	2. Feed "
Engineman	3. Check "

In ordering these parts, if they are required for any change from original dimensions, or are additional to what was first put on the engine, the size and kind of pipes to be used should be specified.

Plate 63



Valves and Cocks

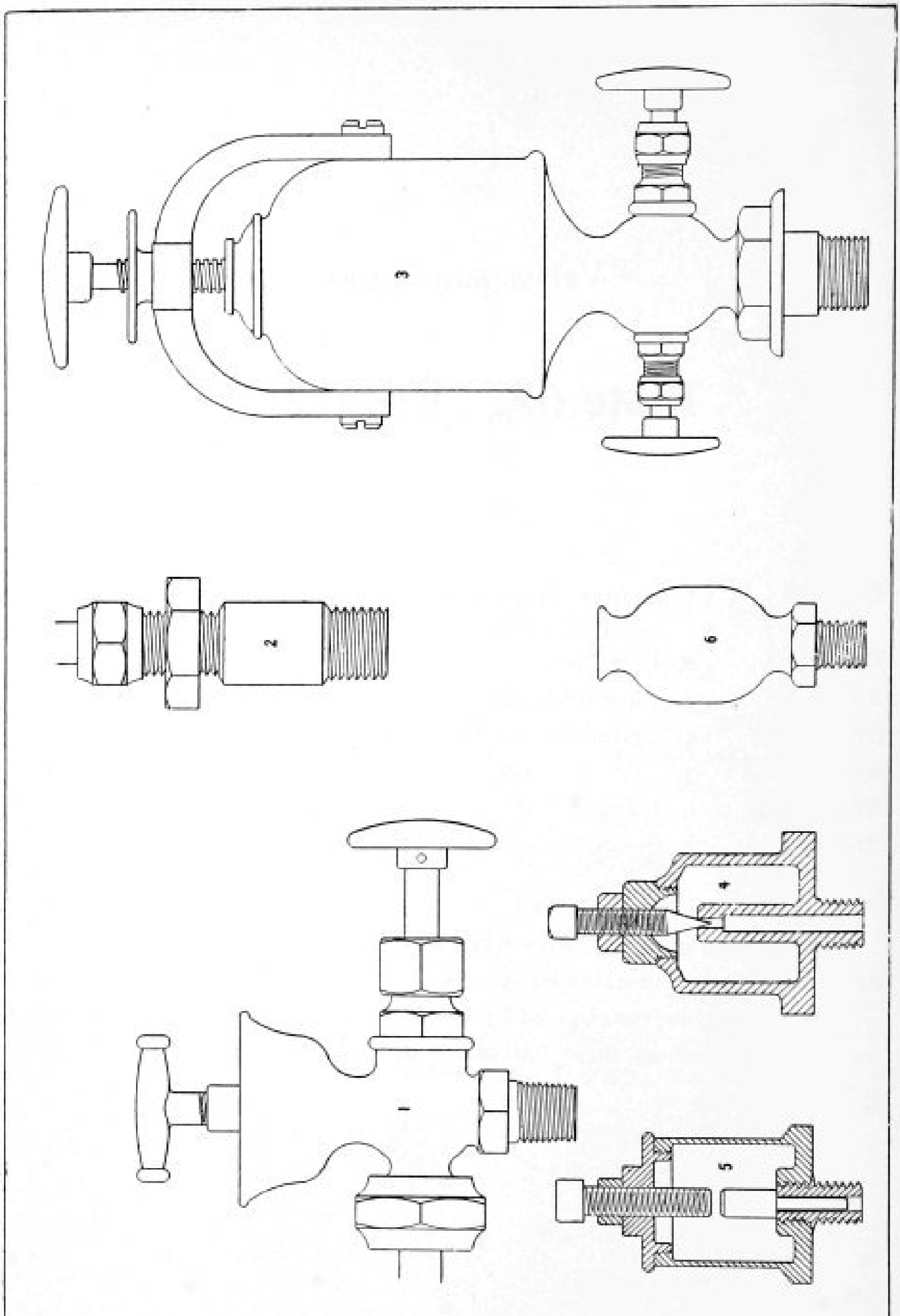
Plate 63. Enginery

Engines . . .	1.	Blower, Heater, Steam Brake Stop Valve or Spark Ejector Valve.
Enginous . .	2.	Drip Cock.
Engirdle . .	3.	Blow-off Cock.
Engirdling .	4.	Cylinder Cock (Buchanan style.)
Engiscopio	5.	" Cock.
Engisome . .	6.	Gauge "
Engisop	7.	Steam Chest Relief Valve.

In ordering cylinder cocks when not in full sets, the side they are wanted for must invariably be specified.

In ordering valves covered by number 1 above, specify the name of the valve wanted, as these valves are of different sizes, though of the same type.

Plate 64



Oil Cups

Plate 64. Englad

Engladded . 1. Cylinder Oiler in Cab, Baldwin style. (See Plates 87, 88, 89 and 90 for Sight Feed Cylinder Lubricators).

Engladding . 2. Oil Pipe Connection on Steam Chest.

Englaender 3. Condensing Oil Cup " " "

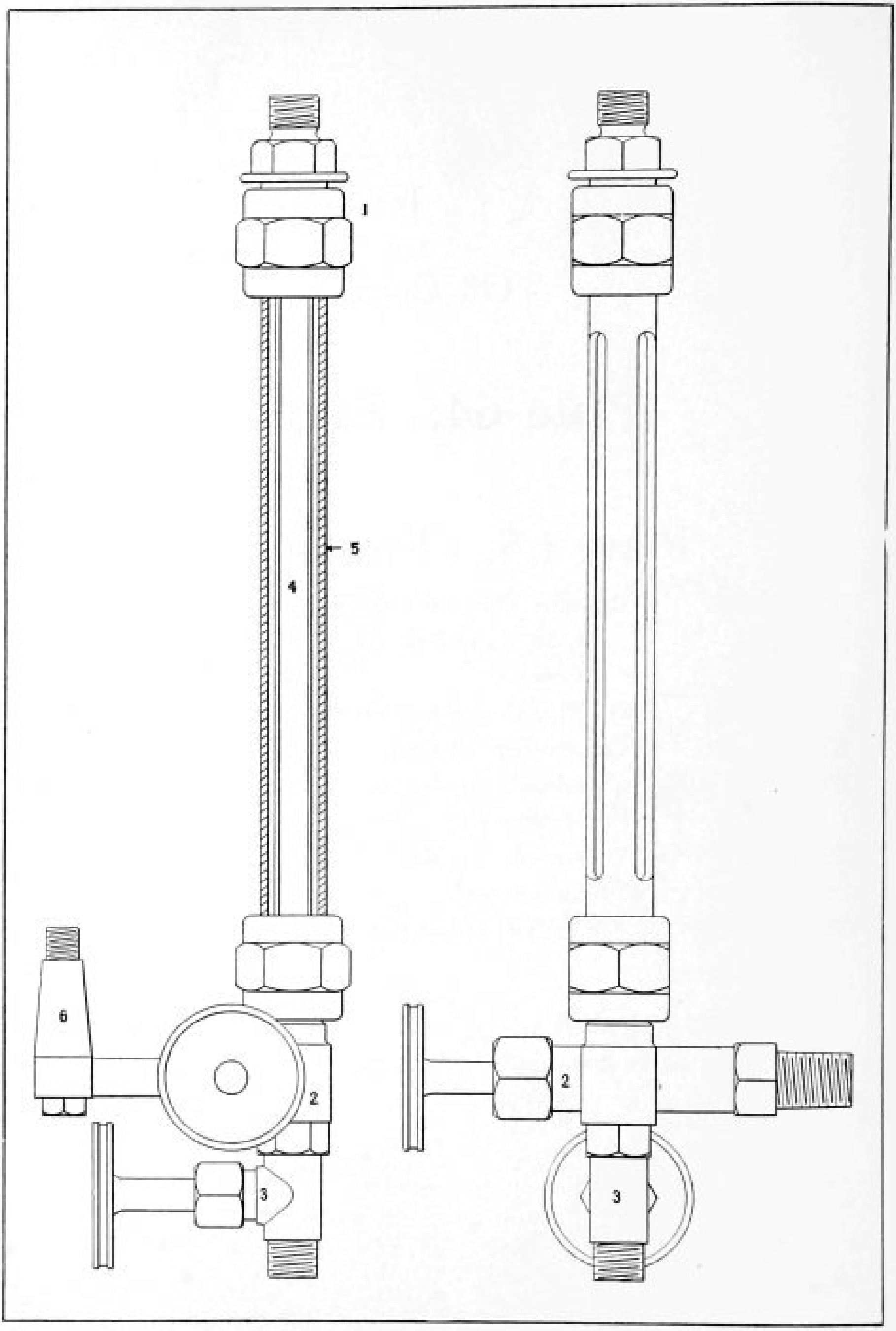
Englaine . . 4. Crosshead, Guide, or Connecting Rod Oil Cup (Needle style).

English . 5. Crosshead, Guide, or Connecting Rod Oil Cup (Plunger style).

Englishman 6. Rock Shaft Oil Cup.

In ordering numbers 4 or 5, it will be necessary to specify whether they are wanted for crossheads, guides, or rods.

Plate 65

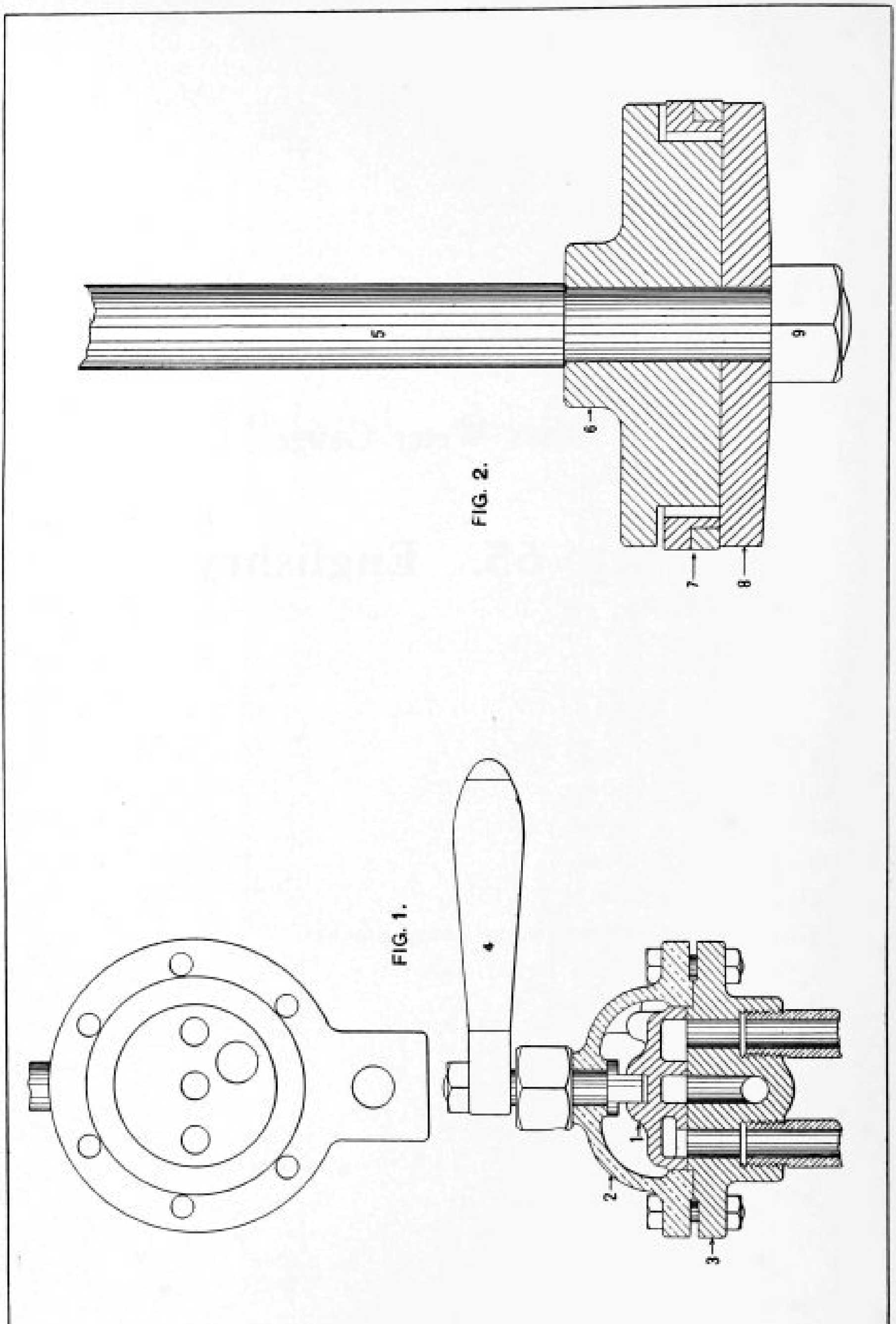


Glass Water Gauge

Plate 65. Englishry

Englobar . .	1. Upper Fitting.
Engloom .	2. Lower "
Engloomed	3. Drain Valve.
Englooming	4. Glass.
Engloutir . .	5. Guard.
Engluage . .	6. Water Gauge Lamp Bracket.

Plate 66



Engineer's Brake Valve, and Steam Brake Piston

Plate 66. Englued

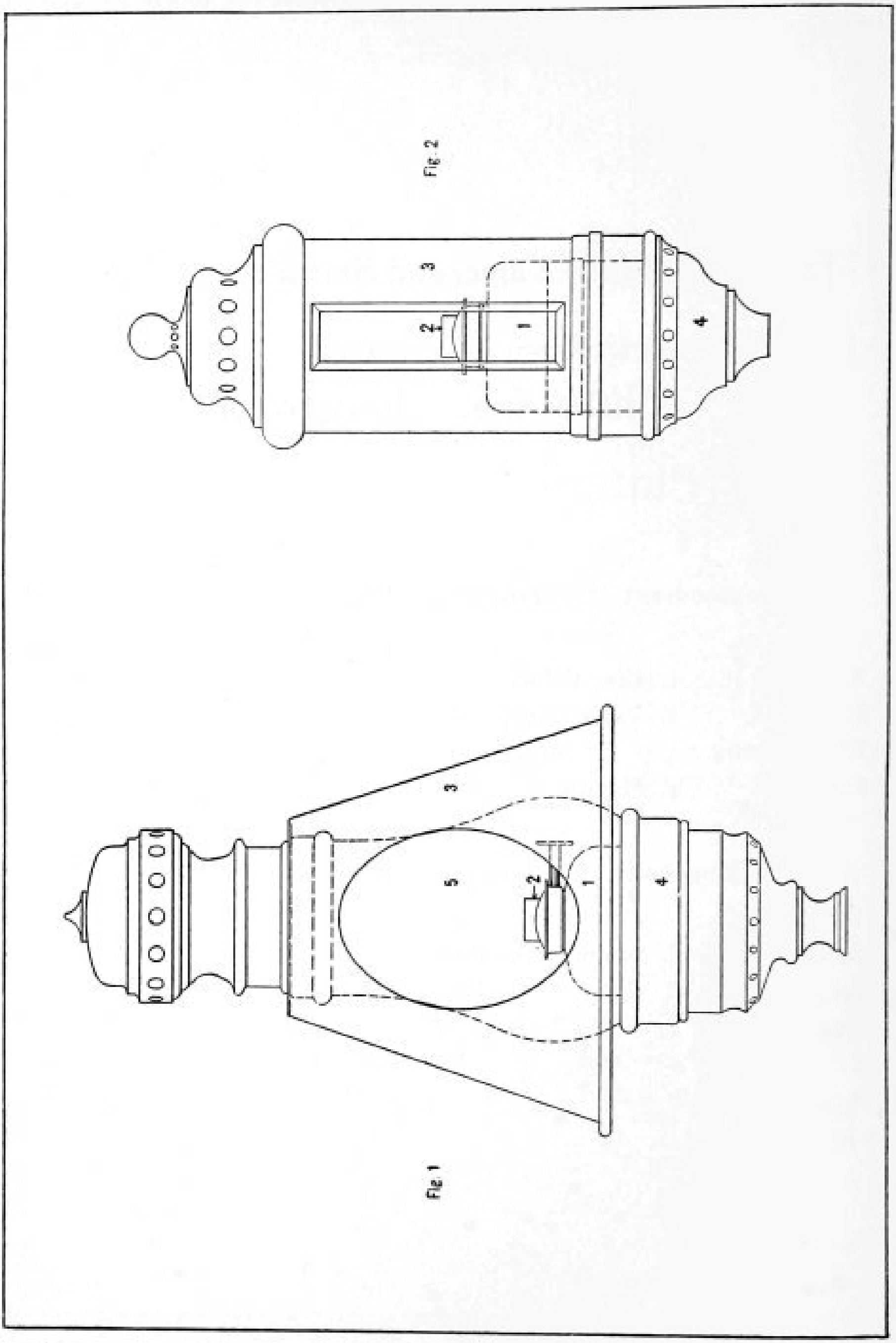
Engluement . . . FIGURE 1.—Engineer's Brake Valve.

Engluing . . . 1. Disc Valve.
Englut . . . 2. Valve Cover.
Engmaschig . 3. " Body.
Engnetz . . . 4. Handle.

Engobage . . . FIGURE 2.—Steam Brake Piston.

Engodado . . 5. Steam Brake Piston Rod.
Engodar . . 6. " " Piston.
Engodativo . 7. " " " Packing Rings.
Engolfaba . . 8. " " " Follower.
Engolfamos . 9. " " " Nut.

Plate 67



Steam Gauge Lamp, and Water Gauge Lamp

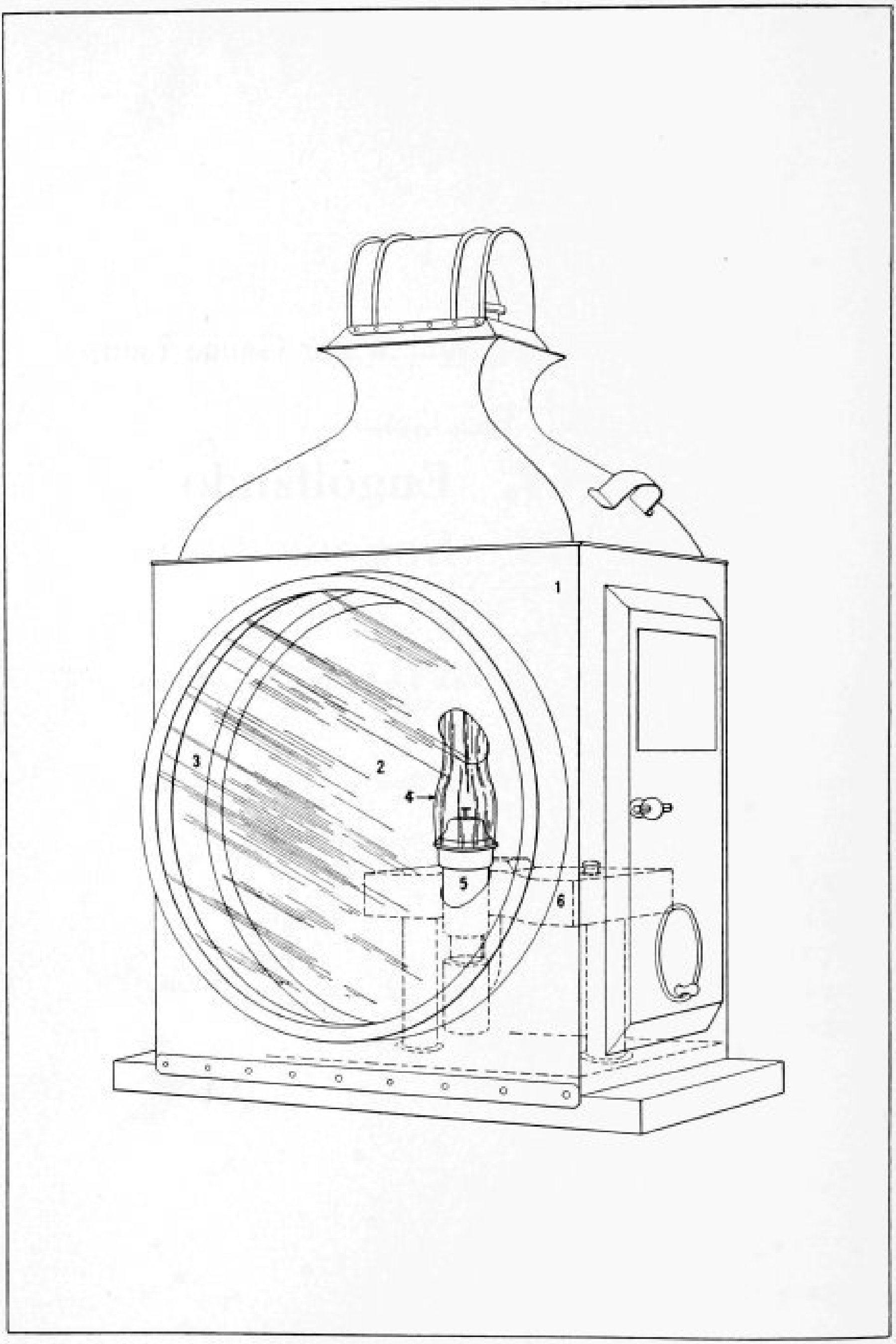
Plate 67. Engolfando

Engolfaron . . FIGURE 1.—Steam Gauge Lamp.

Engolfases . . FIGURE 2.—Water Gauge Lamp.

Engolfeis . . 1. Reservoir.
Engolosino . 2. Burner.
Engomaba . . 3. Shade.
Engomabais . 4. Base.
Engomadas . 5. Globe.

Plate 68

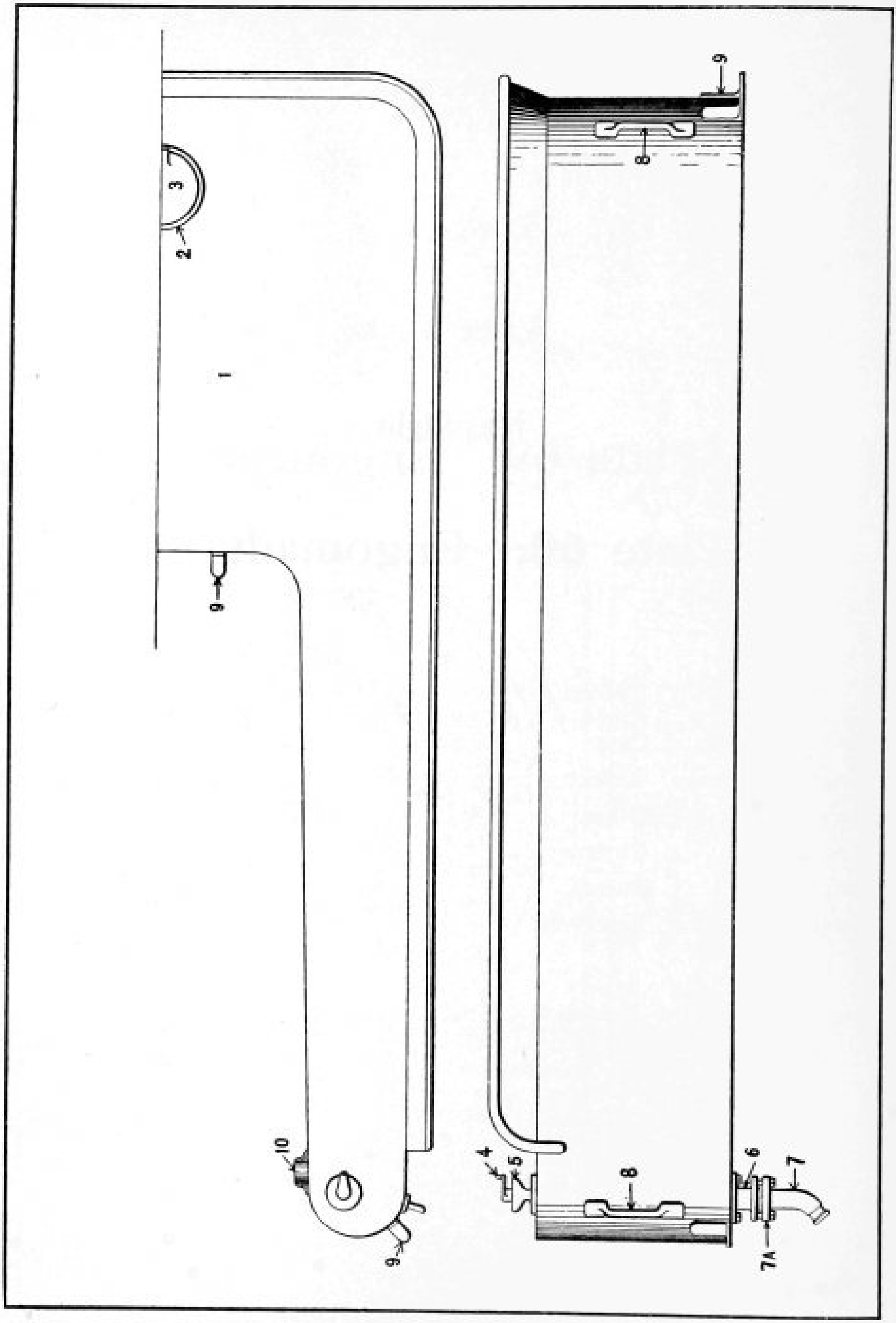


Headlight

Plate 68. Engomadura

Engomamos	1.	Case.
Engomarian	2.	Reflector.
Engomaron	3.	Glass.
Engomeis	4.	Chimney.
Engommant	5.	Burner.
Engonasi	6.	Reservoir.

Plate 69

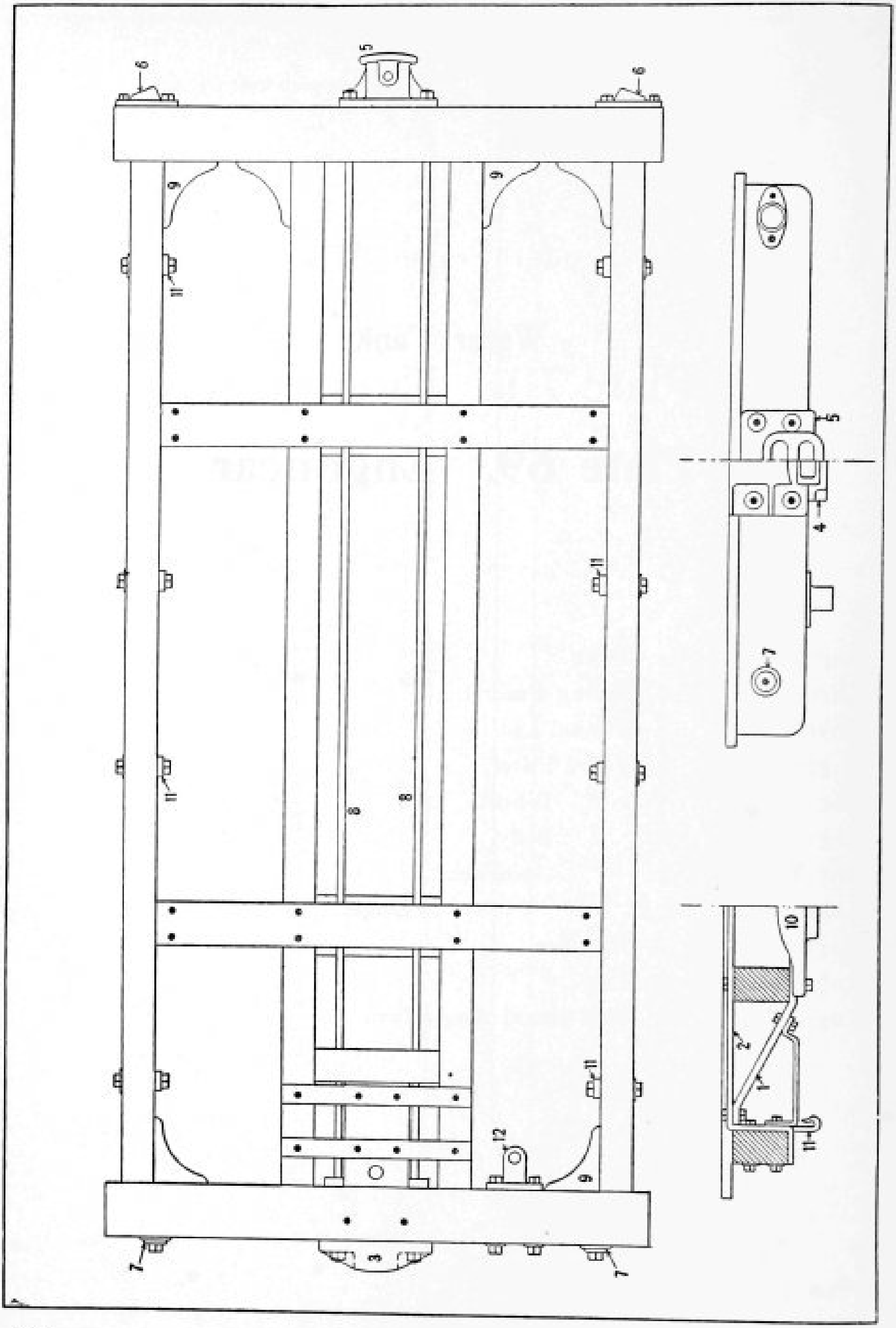


Water Tank

Plate 69. Engoncar

Engordaron	1.	Tank.
Engordasen	2.	Filling Funnel.
Engordurar	3.	Funnel Lid.
Engorgeant	4.	Valve Lifter.
Engorgeth	5.	" Wheel.
Engorgitar	6.	" Body.
Engorlador	7.	" Gooseneck.
Engorlar	7A.	" " Flange.
Engorroso	8.	Handles.
Engouant	9.	Lugs.
Engouffre	10.	Fuel Board Angle Iron.

Plate 70



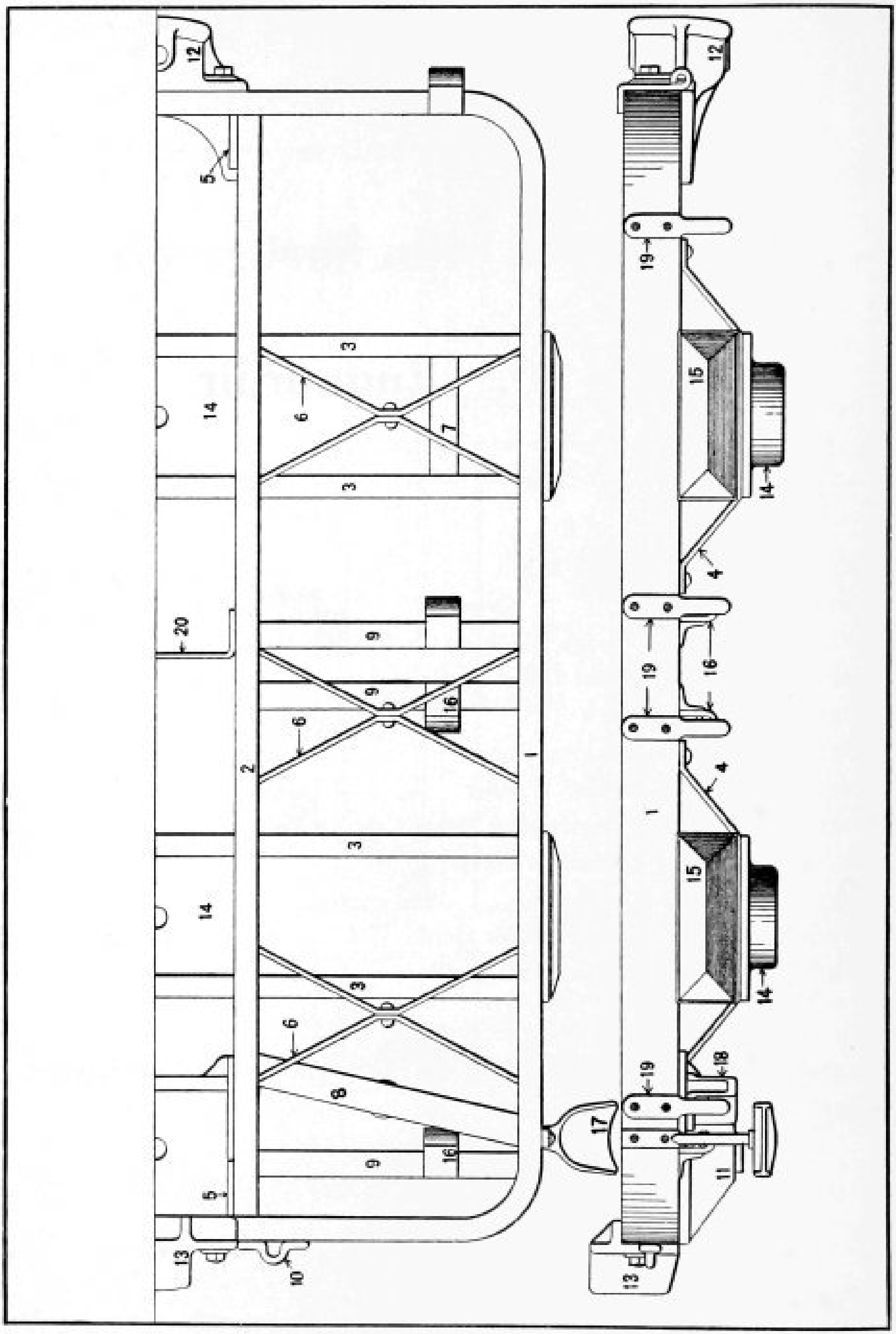
Tender Frame, Wood

Plate 70. Engourdir

Engoznabas	1.	Truss Bar.
Engoznado	2.	" " Crosstie.
Engoznaran	3.	Wedge Block or Chafing Casting.
Engoznas	4.	Front Draw Casting.
Engpaessen	5.	Back " "
Engpass	6.	Pushing Shoe.
Engracado	7.	Frame Washer.
Engracante	8.	Longitudinal Draw Casting Bolt.
Engrachar	9.	Corner Bracket.
Engracia	10.	Center-pin.
Engradecer	11.	Safety Chain Hook.
Engrailing	12.	Brake Shaft Guide.

Orders for center-pins should specify whether front or back are required when not for full sets.

Plate 71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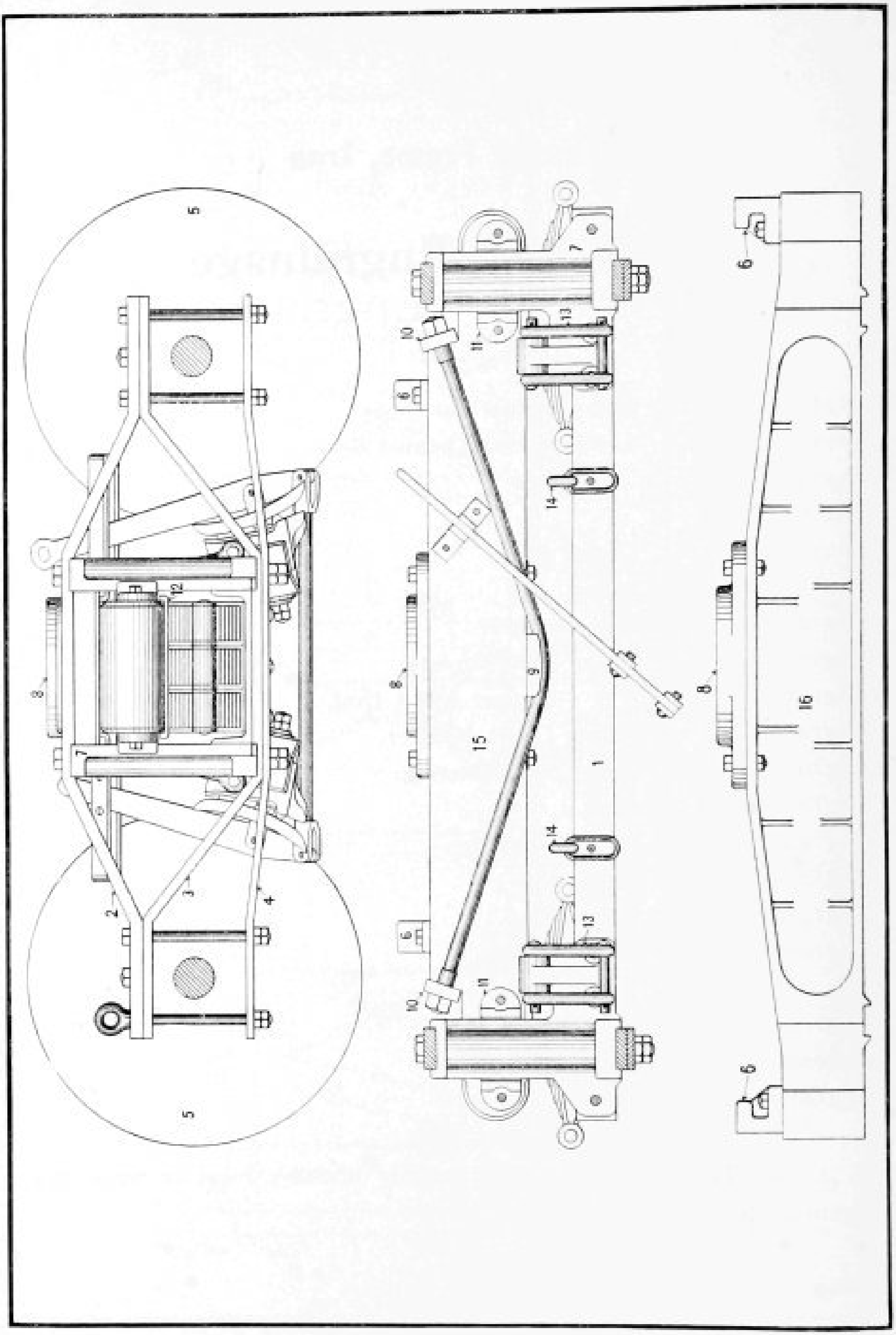
Tender Frame, Iron

Plate 71. Engrainage

Engraisser	1.	Side Channel Bar.
Engraixar	2.	Longitudinal Channel Bar.
Engranaje	3.	Transverse " "
Engrandeci	4.	" " " Strap.
Engranero	5.	Corner Plate.
Engranger	6.	Brace.
Engranizar	7.	Side Bearing.
Engrapador	8.	Brake Shaft Crosstie.
Engraparas	9.	" Hanger Angle Iron.
Engrapas	10.	Safety Chain Hanger.
Engrapasen	11.	Front Draw Casting.
Engrappled	12.	Back " "
Engrasais	13.	Chafing Casting.
Engrasando	14.	Center-pin.
Engrasaran	15.	Bolster Cap.
Engrasaria	16.	Brake Clevis.
Engrases	17.	Tender Step.
Engrasped	18.	Brake Shaft Step.
Engrasping	19.	Safety Chain Hook.
Engratie	20.	Brace.

Orders for center-pins should specify whether front or back are required when not for full sets.

Plate 72



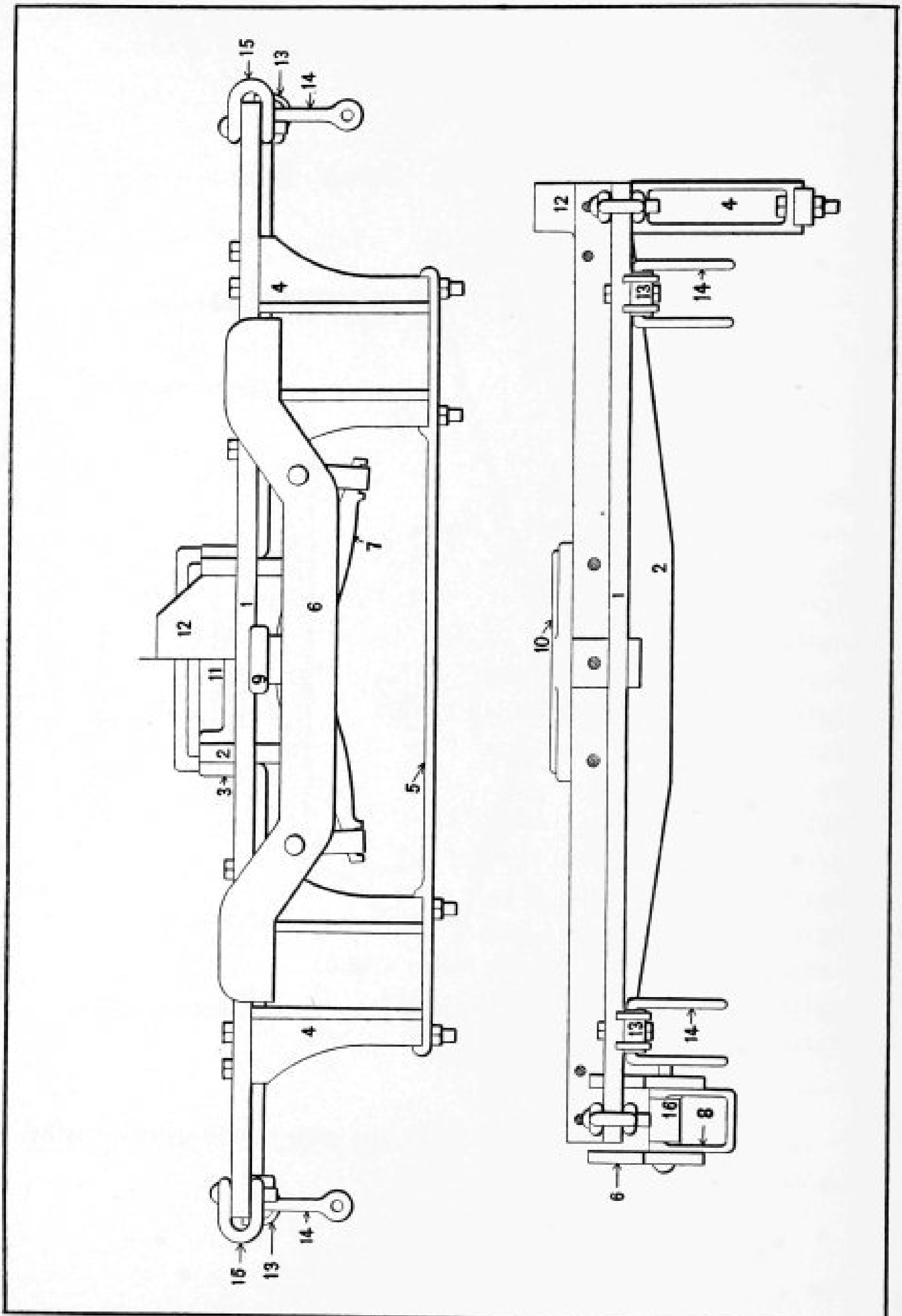
Tender Truck, Arch Bar

Plate 72. Engraulis

Engrave	1.	Channel Bar.
Engravery	2.	Top Bar of Frame.
Engravure	3.	Truss " " "
Engreaten	4.	Bottom " " "
Engrecer	5.	Wheel.
Engregge	6.	Side Bearing.
Engreimos	7.	Frame Filling Piece.
Engreiran	8.	Center Plate.
Engreireis	9.	Truss "
Engrelar	10.	" Washer.
Engrenhar	11.	Bolster Guide.
Engrescado	12.	Spring Seat.
Engrescar	13.	Brake Clevis.
Engresques	14.	" Beam Safety Chain.
Engret	15.	Bolster, Wood.
Engreter	16.	Bolster, Cast Steel.

In ordering parts for a single truck, the order should specify whether they are wanted for front or back truck.

Plate 73



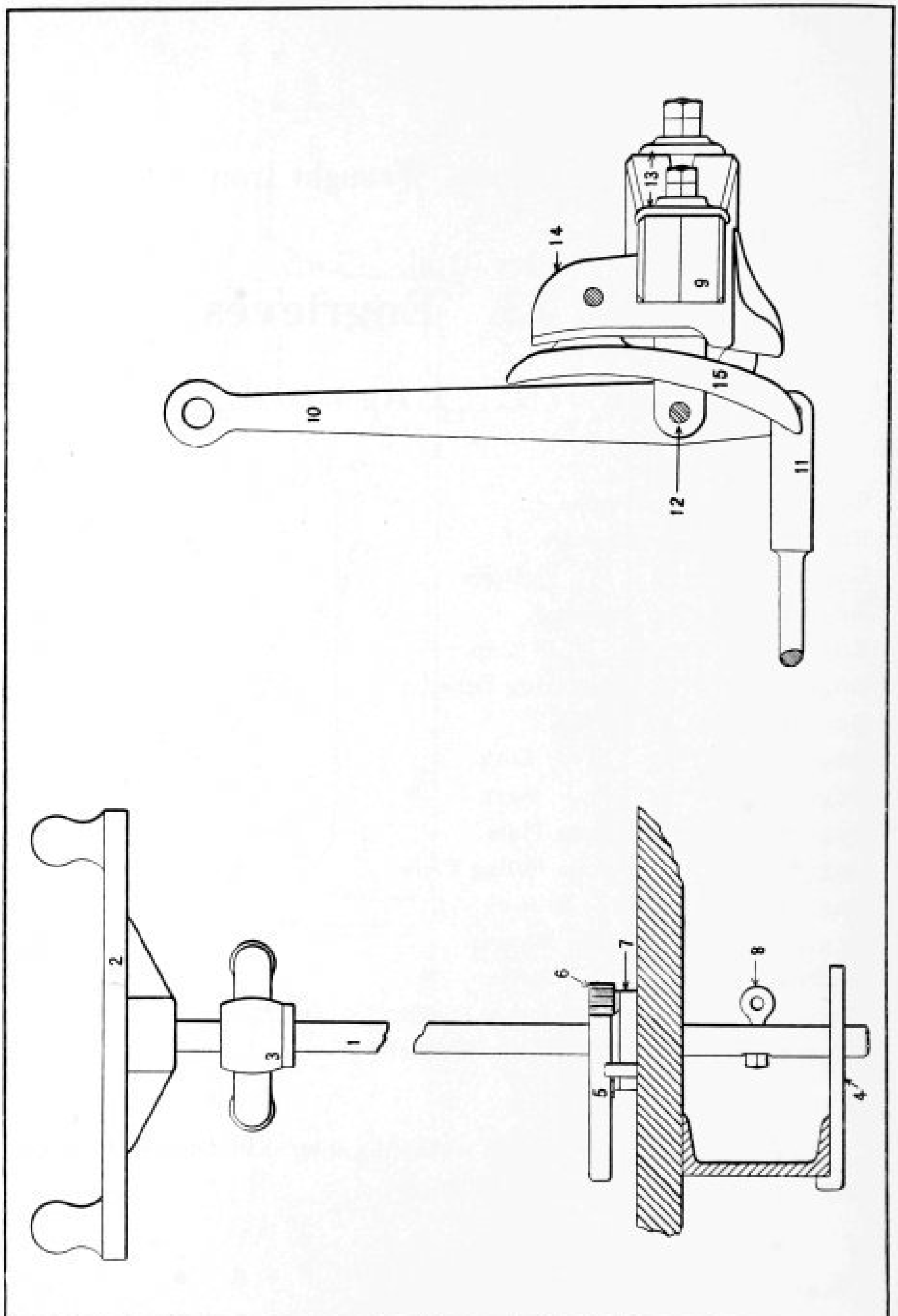
Tender Truck, Wrought Iron

Plate 73. Engrieves

Engrimanco	1.	Frame.
Engrogne . .	2.	Crosstie.
Engrosado	3.	" Brace.
Engrosamos	4.	Pedestal.
Engrossed .	5.	" Cap.
Engrossing	6.	Equalizing Beam.
Engrotar . .	7.	Spring.
Engrudabas	8.	" Link.
Engrudador	9.	" Seat.
Engrudara	10.	Center Plate.
Engrueso .	11.	Frame Filling Piece.
Engrumecer	12.	Side Bearing.
Engrumecio	13.	Brake Hanger.
Engrumele	14.	" Clevis.
Engsichtig	15.	Safety Chain Clevis.
Engsinn . . .	16.	Spring Link Washer.

In ordering parts for a single truck, the order should specify whether they are wanted for front or back truck.

Plate 74

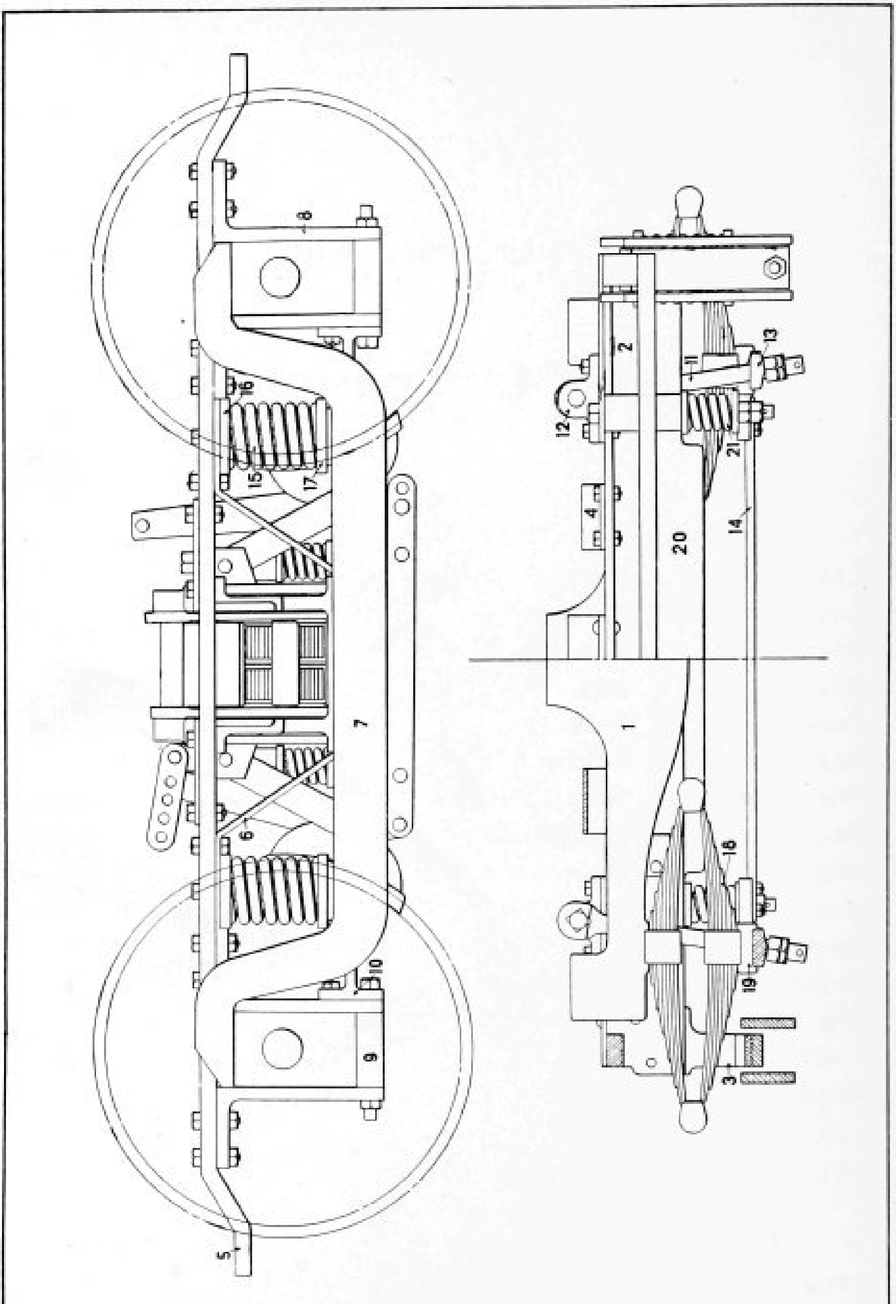


Tender Brake Work

Plate 74. Engsinnige

Engualdado	1. Shaft.
Engualdar	2. Handle.
Engualdeis	3. Hanger.
Engualdo	4. Step.
Enguantada	5. Pawl.
Enguantes	6. Ratchet.
Enguard	7. Plate.
Enguarding	8. Eye Bolt.
Enguenille	9. Beam.
Engueuser	10. Lever.
Enguia	11. " Rod.
Enguicador	12. " Jaw.
Enguicar	13. Washer.
Enguichado	14. Head.
Enguiche	15. Shoe.

Plate 75

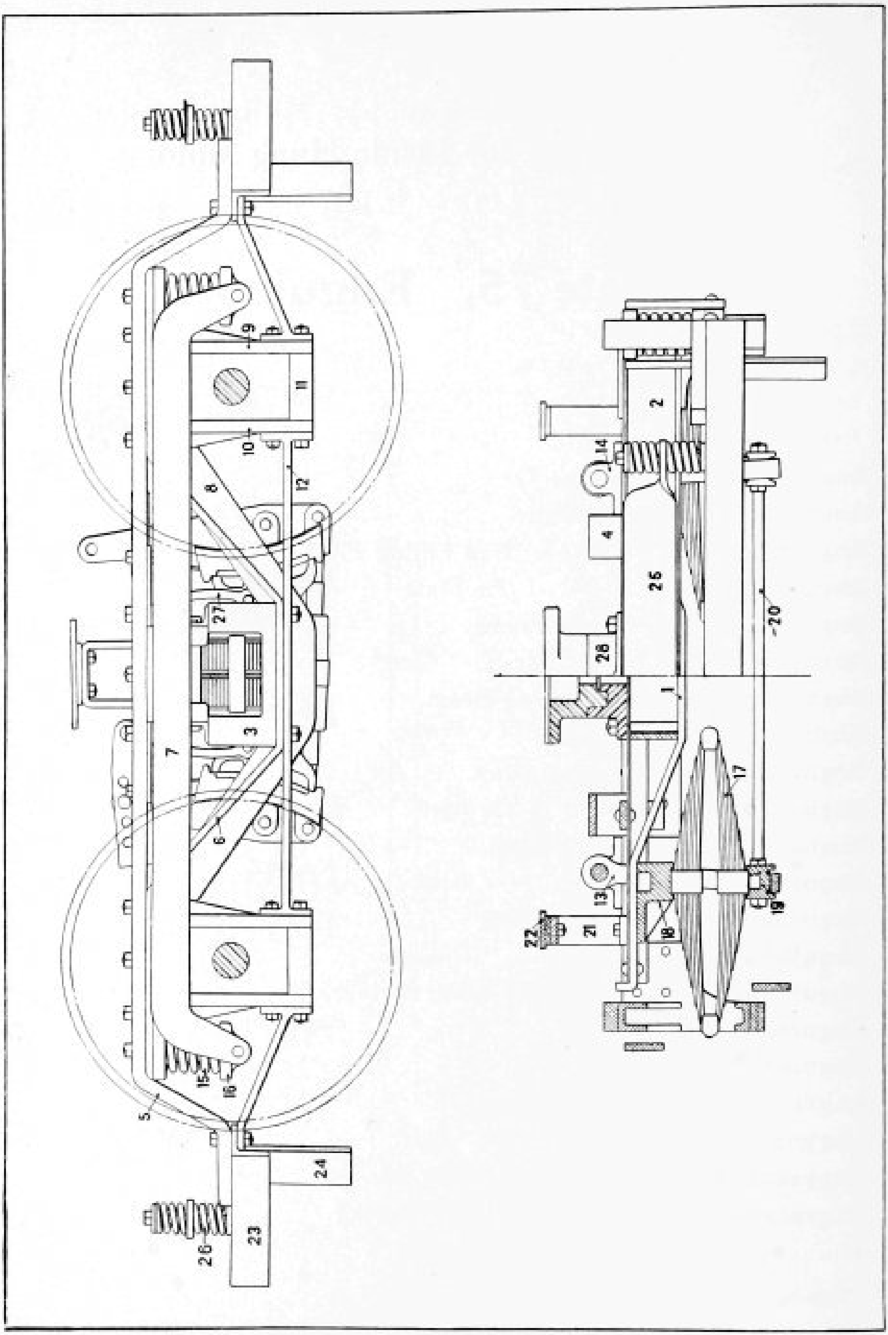


Electric Truck for Inside Hung Motors

Plate 75. Enguico

Enguijarro	1.	Bolster.
Enguinos	2.	Transom.
Enguizgado	3.	" End Filling Piece.
Enguizgo	4.	" Tie Plate.
Enguizgue	5.	Truck Frame.
Engulfed	6.	Truss Bar.
Engulfing	7.	Equalizing Beam.
Engulfment	8.	Pedestal.
Engulho	9.	" Cap.
Engulidor	10.	" Tie Bar.
Engulipar	11.	Swing Link.
Engulir	12.	" " Bearing.
Engulliais	13.	" Beam.
Engullidas	14.	" " Crosstie.
Engulliste	15.	Equalizing Beam Spring.
Engurria	16.	" " " Seat (Top).
Engweg	17.	" " " " (Bottom).
Engyi	18.	Bolster Spring.
Engyon	19.	" " Seat.
Engyscope	20.	Motor Suspension Bar.
Engystome	21.	" " Spring.

Plate 76

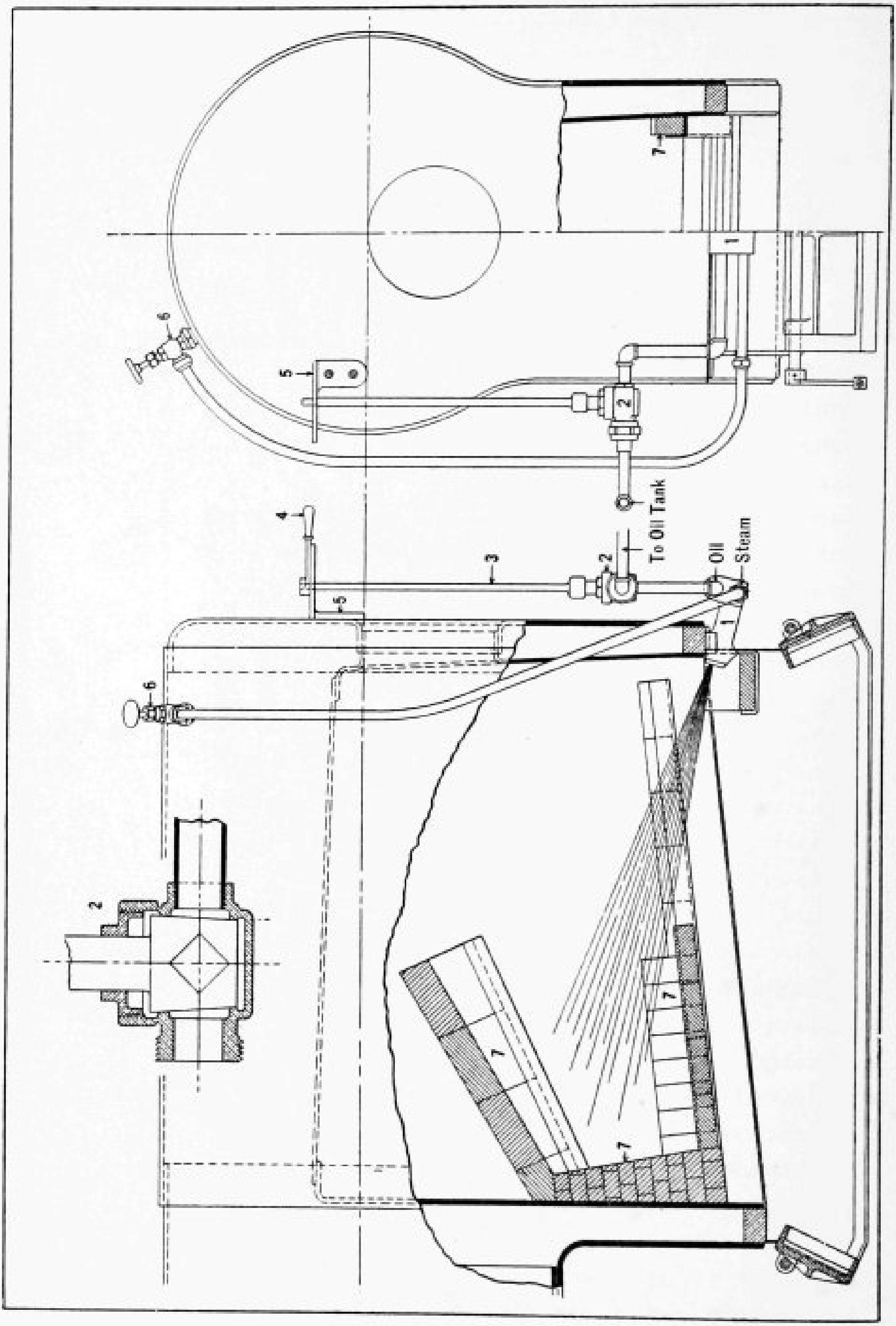


Electric Truck for Outside Hung Motors

Plate 76. Engyum

Enhabile	1.	Bolster.
Enhabiling	2.	Transom.
Enhache	3.	" End Filling Piece.
Enhaemon	4.	" Tie Plate.
Enhale	5.	Truck Frame.
Enhalsing	6.	Truss Bar.
Enhanced	7.	Equalizing Beam (Outside).
Enhancing	8.	" " (Inside).
Enharbour	9.	Pedestal (Outside).
Enhardened	10.	" (Inside).
Enhardimes	11.	" Cap.
Enhardiras	12.	" Tie Bar.
Enharinado	13.	Swing Link.
Enharinar	14.	" " Bearing.
Enharineis	15.	Equalizing Beam Spring.
Enharino	16.	" " " Seat.
Enharmonic	17.	Bolster Spring.
Enharnache	18.	" " Seat (Top).
Enhatijaba	19.	" " " (Bottom).
Enhatijar	20.	" " " Tie Rod.
Enhatijo	21.	Side Bearing.
Enhayeur	22.	" " Plate.
Enhearten	23.	End Frame.
Enhebradas	24.	Rail Guard Bracket.
Enhebrado	25.	Motor Suspension Bar.
Enhebramos	26.	" " Spring.
Enhebrar	27.	Brake Clevis.
Enhebraron	28.	Center Plate.

Plate 77

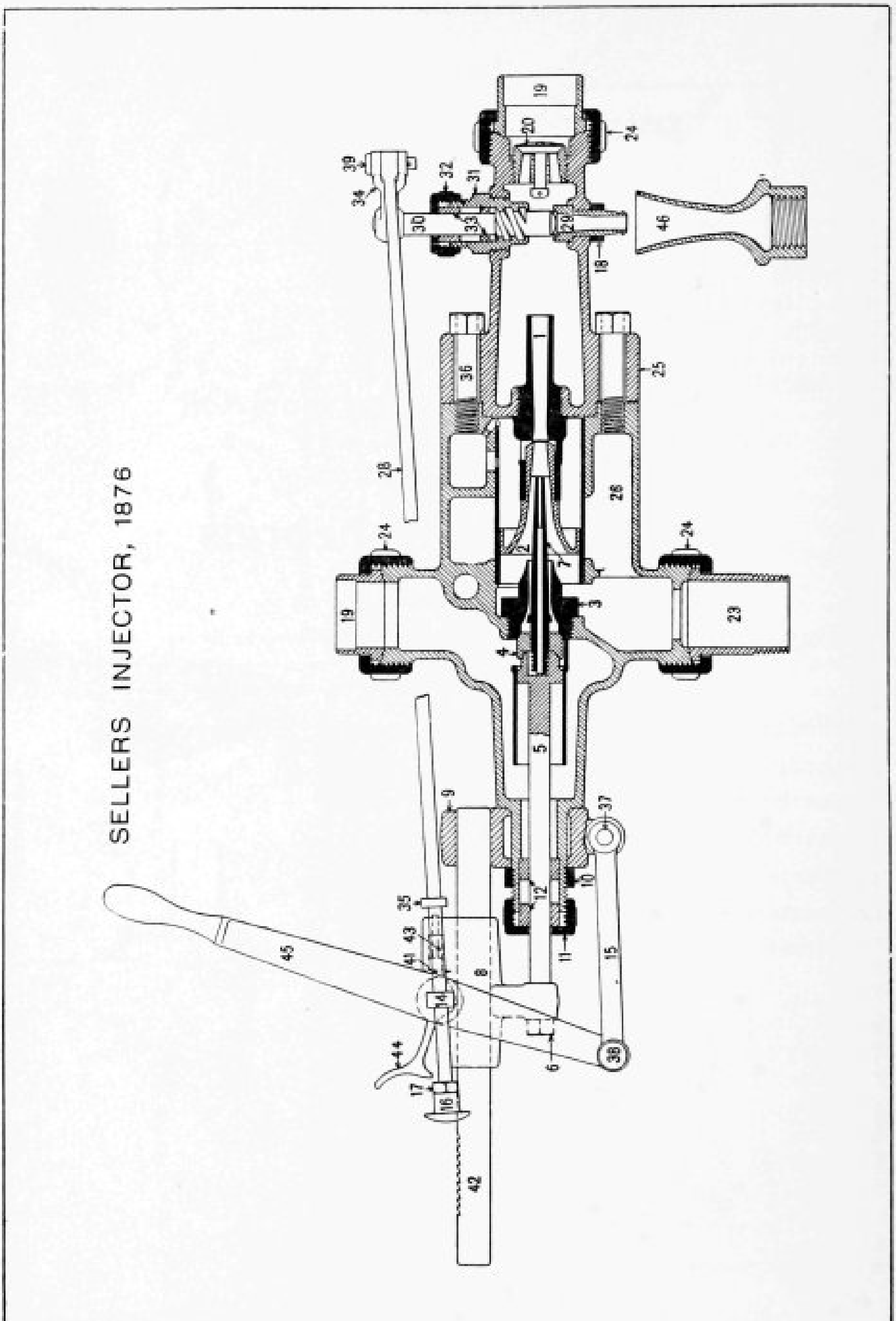


Apparatus for Burning Fuel Oil

Plate 77. Enhebreis

Enhedged . . 1. Oil Injector.
Enhedging . 2. " Cock.
Enherbolar 3. " " Shaft.
Enherbolo 4. " " " Handle.
Enhestador 5. " " Quadrant.
Enhestamos 6. " Injector Steam Valve.
Enhestar . . 7. Fire Brick.

Plate 78



SELLERS INJECTOR, 1876

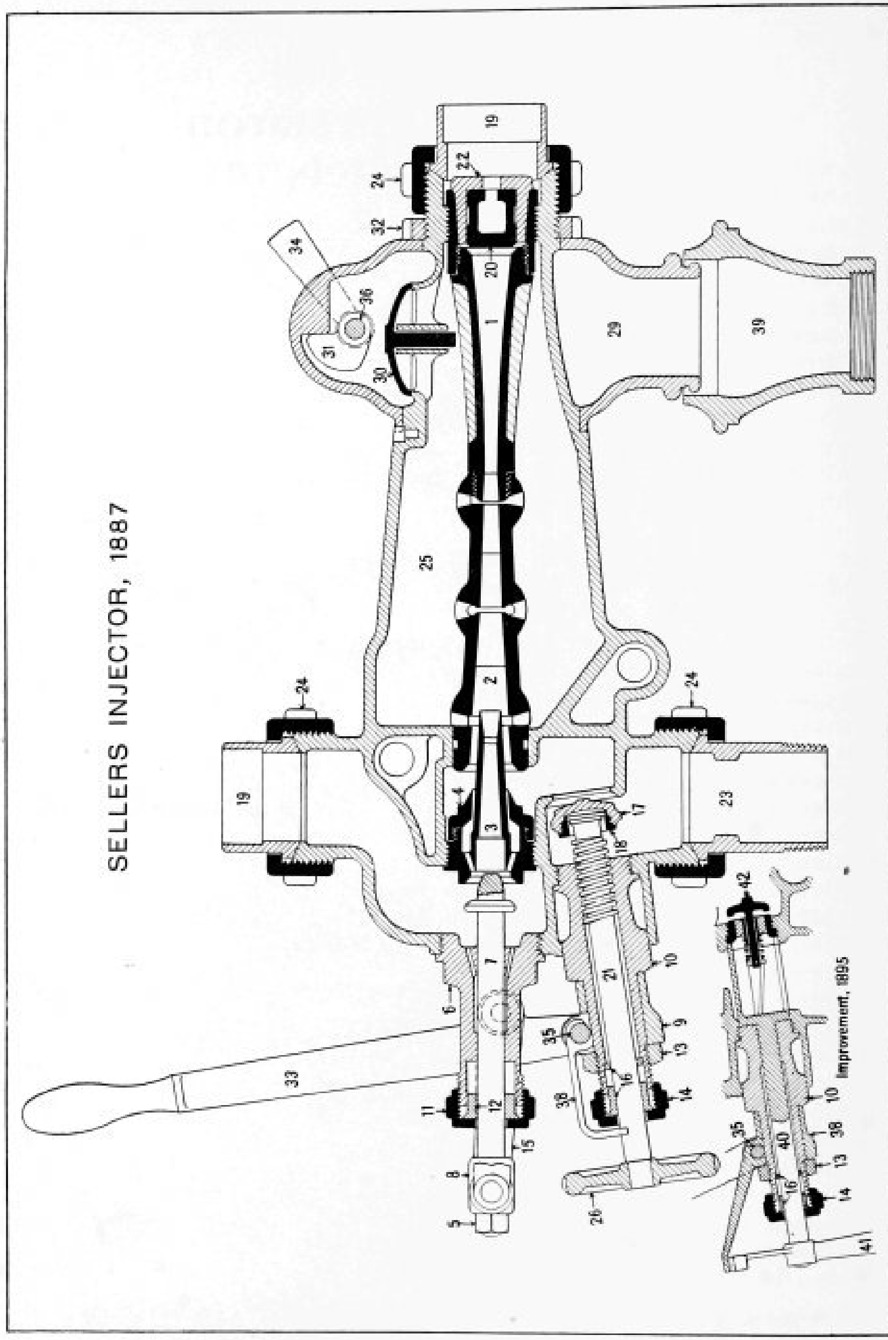
Sellers Injector, 1876

Plate 78. Enhestaron

Enhestases	1.	Delivery Tube.
Enheuder	2.	Combining Tube.
Enhielado	3.	Steam Nozzle.
Enhielar	4.	Valve on No. 7.
Enhielo	5.	Solid Spindle.
Enhoramala	6.	Nut on top of No. 5.
Enhorts	7.	Hollow Spindle.
Enhuche	8.	Crosshead.
Enhuerado	9.	Collar on No. 26.
Enhueraron	10.	Lock Nut for No. 9.
Enhuiler	11.	Follower on No. 26.
Enhunger	12.	Packing Rings under No. 11.
Enhungered	14.	Fulcrum Pin.
Enhydridem	15.	Link.
Enhydro	16.	Knob on end of No. 28.
Enhydrobie	17.	Lock Nut for No. 16.
Enhydrorum	18.	Nut on No. 29.
Enhygros	19.	Plain Ring for Copper Pipe.
Enicabant	20.	Check Valve.
Enicabimus	23.	Union to Pipes.
Enicocere	24.	Coupling Nut.
Enicode	25.	Lower Cylinder.
Eniconette	26.	Upper "
Eniconevre	28.	Connecting Rod.
Enicostome	29.	Waste Pipe.
Enicotarse	30.	Screw Valve.
Enicure	31.	Stuffing Box for No. 30.
Enidride	32.	Follower on No. 31.
Eniellage	33.	Packing Rings under No. 32.
Enigmar	34.	Lever on No. 30.
Enigmatico	35.	Collar on No. 28.
Enigmatist	36.	Stud Bolts.
Enigmatize	37.	Pin through Nos. 9 and 15.
Enigme	38.	" " " 15 " 45.
Enimous	39.	" " " 28 " 34.
Enimvero	41.	Pressure Foot.
Eniousses	42.	Guide Rod.
Enipei	43.	Spring for No. 41.
Enipeos	44.	Latch.
Enipeum	45.	Starting Lever.
Enisurorum	46.	Funnel for Overflow.

In ordering parts for injector, give in all cases the maker's number stamped on the injector.

Plate 79



SELLERS INJECTOR, 1887

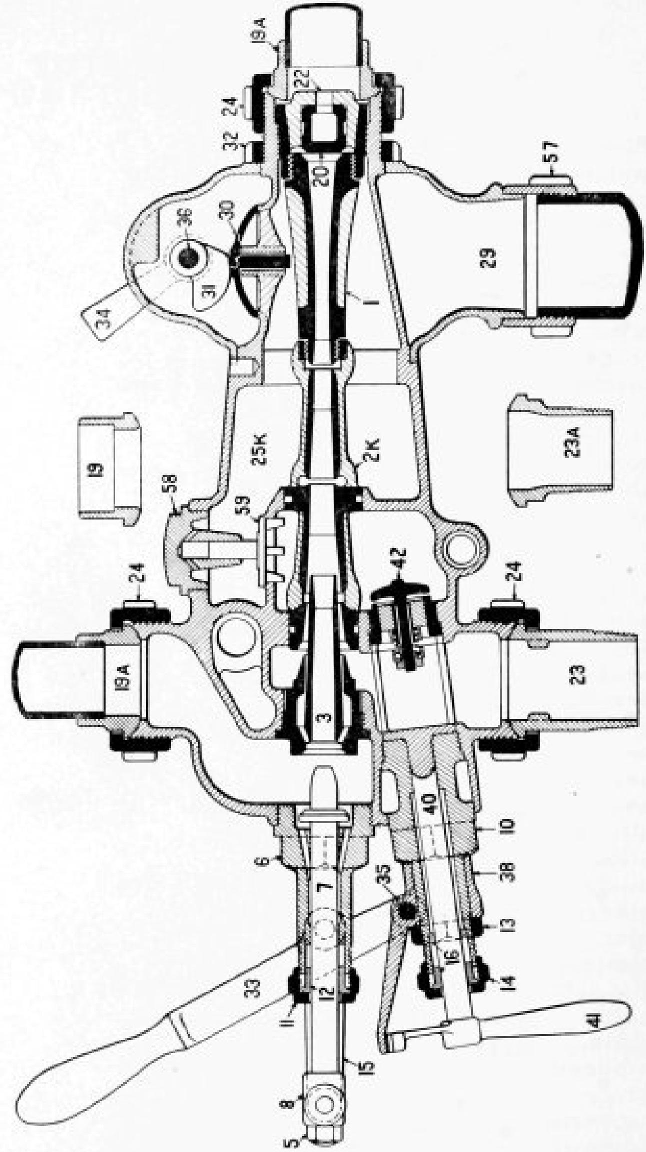
Sellers Injector, 1887

Plate 79. Enitebatur

Enitebunt	1.	Delivery Tube.
Enitentem	2.	Combining Tube.
Enitentis	3.	Forcing Steam Nozzle.
Enithare	4.	Lifting " "
Enivrant	5.	Spindle Nut.
Enivrantes	6.	Stuffing Box for Spindle.
Enivrerais	7.	Spindle.
Enivriez	8.	Crosshead.
Enivrons	9.	Collar on No. 10.
Enixarum	10.	Stuffing Box for Water Valve.
Enixionem	11.	Follower for No. 6.
Enixionis	12.	Packing Ring in No. 6.
Enixo	13.	Lock Nut for No. 9.
Enjabegaba	14.	Follower for No. 10.
Enjabegues	15.	Links.
Enjabler	16.	Packing Ring in No. 10.
Enjabonado	17.	Water Valve.
Enjabonar	18.	Ring in No. 17.
Enjaboneis	19.	Plain Rings for Copper Pipe.
Enjabono	20.	Check Valve.
Enjaezadas	21.	Valve Stem for No. 17.
Enjaezado	22.	Guide for No. 20.
Enjaezar	23.	Plain Unions for Iron Pipes.
Enjaezaron	24.	Coupling Nuts.
Enjaezeis	25.	Injector Body.
Enjaezo	26.	Hand Wheel on No. 21.
Enjail	29.	Waste Pipe.
Enjailed	30.	Waste Valve.
Enjailing	31.	Cam for closing Waste Valve.
Enjalbega	32.	Jam Nut for No. 29.
Enjaler	33.	Starting Lever.
Enjalmada	34.	Lever on Cam Shaft.
Enjalmados	35.	Pin through No. 9. and No. 33.
Enjalmero	36.	Cam Shaft.
Enjalmo	38.	Index.
Enjambage	39.	Funnel for Overflow.
Enjamber	40.	Plug Water Valve.
Enjamberas	41.	Regulating Handle.
Enjambons	42.	Inlet Valve.

In ordering parts for injector, give in all cases the maker's number stamped on the injector.

Plate 80



SELLERS CLASS K INJECTOR
FOR HOT WATER

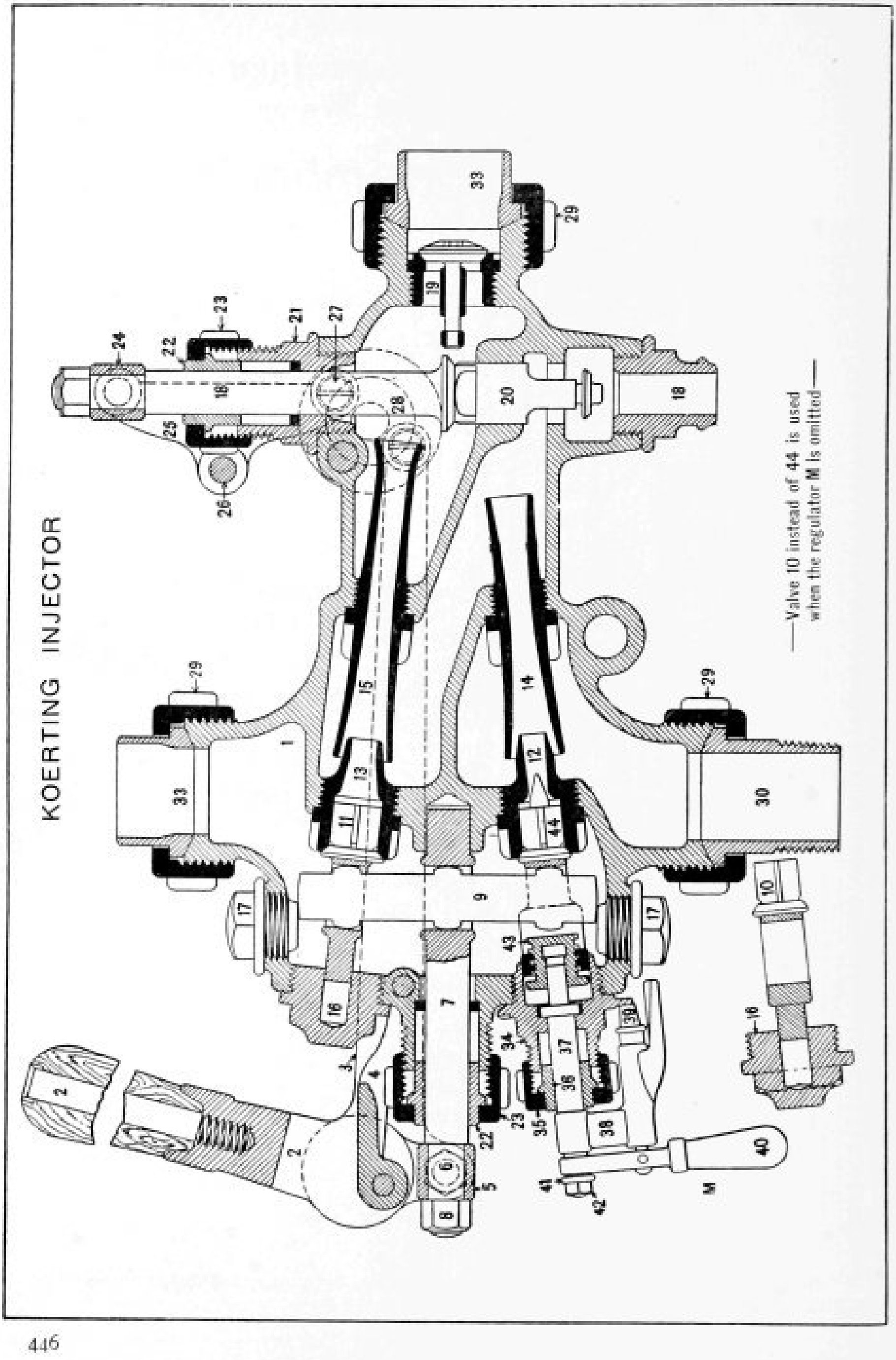
Sellers Self-Acting Injector, Improved Class K for Hot Water

Plate 80. Enjambrado

Enjambrar	1.	Delivery Tube.
Enjambreis	2K.	Combining Tube.
Enjangado	3.	Steam Nozzles.
Enjarcia	5.	Spindle Nut.
Enjarciado	6.	Steam Stuffing Box.
Enjarciara	7.	Spindle.
Enjardinar	8.	Crosshead.
Enjardino	10.	Water Stuffing Box.
Enjaretado	11.	Follower.
Enjaretar	12.	Packing Ring.
Enjareteis	13.	Lock Nut.
Enjarrete	14.	Follower for No. 10.
Enjauger	15.	Links.
Enjaulaban	16.	Packing Ring.
Enjauladas	19.	Plain Ring for Copper Pipe.
Enjaulado	19a.	Reducing Ring for Copper Pipe.
Enjaular	20.	Check Valve.
Enjaulemos	22.	Guide for No. 20.
Enjaulo	23.	Plain Union for Iron Pipe.
Enjeba	23a.	Reducing Union for Iron Pipe.
Enjebabas	24.	Coupling Nuts.
Enjebado	25K.	Injector Body.
Enjebasen	27.	Wrench.
Enjergaban	29.	Waste Pipe.
Enjergais	30.	Waste Valve.
Enjergo	31.	Waste Valve Cam.
Enjergue	32.	Jam Nut for No. 29.
Enjoado	33.	Starting Lever.
Enjoailler	34.	Cam Lever.
Enjoamente	35.	Pin, No. 38 and 33.
Enjoar	36.	Cam Shaft.
Enjoativo	37.	Washer on 36.
Enjoignais	38.	Collar and Index.
Enjoigniez	40.	Plug Water Valve.
Enjoignons	41.	Regulating Handle.
Enjoindras	42.	Inlet Valve.
Enjoindre	57.	Iron Overflow.
Enjoined	57a.	Copper Overflow.
Enjoining	58.	Cap over Hot Water Valve.
Enjoinment	59.	Hot Water Valve.

In ordering parts for injector, give in all cases the maker's number stamped on the injector.

Plate 81


KOERTING INJECTOR
—Valve 10 instead of 44 is used
when the regulator M is omitted—

Koerting Injector

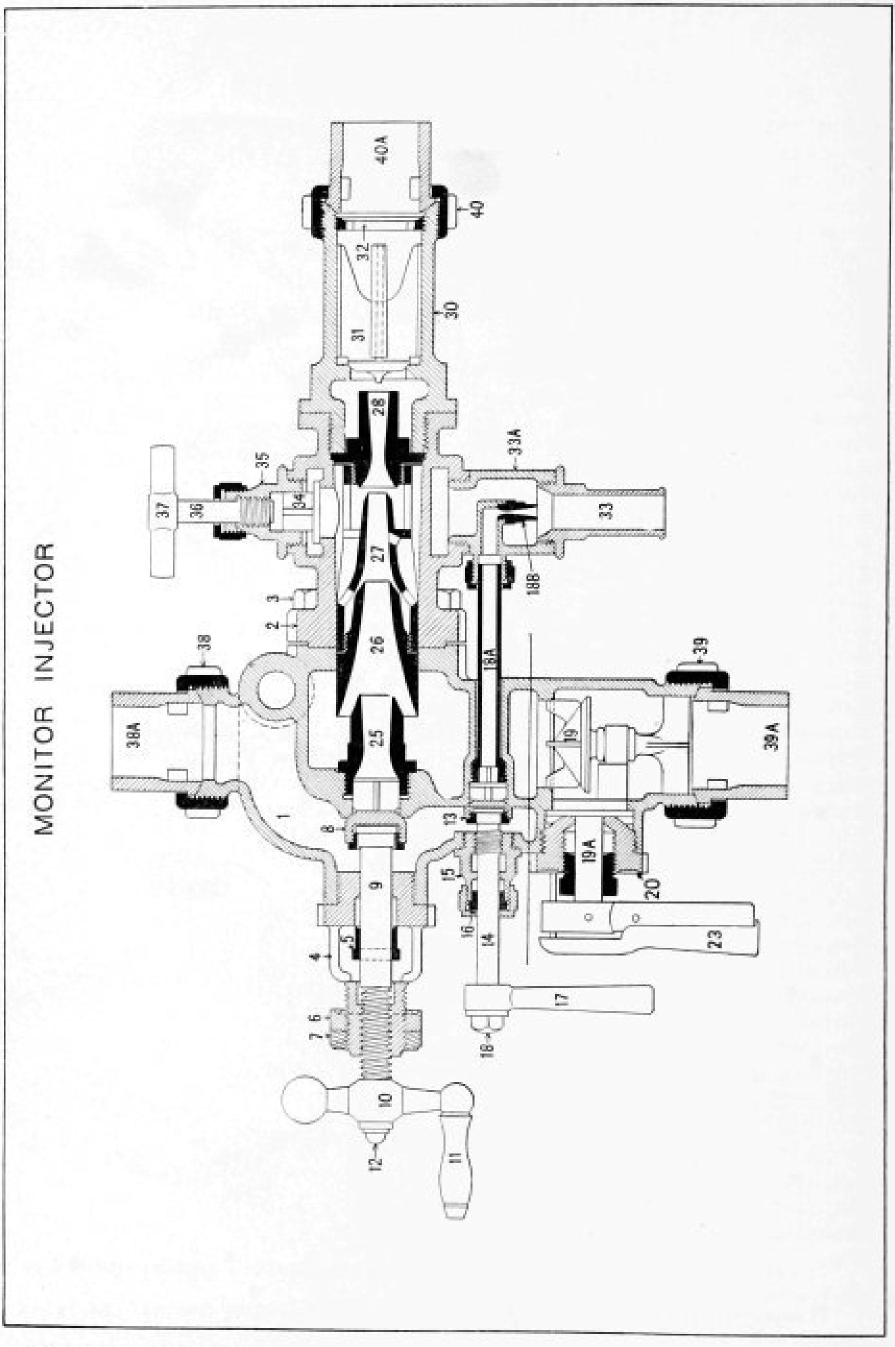
Plate 81. Enjolais

Enjolant	1.	Body.
Enjolasses	2.	Handle Lever Complete.
Enjolerais	3.	Side Rods, Right and Left.
Enjoleriez	4.	Connecting Link and Pins.
Enjoleront	5.	Crosshead for Starting Shaft.
Enjoleur	6.	Nuts for Crosshead.
Enjoliver	7.	Starting Shaft.
Enjolivure	8.	Nuts for Starting and Overflow Shaft.
Enjolons	9.	Yoke Bar.
Enjoncher	10.	Lower Steam Valve.
Enjonquer	11.	Upper " "
Enjoo	12.	Lower " Nozzle.
Enjoyabais	13.	Upper " "
Enjoyamos	14.	Lower Water "
Enjoyaron	15.	Upper " "
Enjoyases	16.	" Front Body Cap. (Also Lower).
Enjoyeis	17.	Top and Bottom Body Caps.
Enjoyelado	18.	Overflow Nozzle.
Enjoyments	19.	Check Valve Complete.
Enjoys	20.	Overflow Valve Complete.
Enjuagado	21.	Overflow Stuffing Box.
Enjuagamos	22.	Followers for Stuffing Boxes.
Enjuagar	23.	Nuts for Stuffing Boxes.
Enjuagaron	24.	Crosshead for Overflow Valve.
Enjuagueis	25.	Connecting Links for Overflow Valve.
Enjugada	26.	Pin for Connecting Links for Overflow Valve.
Enjugadero	27.	Screws " " " " "
Enjugadora	28.	Bell Cranks for Overflow Valve.
Enjugando	29.	Coupling Nuts.
Enjugare	30.	Unions for Iron Pipe.
Enjugaseis	31.	Spanner Wrench.
Enjugeraie	33.	Unions for Copper Pipe.
Enjuguemos	34.	Throttle Valve Stuffing Box.
Enjuiciais	35.	Nuts for Stuffing Box.
Enjuicie	36.	Follower for Stuffing Box.
Enjuncaban	37.	Spindle for Throttle Valve.
Enjuncado	38.	Arm for Latch on Throttle Valve.
Enjuncais	39.	Latch
Enjundia	40.	Handle.
Enjundioso	41.	Washer.
Enjuta	42.	Nut.
Enjutos	43.	Adjusting Screw.
Enkelinnen	44.	Throttle Valve.

In ordering parts for injector, give in all cases the maker's number stamped on the injector.

If injectors do not have the regulator M, the parts including Nos. 34 to 44 are not wanted, and plain valve and cap substituted. Cap No. 16. Lower Steam Valve No. 10.

Plate 82


MONITOR INJECTOR
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
18A
18B
19
19A
20
23
25
26
27
28
30
31
32
33
33A
34
35
36
37
38
38A
39
39A
40
40A

Monitor Injector

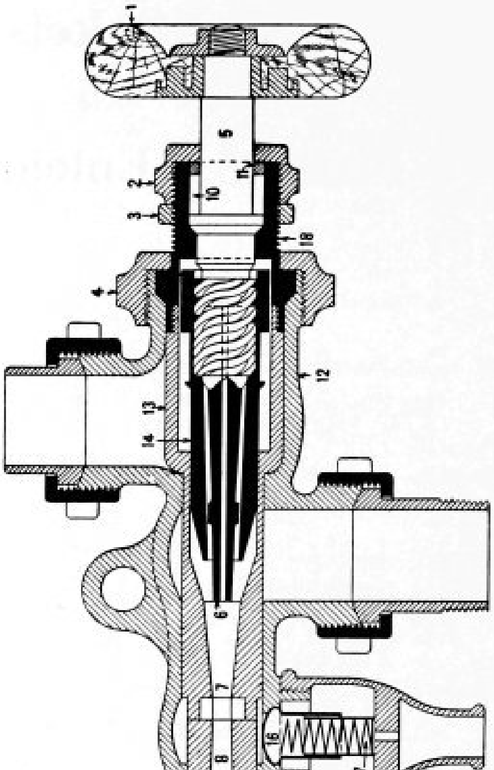
Plate 82. Enkels

Enkelvoud	1.	Body (Back Part).
Enkennel	2.	" (Front Part).
Enkernels	3.	" Screw.
Enkindling	4.	Yoke
Enklauw	5.	" Gland.
Enklauwen	6.	" Packing Nut.
Enkratiten	7.	" Lock Nut.
Enkrinit	8.	Steam Valve Disc and Nut.
Enkystado	9.	" " Spindle.
Enkyste	10.	" " Handle.
Enlabiado	11.	" " Rubber Handle.
Enlabiamos	12.	" " Top Nut.
Enlabiar	13.	Jet Valve Disc and Nut.
Enlabiaron	14.	" " Spindle.
Enlabiases	15.	" " Bonnet and Nut.
Enlabusar	16.	" " Gland.
Enlacador	17.	" " Lever Handle.
Enlacadura	18.	" " Top Nut.
Enlacement	18A.	" Tube.
Enlacerait	18B.	Lifting Nozzle.
Enlaceriez	19.	Water Valve.
Enlacons	19A.	Eccentric Spindle.
Enladrillo	20.	Water Valve Bonnet.
Enlaidir	23.	" " Lever Handle.
Enlaidisse	25.	Steam Nozzle.
Enlaidites	26.	Intermediate Nozzle.
Enlaivar	27.	Condensing "
Enlaminar	28.	Delivery "
Enlangour	30.	Line Check.
Enlapado	31.	" " Valve.
Enlarding	32.	Stop Ring.
Enlargedly	33.	Overflow Nozzle.
Enlarme	33A.	" Chamber and Nut.
Enlarmure	34.	Heater Cock Check.
Enlassure	35.	" " Bonnet and Nut.
Enlazadas	36.	" " Spindle.
Enlazadora	37.	" " T Handle.
Enlazaseis	38.	Coupling Nut, Steam End.
Enlazasen	38A.	Tail Piece, " "
Enlazemos	39.	Coupling Nut, Water End.
Enleague	39A.	Tail Piece, " "
Enleaguing	40.	Coupling Nut, Delivery End.
Enleiar	40A.	Tail Piece, " "

In ordering parts for injector, give in all cases the maker's number stamped on the injector.

Plate 83

ECLIPSE INJECTOR



Eclipse Injector

Plate 83. Enleio

Enlengthen	1.	Handle of Regulating Valve.
Enlenzaba	2.	Small Nut holding in Stem.
Enlenzados	3.	Jam Nut.
Enlenzando	4.	Main Nut holding Injector in Shell.
Enlenzaron	5.	Stem.
Enlenzases	6.	Lifting Jet.
Enlenzeis	7.	Combining Tube.
Enlerdar	8.	Discharge Tube.
Enlevacao	9.	Check Valve.
Enlevage	10.	Space for Packing.
Enlevais	11.	Follower for confining Packing.
Enlevasses	12.	Shell.
Enlevront	13.	Body.
Enliasse	14.	Adjusting Tube regulating Water and Steam Supply.
Enlico	15.	Body of Overflow Valve.
Enlight	16.	Overflow Valve.
Enlighten	17.	" " Spring.
Enlighting	18.	Threaded End of Body.

In ordering parts for injector, give in all cases the maker's number stamped on the injector.

Plate 84

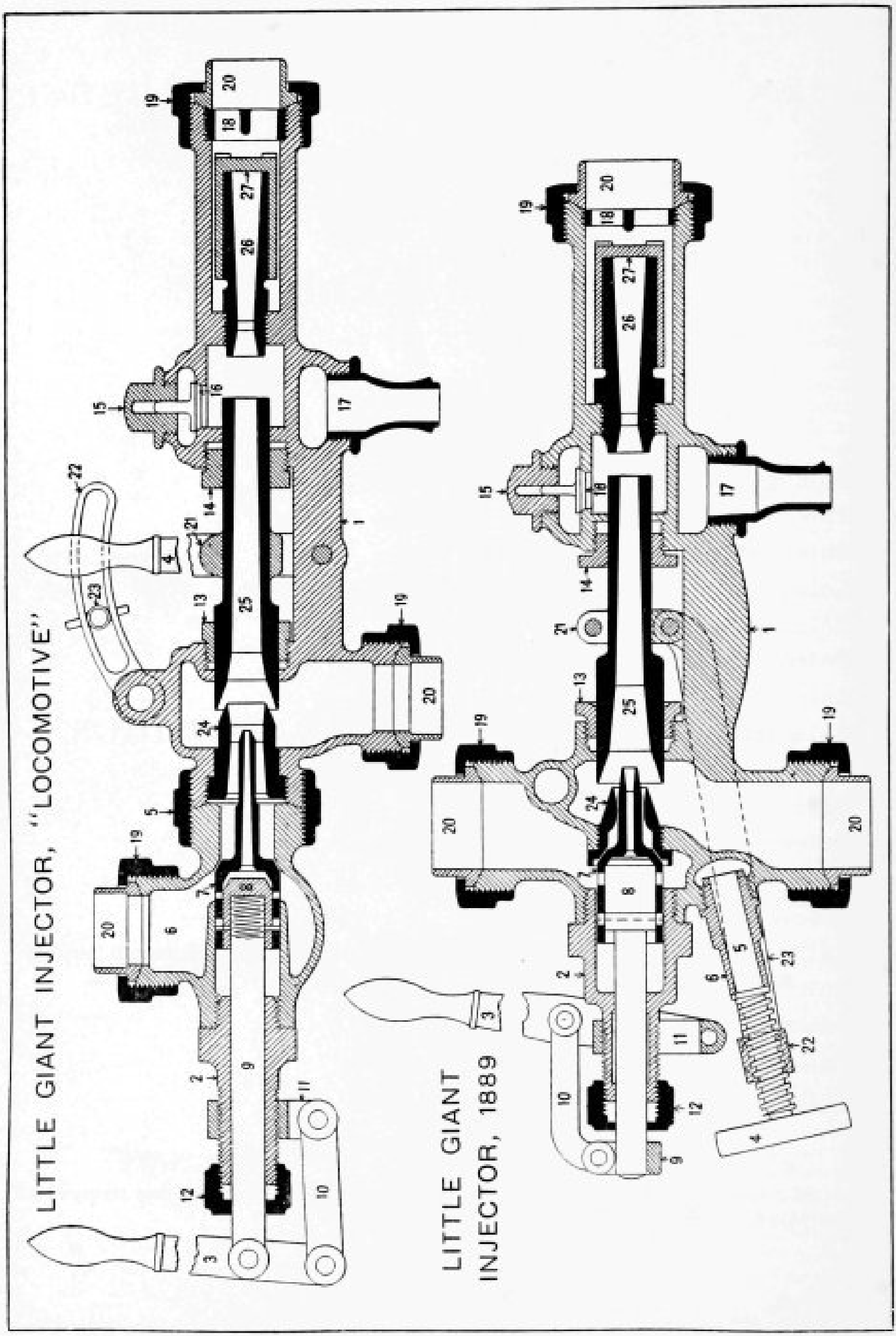

LITTLE GIANT INJECTOR, "LOCOMOTIVE"
LITTLE GIANT INJECTOR, 1889

Plate 84.

Little Giant Injector, "Locomotive" Enligner

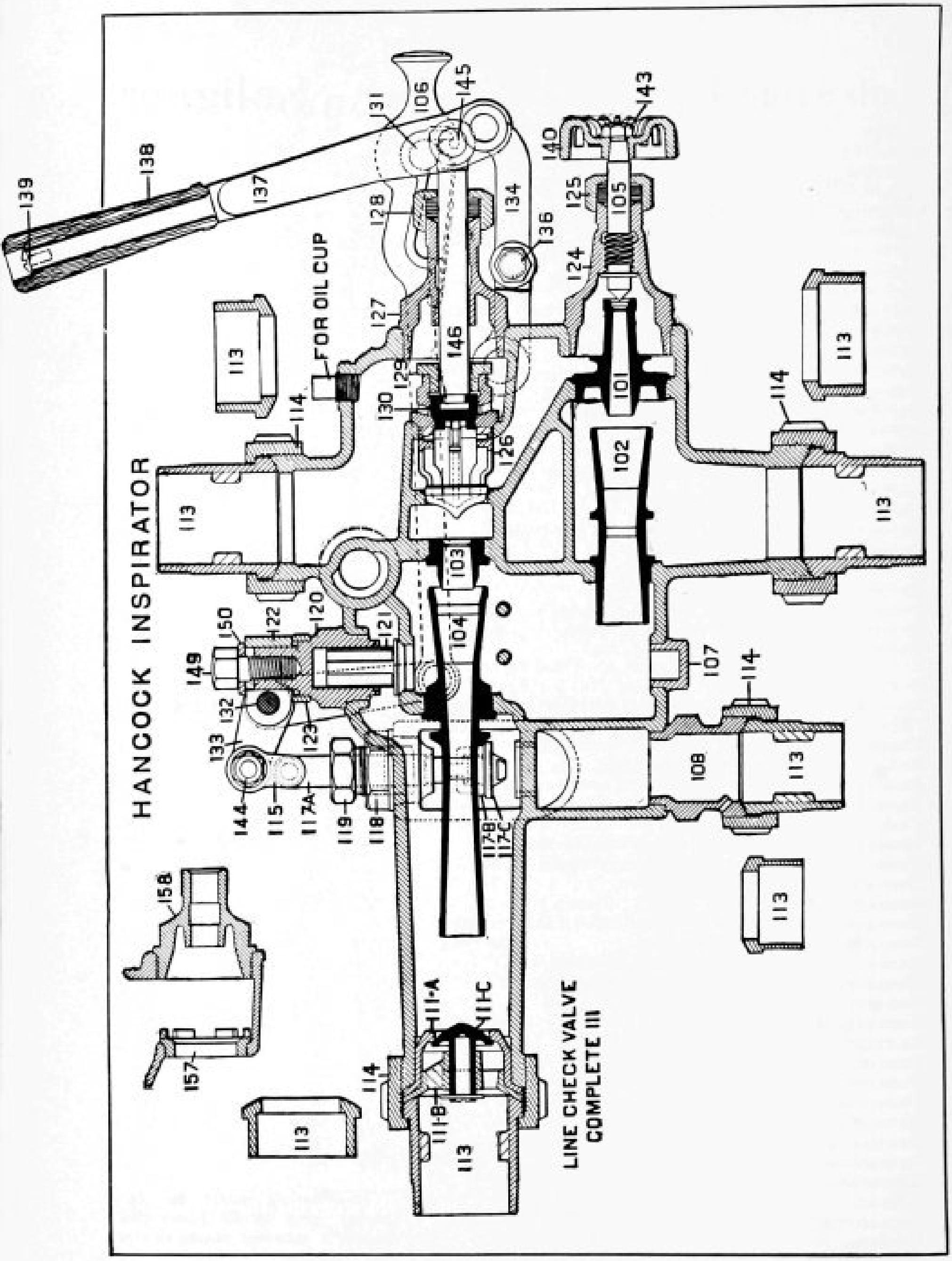
Enlink	1.	Body.
Enlinked	2.	Stuffing Box.
Enlinking	3.	Starting Lever.
Enlist	4.	Injector Lever.
Enlisting	5.	Right and Left Nut.
Enlistment	6.	Starting Valve Body.
Enliven	7.	Main Steam Valve.
Enlivened	8.	Jet Valve.
Enlivening	9.	" " Stem.
Enlodabais	10.	Starting Valve Link.
Enlodadas	11.	Fulcrum.
Enlodado	12.	Stuffing Box Nut.
Enlodamos	13.	Large Packing Nut.
Enlodar	14.	Small " "
Enlodarian	15.	Overflow Cap.
Enlodaron	16.	" Valve.
Enlodeis	17.	" Nozzle.
Enloquecer	18.	Check Valve Stop.
Enloquezco	19.	Coupling Nut.
Enlosados	20.	Swivel.
Enloso	21.	Combining Tube Clamp.
Enlourecer	22.	Quadrant.
Enlouzar	23.	Thumb Screw.
Enlumineur	24.	Steam Tube.
Enluminons	25.	Combining Tube.
Enlutabais	26.	Discharge Tube.
Enlutado	27.	Check Valve.

Little Giant Injector, 1889 Enlutamos

Enlutar	1.	Body.
Enlutarian	2.	Stuffing Box.
Enlutaron	3.	Starting Lever.
Enmaderare	4.	Adjusting Wheel.
Enmadraba	5.	" " Stem.
Enmadrados	6.	" Stem Holder.
Enmadraron	7.	Main Steam Valve.
Enmagrecia	8.	Jet Valve.
Enmagrezca	9.	" " Clamp.
Enmallaban	10.	Starting Valve Link.
Enmallado	11.	Fulcrum.
Enmallar	12.	Stuffing Box Nut.
Enmallemos	13.	Large Packing Nut.
Enmangaban	14.	Small " "
Enmangado	15.	Overflow Cap.
Enmangar	16.	" Valve.
Enmantada	17.	" Nozzle.
Enmantando	18.	Check Valve Stop.
Enmantare	19.	Coupling Nut.
Enmantases	20.	Swivel.
Enmaranado	21.	Combining Tube Clamp.
Enmaranar	22.	Crosshead.
Enmaraneis	23.	Side Bars.
Enmarble	24.	Steam Tube.
Enmaromado	25.	Combining Tube.
Enmaromar	26.	Discharge Tube.
Enmaromeis	27.	Check Valve.

In ordering parts for injector, give in all cases the maker's number stamped on the injector.

Plate 85


HANCOCK INSPIRATOR
FOR OIL CUP
LINE CHECK VALVE
COMPLETE 111

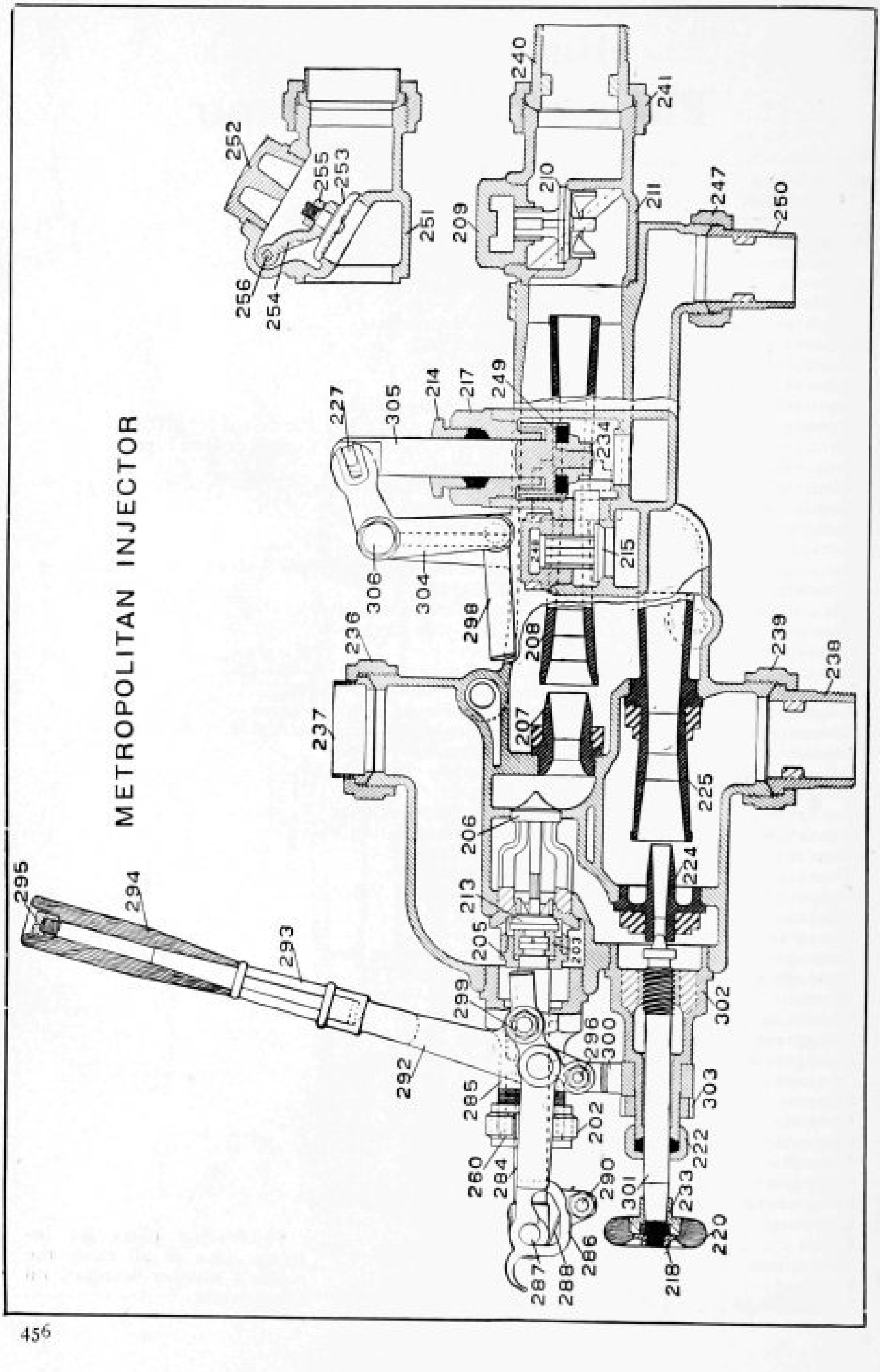
Hancock Inspirator

Plate 85. Enmaromo

Enmascaro	101.	Lifter Steam Nozzle.	
Enmendaba	102.	" Tube.	
Enmendador	103.	Forcer, Steam Nozzle.	
Enmendamos	104.	" Combining Tube.	
Enmendaron	105.	Regulating Valve Spindle.	
Enmentres	106.	Connecting Rod.	
Enmews	107.	Clean-out Plug for Body.	
Enmienda	108.	Overflow Nozzle.	
Enmities	111.	Line Check Valve Complete.	
Enmoheceis	111A.	Case for 111.	
Enmohecer	111B.	Cage " 111.	
Enmohecido	111C.	Valve " 111.	
Enmoves	113.	Nipple for Steam Connection,	Furnished for either Copper or Iron Pipe.
Enmudecias	113.	" " Suction "	
Enmudecido	113.	" " Delivery "	
Enmudezco	113.	" " Overflow "	
Enmured	114.	Coupling Nut Steam Connection.	
Enmuring	114.	" " Suction "	
Ennaeorum	114.	" " Delivery "	
Ennaeos	114.	" " Overflow "	
Ennaeteris	115.	Connecting Link for Final Overflow Valve.	
Ennaeum	116.	Steel Pin for 115.	
Ennarrheur	117.	Final Overflow Valve Complete.	
Ennasser	117A.	" " " Stem.	
Ennastrar	117B.	Nut for 117.	
Ennatar	117C.	Disc " 117.	
Ennation	118.	Bonnet for Final Overthrow Valve.	
Enneacanto	119.	Packing Nut for Final Overflow Valve.	
Enneacordo	120.	Bonnet for Intermediate Overflow Valve.	
Enneacruno	121.	Intermediate Overflow Valve.	
Enneadici	122.	Holder for Overflow Valve Crank.	
Enneadicos	123.	Adjusting Ring.	
Enneaeteri	124.	Bonnet for Regulating Valve.	
Enneafillo	125.	Packing Nut for Regulating Valve.	
Enneagonal	126.	Forcer Steam Valve.	
Enneagono	127.	Bonnet for Steam Valve.	
Enneander	128.	Packing Nut for Steam Valve.	
Enneandria	129.	Coupling Nut for 126.	
Enneandro	130.	Lifter Steam Valve.	
Enneapogon	131.	Steel Stud for Connecting Rod.	
Enneapyle	132.	" " " 122 and 133.	
Enneatic	133.	Crank for Overflow Valve.	
Enneatical	134.	Side Strap, R.H.	
Ennegrecer	135.	" " L.H.	
Ennegrezco	136.	Steel Bolt for 134 and 135.	
Enneige	137.	Lever.	
Ennemi	138.	Wood Handle for 137.	
Ennense	139.	Screw for 137.	
Ennensibus	140.	Rubber Wheel for 105.	
Ennensis	143.	Steel Screw " 105.	
Ennensium	144.	Steel Bolt " 115.	
Enneoctone	145.	Steel Pin Connecting 137 and 146.	
Ennevoar	146.	Steam Valve Stem.	
Ennia	149.	Cap Screw for 120.	
Ennianista	150.	Iron Washer for 120.	
Enniano	157.	Steam Valve Seat.	
Ennianorum	158.	Bonnet for Steam Valve.	

In ordering parts for injector, give in all cases the maker's number stamped on the injector.

Plate 86


METROPOLITAN INJECTOR
202 205 206 207 208 209 210 211 213 214 215 217 218 220 222 224 225 227 233 234 236 237 238 239 240 241 247 249 250 251 252 253 254 255 256 260 284 285 286 287 288 290 292 293 294 295 296 298 299 300 301 302 303 304 305 306

Metropolitan Locomotive Injector

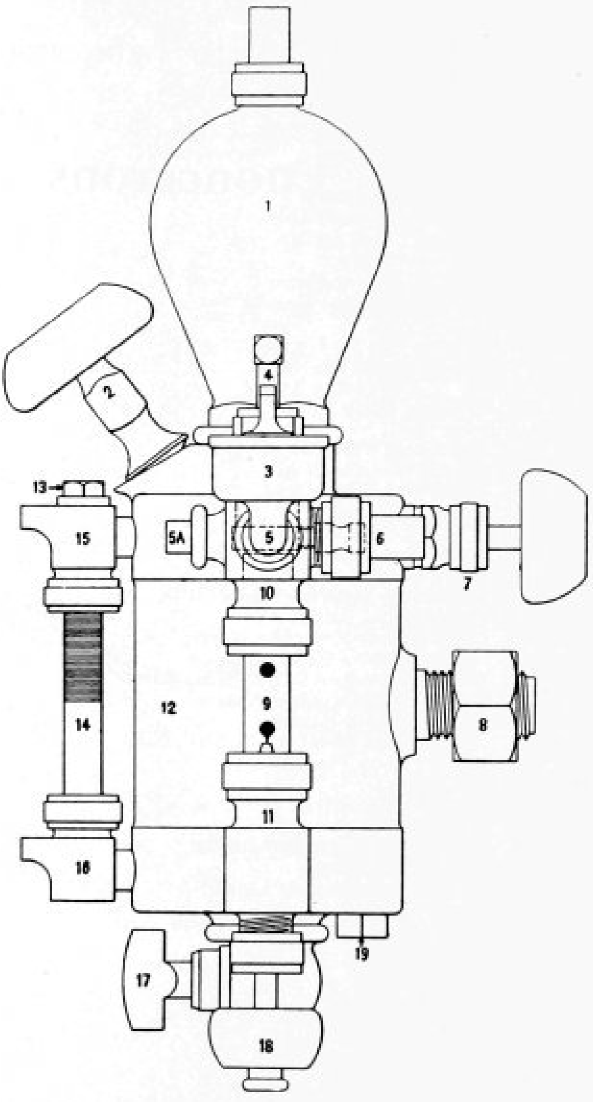
Plate 86. Ennoblecer

Ennoblezco	202.	Packing Nut for No. 285.
Ennoblir	203.	Champ Ring.
Ennobliras	205.	Steam Swivel Ring.
Ennoblites	206.	" Valve.
Ennodius	207.	Forcing Steam Jet.
Ennoeme	208.	" Combining Tube.
Ennoergie	209.	Check Valve Cap.
Ennoicyle	210.	Check Valve.
Ennoitar	211.	Check Valve Casing.
Ennomus	213.	Auxiliary Steam Valve.
Ennosigaeo	214.	Packing Gland for No. 305.
Ennovelar	215.	Overflow Valve.
Ennoyage	217.	" Center Piece.
Ennuvear	218.	Regulating Valve Handle Nut.
Ennuyais	220.	" " Wheel.
Ennuyante	222.	Packing Nut for No. 302.
Ennuyasses	224.	Lifting Steam Jet.
Ennuyerais	225.	" Combining Tube.
Ennuyeux	227.	Overflow Valve Pin.
Ennuyons	231.	Stud Bolt.
Ennychie	233.	Regulating Valve Wheel Disc.
Enodabamus	234.	Nut for Overflow Disc.
Enodabilis	236.	Union Nut, Steam End.
Enodandos	237.	Tail Pipe, Steam End.
Enodantium	238.	" " Suction End.
Enodaremus	239.	Union Nut, Suction End.
Enodation	240.	Tail Pipe, Delivery End.
Enodator	241.	Union Nut, Delivery End.
Enodatoris	245.	Nut for Stud Bolts.
Enodatorum	247.	Union Nut for Overflow Nozzle.
Enodaturam	248.	Overflow Valve Cap.
Enodaturos	249.	Disc for Overflow Valve.
Enodaveris	250.	Tail Pipe for Overflow Nozzle.
Enodavero	260.	Steam Packing Gland.
Enoding	284.	" Valve Stem.
Enodios	285.	" Center Piece.
Enoiseler	286.	Side Links.
Enojaba	287.	Pin for Steam Stem
Enojabamos	288.	Spring.
Enojadas	289.	Outflow Valve Crank Bolt Nut.
Enojadizas	290.	Bolt for Side Links.
Enojamento	291.	Nut for Bolt for Side Links.
Enojamos	292.	Lever.
Enojariais	293.	Handle Rod.
Enojarian	294.	Wood Handle.
Enojaron	295.	Handle Nut.
Enojosas	296.	Fulcrum Bolt.
Enojoso	297.	Nut for Fulcrum Bolt.
Enojuelo	298.	Connecting Bar.
Enologia	299.	Nut for Connecting Bar.
Enologista	300.	Fulcrum Collar.
Enomancia	301.	Regulating Steam Stem.
Enometro	302.	" Center Piece.
Enomotarch	303.	Fulcrum Nut.
Enomphalo	304.	Overflow Valve Crank.
Enoncer	305.	" " Stem.
Enonceriez	306.	" " Crank Bolt.

In ordering parts for injector, give in all cases the maker's number stamped on the injector.

Plate 87

NATHAN SIGHT FEED CYLINDER LUBRICATOR



Nathan Sight Feed Cylinder Lubricator

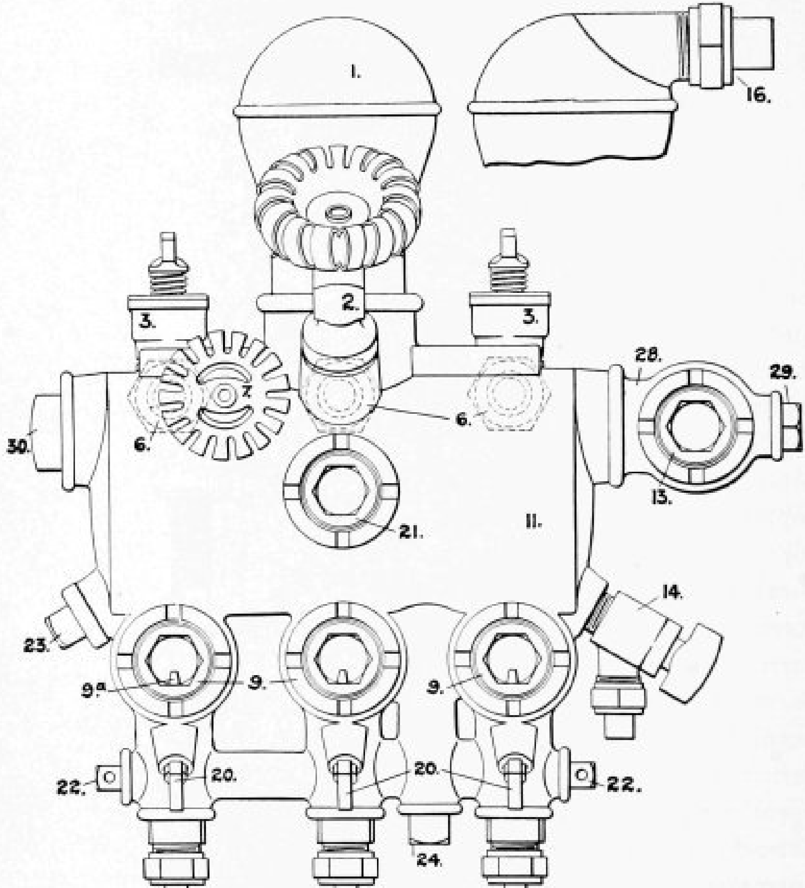
Plate 87. Enoncerons

Enonciatif	1.	Condenser.
Enonciez	2.	Filling Plug.
Enophilo	3.	Auxiliary Oiler.
Enophobia	4.	Safety Valve.
Enophorias	5.	Reducing Plug.
Enopliens	5A.	Blow-off "
Enoplocere	6.	Delivery Nut and Coupling.
Enoplops	7.	Water Valve.
Enopta	8.	Stud Nut.
Enorchibus	9.	Sight Feed Glass.
Enorme	10.	Upper Sight Bracket and Nut.
Enormement,	11.	Lower " " " "
Enormezza	12.	Body.
Enormidade	13.	Gauge Glass Plug.
Enormiorem	14.	" Glass.
Enormioris	15.	Upper Gauge Bracket and Nut.
Enormity	16.	Lower " " " "
Enormous	17.	Waste Cock.
Enormously	18.	Regulating Valve.
Enoscopio	19.	Bottom Plug.

Plate 88

NATHAN TRIPLE SIGHT FEED CYLINDER LUBRICATOR

BULL'S EYE TYPE 166-F-3



Nathan Triple Sight Feed Cylinder Lubricator Bull's Eye Type 166-F-3

Plate 88. Enostose

Enotabamur	1.	Condenser.
Enotaremur	2.	Filling Plug.
Enotatas	3.	Hand Oiler
Enotatura	5.	Reducing Plug.
Enotaturis	6.	Delivery Nut and Tailpiece.
Enotescis	7.	Water Valve.
Enotesco	8.	Stud Nut.
Enotomies	9.	Sight Feed Glass and Casing.
Enotomy	9A.	Feed Nozzle.
Enotria	11.	Body
Enotuerunt	13.	Gauge Glass and Casing.
Enouage	14.	Waste Cock.
Enoueur	15.	Regulating Valve.
Enouricar	16.	Top Connection.
Enpatron	17.	Equalizing Pipe.
Enpatroned	18.	Oil Pipe.
Enpierces	19.	Water Pipe.
Enquerais	20.	Sight Feed Drain Valve.
Enquerant	21.	Reserve Glass and Casing.
Enquerir	22.	Cleaning Plug (Body).
Enquerriez	23.	Body Plug.
Enquerront	24.	Oil Pipe Plug.
Enquest	28.	Gauge Glass Bracket.
Enquester	29.	Cleaning Plug (Gauge Glass).
Enquesting	30.	Gauge Glass Cap.

Plate 89

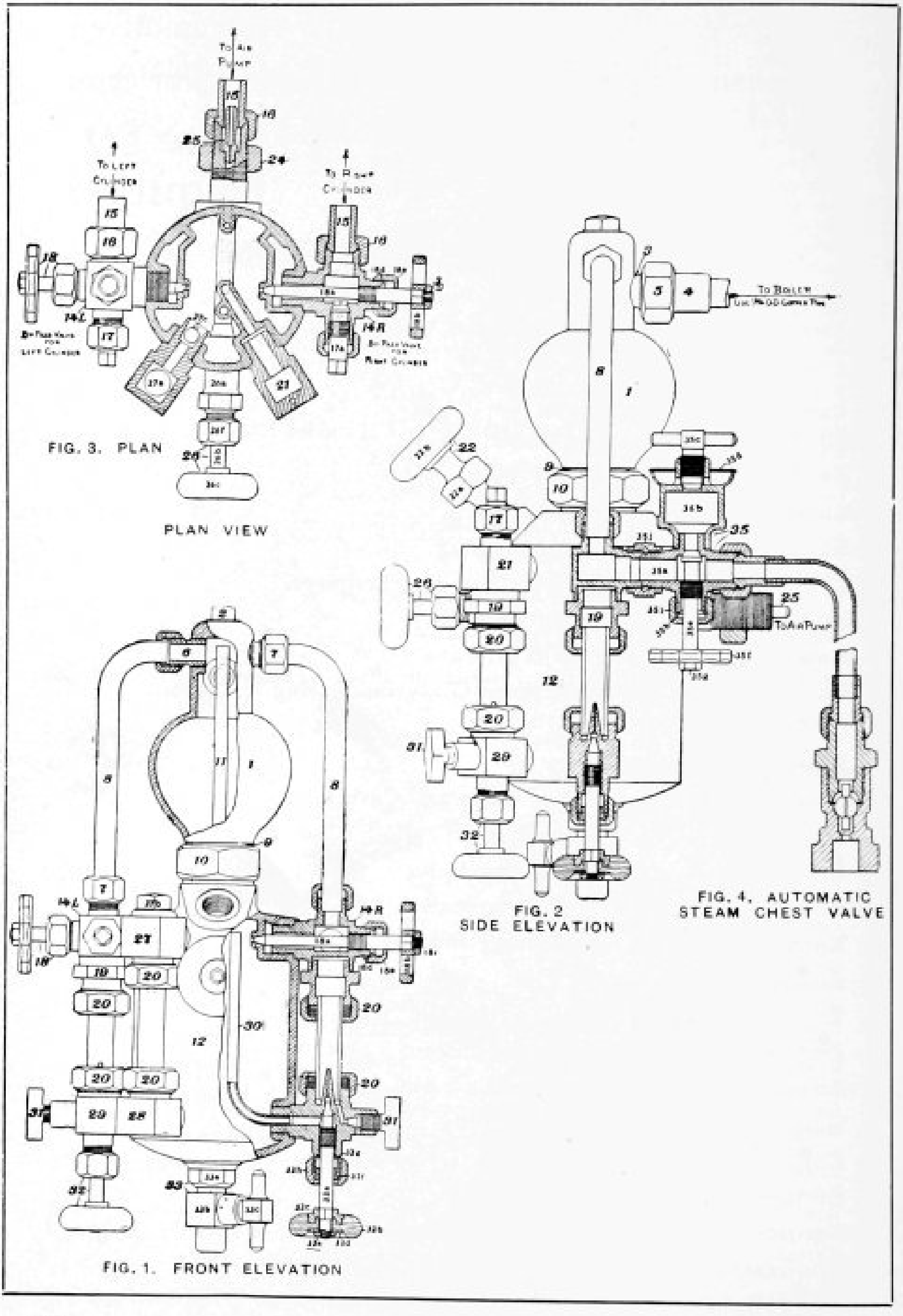


FIG. 3. PLAN

PLAN VIEW

FIG. 2 SIDE ELEVATION

FIG. 4. AUTOMATIC STEAM CHEST VALVE

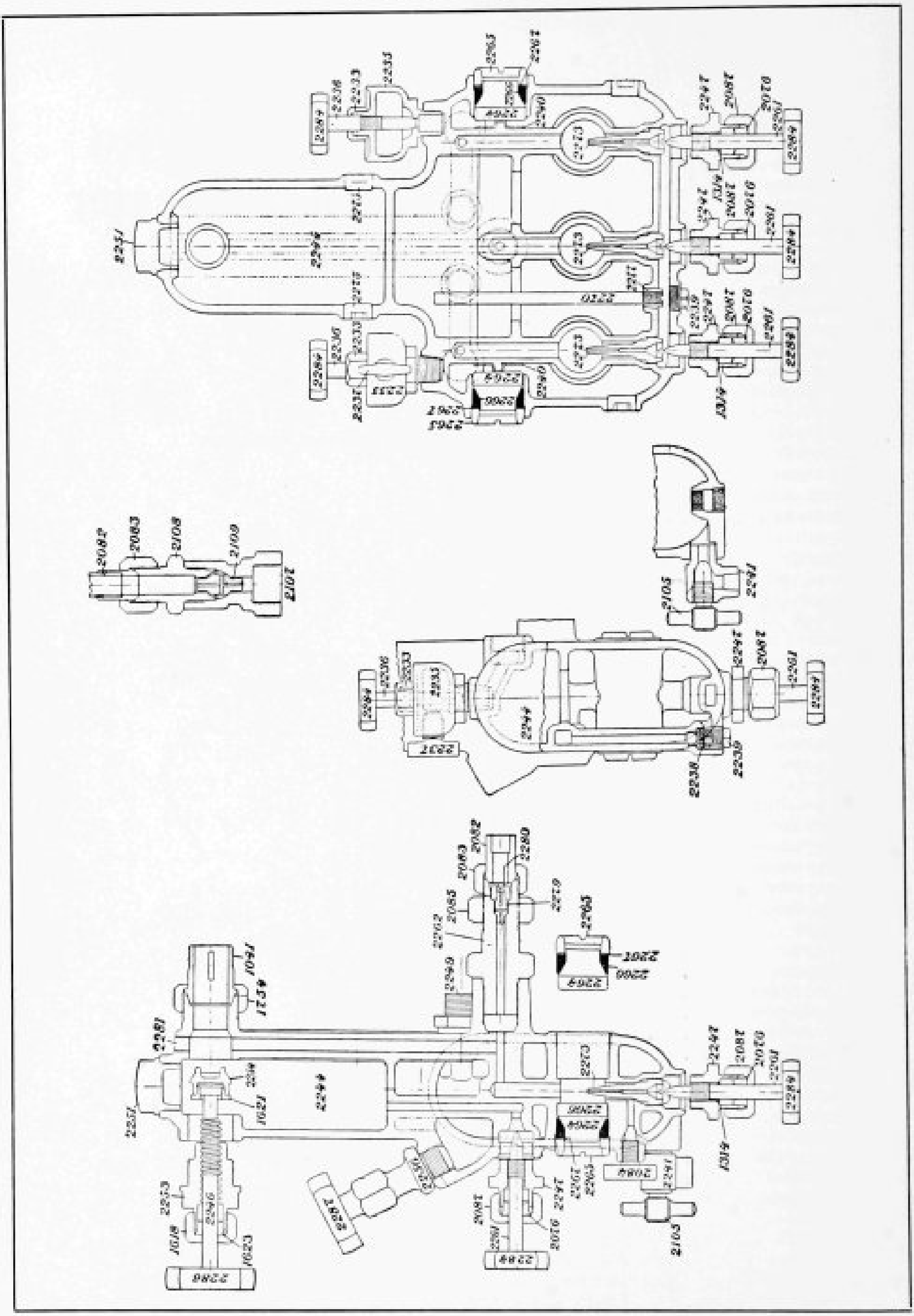
FIG. 1. FRONT ELEVATION

Detroit No. 3-C Locomotive Lubricator

Plate 89 Enqueter

Enquiciado	1.	Condenser.
Enquiciar	2.	" Plug.
Enquicieis	3.	Boiler Nipple.
Enquicio	4.	" " Tail Pipe.
Enquicken	5.	" " " " Nut.
Enquiers	6.	Equalizing Tube Nipple.
Enquimes	7.	" " " Nut.
Enquistado	8.	" Tube.
Enquistai	9.	Condenser Tail Pipe.
Enquisto	10.	" " " Nut.
Enraciner	11.	Air Brake Equalizing Tube.
Enrageais	12.	Oil Reservoir.
Enrageant	13.	Water Tube, Complete.
Enragions	14R.	Upper Feed Arm, Right.
Enraivecer	14L.	" " " Left.
Enraleceis	15.	Tail Pipe.
Enraleci	16.	" " Nut.
Enramabais	17.	Automatic Safety Valve, Complete.
Enramada	17A.	Stem.
Enramados	17B.	Check.
Enramarian	17C.	Bush Ring.
Enramaron	17D.	Packing Nut.
Enrameis	18.	By-Pass Valve, R. or L. Cylinder, Complete.
Enramer	18A.	Stem.
Enrancar	18B.	" Handle.
Enranciado	18C.	" " Nut.
Enrancieis	18D.	" Bush Ring.
Enrancio	18E.	" Packing Nut.
Enrange	19.	Extension Sleeve.
Enranked	20.	Packing Nut.
Enranking	21.	Upper Air Brake Arm.
Enraps	22.	Filler Plug, Complete.
Enrareces	22A.	" Plug.
Enrarecias	22B.	" " Handle.
Enrarecido	23.	By-Pass Valve for Air Brake, Complete.
Enrarezco	23A.	Center Piece.
Enrastraba	23B.	Stem.
Enrastrar	23C.	Handle.
Enrastro	23D.	" Nut.
Enravish	23F.	Packing Nut.
Enravished	24.	Support Arm Nut.
Enrayasen	25.	Air-Brake Nozzle.
Enrayasses	26.	Water Valve, Complete.
Enrayement	26A.	Center Piece.
Enrayemos	26B.	Stem.
Enrayeras	26C.	Handle.
Enrayo	26F.	Packing Nut.
Enrayoir	27.	Upper Gauge Arm, Complete.
Enredaba	27A.	" " Arm.
Enredadera	27B.	" " " Packing.
Enredamos	27C.	" " " Ball Check.
Enredarian	28.	Lower Gauge Arm, Complete.
Enredeis	29.	" Feed Arm.
Enredijo	30.	Oil Tube.
Enredosas	31.	Vent Stem.
Enredoso	32.	Regulating Valve, Complete.
Enregelar	32A.	Stem.
Enrehojaba	32B.	Handle.
Enrehojar	32C.	" Plate.
Enrehojeis	32D.	" Washer.
Enrehojo	32E.	" " Nut
Enrejada	32F.	Gland.
Enrejados	32G.	Bush Ring.
Enrejaseis	32H.	Packing Nut.
Enrejasen	33.	Drain Valve, Complete.
Enrejemos	33A.	" " Seat.
Enrenant	33B.	" " Body.
Enrenoire	33C.	" " Stem.

Plate 90

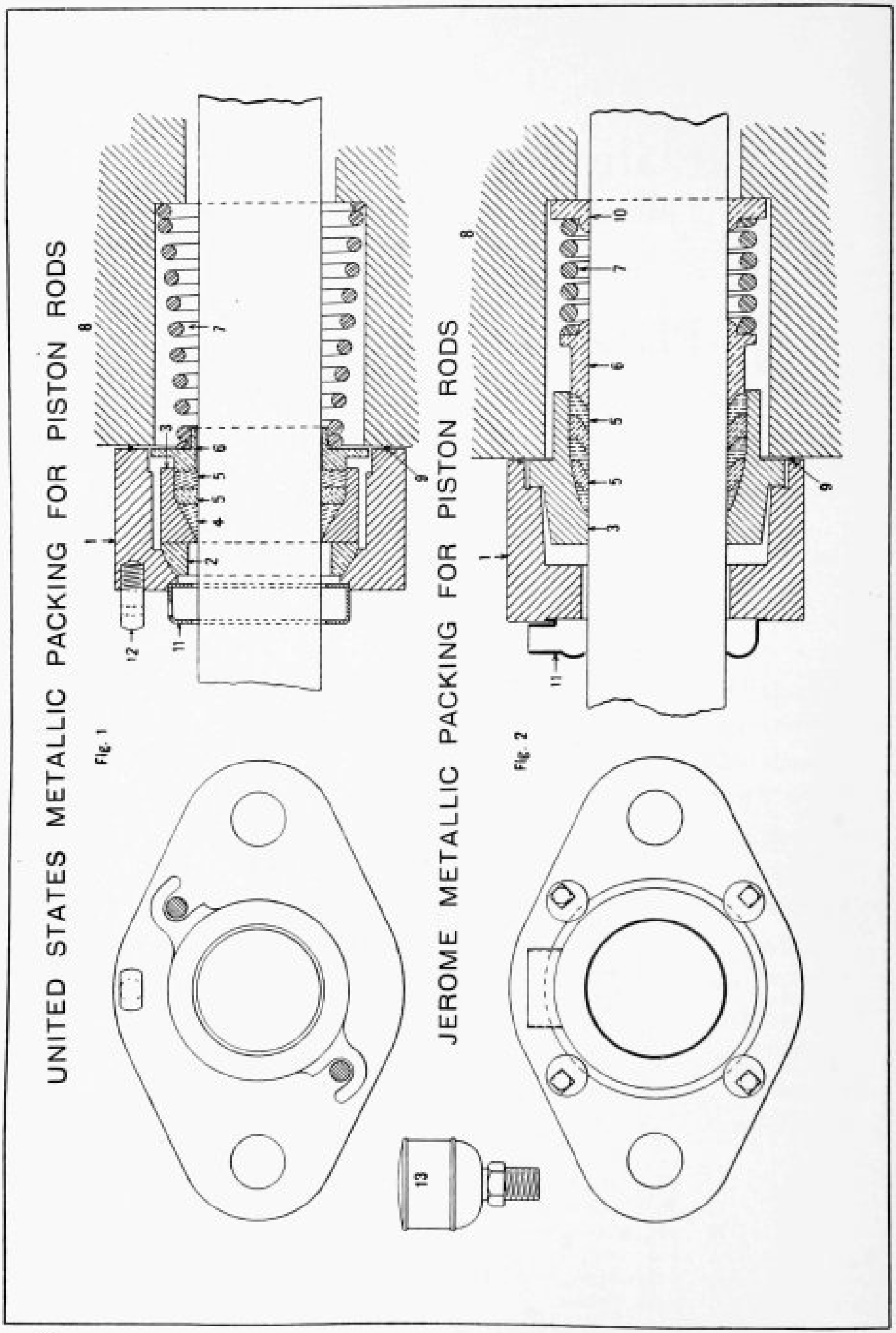


Detroit No. 21 Locomotive Lubricator

Plate 90. Enresinado

Enresinar	1041.	1-inch Tail Pipe.
Enrestar	1314.	Feed Stem Ring.
Enrevesado	1618.	Steam Valve Packing Nut.
Enrheum	1621.	" " Disc Lock Nut.
Enrheumed	1623.	" " Gland.
Enrheuming	1754.	1-inch Tail Nut.
Enrhumais	2076.	Feed Valve Gland.
Enrhumiez	2082.	Tail Pipe.
Enrhumions	2083.	" Nut.
Enrhythmos	2084.	Vent Stems.
Enrich	2085.	Support Arm Jamb Nut.
Enrichetta	2087.	Feed Valve Stem Nuts.
Enrichimes	2105.	Drain Stem.
Enrichir	2107.	Steam Chest Valve Body.
Enrichiras	2108.	" " " Cap.
Enrichment	2109.	" " " Check, 5/64 inches.
Enrielados	2233.	Hand Oiler, Packing Nut.
Enrielaron	2235.	" " Body.
Enrielases	2236.	" " Stem.
Enrieleis	2237.	" " Filler Plug.
Enripen	2238.	Water Check Stop.
Enripened	2239.	11/16 Plugs.
Enripening	2240.	Gauge Glass Reflector.
Enripiadas	2241.	Drain Valve Body.
Enripiado	2246.	Steam Valve Stem.
Enripiar	2247.	Feed Valve Center Piece.
Enripiasen	2249.	Tallow Pipe " "
Enripiemos	2251.	Condenser Plug.
Enripio	2253.	Steam Valve Center Piece.
Enriquecer	2254.	" " Disc.
Enriquezco	2256.	Filler Plug.
Enriscadas	2261.	Feed Valve Stem.
Enriscado	2262.	Support Arm.
Enriscamos	2264.	Sight Feed Glass.
Enrisque	2265.	Feed Glass Packing Ring.
Enrisqueis	2266.	Rubber Packing.
Enristreis	2267.	Feed Glass Washer.
Enritmo	2270.	Oil Tube.
Enrived	2273.	Feed Nozzle.
Enriving	2277.	Oil Tube Bushing.
Enrobage	2279.	Air Brake Check.
Enrobing	2280.	Check Seat.
Enrocabas	2284.	Regulating Valve Handle.
Enrocado	2285.	Hand Oiler Handle.
Enrocaseis	2286.	Steam Valve Handle.
Enrocher	2287.	Filler Handle.

Plate 91


UNITED STATES METALLIC PACKING FOR PISTON RODS
Fig. 1
JEROME METALLIC PACKING FOR PISTON RODS
Fig. 2
1
2
3
4
5
6
7
8
9
10
11
12
13

Metallic Piston Rod Packing

Plate 91. Enrockment

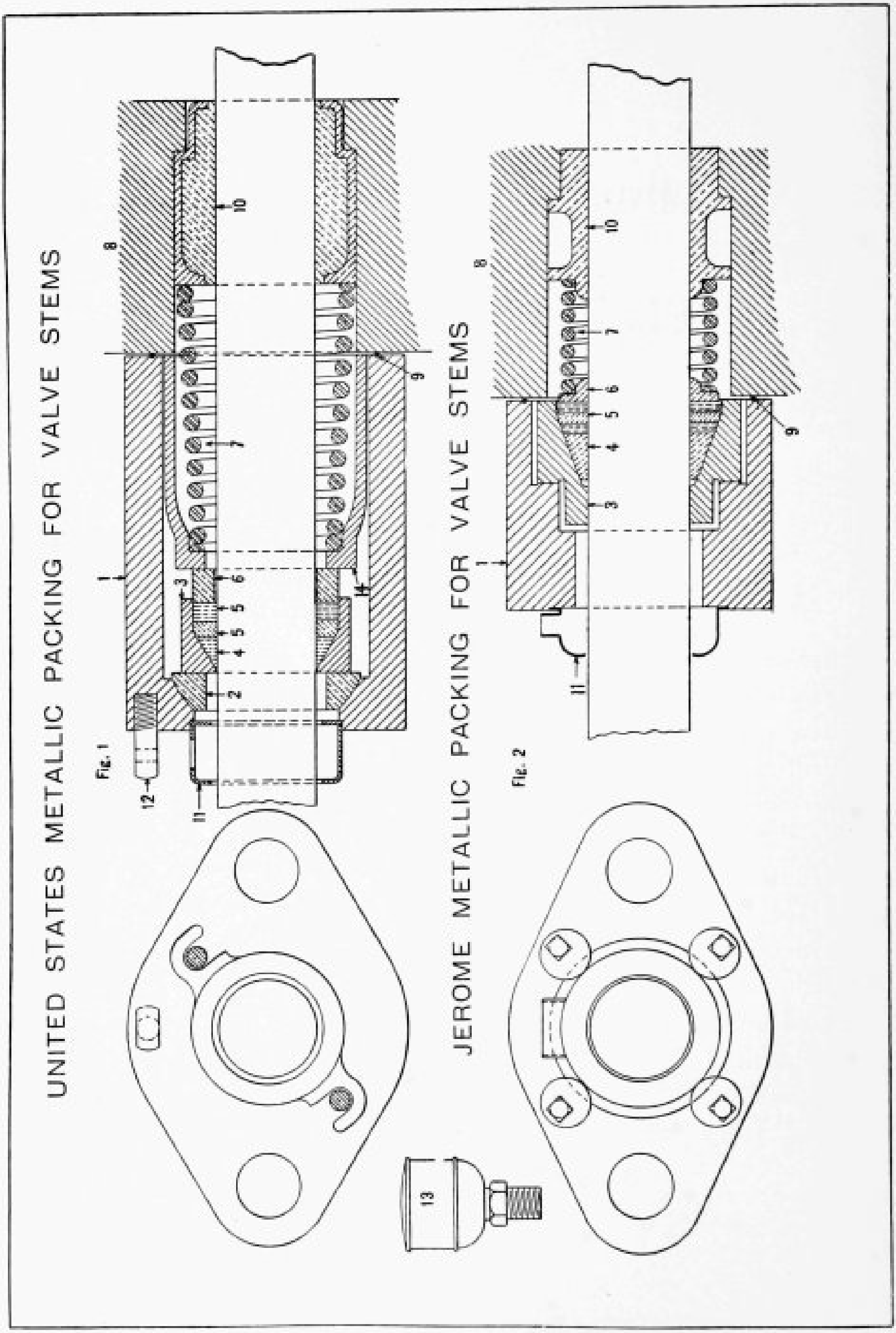
FIG. 1.—Enroco

FIG. 2.—Enrodabais

Enrodada .	1.	Packing Case.
Enrodaron	2.	Ball Joint
Enrodelado	3.	Vibrating Cup.
Enrodilhar	4.	Babbitt Ring.
Enrodrigar	5.	" "
Enrodrigo . .	6.	Follower.
Enrojeceis .	7.	Coil Spring.
Enrojecer . .	8.	Stuffing Box.
Enrojecido	9.	Copper Wire Joint.
Enrojezco	. 10.	Neck Ring.
Enrol . .	. 11.	Swab Holder.
Enrolar . . .	12.	Oil Cup Bracket.
Enroleriez .	13.	" Cup.

In ordering repairs, give in all cases the number stamped on packing case.

Plate 92


UNITED STATES METALLIC PACKING FOR VALVE STEMS
Fig. 1
JEROME METALLIC PACKING FOR VALVE STEMS
Fig. 2
13

Metallic Valve Stem Packing

Plate 92. Enroleront

FIG. 1.—Enrolions

FIG. 2.—Enrolladas

Enrolled	1.	Packing Case.
Enrolleis	2.	Ball Joint.
Enrolling	3.	Vibrating Cup.
Enrolment	4.	Babbitt Ring.
Enronqueci	5.	" "
Enroot	6.	Follower.
Enrooted	7.	Coil Spring.
Enrooting	8.	Stuffing Box.
Enroque	9.	Copper Wire Joint.
Enroqueis	10.	Bushing.
Enroquemos	11.	Swab Holder.
Enroscada	12.	Oil Cup Bracket.
Enroscados	13.	" Cup.
Enroscando	14.	Preventer.

In ordering repairs, give in all cases the number stamped on packing case.

INDEX