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B. S. AIKMAN

FLUID PRESSURE SYSTEM

Filed March 8, 1924

3 Sheets-Sheet 1

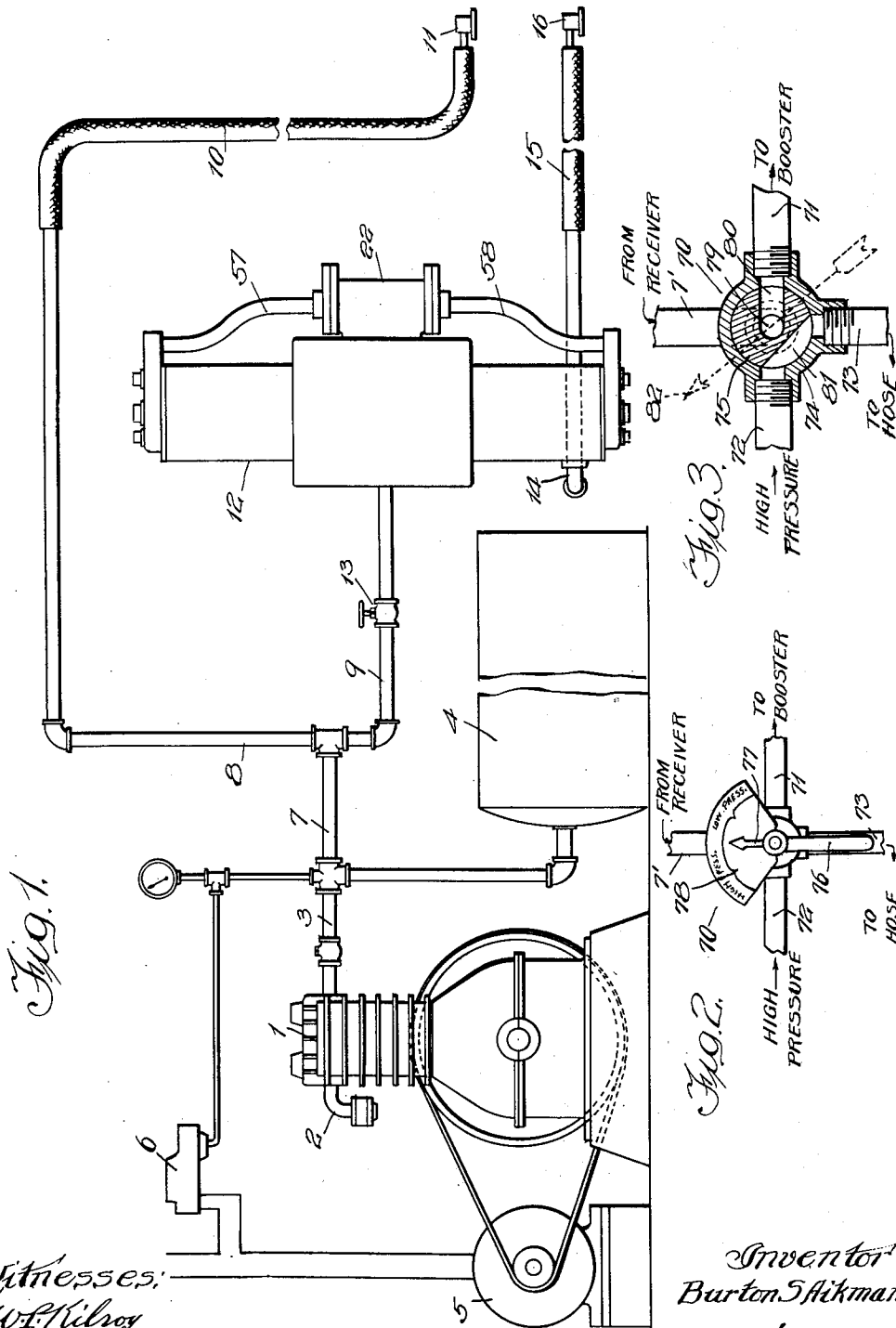


Fig. 1.

Fig. 3.

Fig. 2.

Witnesses:
W. L. Hilroy
Harry R. White

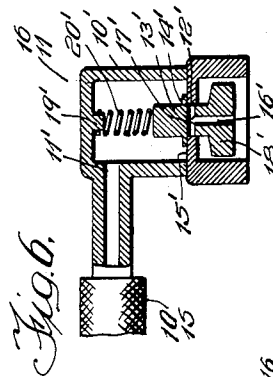
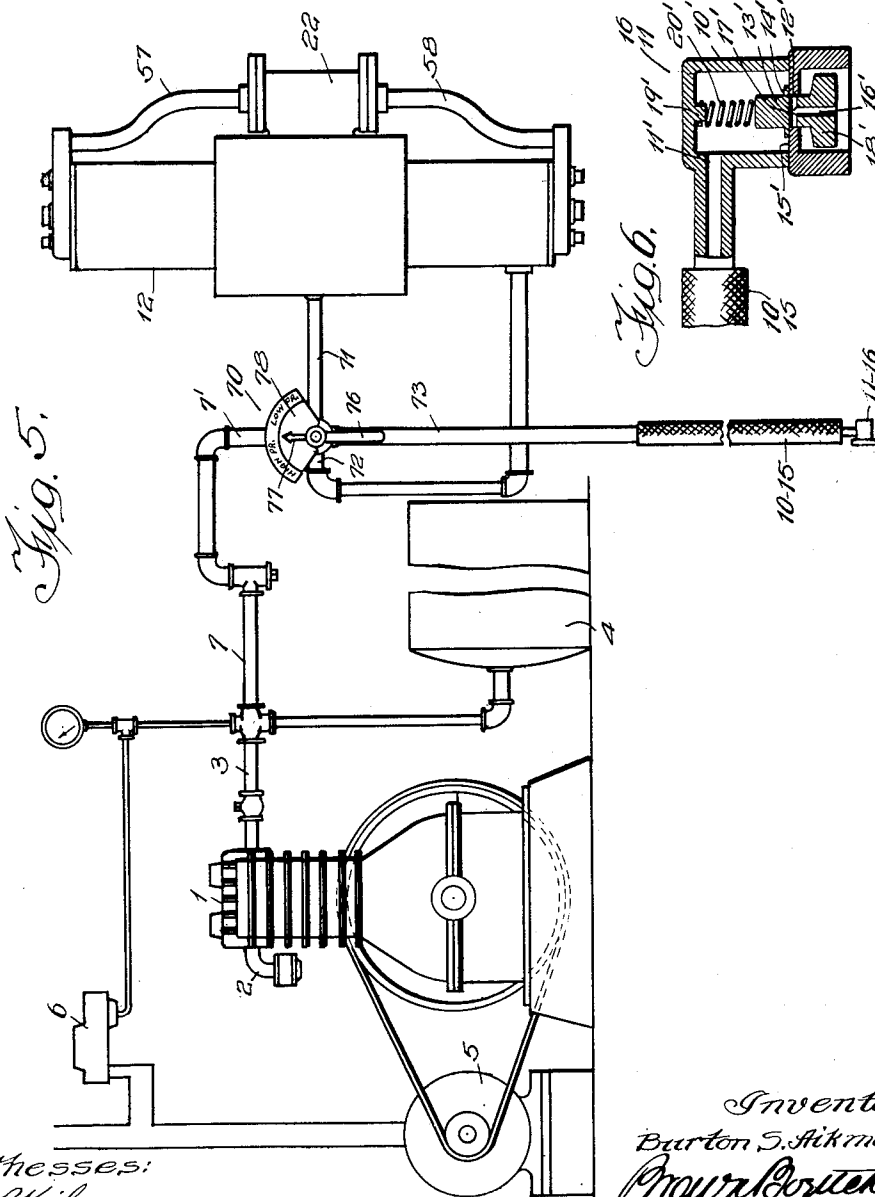
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3 Sheets-Sheet 3



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Patented Sept. 21, 1926.

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UNITED STATES PATENT OFFICE.

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FLUID-PRESSURE SYSTEM.

Application filed March 8, 1924. Serial No. 697,732.

My invention relates to fluid pressure systems.

The modern garage provides a source of compressed air for filling tires. The requirements for such service have heretofore been such that a single stage compressor and reservoir have served satisfactorily. The usual air pressure carried in the reservoir is from 70 to 100 pounds.

With the advent of large truck tires requiring air at from 100 to 150 pounds, the limits of satisfactory single stage compression have been reached, and it is generally considered necessary to employ a two stage compressor for this service.

Since the average garage is now equipped for 90 pounds, such raising of the pressure entails a considerable expense in the cost of a new compressor and a suitable motor, and in many cases a heavier tank.

I have observed that in the usual garage or service station only a small percent of the air is employed for high pressure requirements, but the entire amount that is used for all purposes must be thus compressed against the high pressure of the receiving tank.

In thus compressing against this high false head for the major amount of air, a very considerable waste of power is entailed. The cost of compressing air increases very rapidly as the terminal pressure is increased.

I provide a system in which the air is compressed to the lower pressure and stored in the reservoir at the lower pressure which is suitable for pumping up the majority of tires, and the air for pumping up truck tires and the like is further compressed by an air operated booster which delivers air at a desired higher pressure. Thus the air that is stored is kept at a low pressure. This means, first, that the cost of compressing is low and mechanical efficiency is high; second, that the loss from leakage is less; and finally it means that so much of the equipment which is now standard need not be changed. The booster operates only as there is a demand for air, and hence no more air than is required for immediate operation is compressed to the higher pressure. This effects a saving in initial investment and it saves in cost of operating the system.

I have provided a novel form of booster which takes air from the receiving tank and compresses a part of the same as required and delivers it at a higher pressure.

In pneumatic apparatus it is often difficult to get the working cylinder filled with the fluid. In the present case I insure a full charge of air in the compressing cylinders by causing them to function as motor cylinders prior to their operation as compressor cylinders.

Furthermore, I provide means for employing a single hose for dispensing either high or low pressure when the same is desired. Obviously, two separate distributing systems may be employed if desired.

While I have described my invention in connection with an air pumping system for inflating tires, it is obvious that the invention has many other uses.

The boosting ratio is determined by the ratios of piston areas. This may be widely varied as desired. Also the booster of my invention may be employed to boost by two stage action instead of single stage action, as will be described more in detail later.

In order to acquaint those skilled in the art with the manner of construction and operating a system according to my invention, I shall now describe a tire inflating system embodying the invention.

Fig. 1 is a diagram of a system embodying my invention;

Fig. 2 is a front elevational view of a switching valve for employing a single hose connection which may be switched to the reservoir or to the booster to give either low pressure or high pressure, respectively;

Fig. 3 is a cross section through the valve shown in Fig. 2 in a plane parallel to the plane of the paper;

Fig. 4 is a longitudinal section through the booster and through the control valve therefor;

Fig. 5 is a diagrammatic view showing the application of the valve illustrated in Fig. 2 to the system disclosed in Fig. 1; and

Fig. 6 is a detail view of an automatic charging valve.

In Fig. 1, I have shown the compressor 1, which may be a single stage compressor, having the air inlet 2 and discharge pipe 3 leading to a reservoir 4, which may be of any suitable capacity and of sufficient strength to hold air under pressure at approximately 125 pounds with a suitable factor of safety.

The compressor 1 is driven by a suitable electric motor 5 governed by a pressure controlled governor 6 which may be of any suit-

able form. While I have shown the compressor 1 as driven by an electric motor, it is to be understood that any other suitable means for compressing air and storing the same in the reservoir 4 may be employed. The reservoir 4 has a delivery pipe 7 which branches at 8 and 9, the branch 8 leading to a flexible hose 10 having a suitable automatic charging valve 11 adapted to engage the nipple of the usual tire valve for inflating the tire.

The branch 9 leads through a suitable shut-off valve 13 to the booster 12 and from the discharge connection 14 of the booster 12 to a flexible hose 15 having the automatic valve 16.

The automatic valves 11 and 16 may be of the type shown in Fig. 6 which consists essentially of a casing 10' provided with an opening 11' to which either the hose 10 or 15 may be secured. Positioned in another opening 12' in the casing 10' is a movable valve member 13' having a shoulder 14' for engaging the wall 15' of the casing 10'. The member 13' is provided with an orifice 16' connected to aperture 17'. The member 13' is also equipped with an enlarged portion 18' for preventing the member 13' from being pushed too far into the casing. Formed on the inside of the casing is a lug 19' which is connected to the end of the member 13' by a spring 20' which exerts a downward force or pressure on the member 13'. This downward pressure normally maintains the shoulder 14' of the member 13' on the portion designated by reference numeral 15', thereby closing the valve. It is, of course, obvious that the pressure of the air in the valve will also aid in maintaining the valve closed. By exerting a very slight pressure on the enlarged portion 18' the valve may be easily opened permitting the air under pressure to be discharged therefrom.

The booster 12 comprises a central cylinder 20, which is fitted with a double-acting piston 21. Suitable piston rings are mounted on the piston 21 to prevent leakage between the piston and the cylinder walls. The cylinder 20 is provided with an integral valve housing 22, having the longitudinal passageways 23 and 24 leading through passageways 25 and 26 to the ends of the cylinder 20 upon opposite sides of the piston 21. Compressor cylinders 30 and 31, of smaller diameter than the diameter of the motor cylinder 20, are bolted to the ends of the motor cylinder 20, and plungers or pistons 32 and 33 are secured to the piston 21 and to each other axially in line. The piston 21, with both of its plungers 32 and 33, may be made integral if desired. The ends of the plungers 32 and 33 are provided with suitable packing rings of any preferred or well-known construction. The compressor cylinders 30 and 31 are provided with suit-

able heads 34 and 35, these heads each comprising suitable automatic inlet check valves 40 and automatic discharge check valves 41. These valves are held to their seats by suitable springs, as is well known in the art. The discharge check valves 41 are connected to passageways 42 in the heads 34 and 35 to a common manifold passageway 43-44 formed in the motor cylinder walls and in the compressor cylinder walls, so that compressed air discharged at the boosted pressure may pass to the discharge connection 14.

The valve passageways 23 and 24 terminate in ports 45 and 46 in a valve seat, which is adapted to be served by the D-slide valve 47. An exhaust port 48 lies between the cylinder ports 45 and 46. The D-slide valve 47 is adapted to be shifted to connect one of the ports to exhaust and the other to live air, which live air connection leads from the pipe 9 to the interior of the valve housing 23.

The slide valve 47 is held to its seat by springs 49, and during normal operation is further held by the pressure of the air inside of the housing 22. This valve is mounted upon a valve stem 50, and upon opposite ends of the stem are the pistons 51 and 52 fitting in cylinders 53 and 54 formed at opposite ends of the valve housing 22. These cylinders are closed by heads 55 and 56, and pilot valve connections 57 and 58 lead to passageways 59 and 60 in the cylinder heads 34 and 35. These pilot valve passageways 59 and 60 are controlled by spring pressed pilot valves 61 which have operating stem 62 extending into the cylinders 31 and 32 and are adapted to be engaged by the ends of plungers 32 and 33 to be opened at the end of a compression stroke to discharge some of the compressed air at the boosted pressure to the cylinders 53 and 54 of the main valve motor. It will be noted from Fig. 4 that the pistons of the main valve motor have leakage ports 63 therethrough for the purpose of letting the pressures upon opposite sides of the pistons equalize after the piston has been driven to the limit of its movement.

The inlet valves 40-40 (Fig. 4) control, or valve, ports through the cylinder heads 34 and 35 from pipes 64 and 64', respectively, which are manifolded together at 10' and to the compressed air connection 9 and the pipe 9' which leads to the D valve chamber in the integral housing 22.

Air at normal pressure of from 70 to 90 pounds passes from the reservoir 4 to the pipe 7 and connection 9, and, assuming that the valve 13 is open, air fills the ends of the cylinders 30 and 31 beyond the plungers 32 and 33. This is because the check valves 40 open inwardly and permit the air to pass in and equalize the pressure against opposite ends of the plungers 32 and 33. At the same time, air passes through the manifold

connection into the interior of the valve housing 22, pressing equally against the pistons 51 and 52; therefore, not moving the same but passing as indicated in Fig. 4 through the port 46, passageway 24 and port 26 into the cylinder 20 below the piston 21. The opposite end of the cylinder 20, above the piston 21, communicates with atmosphere through the exhaust port 48. The piston 21, with its connected plungers 32 and 33, is therefore driven toward the top as viewed in Fig. 4, compressing the air and driving the same past the check valve 41, and finally striking the valve stem 62 of the valve 61 in cylinder head 34, and thereby discharging a small quantity of high pressure air through the port 59 through flexible tubing connection 57 to the top of the motor piston 51, driving said valve motor, together with the valve 47, to the lowermost position. Pressures quickly equalize upon the opposite sides of the pistons 51 and 52, and the return stroke is then made, the lower end of double-acting cylinder 20 being then connected to exhaust and the top end, above the piston 21, being connected to live air. The booster will then proceed to discharge air at any desired pressure between the low pressure air in the pipe 9 and any higher pressure which is in proportion to the ratios of the piston areas. That is to say, the ratios of the piston areas determine at what boosted or terminal pressure the booster will stall and end its upper working limit. It is not necessary to pump or boost all of the air to the maximum pressure, as air at a less pressure is quite suitable so long as it will overcome a resistance. With automatic valve 16 closed, the booster will make a few strokes filling the line and flexible pipe 15, and then will stand under pressure until air is drawn, just like a faucet controlled pneumatic displacement water pump.

Therefore, so long as the valve 13 is open and booster 12 stands under pressure in the system indicated in Fig. 1, low pressure air may be drawn at the valve 11, or high pressure air may be drawn at the valve 16.

If desired, a suitable common controlling valve 70, as shown in Figs. 2 and 3, may be employed for utilizing a single hose and valve and to connect the same to either the reservoir 4 or to the booster 12 and to connect the booster automatically to the receiver 4 where high pressure air is desired.

The valve 70 has four connections; namely, the connection 7' from the receiver, the connection 71 leading to the booster corresponding to the pipe 9 of Fig. 1, the pipe 72 leading to the high pressure manifold of the booster, and the pipe 73 leading to the common hose and valve, such as shown at 15-16 in Fig. 1. The valve 70 comprises a suitable body 74 and plug 75, preferably

fitted on a taper as is common in valves of this class. This valve plug has a suitable handle 76 and a pointer 77 playing over a suitable indicating dial 78 for indicating when the hose is connected to high pressure or low pressure. The valve plug 75 has an axial passageway 79 communicating at all times with the receiver connection 7' and having a radial port 80 which is adapted to be brought into register or out of register with the port leading to the booster. The valve plug 75 is also provided with a cut-away passage 81 for connecting the high pressure discharge manifold connection 72 to the hose connection 73 when low pressure air is connected to the booster. Thus, when the handle is in the position shown in Fig. 2, all connections are cut off, and when the handle is moved to the position indicated by the dotted arrow 82 in Fig. 3, the hose is connected to the high pressure discharge manifold of the booster 12 and the receiver is connected to the booster for supplying air thereto.

It will be noticed in the operation of the booster that each cylinder full of air is supplied to the connection 9, and hence the cylinder is filled completely with air for each stroke. Hence there is a maximum effectiveness of the booster and evenness of load which permits the device to operate efficiently and at relatively high speed. Even when the demand for high pressure air is great, there is sufficient trapping of air, by the restriction of the discharge passageways, to prevent pounding of the piston against the cylinder heads.

As above stated, the booster may be made to operate in two stages by reducing the diameter of one compressor cylinder and causing the other cylinder to discharge directly into said smaller cylinder by a connection such as shown in the manifold 43-44. The reduction in diameter of the second stage compressor cylinder and piston does not disturb the balanced relation since the sum of the pressures acting in the particular direction to make a stroke remains the same; that is to say, assume that the cylinder 30 and its piston are reduced in diameter, then the total area is less, and even if a higher unit pressure is encountered, the area has been reduced so that the total resistance may be the same as before.

The valve mechanism which I have shown is of as simple and direct a construction as I can at present conceive of, but it is to be understood that the construction of valve and motor therefor may be varied within the spirit and scope of my invention as defined by the appended claims.

The result is a highly efficient system of low initial cost and economical operation.

I do not intend to be limited to the precise details shown or described.

I claim:

1. A system of the class described comprising a compressor, a receiver therefor for storing air at a relatively low pressure, a distributing pipe for distributing said low pressure air, an air operated booster connected to said receiver, and means for distributing the air from said booster at a high pressure, said booster operable only upon demand for high pressure air.
2. A system of the class described comprising a single stage compressor, a receiving tank therefor for storing air at a relatively low pressure, automatic means for starting and stopping the compressor to maintain a given pressure in said tank, means for distributing air at said low pressure, an air operated booster connected to said tank for taking air from said tank and delivering it at a relatively high pressure, and means for distributing said high pressure air, said booster operable only upon demand for high pressure air.
3. In combination, a receiver, a compressor for charging said receiver with compressed air to a relatively low pressure, a booster operated by compressed air from said receiver to discharge air at a relatively high pressure, and a distributing hose having a normally closed, manually controllable outlet connected to the delivery side of said booster, said booster being adapted to be stalled by back pressure when the outlet is closed.
4. In combination, a receiver, a compressor for automatically charging the receiver to a relatively low pressure, a booster operated by compressed air from said receiver to compress a part of the air taken from the receiver to a relatively high pressure, a distributing hose, and a valve for connecting said hose at will to the delivery side of the booster or to the receiver.
5. In combination, a receiver, a compressor for automatically charging the receiver to a relatively low pressure, a booster operated by compressed air from said receiver to compress a part of the air taken from the receiver to a relatively high pressure, a distributing hose, and a valve for connecting the booster to the tank and the hose to the booster, or to disconnect the booster from the tank and connect the hose directly to said tank.
6. In combination, a receiver, a compressor for automatically charging the receiver to a relatively low pressure, a booster having an intake connection and a discharge connection and constituting means for automatically taking air from the receiver and compressing a part thereof to a relatively high pressure, a distributing hose, a valve having a tank connection, a hose connection, a booster intake connection and a booster delivery connection, said valve having a movable element for establishing simultaneous communication of the tank connection with booster intake and of the booster delivery with the hose.
7. In combination, a receiver, a compressor for automatically charging the receiver to a relatively low pressure, a booster having an intake connection and a discharge connection and constituting means for automatically taking air from the receiver and compressing a part thereof to a relatively high pressure, a distributing hose, a valve having a tank connection, a hose connection, a booster intake connection and a booster delivery connection, said valve having a movable element for establishing simultaneous communication of the tank connection with booster intake and of the booster delivery with the hose, said movable element being movable to shut off the booster intake and discharge and to establish communication between the tank connection and the hose connection.
8. In combination, means for putting a medium under pressure, a receiver for the said medium under pressure, a second means connected to said receiver operable by the said medium under pressure for increasing the pressure of the said medium and means for distributing the medium from the second means at a high pressure, said second means operable upon demand for high pressure medium.
9. In combination, a receiver, a first means for charging the said receiver with a medium under pressure, a second means operated by the medium under pressure from said receiver for increasing the pressure of the said medium, and a third means having a normally closed outlet connected to the said second means for distributing the medium under pressure, the said second means being adapted to be stopped by back pressure when the said outlet is closed.
10. In combination, a receiver, a first means for charging the said receiver with a medium under pressure, a second means operated by the said medium under pressure for increasing the pressure of the said medium under pressure, a distributing element, and a member connecting the second means to the receiver and the element to the second means, or to disconnect the second means from the receiver and connect the element directly to the said receiver.
11. In combination, a receiver, a first means for charging the said receiver with a medium under pressure, and a second means operated by the medium under pressure from said receiver for increasing the pressure of the said medium comprising three connected pistons one of which is of a greater effective diameter than the others, three cylinders therefor, the cylinders of the small pistons having automatic intake check

valves adapted to be connected to the medium under pressure and having automatic discharge check valves connected to a common discharge outlet, and an automatic control valve for the said one cylinder, a motor for the control valve and a pilot valve actuated upon the completion of a stroke for admitting medium under pressure to the said motor to shift the valve.

12. In combination, a receiver, a first means for charging the said receiver with a medium under pressure, and a second means operated by the medium under pressure from said receiver for increasing the pressure of the said medium, comprising a central motor cylinder of relatively large diameter, a double acting piston therein, compressor cylinders at the ends of the motor cylinder, single acting pistons in said compressor cylinders connected to said compressor cylinders, said cylinders being connected to the medium under pressure, automatic intake and discharge check valves for said compressor cylinders, a control valve for the motor piston, motor means for shifting the control valve and pilot valve means operated upon the end of the strokes of the pistons for controlling the operation of said motor means.

13. In combination, means for putting a medium under pressure, and means operable by the said medium under pressure for increasing the pressure of the said medium comprising a central motor cylinder, a double acting piston therein, compressor cylinders of relatively smaller diameter connected to the ends of said motor cylinder, single acting compressor pistons connected to said motor piston, the said cylinders being connected to the said medium under pressure, a discharge connection for said compressor cylinders for delivering high pressure medium, a motor control valve, a valve motor therefor and means for admitting high pressure medium to the valve motor upon the completion of the compression stroke.

14. In combination, a receiver, means for charging the said receiver with a medium

under pressure, and a second means operated by the medium under pressure from said receiver for increasing the pressure of the said medium, comprising a central motor cylinder, a double acting piston therein, compressor cylinders of relatively smaller diameter connected to the ends of said motor cylinder, single acting compressor pistons connected to said motor piston, the said cylinders being connected to the said medium under pressure, a discharge connection for said compressor cylinders for delivering high pressure medium, a D-slide valve for the motor cylinder, an opposed piston motor for shifting said slide valve, and pilot valves for said compressor cylinders for controlling the shifting of said opposed piston motor.

15. In combination, means for putting air under pressure, and means operable by the said air under pressure for increasing the pressure of the said air comprising a central motor cylinder, a double acting piston therein, compressor cylinders of relatively smaller diameter connected to the ends of said motor cylinder, single acting compressor pistons connected to said motor piston, means for supplying compressed air to all of said cylinders, a discharge connection for said compressor cylinder delivering high pressure air, a control valve for controlling the strokes of the motor piston, and pneumatic means actuated at the end of each compression stroke to shift said control valve.

16. In combination, a first means for putting a medium under pressure, a receiver for said medium under pressure, a second means operable by said medium under pressure for increasing the pressure of said medium under pressure, a third means for selectively dispensing the said medium under pressure from the said receiver and the medium under high pressure from the said second means, said second means being operable only upon demand for said medium under high pressure.

In witness whereof, I hereunto subscribe my name this 28th day of February, 1924.

BURTON S. AIKMAN.