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COMPRESSED AIR SYSTEM FOR OPERATING PNEUMATIC TOOLS.

APPLICATION FILED APR. 20, 1907.

1,154,793.

Patented Sept. 28, 1915.

2 SHEETS—SHEET 1.

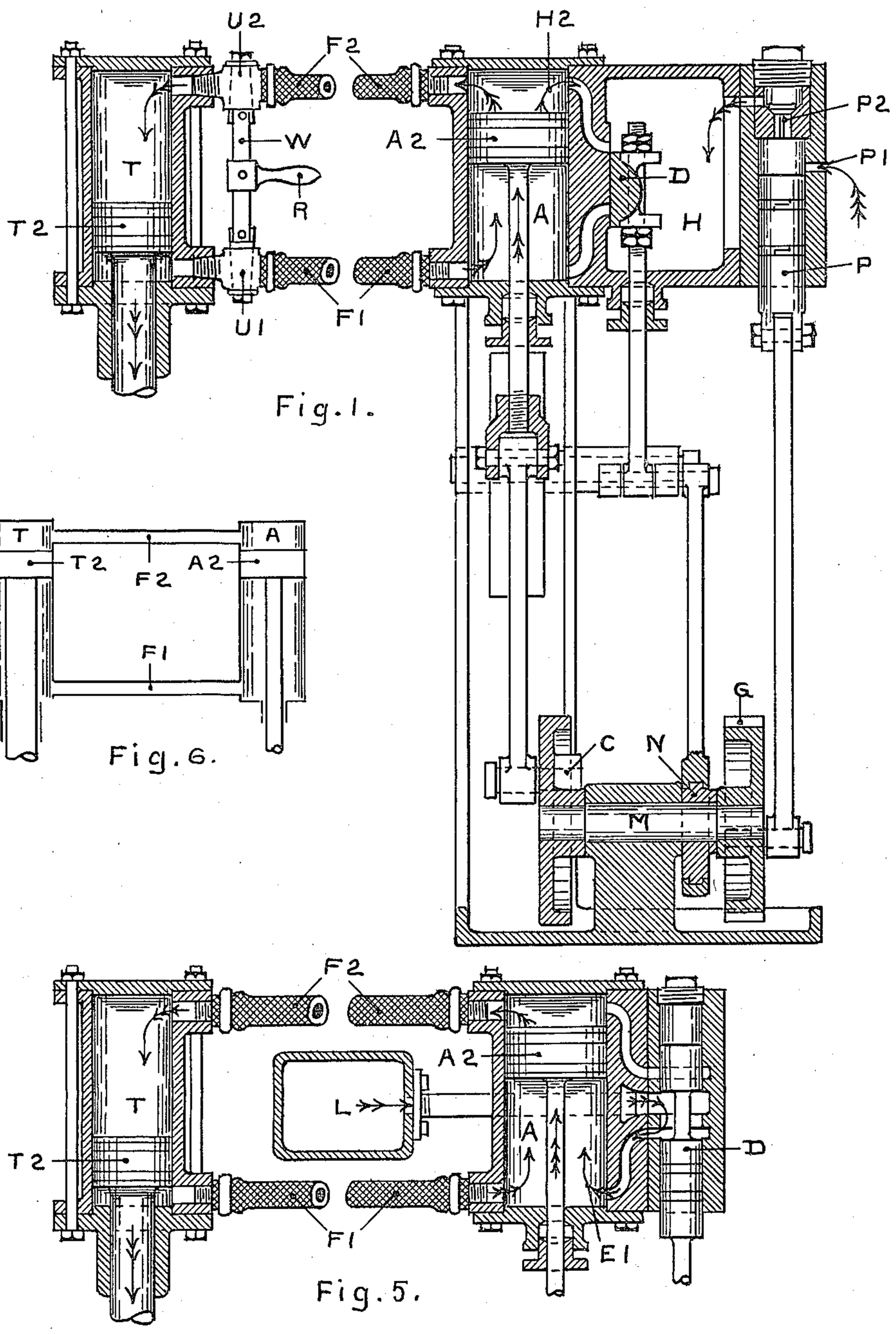

Fig. 1.

Fig. 6.

Fig. 5.

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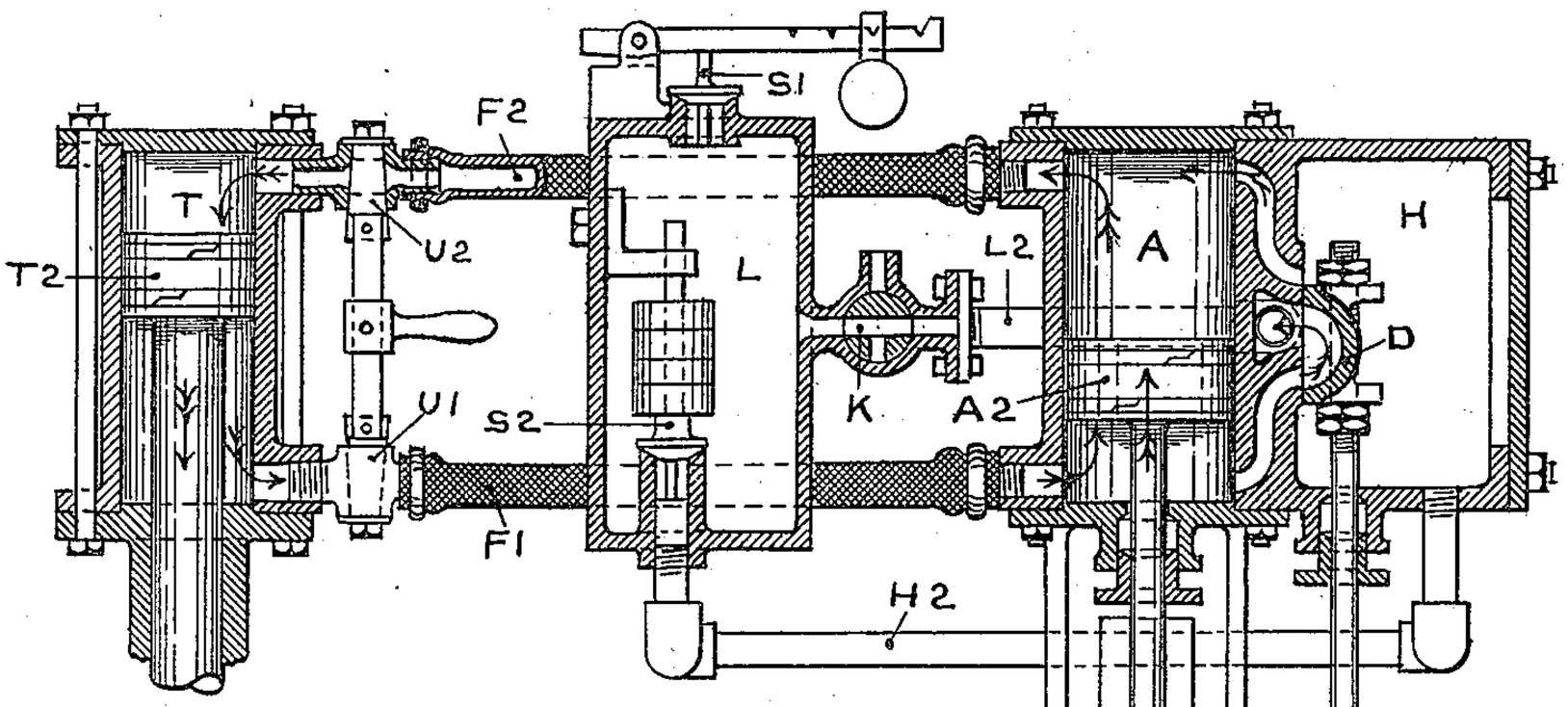


Fig. 3.

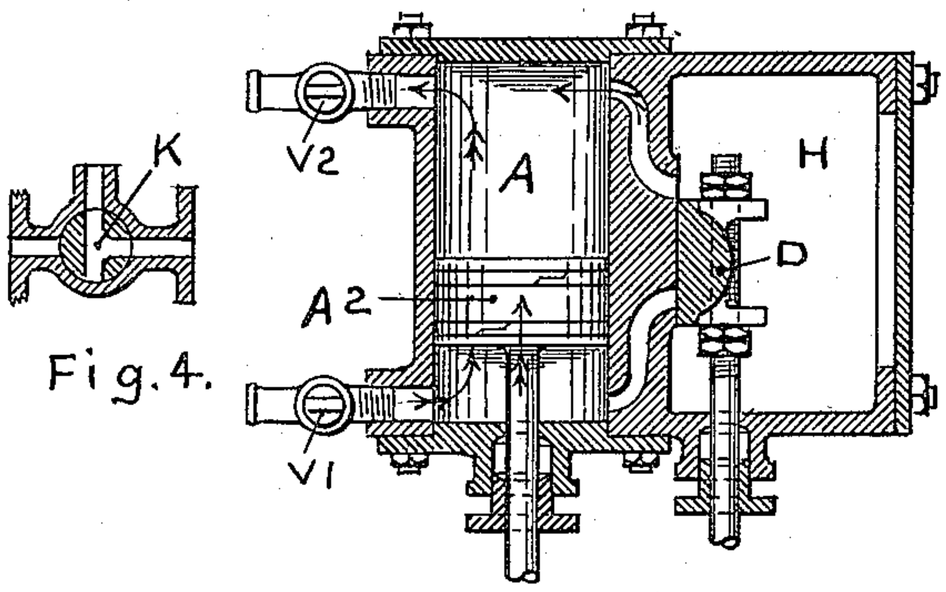
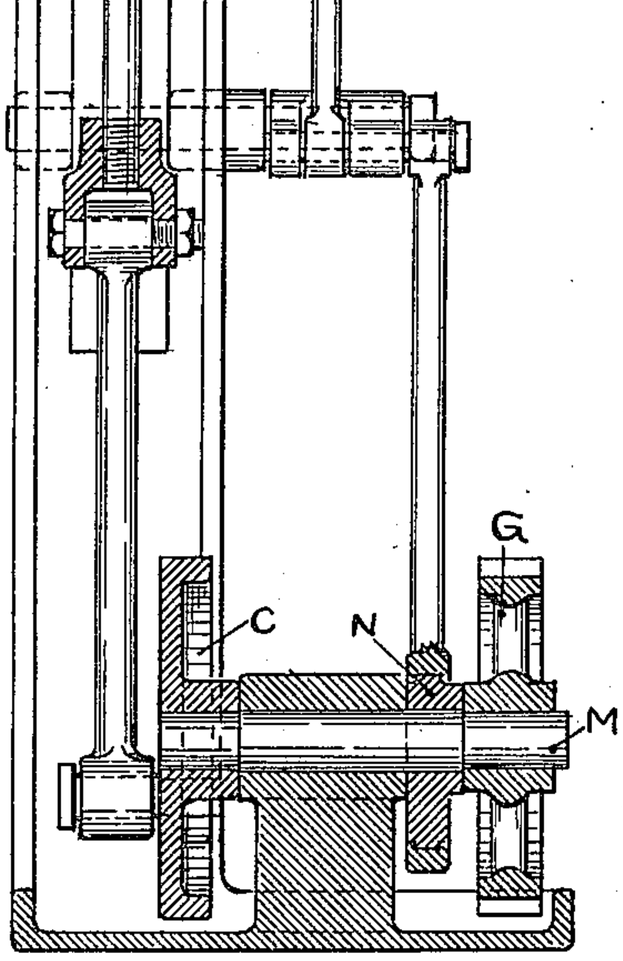


Fig. 4.

Fig. 2.



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COMPRESSED-AIR SYSTEM FOR OPERATING PNEUMATIC TOOLS.

1,154,793. Specification of Letters Patent. Patented Sept. 28, 1915.

Application filed April 20, 1907. Serial No. 369,258.

To all whom it may concern:

Be it known that I, CHARLES OTIS PALMER, a citizen of the United States of America, and a resident of Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Compressed-Air Systems for Operating Pneumatic Tools, of which the following is a specification.

My invention relates to a closed air system for operating pneumatic tools that employ a reciprocating piston, and more especially to coal mining machines of the reciprocating pick type rock drills, etc. that do their work a considerable distance from the power plant.

Among the objects sought are, to provide a closed air system that shall not get out of pneumatic "balance"; to control the blow given by the tool that it may be powerful, elastic, and under control; to simplify the tool and give the tool piston reciprocating impulses when stalled; and to provide a simple means for raising the pressure of the closed air system.

To this end my invention consists primarily in placing a chamber for compressed air alternately in communication with the air on each side of the compressor piston by means of a positively operated equalizer valve in connection with the compressor. In placing a second air chamber in connection with the compartment on the opposite side of the compressor piston from that connected with the first chamber. In providing a simple valvular means positively operated for interchanging said chambers in the said compartments. In placing hand faucets in the connecting tubes for controlling the stroke and raising the effective pressure. In novel arrangements for supplying air to the air system and controlling pressures in the system: and in various details set forth and pointed out in the claims.

I will now describe my invention as applied to a coal mining machine of the pick type; and from which applications to rock drills and other reciprocating tools will be readily understood.

Both in first cost and economy of maintenance electricity is the preferable means of transmitting power. On the other hand compressed air has the advantage of simplicity of application to reciprocating tools. Accordingly I employ both these agencies and attain corresponding advantages in the practice of my invention.

In the accompanying drawings Figure 1 is a diagram of a simple form of construction of a compressed air system containing some of my improvements and having an auxiliary compressor, the air chamber H being connected with the high pressure end of the compressor cylinder A; Fig. 2 is a diagram of the air compressor cylinder and valve as shown in Fig. 1 with the piston in the fore part of its stroke; Fig. 3 is a diagram of my system provided with both high and low pressure air chambers the valve and tool connections, the piston and valve driving connections, the safety valves and charging device, both pistons being in the fore part of the stroke; Fig. 4 is a sectional view of the three way faucet K when in the position for charging the system; Fig. 5 is a diagram of a form of my system showing the air chamber L connected with the low pressure end of the compressor cylinder, the pistons A2 and T2 having reached the last part of their strokes; Fig. 6 is a diagram of an ordinary closed system out of pneumatic balance. Figs. 2 and 3 illustrate the flow of air at the fore part of the piston stroke, and Figs. 1 and 5 illustrate the flow of air in the latter part of the stroke.

The same characters denote the same parts throughout the several views.

The arrows on the pistons of the various figures show the direction of motion of the pistons themselves, and the arrows in the air passages the direction the air is flowing in them at that time.

Fig. 1 is a diagram of a closed air system having an air compressor cylinder A and a tool cylinder T. Their ends are connected by the flexible tubes F1 and F2. In the cylinder A reciprocates the compressor piston A2 and in the cylinder T reciprocates the tool piston T2. The confined air in these cylinders and connecting tubes is thereby divided into two closed compartments by the pistons in the cylinders. The piston A2 is connected to the pitman which is operated by the crank C on the shaft M, which is in turn driven by gear G that engages a pinion on the motor (not shown). Or the said piston may be driven in any other suitable manner. The flexible tubes F1 and F2 are made of convenient length to form the connection between the tool and compressor

and are filled with air. The reciprocations of the compressor piston A2 in Fig. 1 are transmitted by the air in the compartments of which tubes F1 and F2 respectively form parts to the tool piston T2. This makes a closed air system from which no air escapes to the atmosphere except through unavoidable leaks.

To make the tool piston respond promptly to the reciprocations of the compressor piston the air in the system may be compressed to several atmospheres by an auxiliary air compressor P or in any other suitable well known manner.

A bit or chisel (not shown) of the required form is held by the end of the tool piston T2 and operates on the coal or other material. The pressure of the material against the end of the bit shoves the tool piston to the back (or top) end of the cylinder by allowing the air to slip by the piston. This would bring both the pistons A2 and T2 near the upper end of their cylinders at the same time as shown in Fig. 6. Since the only movement this compressor piston can then make is downward, and that downward movement forces the piston T2 upward, it is impossible for the tool of Fig. 6 to make an effective stroke downward. The system in this condition is "out of balance" and requires that the air above and below the pistons be equalized by allowing the air which had slipped by the tool piston to pass to its original compartment above the pistons. This has heretofore been done by means of bypasses and valves, etc. on the tool.

As seen in Fig. 1 my system is kept in balance by means of the equalizer valve D which serves to connect the high pressure end of the compressor cylinder C with the high pressure air chamber H. The valve D is operated by the eccentric N on the main shaft through the valve rod as here shown or in any other suitable manner. On the return stroke of the compressor piston A2 the valve D is moved to its upper position and the air chamber H is connected with the lower end of the compressor cylinder. The air chamber H is thus alternately connected first with the air above the compressor piston and then with the air below the compressor piston. If therefore the system of Fig. 1 was out of pneumatic balance by the pistons A2 and T2 being in the relative positions shown in Fig. 6, the downward stroke of the compressor piston would force the air in its cylinder into the air chamber H from whence it would be delivered above the piston as soon as the valve D reversed its position on the next stroke of the piston and the system would in this way again resume its pneumatic balance. The system may be thrown out of balance by the air leaking out through stuffing boxes or otherwise as well as by air slipping by a piston.

It will be noted that my system does not make direct connection from one side of the piston to the other but connects an air chamber first with the air on one side of the piston and then with the air on the other side of the piston.

In the ordinary closed air system, having no air chamber and equalizer valve, the effective pressure in the compressor cylinder starts with zero or less, and gradually raises as the compressor piston advances in its stroke. In my system the opening of the automatic valve D in the early part of the compressor stroke (see Figs. 2 and 3) puts the active end of the compressor cylinder A (directly), and the tool cylinder T (indirectly), at once, in communication with the high pressure chamber H of compressed air. This of itself raises the pressure in the tool cylinder T in the fore part of the stroke, when it is most desired. Moreover, during the latter end of the stroke, in the ordinary system (especially with a short stroke of the tool piston), the effective pressure raises, which lessens the elasticity of the stroke. In my system the high pressure air chamber H furnishes a reservoir as an outlet for this excessive pressure on the working side of the piston, and stores this superfluous air at the end of the stroke for the beginning of the succeeding stroke.

In the beginning of the stroke, in the ordinary system that is operated above atmospheric pressure, the exhaust air in the tool not having an air chamber into which it may escape, must wait until the compressor piston makes room in the end of the compressor cylinder for it to escape. In the beginning of the stroke in my system, however, the opening of the equalizer valve D allows the exhaust air on the low pressure end of the tool to escape to a low pressure chamber L (see Fig. 3) and so lowers the pressure in the tool cylinder on the exhaust side of the tool piston. This also raises the effective pressure in the tool cylinder. In the latter part of the stroke, however, the air flows back from this air chamber L of Fig. 3 as seen in Fig. 5, and so tends to cushion the stroke of the tool, and make the stroke more elastic. This is the opposite of the action in the ordinary system in which the last part of the stroke is not cushioned, as above explained.

On comparing Fig. 1 which shows the compressor piston in the last part of the stroke with Fig. 3 which shows the valve setting with the piston in the fore part of the stroke it will be noted that the air which is compressed in the air chamber H on the last part of the piston stroke is given out again on the first part of the succeeding stroke. It will thus be seen that in my system the air chamber and valve coöperate with the compressor piston to raise the pres-

sure in the tool cylinder in the beginning of the stroke when the tool most needs it, and to relieve the pressure at the end of the stroke when the tool does not want it.

A hard blow of the tool well directed is more effective than a light one, but it is much easier to guide the tool when it strikes a light blow. To govern the stroke I place the controller faucets U1 and U2 between the connecting tubes F1 and F2 and the tool cylinders T. These controller faucets are connected by the controller rod W and operated by the controller handle R which is placed within convenient reach of the operator who operates the said faucets simultaneously. The controller faucets are partially closed when it is wanted to lighten the stroke and are closed entirely when the tool is not in use and the system is being charged through the three way faucet K. The force of the impulse given the tool piston is therefore immediately under the control of the operator who is thereby enabled to point it to the best advantage to do the work.

The compressor clearance due to the tubes F1 and F2 may be eliminated by placing faucets V1 and V2 at the entrance to the compressor cylinder as shown in Fig. 2 and closing them when charging the system through the faucet K as hereafter explained.

The closed air chamber instead of being connected to the high pressure end of the compressor cylinder as just explained may be connected to the low pressure end as shown in Figs. 3 and 5 where the air chamber L is shown in communication with the low pressure end of the compressor cylinder A; Fig. 5 shows the direction of the air with the pistons in the latter part as Fig. 3 does in the fore part of the stroke.

The setting of the valve D to connect with either the high or low pressure end of the compressor cylinder may be reversed by simply turning the eccentric N on the shaft M of Figs. 1 or 3 through an angle of 180 degrees. Also by reversing the direction of rotation of the main shaft M. the original high pressure chamber is changed to the low pressure chamber, and the original low pressure chamber then becomes the high pressure chamber. Connection with the high pressure end is preferable.

Instead of using only one air chamber connected either with the high or low pressure side of the compressor piston I may have one air chamber H connected with the high pressure side and one air chamber L connected with the low pressure side of the compressor piston as shown in Fig. 3. As here shown the piston A2 has just begun to compress the air in the upper part of its cylinder and the equalizer valve D has opened, allowing the compressed air in the chamber H to fill the compartment composed of the upper ends of the tool and compressor cylinders and tube F2. This forces the tool piston downward. The valve D has also opened connection between the compartment composed of F1 and the lower ends of the compressor and tool cylinders and allows the air in this compartment to escape into the low pressure chamber L. During the last part of the same stroke of the compressor piston the direction of flow of air at the valve D will be reversed as before explained in connection with Fig. 1. During the down stroke of the compressor piston the valve D changes to the upper position and the process is reversed.

By placing a three way faucet K in the pipe L2 leading from the valve D to the low pressure chamber the auxiliary air compressor P may be omitted and the system charged with the main compressor. The faucet K is left in the position shown in Fig. 3 when the tool is at work. But if through leakage or otherwise the pressure of the system is lowered, it may be again built up by turning the faucet K to the position shown in Fig. 4 so that communication with the low pressure chamber L is closed and communication between valve D and the atmosphere is opened. The compressor now takes air from the atmosphere instead of from the chamber L as above explained and delivers it into the high pressure chamber H. The controller faucets U1 and U2 being closed in the mean time as before explained so as to cut out the tool and save the compressor the work necessary to operate it. The chamber L now being cut out by the three-way faucet K the compressor draws air from the atmosphere through the side branch of faucet K (see Fig. 4) and pipe L2 to cylinder A, below piston A2, and from there compresses it into chamber H in the following stroke. The direction of the piston A2 being upward as shown by the arrow on the piston A2, the direction of the air in the ports of cylinder A will be the opposite from that shown by the arrow in valve D of Fig. 3.

To limit the pressure in the high pressure chamber H a pipe H2 may be led from it to the low pressure chamber L and a safety valve S2 placed in said pipe which blows off into the low pressure chamber L. The adjustment of this valve limits the pressure in the high pressure chamber. A safety valve S1 may also lead from the low pressure chamber L to the atmosphere to limit the pressure in the low pressure chamber. The air compressor may continue to work until the low pressure air chamber is charged as indicated by valve S2 blowing off. The three way faucet K is then turned to the position shown in Fig. 3.

It might be noted that in designing machines of this character, the total effective

pressure alternately exerted on each side of the tool piston should not be greatly disproportionate to get the best results. This may be done by making the effective working pressure area on the backside of the tool piston-head nearly equal to that of the piston rod side.

It is hardly necessary to add that the pressure produced in the system of Fig. 1 is limited by the clearance of the auxiliary compressor P. The pressure in the system in Fig. 3 may also be limited by the clearance in cylinder A and the safety valves S1 and S2 omitted. The chamber L of Fig. 3 may be cut out of use by turning the three way faucet K half way round from the position shown in Fig. 4. The pressure in the system may be maintained through the three way faucet K as before explained or by any other well known means. The valve D of Fig. 3 takes the place of several valves in the same way as does the slide valve in an ordinary steam engine.

By using the same air over and over the troubles due to heat of compression are largely neutralized by the cold due to expansion in driving a piston. Also by lessening the amount of free air taken into the system the amount of dust taken into the cylinders and valve to wear and obstruct them is reduced. It is preferable to have a pressure of several atmospheres in the low pressure chamber.

The form of equalizer valve D shown is the slide valve common to steam engines and air compressors, but any other suitable valve would answer the purpose.

While I have described my invention as using air, any suitable gas may be used in its stead.

The same necessity exists for, and the same advantages are secured by, cushioning the tool piston of my system as those at present in use.

The details of the frame work, valves, driving gear, etc. used in carrying out my invention are not necessarily those shown in the drawings but may be of any suitable description known to the art.

As herein described, the term "tube" refers to the whole pressure connection from cylinder to cylinder that join the ends of the compressor and tool cylinders. The cross-section of said tube may be rectangular, or circular, or any other shape that will facilitate the construction and operation of the machine. The term "compartment" refers to the space inclosed by one connecting tube plus the space between the piston head and cylinder head in both of the tool and compressor cylinder ends at the extremities of said conecting tube. The term "ports" refers to passages or pressure connections that join an equalizer chamber with a compartment. These terms are used as above stated in order to aid the reader to more readily understand the various valvular and other pressure connections referred to in the specification and claims.

I would not have it understood that my invention is limited to any one means of building up and maintaining the pressure in the system because this may be done in any suitable and well known manner.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. The combination with an air compressor cylinder and piston therein, of a tool cylinder and piston therein, fluid pressure connections between the ends of said cylinders forming thereby two closed compartments, an equalizer chamber, ports connecting the equalizer chamber with both of said compartments, an equalizer valve controlling both of said ports, means to reciprocate the compressor piston, and means operatively timed with the compressor piston to operate said valve to open the chamber to each of said compartments alternately.

2. The combination with an air compressor cylinder and piston therein, of a tool cylinder and piston therein, fluid pressure connections between the ends of said cylinders forming thereby two closed compartments, an equalizer chamber, ports connecting the equalizer chamber with both ends of the compressor cylinder, an equalizer valve controlling said ports, means to reciprocate the compressor piston and means operatively timed with the compressor piston for operating said valve to establish communication between said equalizer chamber and each end of the compressor cylinder alternately.

3. The combination with an air compressor cylinder and piston therein, of a pneumatic tool cylinder and piston therein, fluid pressure connections between the ends of said cylinders forming thereby two closed compartments, a high pressure chamber, a low pressure chamber, ports connecting both of said chambers with both of said compartments, an equalizer valve controlling all of said port connections, means for reciprocating the compressor piston and positively operating said valve to interchange the chamber connections to said compartments reversely at each stroke of the compressor piston.

4. In a system of the class described the combination with an air compressor cylinder, of a pneumatic tool cylinder, reciprocating pistons in said cylinders, tubes connecting the ends of said cylinders forming thereby two closed compartments, a high pressure equalizer chamber, a low pressure equalizer chamber, equalizer ports connecting both of said chambers with both ends of said compressor cylinder, an equalizer valve controlling all of said ports, and means for

reciprocating said compressor piston and operating said equalizer valve to simultaneously connect the high pressure chamber to the high pressure end of the compressor cylinder and the low pressure chamber to the low pressure end of the compressor cylinder at each stroke of the compressor piston.

5. In a compressed air system the combination with a pneumatic tool cylinder, of an air compressor cylinder, reciprocating pistons in said cylinders, fluid pressure connections between the ends of said cylinders forming thereby two closed compartments, controller faucets in said fluid pressure connections, an equalizer air chamber, ports connecting both ends of said compressor cylinder with the equalizer chamber, an equalizer valve controlling both of said ports, a driving shaft, and means for positively reciprocating said compressor piston and operating said equalizer valve from said shaft to establish communication between said equalizer chamber and each end of the compressor cylinder alternately.

6. The combination with an air compressor cylinder and piston therein, of a pneumatic tool cylinder and piston therein, fluid pressure connections between the ends of said cylinders forming thereby two closed compartments, faucets in said fluid pressure connections, an equalizer chamber, port openings between said chamber and both ends of said compressor cylinder, an equalizer valve controlling both of said port openings, means for reciprocating said piston and operating said equalizer valve to alternately open each of said port openings to the high pressure compartment, whereby the effective pressure between said compartments is utilized in the tool cylinder by opening said faucets.

7. The combination with an air compressor cylinder and piston therein, of a pneumatic tool cylinder and piston therein, fluid pressure connections between the ends of said cylinders forming thereby two closed compartments, faucets in said fluid pressure connections, a high pressure air chamber, a low pressure air chamber, port openings between both of said chambers, and both of said compartments, an equalizer valve controlling all of said port openings, means for reciprocating the compressor piston and operating the equalizer valve to interchange said chamber connections with said compartments reversely, whereby the closing of said faucets operates to raise the effective pressure between said air chambers, and the opening of said faucets operates to utilize the effective pressure between said air chambers in the operation of the tool piston.

8. In a closed pneumatic tool system the combination with a pneumatic tool cylinder, of a compressor cylinder, reciprocatory pistons in said cylinders, tubes connecting the ends of said cylinders forming thereby two closed compartments, controller faucets in said connecting tubes, an equalizer air-chamber, equalizer ports connecting both of said closed compartments with the equalizer chamber, an equalizer valve controlling both of said ports, means for reciprocating the compressor piston and positively operating said equalizer valve in coöperative conjunction to raise the effective pressure in the tool cylinder in the beginning of its stroke and relieve the excessive pressure in said cylinder in the end of the stroke.

9. In a closed pneumatic tool system the combination with an air compressor cylinder, of a pneumatic tool cylinder, reciprocatory pistons in said cylinders, air tubes leading from the ends of the tool cylinder and connecting with the compressor cylinder, a chamber for compressed air, ports leading from both ends of said compressor cylinder to said air chamber, a positively operated valve controlling both of said ports, a crank shaft, positive driving connections from the crank shaft to both the compressor piston and valve, and means for rotating said crank shaft.

10. In a compressed air system of the class described the combination with an air compressor cylinder, of a pneumatic tool cylinder, reciprocatory pistons in said cylinders, tubes connecting the ends of said cylinders forming thereby two closed compartments, an equalizer chamber, equalizer ports connecting said chamber with both of said compartments, a positively operated equalizer valve controlling both of said equalizer ports, a passage leading from the atmosphere to both of said ports, a three-way faucet in the outer end of said passage, and means for operating said compressor piston and said equalizer valve to connect said air chamber to said compartments alternately.

11. In a compressed air system of the class described the combination with an air compressor cylinder, of a pneumatic tool cylinder, reciprocatory pistons in said cylinders, tubes connecting the ends of said cylinders forming thereby two closed compartments, a high pressure equalizer chamber a low pressure equalizer chamber, equalizer ports connecting both of said chambers with both of said compartments, a positively operated valve controlling all of said equalizer ports, a passage with a safety valve therein connecting said high and low pressure air chambers, a passage with a safety valve therein connecting said low pressure air chamber with the atmosphere, and means for operating said compressor piston and said equalizer valve to interchange said chamber connections with said compartments reversely at each stroke of the compressor piston.

12. In a compressed air system of the class described the combination with an air compressor cylinder, of a pneumatic tool cylinder, reciprocatory pistons in said cylinders, passageways connecting the ends of said cylinders, forming thereby two closed compartments, a high pressure equalizer chamber a low pressure equalizer chamber, ports connecting both of said chambers with both of said compartments, a valve controlling both of said equalizer ports, a passage with a safety valve therein connecting said equalizer chambers and positively operated means to reciprocate said piston and to operate said equalizer valve to interchange said chamber connections with said compartments reversely at each stroke of the compressor piston.

13. In a closed pneumatic tool system the combination with an air compressor cylinder, of a pneumatic tool cylinder, reciprocatory pistons in said cylinders, passageways connecting the ends of said cylinders forming thereby two closed compartments, a high pressure equalizer chamber, a low pressure equalizer chamber, ports connecting both of said chambers with both of said compartments, a positively operated equalizer valve controlling both of said ports, a passage with a relief valve therein connecting said high and low pressure air chambers, a passage with a second safety valve therein connecting one of said air chambers with the atmosphere and positively operated mechanism to reciprocate said piston and operate said equalizer valve to interchange said chamber connections with said compartments reversely at each stroke of the compressor piston.

Signed at Cleveland, this 19th day of April, 1907, in the presence of two subscribing witnesses.

CHARLES OTIS PALMER.

Witnesses:

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ALBERT LOGAN LAWRENCE.

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