Oct. 26, 1926. 1,604,587

G. C. KNIGHT

FLUID PRESSURE ENGINE AND CONTROL MECHANISM THEREFOR

Filed April 30, 1925 3 Sheets-Sheet 1

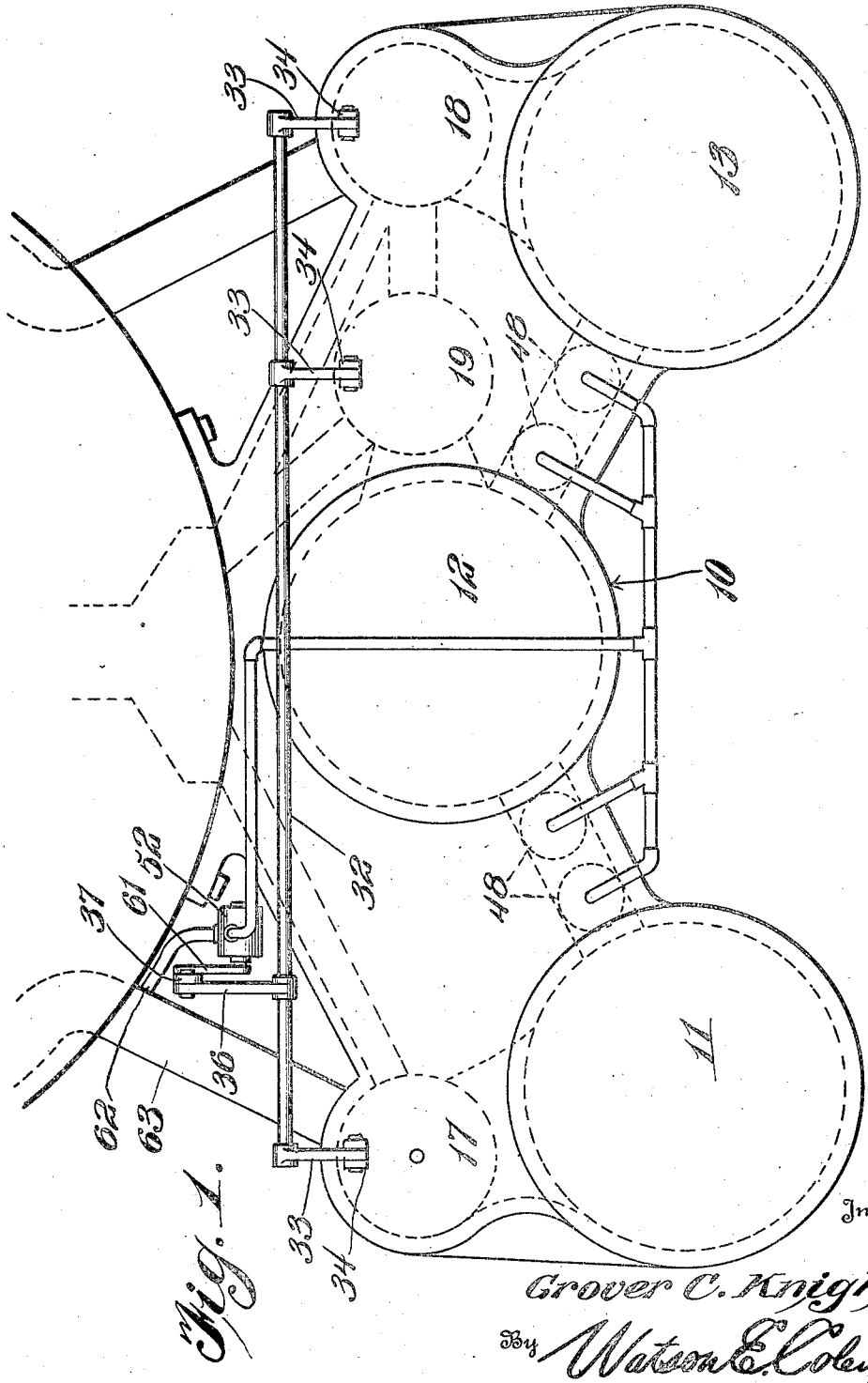


Fig. 1.

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Fig. 2.

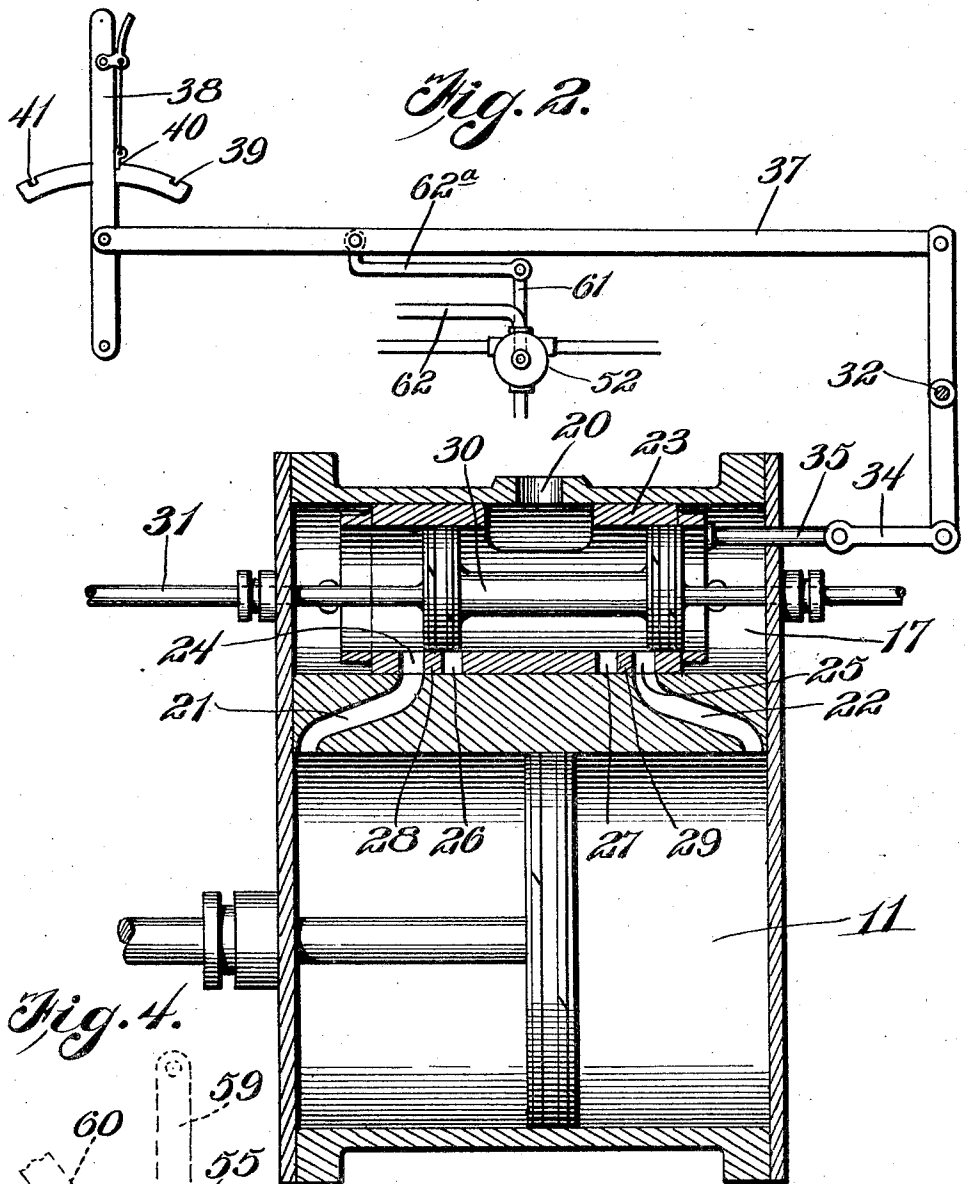
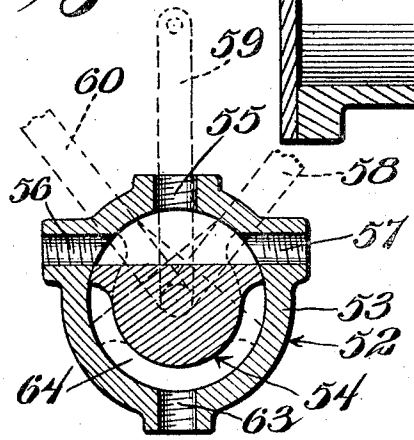


Fig. 4.



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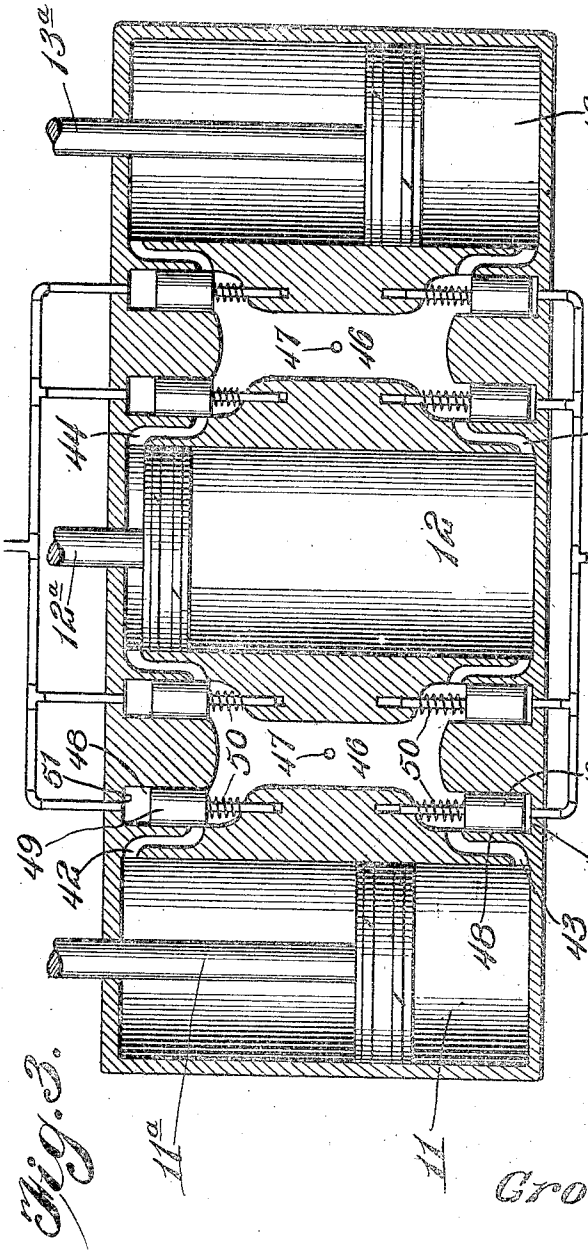


Fig. 3.

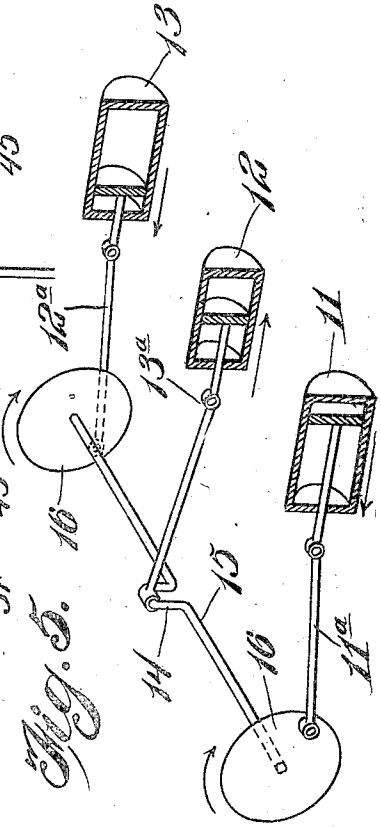


Fig. 5.

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UNITED STATES PATENT OFFICE.

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FLUID-PRESSURE ENGINE AND CONTROL MECHANISM THEREFOR.

Application filed April 30, 1925. Serial No. 27,006.

This invention relates to improvements in fluid pressure engines and control mechanism therefor and more particularly to engines employed as driving apparatus for locomotives.

An important object of the invention is to provide means for controlling multiple cylinder engines which are operated under sustained loads so that they may be changed readily from double to single acting engines after the load has been started, thus eliminating the unnecessary expenditure of the operating fluid thereof.

A further object of the invention is the provision of means automatically placing those ends of the cylinders of an engine of the type above described and which are not in use while the cylinders are being employed as single acting cylinders in communication with one another so that any tendency to the formation of pressure or vacuum behind the pistons of the cylinders is effectually avoided.

A still further object of the invention is to provide in a device of this character particularly adapted for use with locomotive engines a control mechanism for determining whether the steam is delivered to both ends or only one end of the cylinder and in the latter case to determine to which end of the cylinder the steam is admitted.

A further and more specific object of the invention is the provision of control mechanism of the character just described of such character that it may be readily substituted in the ordinary piston valve cage of locomotive engines for the removable and replaceable bushing now employed in such cages.

A still further object of the invention is the provision of a locomotive driving mechanism including three cylinders, two of which are connected in the usual manner to the drive wheels and the other of which is connected with the crank formed in the axle upon which the drive wheels are secured. These cylinders have control means associated therewith whereby they apply their working stroke only at the upper arc of movement of the crank connections to which they are applied, it having been noted that the thrust applied by the application of power during the lower arc of movement of such connections apparently places great thrust upon the bearings and bushings of the rod and the crank connections and transmits a hammering blow to the rail at each application of pressure.

These and other objects I attain by the construction shown in the accompanying drawings, wherein for the purpose of illustration is shown a preferred embodiment of my invention and wherein:—

Figure 1 is a front elevation of a locomotive saddle and its associated parts during the connections employed in accordance with my invention;

Figure 2 is an enlarged detailed sectional view taken through a cylinder and its associated valve chest and showing in connection therewith the operating mechanism for the sleeve 23 and for the relief control valve 52;

Figure 3 is a sectional view showing the relief ports and their control valves, the position of the parts being that assumed when steam is being admitted to the crank ends of the cylinders only;

Figure 4 is a detailed sectional view through the relief valve control showing in solid lines the valve in the position assumed when steam is admitted to both ends of the cylinders and the relief ports are closed and illustrating in dotted lines the position when steam is being admitted only to the head or crank ends of the cylinders; and

Figure 5 is a diagrammatic view showing the connections employed for each of the three cylinders.

Referring now more particularly to the drawings, the numeral 10 designates a locomotive saddle having cylinders 11, 12 and 13, the cylinders 11 and 13 occupying the positions ordinarily occupied by the cylinders of the ordinary type of locomotive while the cylinder 12 is centrally located and has its rod 13ª connected with a crank 14 formed in the axle 15 upon which drive wheels 16 operated from the rods 11ª, 12ª, of the cylinders 11 and 13 are secured. The crank connections between the axle and the several cylinders are best disclosed in the diagrammatic view of Figure 5. Each cylinder 11, 12 and 13 has associated therewith a valve chest 17, 18 and 19. For the purpose of illustration, the valve chest 17 has been shown in section, the valve chest 18 and 19 being exactly similar in construction.

The valve chest has in the form of a cyl-

inder a centrally located steam inlet port 20 and cylinder ports 21, 22, communicating with the opposite ends of the associated cylinder. Arranged within the cylinder provided in the valve chest is a sleeve 23 which is longitudinally shiftable within the cylinder and which has a pair of ports 24, 25, simultaneously alignable with the valve chest ends of the cylinder ports 21, 22. Between the cylinder ports 24 and 25 and adjacent these cylinder ports are arranged further ports 26 and 27, the web between the ports 24 and 26 being such that the dividing wall 28 will not close the port 21 when positioned there over and the web 29 between the ports 25 and 27 being similarly constructed. It will be obvious that by shifting this sleeve in one direction or the other, a cylinder port 21 or 22 is placed into communication with the valve chest while the second cylinder port 21 or 22 is cut off from communication with the valve chest. Within the sleeve 23, which corresponds to the bushing at present employed in the piston valve chest of locomotive engines, is arranged the usual piston valve 30, the stem of which, indicated at 31, may be operated in the usual manner. The valve chest has, of course, the usual exhaust ports E.

Operation of the sleeves 23 of the valve chest 17, 18 and 19 is effected by pivotally mounting upon the saddle a transversely extending rock or tumbling shaft 32 having depending arms 33 corresponding in number and arrangement to the valve chest and each having connected thereto in opposition to the valve chest a link 34, the free end of which is pivotally connected with a stem 35 secured to the sleeve 23. The rock shaft has a further arm 36 to which is connected the forward end of a link 37, the rear end of which is operatively connected with a latch lever 38 having three positions 39, 40 and 41. When the latch lever 38, which may be located within the locomotive cab (not herein shown), is in the position 39, the sleeves are shifted so that the ports 26 align with the cylinder ports 21 from the crank end cylinder ports and accordingly steam or fluid pressure is admitted only to the crank end of the cylinders 11, 12 and 13. When it is in the position 40, both ports 21 and 22 are in communication with the valve chest and steam is admitted to both ends of the cylinder and when it is in the position 41, the steam is admitted only to the head end of the cylinder.

If the crank connections of the cylinders 11, 12 and 13 are spaced one hundred and twenty degrees about the circumference upon which they operate and the power strokes of the engine are represented by the upper and lower cycles of rotation of the crank connections, then as the engine is operating forwardly, if steam is only applied during the upper half of travel, there will be three impulses applied to the axle during each rotation and since these impulses are approximately one hundred and eighty degrees duration, the power impulses will overlap, thus giving a continuous application of power to the axle with a reduction in steam expenditure in the cylinders 11, 12 and 13 of twenty five percent as compared with the two cylinder driving mechanism ordinarily employed where steam is admitted to both ends of the cylinder. Furthermore, hammering of the bearings at connections is avoided during the return or lower cycle and at the same time, substantially the same power is transmitted to the driving axle. When reversing the engine, steam may be admitted to the head ends of the cylinders only and the same condition applies. When starting a heavy load, steam may be admitted to both ends to give the extra power desired at this time.

It will be obvious that some means must be provided for relieving the ends of the cylinders which are not in operation and to which steam is not being alternately fed and exhausted as otherwise an alternate vacuum and pressure will be formed in these cylinders with the result that the engine would become inoperative. This I provide by forming in the saddle ports 42 and 43 connecting corresponding ends of the cylinders 11 and 12 and ports 44 and 45 connecting corresponding ends of the cylinders 12 and 13. Each pair of ports 42 and 43 and 44 and 45 is connected by a port 46 having a small bleed outlet 47 communicating with the atmosphere. Intercepting each port 42, 43, 44 and 45, adjacent each cylinder 11, 12 and 13 is a cylindrical bore 48 having arranged therein a piston valve 49, each shiftable to positions where it opens or closes the port with which it is associated. These valves are normally held in the open position by springs 50 and are moved to the closed position by the application of fluid pressure between the piston valve and the outer end 51 of the bore 48 in a manner hereinafter to be described.

It will be obvious that when the valves 49 are in the position to close a given port, as for example, the port 42, no communication is established between the cylinders connected by this port and in the present instance the cylinders 11 and 12, while, when the valves are in the open position, communication is established between the cylinders. The operating mechanism employed is such that the valves of the ports 42, 44 are simultaneously operated and the valves of the ports 43 and 45 are simultaneously operated.

This operating mechanism includes a bypass valve 52 comprising a circular chamber 53 in which is rotatable a segment 54. The chamber 53 has ports 55, 56 and 57 and the

segment has three positions 58, 59 and 60 corresponding to the positions 39, 40, 41, of the lever 38, as will hereinafter more fully appear. In the position 58 of the segment which is effected by its operating lever 61, the ports 55 and 57 are placed in communication. In the position 59, the ports 55, 56 and 57 are placed into communication and in the position 60, the ports 55 and 56 are placed into communication. The port 55 is in communication with a branch 62 of the steam line 63 to the valve chests while the port 57 communicates with the outer ends of the bores 48 associated with the ports 42 and 44 and the port 56 is in communication with the outer ends of the bores 48 associated with the passages 43 and 45. The operating handle 61 of the segment 54 is connected by a link 62[a] with the link 37 through which an operation of the sleeves 23 is effected so that this segment is shifted as the lever 38 is shifted.

Assuming that the engine is to start under load and that it is desired that steam be admitted to both ends of all of the cylinders, the lever 38 is moved to its position 40 and then steam is admitted in the usual manner. With the lever in the position above described, each piston valve sleeve has the position shown in full lines in Figure 2 and the ports 21 and 22 are in communication with their respective valve chests. At the same time, the segment 54 is placed to place the ports 56, 57 into communication with the port 55. As steam is admitted, steam passes through the ports 56 and 57 to each of the piston valve cylinders 48 forcing the piston valves inwardly so that they close the ports 42, 43, 44 and 45 and the ends of the cylinders 11, 12 and 13 are thrown out of communication with one another. Steam is admitted to the cylinders in the usual manner and after the load has been started, the lever 38 may be shifted to its position 39 so that the ports 26 and 21 are aligned and the ports 22 are cut off from their valve chambers. At the same time, the supply of steam to the piston valves 49 associated with the ports 43 and 45 is removed. The trapped pressure being relieved by a relief port 63 and a relief groove 64 formed in the segment 54 and which, when in the position 58, places the ports 56 and 63 into communication. When in the position 60, this relief groove places the ports 57 and 63 into communication but when in the position 59, the relief groove is out of communication with both of the ports 56 and 57. The exhaust ports E are, of course, in communication with the interior of the valve chest in all positions of the sleeve.

When the trapped pressure is released, the valves 49 will, of course, be moved to their open positions by the springs 50 so that under the circumstances above described, when steam is admitted to the crank ends of the cylinders 11, 12 and 13, communication between these crank ends of the cylinders is cut off and communication established between the head ends of these cylinders. Therefore, the pressure formed in front of the piston in any given cylinder may find relief in one or the other of the remaining cylinders and no vacuum or pressure will be formed between the ends of the cylinders and the piston. When the lever 38 is moved to the position 41, the conditions just described are reversed. Steam is admitted to the head ends of the cylinder, the valves 49 of the ports 43 and 45 are moved to the closed position and the valves 49 of the ports 42 and 44 are moved to the open position, thus placing the crank ends of the cylinders in communication.

Attention is directed to the fact that if steam is cut off from the cylinders during the operation of the engine at any time and at any one of the positions of the lever 38, since the valve 52 obtains its pressure from the feed line, the valves 49 will all be released and move to the open position permitting fluid within the cylinders 11, 12 and 13 to intercommunicate between these cylinders at both ends. Since the displacement will be constant and by this construction not only are the corresponding ends of the cylinders placed in communication with one another but likewise with the opposite ends of the cylinders, it will be obvious that an efficient drifting mechanism is provided in which there will be no tendency to the formation of vacuum or pressure.

It will furthermore be obvious that the construction hereinbefore set forth is capable of a certain range of change and modification without materially departing from the spirit of my invention and I accordingly do not limit myself to such specific structure except as hereinafter claimed.

I claim:—

1. In a steam engine, a plurality of cylinders, a valve chest for each cylinder, a pair of ports communicating at opposite ends of each cylinder and opening to the valve chest thereof, a sleeve within each valve chest and shiftable therein to establish communication between the valve chest and a selected port or to permit said ports to simultaneously communicate with the valve chest, a piston valve within each sleeve controlling the admission of fluid pressure to, and exhaust of fluid pressure from the associated cylinder through the port or ports communicating with the valve chest and means for simultaneously shifting said sleeves and for locking the sleeves in adjusted positions, ports connecting corresponding ends of said cylinders, valves shiftable to close said ports and means operated by the control mechanism of said sleeves for shifting said valves

to close the ports at the end or ends of the cylinders to which fluid pressure is being admitted.

2. In a steam engine, a plurality of cylinders, a valve chest for each cylinder, a pair of ports communicating at opposite ends of each cylinder and opening to the valve chest therof, a sleeve within each valve chest and shiftable therein to establish communication between the valve chest and a selected port or to permit said ports to simultaneously communicate with the valve chest, a piston valve within each sleeve controlling the admission of fluid pressure to, and exhaust of fluid pressure from the associated cylinder through the port or ports communicating with the valve chest, means for simultaneously shifting said sleeves and for locking the sleeves in adjusted positions, ports connecting corresponding ends of said cylinders, valves shiftable by fluid pressure to close said ports and a valve operated by the control mechanism of said sleeves for admitting fluid pressure to close the valves of the ports at the end or ends of the cylinder to which fluid pressure is being admitted.

3. In a steam engine, a plurality of cylinders, a valve chest for each cylinder, a pair of ports communicating at opposite ends of each cylinder and opening to the valve chest thereof, a sleeve within each valve chest and shiftable therein to establish communication between the valve chest and a selected port or to permit said ports to simultaneously communicate with the valve chest, a piston valve within each sleeve controlling the admission of fluid pressure to, and exhaust of fluid pressure from the associated cylinder through the port or ports communicating with the valve chest, means for simultaneously shifting said sleeves and for locking the sleeves in adjusted positions, ports connecting corresponding ends of said cylinders, valves shiftable by fluid pressure to close said ports, a valve operated by the control mechanism of said sleeves for admitting fluid pressure to close the valves of the ports at the end or ends of the cylinder to which fluid pressure is being admitted, said valve having a fluid pressure inlet and a pair of fluid pressure outlets, one of said pairs of fluid pressure outlets communicating with each of the valves of the ports connecting the head ends of the cylinders, the other of said outlets communicating with each of the valves of the ports connecting the crank ends of the cylinders.

4. In a steam engine, a plurality of cylinders, a valve chest for each cylinder, a pair of ports communicating at opposite ends of each cylinder and opening to the valve chest therein, a sleeve within each valve chest and shiftable therein to establish communication between the valve chest and a selected port or to permit said ports to simultaneously communicate with the valve chest, a piston valve within each sleeve controlling the admission of fluid pressure to, and exhaust of fluid pressure from the associated cylinder through the port or ports communicating with the valve chest, means for simultaneously shifting said sleeves and for locking the sleeves in adjusted positions, ports connecting corresponding ends of said cylinders, valves shiftable by fluid pressure to close said ports, a valve operated by the control mechanism of said sleeves for admitting fluid pressure to close the valves of the ports at the end or ends of the cylinder to which fluid pressure is being admitted, said valve having a fluid pressure inlet and a pair of fluid pressure outlets, one of said pairs of fluid pressure outlets communicating with each of the valves of the ports connecting the head ends of the cylinders, the other of said outlets communicating with each of the valves of the ports connecting the crank ends of the cylinders, said valve further including a relief port and a relief groove placing either of said outlets in communication with the relief port when the other of the outlets alone is in communication with said inlet port.

5. In a steam engine, a plurality of cylinders, a valve chest for each cylinder, a pair of ports communicating at opposite ends of each cylinder and opening to the valve chest therein, a sleeve within each valve chest and shiftable therein to establish communication between the valve chest and a selected port or to permit said ports to simultaneously communicate with the valve chest, a piston valve within each sleeve controlling the admission of fluid pressure to, and exhaust of fluid pressure from the associated cylinder through the port or ports communicating with the valve chest, means for simultaneously shifting said sleeves and for locking the sleeves in adjusted positions, ports connecting corresponding ends of said cylinders, valves shiftable by fluid pressure to close said ports, a valve operated by the control mechanism of said sleeves for admitting fluid pressure to close the valves of the ports at the end or ends of the cylinder to which fluid pressure is being admitted, said valve having a fluid pressure inlet and a pair of fluid pressure outlets, one of said pairs of fluid pressure outlets communicating with each of the valves of the ports connecting the head ends of the cylinders, the other of said outlets communicating with each of the valves of the ports connecting the crank ends of the cylinders, said valve further including a relief port and a relief groove placing either of said outlets in communication with the relief port when the other of the outlets alone is in communication with said inlet port, a fluid pressure feed line for the cyl-

inders and communicating with each valve chest of each cylinder and a connection between said fluid pressure feed line and the inlet of said control valve.

6. In a multiple cylinder steam engine, a piston reciprocable within each cylinder, ports connecting corresponding ends of the cylinder, means for closing said ports when steam is admitted to the cylinders, comprising normally open valves closable by the admission of fluid pressure to the cylinders, a steam line for the cylinders, and a connection between the steam line of the cylinders and the valves admitting steam to the valves to close the same during its admission to the cylinders, said cylinders each including valve mechanism for limiting the application of steam therein to either end alone or to both ends of the cylinder, the connection between the steam line and said valves including a valve for controlling admission of steam to the valves of the ports whereby steam may be admitted only to those valves at that end of the cylinders at which steam is being admitted.

7. In a steam engine, a plurality of cylinders, a piston reciprocable within each cylinder, means for admitting fluid pressure to said cylinders at selected corresponding ends of said cylinders or to opposite ends thereof, ports connecting corresponding ends of said cylinders and means under control of the first named means for closing the ports connecting the ends of the cylinders to which fluid pressure is being admitted.

8. In a multiple cylinder steam engine, a piston reciprocable within each cylinder, means for admitting fluid pressure to said cylinders at selected corresponding ends thereof or to opposite ends thereof, passages connecting corresponding ends of the cylinders, a connection between the passages connecting corresponding ends of the cylinders and means for closing the passages connecting the ends of the cylinders to which steam is admitted by the first named means.

9. In a multiple cylinder steam engine, a piston reciprocable within each cylinder, means for admitting fluid pressure to said cylinders at selected corresponding ends thereof or to opposite ends thereof, passages connecting corresponding ends of the cylinders, a connection between the passages connecting corresponding ends of the cylinders and means for closing the passages connecting the ends of the cylinders to which steam is admitted by the first named means, the last named means being under the control of the first named means.

10. In a multiple cylinder steam engine, a piston reciprocable within each cylinder, means for admitting fluid pressure to said cylinders at selected corresponding ends thereof or to opposite ends thereof, passages connecting corresponding ends of the cylinders, a connection between the passages connecting corresponding ends of the cylinders and means for closing the passages connecting the ends of the cylinders to which steam is admitted by the first named means, said connection having a bleed port communicating with the atmosphere.

In testimony whereof I hereunto affix my signature.

GROVER C. KNIGHT.