H. R. STAFFORD.

COMPOUND LOCOMOTIVE.

APPLICATION FILED DEC. 7, 1912.

1,066,232.

Patented July 1, 1913.

4 SHEETS—SHEET 1.

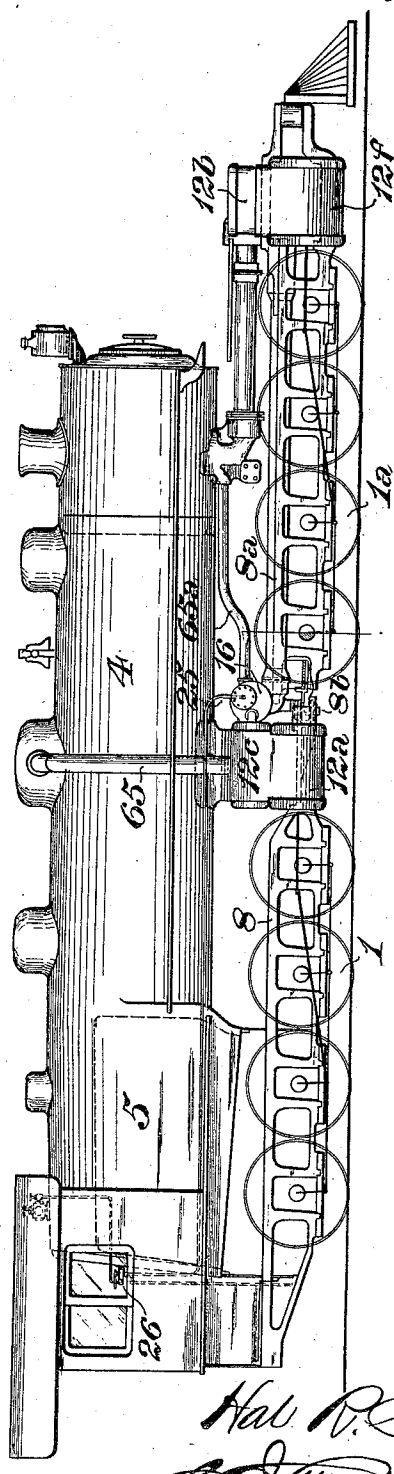


FIG. 1.

WITNESSES

Edward A. Wright.

S. R. Bell

INVENTOR

Hal R. Stafford,

by J. Mowdew Bell,

atty

H. R. STAFFORD.

COMPOUND LOCOMOTIVE.

APPLICATION FILED DEC. 7, 1912.

1,066,232.

Patented July 1, 1913.

4 SHEETS—SHEET 2.

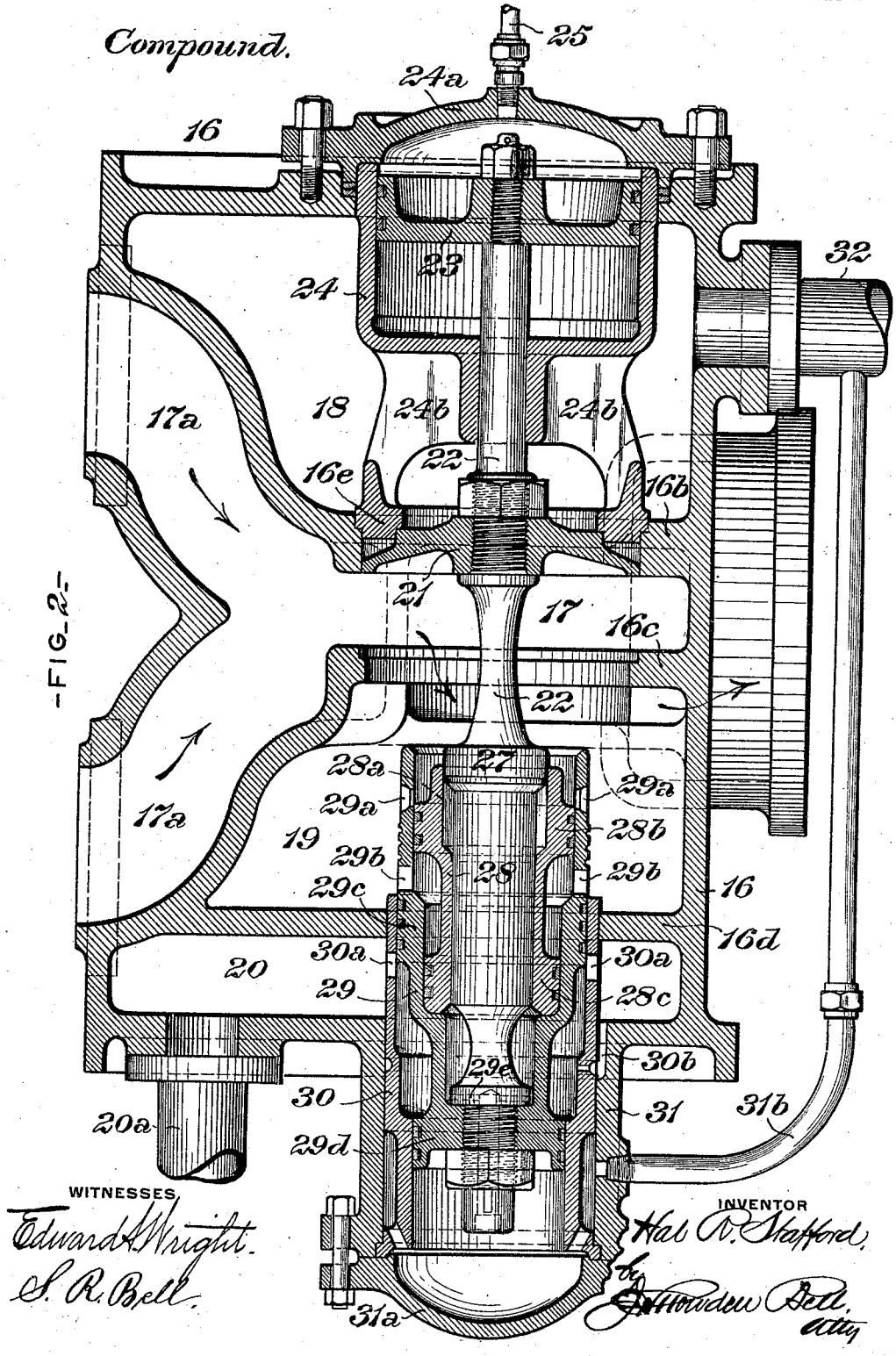


FIG. 2.

WITNESSES.

Edward A. Wright.

S. R. Bell.

INVENTOR

Hab R. Stafford,

by Thorndew Bell,

atty

H. R. STAFFORD.

COMPOUND LOCOMOTIVE.

APPLICATION FILED DEC. 7, 1912.

1,066,232.

Patented July 1, 1913.

4 SHEETS—SHEET 3.

Simple.

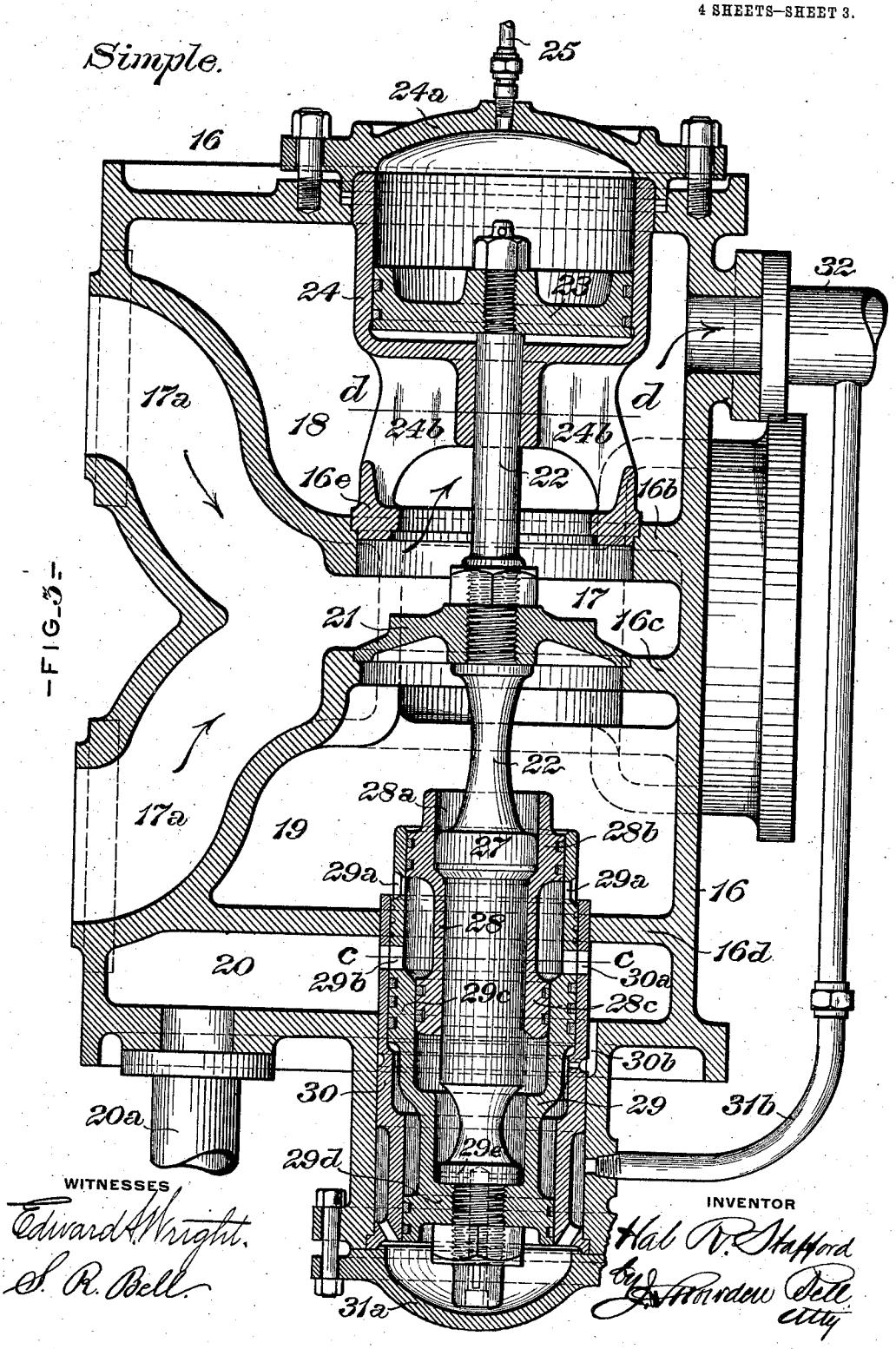


FIG. 3.

WITNESSES

Edward A. Wright.

S. R. Bell.

INVENTOR

Hal R. Stafford

by J. Andrew Bell

Atty

H. R. STAFFORD.

COMPOUND LOCOMOTIVE.

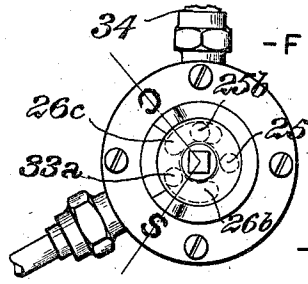
APPLICATION FILED DEC. 7, 1912.

1,066,232.

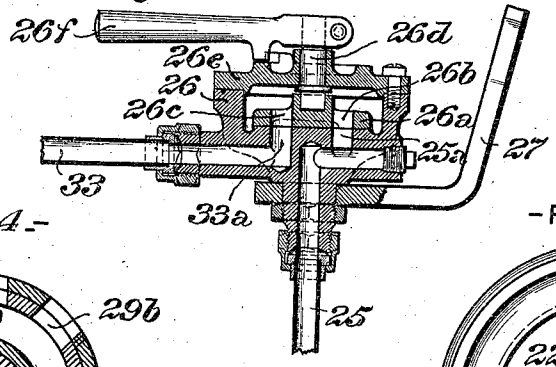
Patented July 1, 1913.

4 SHEETS—SHEET 4.

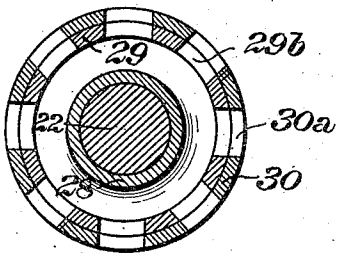
-FIG. 8.-



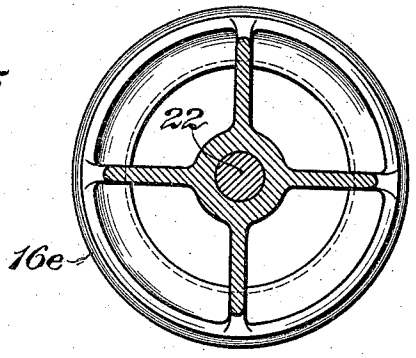
-FIG. 7.-



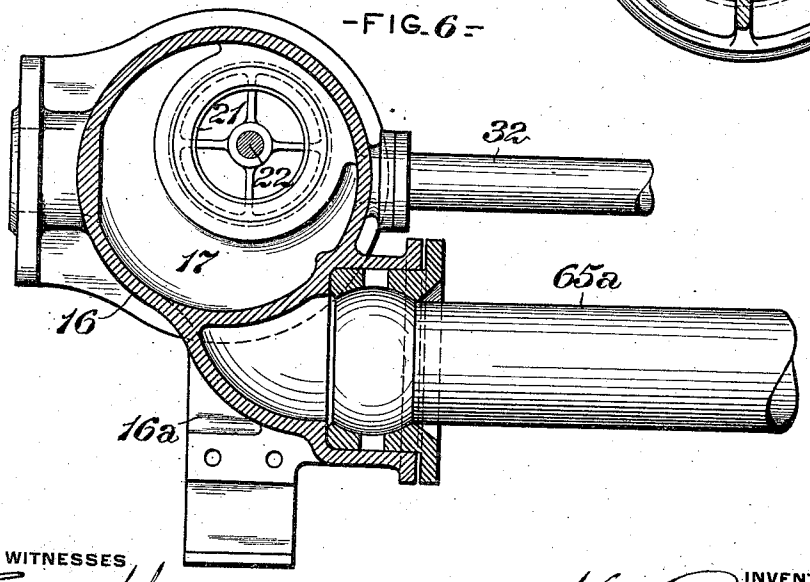
-FIG. 4.-



-FIG. 5.-



-FIG. 6.-



WITNESSES.

Edward A. Wright.

S. R. Bell.

INVENTOR

Hal R. Stafford,

by Johnson & Bell,

Atty.

UNITED STATES PATENT OFFICE.

HAL R. STAFFORD, OF SCHENECTADY, NEW YORK.

COMPOUND LOCOMOTIVE.

1,066,232. Specification of Letters Patent. Patented July 1, 1913.

Application filed December 7, 1912. Serial No. 735,453.

To all whom it may concern:

Be it known that I, HAL R. STAFFORD, of Schenectady, in the county of Schenectady and State of New York, have invented a certain new and useful Improvement in Compound Locomotives, of which improvement the following is a specification.

My invention, while more particularly designed for application in compound locomotives of the articulated or "Mallet" type, is adaptable, similarly and with equally advantageous results, in those of the "cross compound" type, and its objects are to effect a general simplification of structures, and effect a reduction of the undue and objectionable steam leakages which are ordinarily experienced by conveying the various vents, drains, and relief passages to the exhaust passage and thence to the stack, and by effecting a reduction in the number of steam joints and the provision of such a construction of those that cannot be eliminated, as will enable them to be readily maintained in proper operative condition.

The improvement claimed is hereinafter fully set forth.

In the accompanying drawings: Figure 1 is a diagrammatic side view of an articulated compound locomotive embodying my invention; Fig. 2, a longitudinal central section through the intercepting valve chamber, the parts being shown in position when working as a compound engine; Fig. 3, a similar section, the parts being shown in position when working as a simple or single expansion engine; Fig. 4, a transverse section, on an enlarged scale, on the line *c c* of Fig. 8; Fig. 5, a similar section, on the line *d d* of Fig. 3; Fig. 6, a central transverse section through the intercepting valve chamber; Fig. 7, a vertical central section through the simpling valve mechanism; and, Fig. 8, a plan or top view of the same.

My invention is herein exemplified as applied in a locomotive engine of the Mallet articulated compound type, comprising a rear frame, 8, supported on a plurality of driving wheels, 1, and a front frame, 8^a, supported on a plurality of driving wheels, 1^a. The rear frame, as in the regular practice with locomotives of this type, carries, at its front end, which is located nearly at the middle of the length of the boiler, 4, a pair of high pressure cylinders, 12^a, the pistons of which are coupled to crank pins on the driving wheels, 1, and the front frame carries a pair of low pressure cylinders, 12^f, the pistons of which are coupled to crank pins on the driving wheels, 1^a. The boiler, 4, is fixed on the rear frame, 8, and the front and rear frames are coupled, in the longitudinal central plane of the locomotive, by a pivot pin, 8^b, the forward portion of the boiler being thus, as is characteristic in locomotives of this type, free to swing or traverse laterally, relatively to the front frame, 8^a, in passing curves. Steam from the boiler is admitted to the valve chests, 12^c, of the high pressure cylinders, through outside steam pipes, 65, and in the normal operation of the locomotive, that is to say, when it is working compound, is exhausted from the high pressure cylinders into a receiver pipe, 65^a, leading to the low pressure cylinders, from which it is exhausted to the atmosphere through the stack. So far as above stated, the locomotive herein set forth accords generally with instances of the articulated type known and used in practical railroad service prior to my invention, the several features of improvement of which will now be described. These comprehend the structure and relation to other members, of the intercepting valve mechanism and its chamber, and the simpling valve by which changes of operation from compound to simple, and vice versa, are effected as desired. In order to prevent such discharge, a vent valve, 15, is fitted in a cage or chest, 15^a, secured in the wall of the exhaust passage, 12^t, said valve controlling a vent opening, 15^b, leading through the cage, from the passage, 14, to the exhaust passage, and seating normally in the direction of the passage, 14. The vent valve which is herein shown is of the ball type, but may be of any other suitable and preferred construction, and by its application, the discharge of steam is effected through the exhaust pipe, and stack, as in the case of the relief valve before described, and gases from the front end, which would gum up the by pass valve seats, are prevented from being drawn in from the exhaust passage.

The intercepting valve mechanism, instead of being, as in usual practice, inclosed within one of the high pressure cylinders, is fitted in a separate casing, 16, of substantially cylindrical form, which is connected detachably to the front sides of said cylinders, and is suitably supported on the rear frame, 8, or one of its accessories, as for

example, by means of a downwardly extending lug, 16^a. The interior of the casing is divided, by transverse partitions, 16^b, 16^c, and 16^d, into a high pressure exhaust chamber, 17; an independent or direct exhaust chamber, 18; a receiver chamber, 19; and a live steam chamber, 20. Two curved passages, 17^a, lead from the high pressure exhaust chamber, 17, to openings in the wall of the casing, 16, which, when the casing is secured in position on the high pressure cylinders, register with the openings, 12^m, of the exhaust passages of said cylinders, ball joint rings, 17^b, being interposed at the joints to insure tightness while permitting a limited degree of relative movement. Instead of controlling communication between the high pressure exhaust chamber and the receiver by an intercepting valve, and between the high pressure exhaust chamber and the direct exhaust chamber by a separate and independent direct or emergency exhaust valve, as has ordinarily been the practice prior to my invention, I provide a single valve, 21, which, operating in combination with a reducing valve, performs the functions of the two independent valves of the prior art, and which I therefore term an intercepting and direct exhaust valve. The valve, 21, is fixed upon a stem, 22, by the movements of which, as presently to be described, it is either closed on a seat, 16^e, surrounding an opening in the partition, 16^b, when the locomotive is working as a compound engine, as shown in Fig. 7, or in a seat surrounding an opening in the partition, 16^c, when the locomotive is working as a simple engine, as shown in Fig. 8. The seat 16^e, is made integral, and in line axially, with the operating cylinder, 24, hereinafter specified, and is connected therewith by radial ribs or webs, 24^b.

The stem, 22, of the intercepting and direct exhaust valve carries, upon one of its ends, a properly packed piston, 23, which is fitted to move longitudinally in a combined operating and dash pot cylinder, 24, connected detachably to one of the ends of the casing, 16, in which there is formed an opening through which said cylinder, together with the valve, 21, and its stem, may be inserted and removed, as desired. The stem, 22, passes, with a comparatively loose fit, through an opening in the inner head of the cylinder, and the outer end of the cylinder is closed by a detachable head, 24^a, in which is formed an opening, communicating, by a pipe, 25, with the casing, 26, of a manually operated simpling or operating valve, 26^a, located in the cab of the locomotive and controlling the supply of steam from the boiler to the cylinder through the pipe, 25.

The stem, 22, is reduced in diameter for a portion of its length, on the side of the valve, 21, farther from the cylinder, 24, and a reducing valve dash pot piston, 27, is formed or fixed upon it, at the end of its reduced portion, said piston fitting, and working longitudinally, in a reducing valve dash pot, 28^a, formed in a tubular reducing valve, 28, said valve having a piston, 28^b, adjoining its end in which the dash pot is formed, and a piston, 28^c, of smaller diameter, at its opposite end. The pistons, 28^b and 28^c, of the reducing valve, are fitted with suitable packing rings, so as to work steam tight in a main live steam admission valve, 29, which is secured upon the end of the stem, 22, opposite to that on which the piston, 23, is secured. The valve, 29, is open to the receiver chamber, 19, at its end nearer the intercepting and direct exhaust valve, 21, to permit its free traverse relatively to the reducing valve, 28, and near said end is provided with peripheral ports, 29^a, through which, when in simple position, as shown in Fig. 8, communication is established between its interior and the receiver chamber, and with peripheral ports, 29^b, of greater area than the ports, 29^a, which ports, 29^b, in the same position, register with ports, 30^a, in a sleeve or bushing, 30, fixed in a cylinder, 31, projecting outwardly from the casing, 16, and closed, at its outer end, by a removable head, 31^a. The ports, 30^a, lead through the bushing, 30, into the live steam chamber, 20. A packed piston 29^c, is formed on the valve, 29, said piston forming one of the walls of the ports, 29^b, and a packed piston, 29^d, of smaller diameter, is formed on the end of said valve at which it is connected to the stem, 22, said piston fitting a corresponding bore in the bushing, 30. The space within the bushing around the body of the valve, 29, between the pistons, 29^c, and 29^d, communicates with the live steam chamber, 20, by a balancing port, 30^b, and reducing valve vent ports, 29^e, lead through the valve, 29, into the cylinder, 31, from which a vent pipe, 31^b, leads to the separate exhaust pipe, 32, which leads from the independent or direct exhaust chamber, 18, to an independent exhaust pipe in the smoke box. A pipe, 20^a, supplies steam from the boiler to the live steam chamber, 20.

In operation, when it is desired to work the locomotive as a simple engine, steam from the boiler is admitted by the engineer to the operating and dash pot cylinder, 24, by the manipulation of the operating or simpling valve hereinafter described. The intercepting and direct exhaust valve, 21, is thereby moved by the pressure on the outer side of the piston, 23, to its seat in the partition, 16^c, closing communication between the high pressure exhaust chamber and the receiver chamber, and opening communication between the high pressure exhaust chamber and the direct exhaust chamber and separate exhaust pipe. The valve is

seated without shock by reason of the compression of the fluid contents of the dash pot formed by the space on the inner side of the piston, 23. In this traverse of the valve, 21, and its stem, 22, the main live steam admission valve is first moved, by its direct connection with the stem, into position to bring its ports, 29^b, into register with the live steam chamber ports, 30^a. The reducing valve, 28, is then moved by the pressure of the live steam acting on its differential pistons, 28^b, and 28^c, thereby opening the receiver chamber ports, 29^a, and being seated without shock by reason of the resistance exerted in the dash pot, and all parts stand in the position shown in Fig. 8. In this position, the exhaust from the high pressure cylinders is discharged directly through the separate exhaust pipe, 32, and live steam at reduced pressure, is supplied directly to the low pressure cylinders through the live steam chamber, the ports, 30^a, 29^b, and 29^a, the receiver chamber, and the receiver pipe.

When it is desired to work the locomotive as a compound engine, the engineer releases the pressure from the operating cylinder, by movement of the simpling valve to proper position, whereupon the pressure of the live steam on the differential pistons, 29^c, and 29^d, of the live steam admission valve, forces the valve, 21, to its seat in the partition, 16^b, and brings the main live steam admission valve and the reducing valve to the position shown in Fig. 7. The exhaust steam from the high pressure cylinders is then discharged into the receiver chamber, and thence to the low pressure cylinders, and the direct supply of live steam to the low pressure cylinders is cut off.

Among the structural and operative advantages of the valve mechanism above described, the following may be noted:

(*a*) The insured cutting off of the supply of live steam past the reducing valve when working compound.

(*b*) The capability of accommodation of the parts to slight inaccuracies in workmanship, and the prevention of sticking attained by the flexibility of the reduced diameter portion of the valve stem.

(*c*) The conduction of all leakage from balancing or pressure cylinders to a single cavity piped to the separate exhaust passage or to the smoke box of the locomotive.

(*d*) The symmetrical relation of all joints in heads, bushing, etc., enabling them to be made and kept tight.

(*e*) The elimination of all ground or gasket joints to the atmosphere for holding steam under pressure when working compound.

(*f*) The operation of the intercepting and direct exhaust valve, in changing from compound to simple, independently of any preliminary reduction of receiver pressure, the change being made by direct pressure on the operating piston.

(*g*) Capability of complete control of the power of the high pressure engine by regulation of the area of the separate exhaust nozzle, as the intercepting and separate exhaust valve cannot become unbalanced by back pressure when the engine is working simple.

(*h*) Facility and economy of manufacture of the valve mechanism, as all parts requiring to be finished are circular or cylindrical, and the work can therefore be done on a lathe and drill press. The castings used contain no irregular internal cores, and are of very simple form.

(*i*) The intercepting and direct exhaust valve, being non-automatic, is not, as are all automatic valves, sensitive to exact balances of pressure, there being an ample reserve of power for moving the valve in either direction, which overcomes the resistance caused by core sand, cinders, or insufficient lubrication, which would cause automatic valves to become inoperative.

(*j*) Reduction of space occupied by the entire valve mechanism and capability of removing it, as a whole, by taking off a single head.

(*k*) Beneficial effect on the working of the engine by the venting of the valve to the separate exhaust passage, as the back pressure in said passage has a slight, but appreciable, effect in varying the cutting off pressure of the reducing valve. When the engine is working hardest, the pressure in the separate exhaust chamber is highest, causing the reducing valve to deliver steam to the low pressure cylinders at a higher pressure and better maintaining the balance of power between the two engines.

In the operation of locomotives of the Mallet or articulated compound type, they should be, and usually are, started as simple engines, for the reason that the train can be started more easily and with less destructive effect to draft gear, and the engine can be more quickly stopped in the event of accident to couplers. As the valve by which the working of the engine is changed from compound to simple, and vice versa, is frequently used, it should be small and compact, and be so located as to be readily accessible by the engineer.

In the practice of my invention, I provide a simpling or operating valve, 26^a, which is of the rotary type, and is adapted to be moved about its axis on a valve face in a valve casing, 26, which, in order to be conveniently accessible by the engineer, is located immediately in rear of the back head of the firebox, 5, near, and about on a level with, the engineer's brake valve, and is supported on the firebox by a bracket, 27. A pipe, 33, leads from a turret or small

dome on the boiler, to a supply port, 33^a, in the valve casing, and an application port, 25^a, in the casing, communicates with the pipe, 25, which leads to the operating cylinder, 24. An exhaust port, 25^b, in the casing, communicates with an exhaust pipe, 34, leading to the ash pan. A segmental supply port, 26^b, and a similar exhaust port, 26^c, are formed in the valve, 26, said valve having a central stem, 26^d, which passes through the head, 26^e, of the casing, and is provided with a handle, 26^f. By the appropriate movements of the handle, the valve may be moved either into position to bring the supply port, 33^a, into communication with the application port, 25^a, and thereby to admit steam to the operating cylinder, 24, and move the valve mechanism into position for the working of the locomotive as a simple engine, or to bring the exhaust port, 26^c, into communication with the application port and thereby to open an exhaust from the operating cylinder, whereby the valve mechanism is moved into position for the working of the locomotive as a compound engine. The two positions of the handle, for simple and compound operation, respectively, are plainly marked upon the head of the valve casing, as for example, by the letters "S" and "C".

I claim as my invention and desire to secure by Letters Patent:—

1. In a compound engine, an intercepting valve casing divided by partitions into a high pressure exhaust chamber having passages adapted for connection to the exhaust passages of two high pressure cylinders; a receiver chamber having a passage adapted for connection to a receiver pipe; a separate exhaust chamber having a passage adapted for connection to a separate exhaust pipe; and a live steam chamber having a passage adapted for connection to a steam supply pipe; concentric openings for the reception and removal of valve controlling mechanism being provided in each of the dividing partitions and in one end of the valve casing.

2. In a compound engine, the combination of an intercepting valve casing having a separate exhaust chamber, a receiver chamber, and an interposed high pressure exhaust chamber, openings, in line axially, being formed in the partitions between said chambers, an operating cylinder fixed to said casing, and insertible and removable through an end opening therein, and a valve seat fixed to, and in line axially with, said cylinder, and fitting in the opening in the adjoining partition.

3. In a compound engine, the combination of a casing having a separate exhaust chamber, a receiver chamber, and an interposed high pressure exhaust chamber, openings being formed in the partitions between said chambers, an operating and dash pot cylinder, a piston working therein, a stem fixed to said piston, and a single valve fixed to said stem and adapted to control each of the partition openings.

4. In a compound engine, the combination of an intercepting valve casing having a separate exhaust chamber, a receiver chamber, and an interposed high pressure exhaust chamber, openings being formed in the partitions between said chambers, an operating and dash pot cylinder fixed to the casing, a piston working therein, a stem fixed to said piston, a single valve fixed to said stem and adapted to control the partition openings, a dash pot piston fixed to the stem on the side of the valve further from the operating cylinder, and a reducing valve having a dash pot within which said piston is fitted to traverse.

5. In a compound engine, the combination of an intercepting valve casing having a separate exhaust chamber, a receiver chamber, and an interposed high pressure exhaust chamber, openings being formed in the partitions between said chambers, an operating cylinder fixed to the casing, a piston working therein, a stem fixed to said piston, a single valve fixed to said stem and adapted to control each of the partition openings, a reducing valve movable on and controlled by the piston stem, and a differential piston live steam admission valve fixed on said stem.

6. In a compound engine, the combination of an intercepting valve casing having a separate exhaust chamber, a receiver chamber, and an interposed high pressure exhaust chamber, openings being formed in the partitions between said chambers, an operating cylinder fixed to the casing, a piston working therein, a stem fixed to said piston, a single valve fixed to said stem and adapted to control each of the partition openings, and a reducing valve controlled by the piston stem, said piston stem being reduced in diameter for a portion of its length between the single controlling valve and its surface of contact with the reducing valve.

7. In a compound engine, the combination of an intercepting valve casing having a separate exhaust chamber, a receiver chamber, and an interposed high pressure exhaust chamber, openings being formed in the partitions between said chambers, an operating cylinder fixed to the casing, a piston working therein, a stem fixed to said piston, a single valve fixed to said stem and adapted to control each of the partition openings, a reducing valve controlled by the piston stem, a ported sleeve within which said reducing valve operates, and a vent pipe leading from the interior of said sleeve to a determined point of discharge.

8. In a compound engine, the combination of an intercepting valve casing having a

separate exhaust chamber, a receiver chamber, and an interposed high pressure exhaust chamber, openings being formed in the partitions between said chambers, an operating cylinder fixed to the casing, a piston working therein, a stem fixed to said piston, a single valve fixed to said stem and adapted to control each of the partition openings, a live steam chamber in the casing, a reducing valve surrounding the piston stem and controlling communication between the live steam chamber and the receiver chamber, a dash pot in said reducing valve, and a dash pot piston on the piston stem which works in said dash pot and controls the reducing valve in opening communication between the live steam chamber and the receiver chamber.

HAL R. STAFFORD.

Witnesses:
MARCUS E. FRANCE,
S. W. TYLER.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."