

[54] AIR COMPRESSOR WITH GOVERNOR

[75] Inventor: Claude H. Nickell, Dearborn, Mich.

[73] Assignees: Winfred D. Weldon, Detroit;
Manuel Pinko; Adam Pianga, both
of Dearborn, all of, Mich.; part
interest to each

[22] Filed: Feb. 27, 1973

[21] Appl. No.: 336,299

[52] U.S. Cl. 417/298, 137/102

[51] Int. Cl. F04b 49/08

[58] Field of Search 137/102; 417/298

[56] References Cited

UNITED STATES PATENTS

598,283	2/1898	Christensen	417/298
713,848	11/1902	Bullard	417/298
1,931,833	10/1933	Sparacino	417/298
2,052,168	8/1936	Crittenden et al.	417/298 X
3,002,520	10/1961	Morse	137/102

3,043,496 7/1962 Glass et al. 417/298 X

FOREIGN PATENTS OR APPLICATIONS

1,340,965 9/1962 France 417/298

595,612 9/1958 Italy 417/298

Primary Examiner—William L. Freeh

Assistant Examiner—Richard Sher

Attorney, Agent, or Firm—Dowell & Dowell

[57]

ABSTRACT

An air compressor apparatus for maintaining the air pressure in a reservoir within predetermined upper and lower limits. The air compressor is driven continuously but the compressing of air is intermittently cycled on and off automatically in response to pressure in the reservoir by means of a governor which is directly attached to the compressor. The governor includes apparatus for unloading the suction side of the compressor in direct response to fluid pressure in the pressure side of the compressor.

2 Claims, 10 Drawing Figures

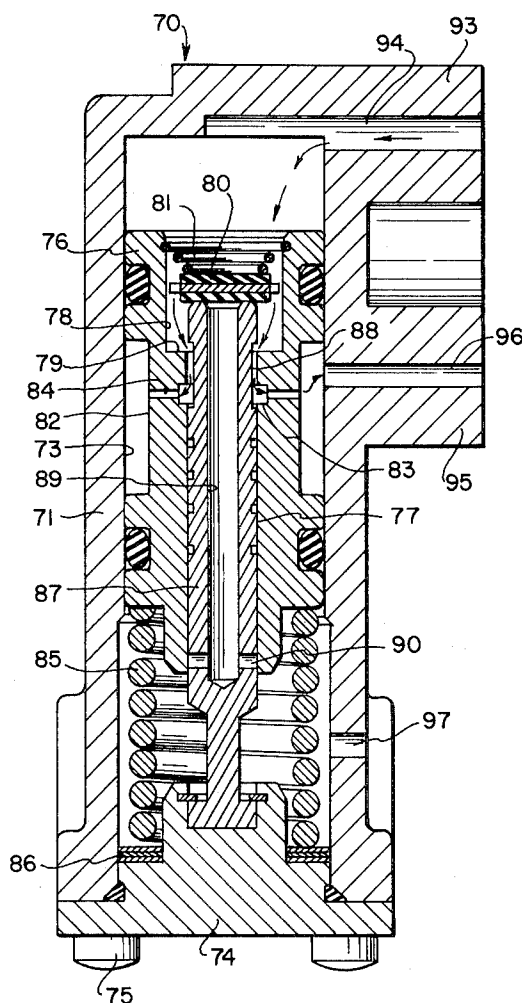


FIG. 1

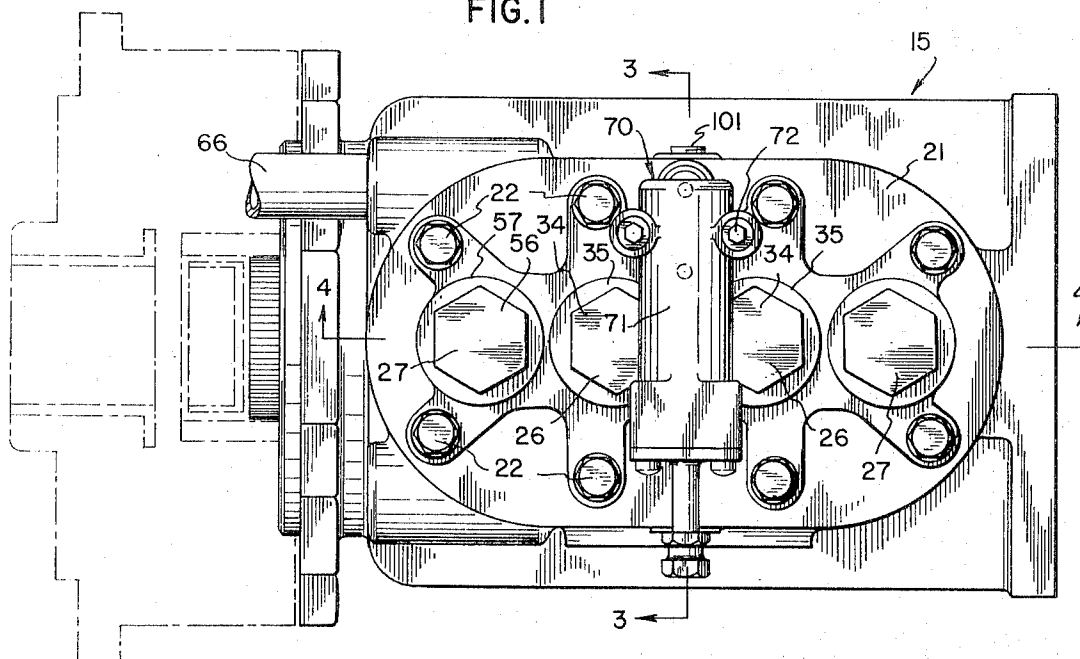


FIG. 3

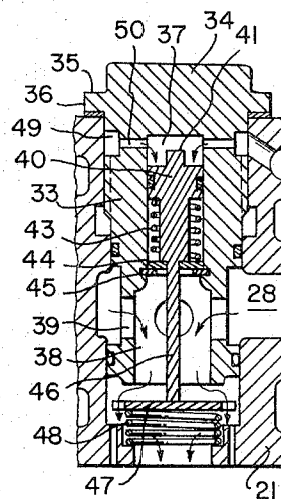
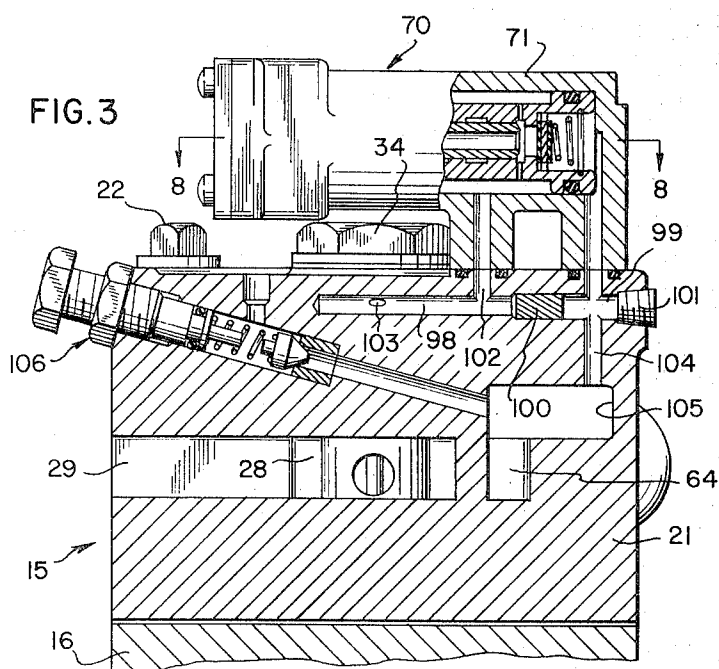
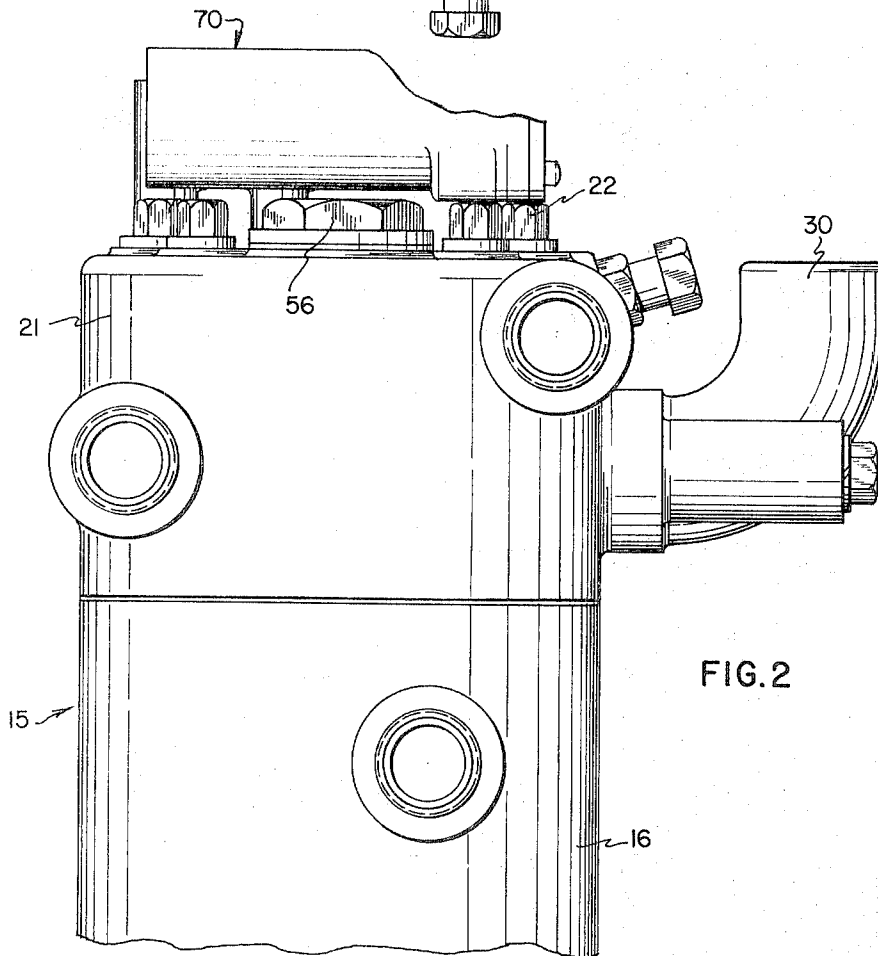
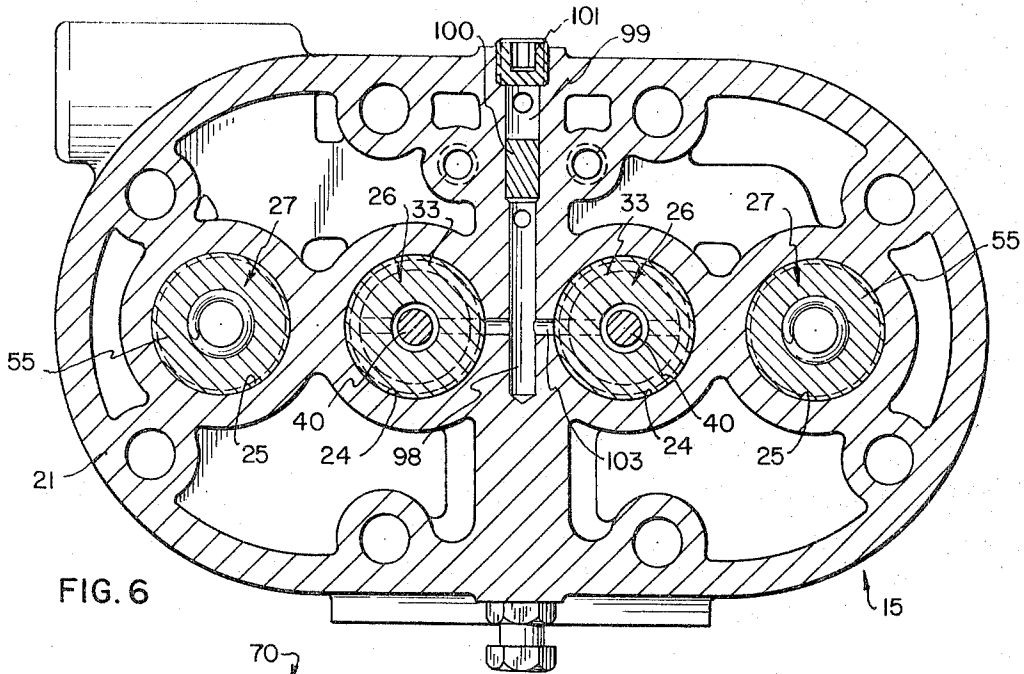


FIG. 7



SHEET 3 OF 4

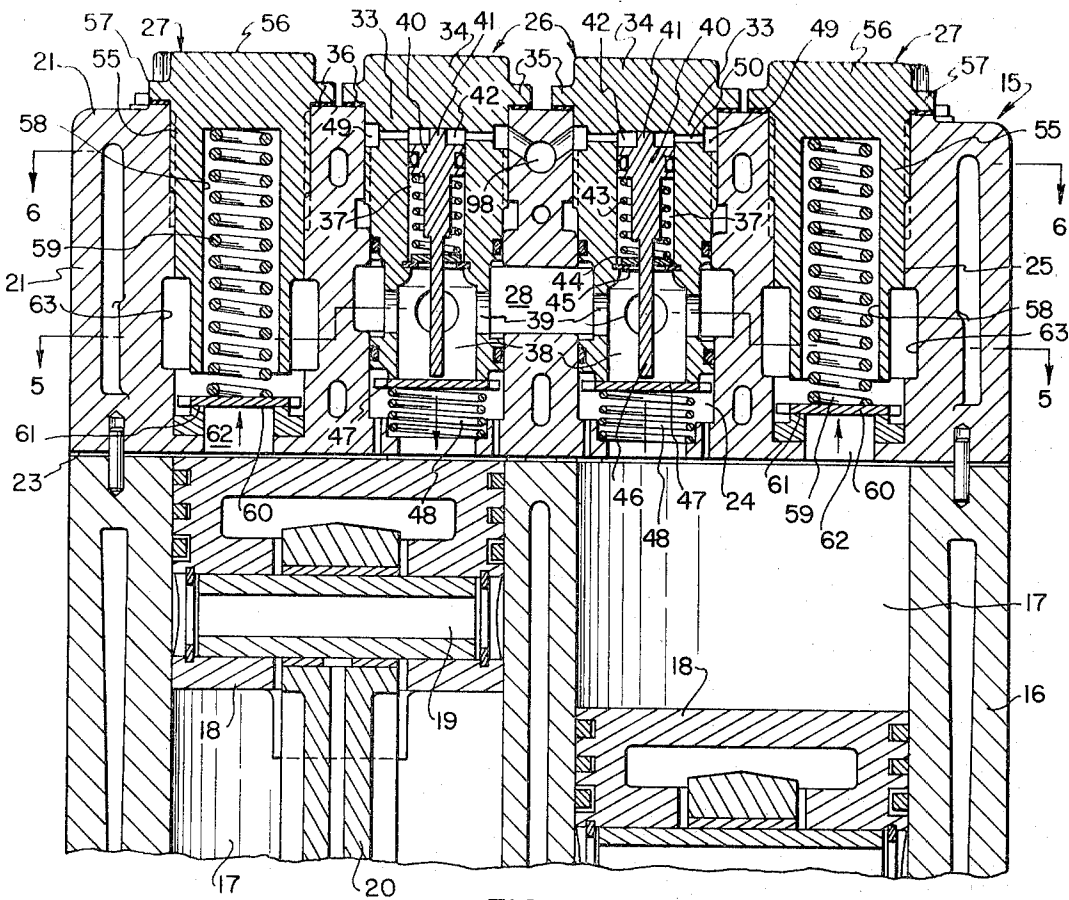


FIG. 4

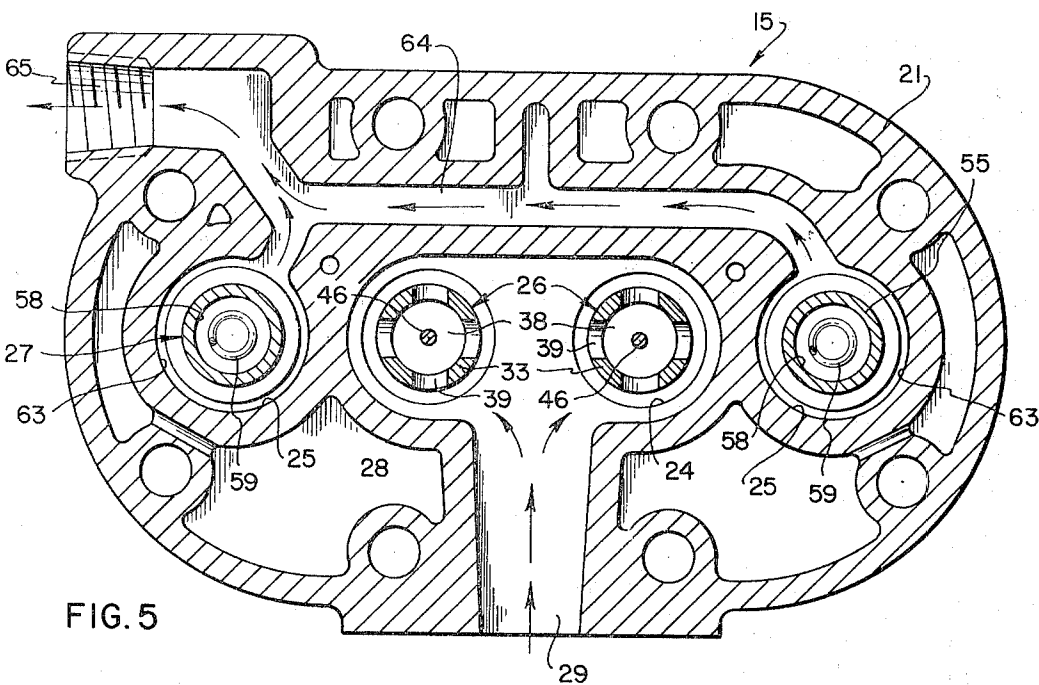
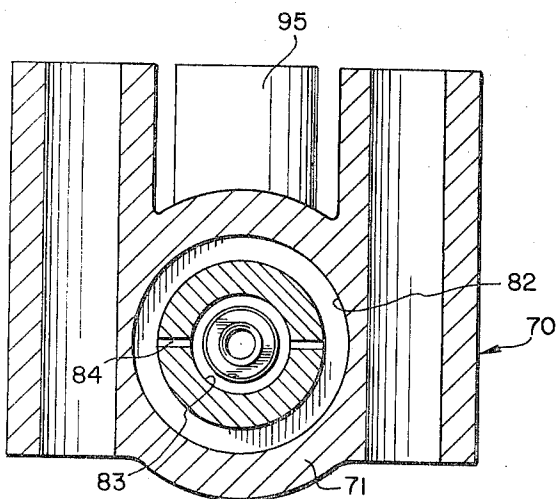
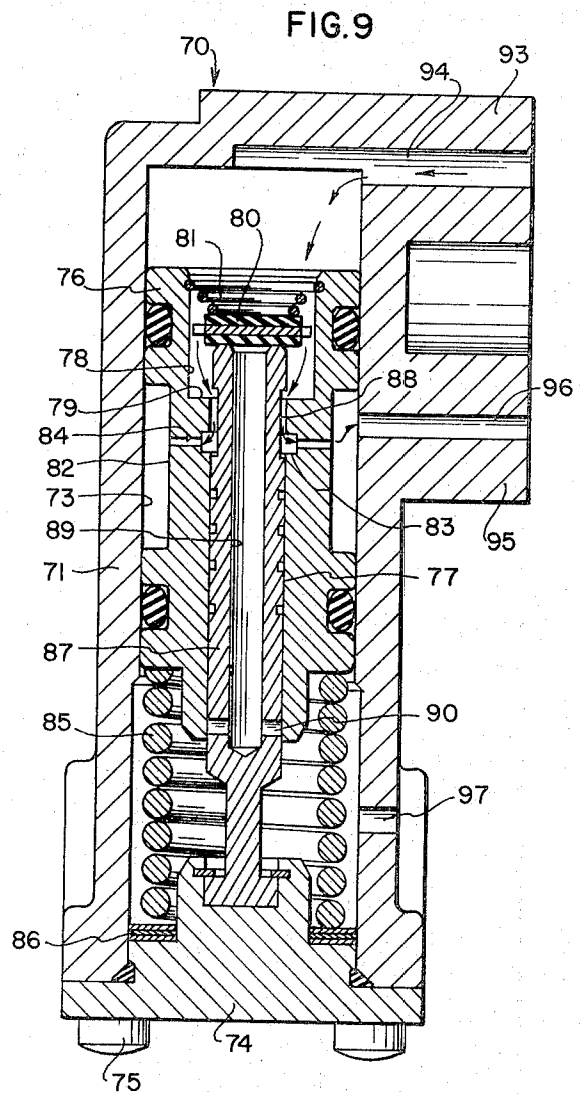
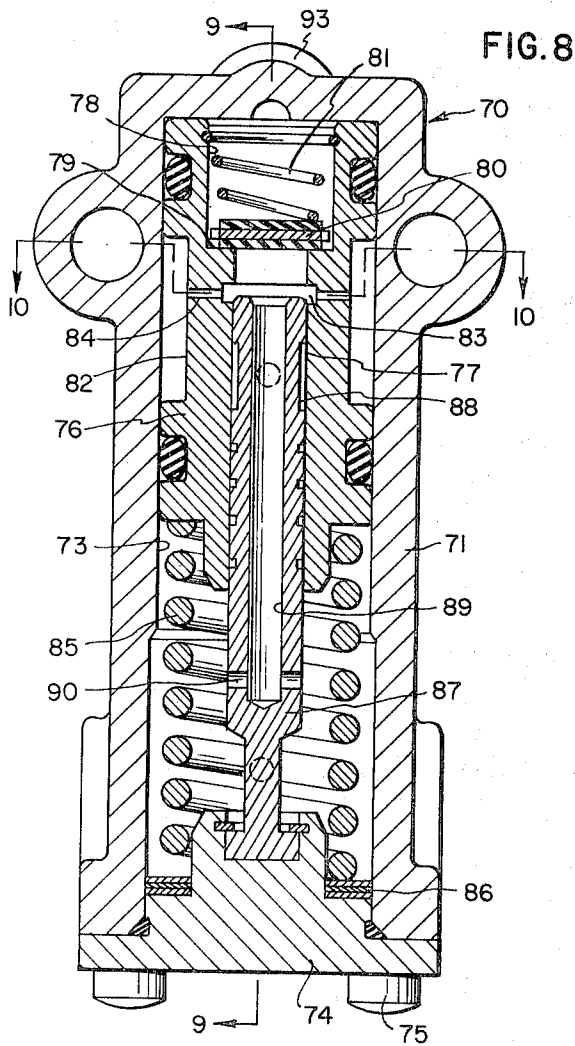


FIG. 5



AIR COMPRESSOR WITH GOVERNOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to the compressing of fluids and relates specifically to air compressors which are operated intermittently to maintain the pressure in a reservoir between predetermined limits.

2. Description of the Prior Art

Heretofore many efforts have been made to provide air compressors with a control mechanism for controlling the operation of the compressor so that the compressor introduces air under pressure into a reservoir on demand. In many instances, the control mechanism is located in a position remote from the compressor and is operated to cause the compressor to be selectively energized so that it operates only when the fluid in the reservoir falls to a predetermined pressure. Some efforts have been made to provide a compressor control for use with compressors which are constantly driven and are provided with control means or governors for maintaining the compressor in an unloaded condition so that no air or other fluid is compressed until the pressure within a reservoir falls to a predetermined level at which time the compressor is relieved of its unloaded condition so that the compressor compresses air or other fluid and introduces the same into the reservoir. Most of these control devices are located at a position remote from the compressor and connected thereto by hoses or tubing. The hoses or tubing are not satisfactory since they are subject to rupture which produces an additional hazard, particularly when the compressor provides air under pressure to a reservoir of a truck or other motor vehicle which utilizes air brakes. Some examples of this type of structure are the patents to Fishwood et al. U.S. Pat. No. 2,804,878 and Glass et al. U.S. Pat. No. 3,043,496.

Some efforts have been made to eliminate the hoses or tubing connecting the control mechanism to the compressor by mounting the governor directly on or adjacent to the cylinder head of the compressor. The governor includes means for unloading the suction valve of the compressor so that the compressor performs no useful work until the pressure within the reservoir falls to a predetermined lower limit. Some examples of this type of structure are the patents to McCune et al. U.S. Pat. No. 2,033,437 and Valentine U.S. Pat. No. 2,792,169.

SUMMARY OF THE INVENTION

The present invention is an air compressor of the reciprocating type for supplying fluid under pressure to a reservoir and having a governor mounted directly on the cylinder head and such governor is adapted to a cycle a compressor "On" and "Off" intermittently and automatically in response to demand from a remote reservoir. The governor is operated by fluid under pressure from the high pressure side of the air compressor and is adapted to unload the suction side of the compressor when a predetermined pressure has been obtained.

It is an object of the invention to provide an air compressor having a governor mounted directly thereon. Such governor is directly responsive to the high pressure fluid being discharged from the compressor into a reservoir and such governor is adapted to move the

suction valves of the compressor to an unloaded position when the outlet pressure reaches a predetermined upper level and permit the suction valves to move to a closed position when the pressure within the reservoir falls to a predetermined lower limit.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top plan view of an air compressor having a governor or control mechanism mounted thereon.

FIG. 2 is an end elevation thereof.

FIG. 3 is an enlarged section on the line 3—3 of FIG. 1.

FIG. 4 is an enlarged vertical section on the line 4—4 of FIG. 1.

FIG. 5 is a section on the line 5—5 of FIG. 4.

FIG. 6 is a section on the line 6—6 of FIG. 4.

FIG. 7 is a fragmentary vertical section illustrating one of the suction valves of the compressor in unloaded condition.

FIG. 8 is an enlarged section of the governor taken on the line 8—8 of FIG. 3 and illustrating the condition of the governor when air is being compressed by the compressor.

FIG. 9 is a section on the line 9—9 of FIG. 8 and illustrating the condition of the governor when the suction valve of the compressor is unloaded.

FIG. 10 is a section on the line 10—10 of FIG. 8.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With continued reference to the drawings, an air compressor 15 is provided having a body or jacket 16 with a plurality of cylinders 17. As illustrated, the compressor 15 includes a pair of cylinders 17 each of which has a reciprocating piston 18 connected by a wrist pin 19 to one end of a connecting rod 20. The opposite end of each connecting rod is rotatably mounted on an off-set lobe of a conventional crankshaft (not shown). Normally the crankshaft is driven continuously from a power plant such as the gasoline or diesel engine of a truck or motor vehicle. When the power plant is operated, the crankshaft alternately raises and lowers each of the pistons 18 in such a manner that when one of the pistons is fully raised, the other piston normally is at its lowestmost position.

A head 21 is mounted on the upper end of the body 16 and is secured thereto in any desired manner, as by a plurality of head bolts 22 (FIGS. 1 & 2), and preferably a head gasket 23 is located between the body 16 and the head 21 to prevent leakage of air under pressure.

The head 21 is provided with a pair of spaced vertically disposed inner bores 24 located generally centrally along the longitudinal axis of the head 21 and a pair of outer bores 25 located along the longitudinal axis of the head and disposed outwardly of and in alignment with the bores 24. The inner bores 24 communicate with the cylinders 17 and are provided with suction operated valves 26 to introduce air under atmospheric pressure into the cylinders 17 when the pistons 18 are being retracted. The outer bores 25 communicate with the cylinders 17 and are provided with pressure operated valves 27 which are adapted to open when a predetermined pressure has been attained within the cylinders 17 during the compression stroke of the pistons 18.

In order to introduce atmospheric air into the cylinders, each of the inner bores 24 is in communication with an enlarged well or recess 28 and such well in turn is in communication with a passageway 29 which is open to atmosphere. If desired, a horn 30 (FIG. 2) could be provided for directing atmospheric air into the passageway 29, and preferably such horn includes a screen (not shown) to exclude foreign material from the passageway.

Each of the suction operated valves 26 includes an elongated generally cylindrical body 33 having a cap 34 at one end with an outwardly extending flange 35. The end of the body 33 adjacent to the flange 35 is threadedly received within the inner bores 24. A fluid tight gasket 36 is disposed beneath the flange 35 to form an airtight seal between the suction operated valve 26 and the head 21. An axial bore 37 extends upwardly from the end of the body 33 remote from the cap 34. Such bore extends most of the length of the body 33 and a counterbore 38 extends inwardly from the lower end of the body 33 generally concentrically of the bore 37. As illustrated in FIGS. 4, 5 and 7, the wall structure of the body 33 surrounding the counterbore 38 has a plurality of openings 39 providing communication between the counterbore 38 and the well 28 so that atmospheric air can enter the counterbore.

Within the bore 37, a piston 40 is slidably mounted and such piston includes a reduced upwardly extending stop 41 adapted to engage the upper end of the bore 37 and define an annular chamber 42 at the upper end of the piston 40. The stop 41 normally is urged against the end of the bore 37 by a spring or other resilient member 43 the upper end of which engages a shoulder of the piston 40 and the lower end of such spring bears against a stop plate 44 held in position by a spring retainer 45. The lower end of the piston 40 is provided with a reduced elongated finger or prong 46 which extends downwardly through an opening in the stop plate 44 and terminates slightly above the lower end of the valve body 33 when the stop 41 is against the upper end of the bore 37.

The lower end of the valve body 33 forms a seat for a valve member 47, which normally is urged into intimate contact with the valve seat at the end of the body 33 by a spring or other resilient member 38. Adjacent to the flange 35, the valve body 33 is provided with an annular recess or groove 49 which communicates with the annular chamber 42 at the top of the piston 40 by means of a plurality of orifices 50 for a purpose which will be described later.

Each of the pressure operated valves 27 includes an elongated generally cylindrical body 55 having a cap 56 at one end with an outwardly extending annular flange 57. The end of the pressure valve body adjacent to the flange 57 is threadedly received within the outer bores 25 of the head 21 and a gasket 36 is disposed below the flange 57 to provide an airtight connection between the valve body 55 and such head. An axial bore 58 extends upwardly from the end of the body 55 remote from the cap 56. A compression spring or other resilient member 59 is mounted within the bore 58 and such spring is adapted to bear against a valve 60 and normally force such valve into intimate engagement with a valve seat 61 mounted within each of the outer bores 25. An opening 62 provides communication between the cylinders 17 and the bores 25 so that fluid being compressed on the compression stroke of the pistons 18 overcomes

the tension of the spring 59 and unseats the valve 60 so that fluid under pressure can be discharged from the cylinders.

As illustrated best in FIG. 5, each of the outer bores 25 is provided with an enlarged pocket 63 and such pockets communicate with a passageway or outlet manifold 64 extending through the body 16 to an outlet port 65. A pressure line 66 (FIG. 1) has one end connected to the outlet port 65 and the opposite end of such pressure line is connected to a high pressure fluid reservoir (not shown) of conventional construction. Fluid under pressure within the bore 25 passes through the pockets 63, manifold 64, and pressure line 66 into the fluid reservoir.

In order to move the inlet or suction valves 47 to an open unloaded position when the pressure within the reservoir reaches a predetermined value, a governor 70 is provided and such governor includes a body 71 mounted on the head 21 in any desired manner, as by cap screws 72 or the like. The body 71 includes an axial bore 73 which extends substantially through the body, as illustrated best in FIGS. 8 and 9. A cap or plug 74 is connected by screws or other fasteners 75 to the body 71 in a manner to seal the open end of the bore 73. A piston 76 is slidably mounted within the bore 73. The piston 76 has an axial bore 77 extending entirely through the same and a counterbore 78 extends inwardly from one end of the piston in concentric relationship with the bore 77. The shoulder between the bore 77 and the counterbore 78 defines a valve seat 79 which is engaged by a valve 80. A spring or other resilient member 81 is mounted within the counterbore 78 and normally maintains the valve 80 in intimate engagement with the valve seat 79.

The piston 76 has an annular groove or recess 82 intermediate its ends and such groove is in communication with an internal groove 83 by means of a plurality of orifices 84. The internal groove 83 communicates with the axial bore 77 of the piston in spaced relation to the valve seat 79. A calibrated spring 85 is located within the bore 73 of the body 71 and such spring urges the piston 76 against the end of the bore 73 under a predetermined force. One end of the spring 85 engages the end of the piston 76 and the opposite end of such spring normally bears against one or more shims 86 carried by the cap 74. The predetermined force of the spring 85 can be adjusted by adding or removing one or more shims 86.

A post 87 is connected at one end to the cap 74 and the axial bore 77 of the piston 76 is slidably mounted on the opposite end of such post. As illustrated in FIG. 8, the post 87 normally extends through the piston 76 substantially to the internal groove 83 for a purpose which will be described later. The end of the post 87 located within the axial bore 77 of the piston 76 is provided with an annular recess 88 spaced from the end of the post. If desired, the post 87 may have a plurality of annular grooves forming a labyrinth seal which creates a pressure drop between one groove and the next adjacent groove to retard leakage along the axial bore 77 of the piston. The post 87 is provided with an axial bore 89 extending downwardly along most of the length of the post and such bore is in communication with the bore 73 of the body 71 exteriorly of the post by means of one or more orifices 90.

With particular reference to FIG. 9, the end of the body 71 remote from the cap 74 is provided with an en-

largement 93 having an orifice 94 extending inwardly from the exterior of the enlargement and providing communication with the bore 73. A second enlargement or boss 95 is connected to the body 71 in spaced relation to the enlargement 93 and such enlargement 95 has an axial orifice 96 providing communication between the exterior of such enlargement 95 and the bore 73 of the body 71 in the area of the annular groove 82 of the piston. Adjacent to the opposite end of the body 71, an orifice 97 provides communication between the bore 73 and atmosphere.

With particular reference to FIGS. 3 and 4, the compressor body or block 16 is provided with a bore 98 extending inwardly from one side thereof and counterbore 99 arranged generally concentrically of the bore 98. A plug 100 is force fitted into the counterbore 99 to divide the bore and counterbore into two separate airtight compartments. The outer end of the counterbore 99 is closed by a threaded plug 101.

The governor 70 is mounted on the top of the body 16 in such a manner that a downwardly extending orifice 102 in the body 16 provides communication between the bore 98 and the orifice 96 of the enlargement 95. A pair of orifices 103 extend outwardly from the bore 98 to the inner bores 24 and provide communication between the bore 98 and the annular recess or groove 49 in each of the suction valve bodies 33. An orifice 104 in the body 16 extends through the counterbore 99 and such orifice provides communication between the orifice 94 of the enlargement 93 and a chamber 105 within the compressor body 16. The chamber 105 communicates with the high pressure passageway 64 of the body 16.

In order to protect the pressurized system, a safety relief valve 106 (FIG. 3) communicates with the chamber 105 and is provided with an exhaust to atmosphere so that excessive pressures within the system will open the safety relief valve and exhaust excess pressures to atmosphere.

In operation of the device, the crankshaft of the air compressor 15 normally is driven substantially continuously as long as the power plant of the vehicle is in operation. When the crankshaft is being rotated, the connecting rods 20 cause the pistons 18 to be reciprocated within the cylinders 17. A fluid reservoir (not shown) is associated with the air compressor 15 and is in communication therewith through the pressure line 65 to permit air or other fluid being compressed by the air compressor 15 to be discharged into the reservoir so that a supply of air or fluid under pressure is available for use by the brakes and other apparatus of the vehicle. When a portion of the compressed fluid within the reservoir has been utilized, it is necessary to replenish the supply automatically so that the fluid pressure operated devices can continue to function.

With particular reference to FIGS. 3-6, the supply of fluid under pressure within the reservoir has been depleted to the point where the air compressor is cycled "On". In this position, atmospheric air enters the passageway 29 in the head 21 and passes into the well 28. From the well 28 air passes through the openings 39 in the wall structure of each of the inlet valve bodies 33 into the counterbore 38. During the suction stroke of the piston 18 (as illustrated on the right in FIG. 4) a negative pressure is created within the cylinder 17 and the pressure differential between the counterbore 28 and the cylinder 17 causes the valve member 47 to

overcome the tension of the spring 48 and unseat the valve member. This permits air under atmospheric pressure to flow around the valve member 47 and into the cylinder 17. As the connecting rod 20 approaches bottom dead center of the crankshaft lobe on which it is mounted, the pressure differential on opposite sides of the valve 47 is substantially equalized so that the spring 48 urges the valve member to closed or seated position.

During the compression stroke of the piston 18 (as illustrated on the left of FIG. 4) initial upward movement of the piston begins to compress the air within the cylinder and forces the inlet valve member 47 against the seat at the bottom of the suction valve body 33. As the piston continues its upward movement, the fluid within the cylinder is compressed until it is sufficient to overcome the tension of the spring 59 at which time the valve 60 is unseated so that the fluid under pressure flows through the opening 62 and the outer bore 25 of the head 21 into the pocket 63. From the pocket 63, the fluid under pressure flows into the passageway 64 and through the pressure line 66 to the fluid reservoir. The compressing of the fluid within the cylinders continues until the pressure within the reservoir approaches its designed upper limit.

In order to automatically interrupt the introduction of fluid under pressure into the reservoir after a predetermined pressure has been attained, a governor 70 is mounted on the head 21 in such a manner that the orifice 94 communicates with the passageway 64 through the orifice 104 and chamber 105. When the pressure within the passageway 64 increases, fluid under pressure is introduced into the counterbore 78 of the piston 76 and urges such piston away from the end of the bore 73 in the governor body. As the pressure within the passageway 64 approaches the designed limit of the reservoir, the pressure is sufficient to move the piston 76 against the tension of the calibrated spring 85. Initial movement of the piston 76 causes the valve 80 to engage the end of the post 87 and seal the axial bore 89 of such post. During continued movement of the piston 76, the post 87 moves the valve 80 away from the valve seat 79 so that fluid under pressure leaks past the post 87 into the internal groove 83 and then through the orifices 84 into the annular groove 82 around the exterior of the piston 76. From the annular groove 82, fluid under pressure passes through the orifice 96 into the bore 98 within the body 16 of the compressor and from the bore 98 fluid under pressure passes through orifices 103 into the annular recesses 49 of the suction valve body 33 and then through the orifices 50 into the annular chamber 42 at the upper end of each of the inlet pistons 40 and begins a buildup of pressure against the springs 43.

Continued movement of the governor piston 76, as pressure within the upper end of the bore 73 continues to rise, causes the annular recess 88 of the post 87 to communicate with the counterbore 78 and permits free passage of fluid under pressure from the counterbore 78 into the annular chambers 42 within the suction valve bodies 33. When full pressure is applied to the annular chambers, such pressure overcomes the tension of the springs 43 and moves the pistons 40 downwardly into engagement with the stop plate 44. Downward movement of the pistons causes the fingers or probes 46 to engage the valve members 47 and move such valve members to open or unloaded position, as illus-

trated in FIG. 7. As long as the valve members 47 remain open, fluid within the cylinders 17 cannot be compressed since the air drawn into the cylinders during the suction stroke is merely forced back through the inlet valves during the pressure stroke. In this manner, the compressor is automatically cycled to the "Off" position so that no compression can occur.

As fluid within the reservoir is used, the pressure begins to drop and the calibrated spring 85 begins to force the piston 76 back toward the end of the bore 73 in the governor body 71. As more and more fluid under pressure is removed from the supply within the reservoir, the piston 76 is forced back until the valve 80 engages the valve seat 79 and removes the valve from the end of the post 87. As soon as the valve 80 is removed from the post, air under pressure within the bore 37 of the suction valve body passes through the orifices 50 and annular recesses 49 into and through the orifices 103 and bore 98 back through the orifices 102 and 96, annular groove 82, orifices 84, internal groove 83 to the bore 89 of the post. The annular bore 89 permits fluid to flow through the orifices 90 into the bore 73 of the governor body and from the bore 73 air under pressure is exhausted to atmosphere through the orifice 97. Since the annular chamber 42 is thus opened to atmosphere, the spring 43 quickly moves the piston 40 until the stop 41 engages the end of the bore 37 and permits the valve member 47 to seat against the end of the valve body 33 to cycle the compressor to the "On" position.

The gradual buildup of pressure in the annular chamber 42 substantially reduces or prevents vibration and chatter when the inlet valve are moved to unload position.

When the device is to be used with a truck or other vehicle, it is contemplated that the compressor 15 will be cycled "On" when the pressure within the air supply reservoir reaches approximately 90 p.s.i. and will be cycled "Off" when the pressure reaches 110 p.s.i. Since the reservoir normally is located in a position remote from the compressor, it is recognized that there may be a pressure drop in the pressure line 66 so that a pressure differential between the reservoir and the outlet manifold 64 may exist. This differential can be overcome by adjusting the governor 70 by adding or removing shims 86 so that the compressor is cycled "On" and "Off" at desired pressures within the outlet manifold. For example, the governor may close the compressor inlet valve when the pressure within the outlet manifold is approximately 100 p.s.i. and may move the inlet valve to open or unloaded condition when the pressure within the manifold is approximately 120 p.s.i.

I claim:

1. In a governor for controlling the operation of an air compressor having an inlet valve and including a body having a first axial bore closed at one end, a cap closing the other end of said body, a hollow post mounted on the cap and extending into the first bore, a piston slidably mounted within the first bore, the piston having a second axial bore for slidably receiving one end of the post and having a generally concentric counterbore, resilient means urging said piston toward said one end of the body, a valve member located within said counterbore and normally closing the bore of the piston, and means for introducing fluid under pressure into the counterbore of the piston, the improvement comprising an internal groove in said piston

communicating with the second bore in predetermined spaced relationship with said counterbore, said groove communicating with the inlet valve of the compressor, said post having an annular recess spaced from said one end and being of a length greater than the distance between the internal groove of the piston and the counterbore thereof, and said post having a diameter slightly less than the diameter of the piston bore between said one end and said annular recess, whereby fluid under pressure within the counterbore of the piston leaks past said one end of said post to the internal groove of said piston when the valve member is initially opened so that a buildup of pressure occurs at the inlet valve of the compressor and continued movement of the piston against the tension of the resilient means causes the annular recess of said post to extend into the counterbore of the piston to permit free flow of fluid under pressure to the inlet valve of the compressor.

2. The combination of an air compressor and a governor for automatically controlling the operation of the air compressor, said air compressor comprising a body having at least one cavity defining a cylinder, a first piston reciprocally mounted within said cylinder, a cylinder head mounted on said body at one end of said cylinder, said head including an inlet bore and an outlet bore communicating with said cylinder, inlet valve means removably mounted in said inlet bore, outlet valve means removably mounted in said outlet bore, said inlet valve means including a body having an axial bore with a valve seat at one end, a first valve member normally engaging said inlet valve seat, a second piston slidably mounted within the bore of said inlet valve body, said second piston being selectively movable into engagement with said first valve member to unseat the same, means for introducing fluid under atmospheric pressure into said inlet valve bore, said outlet bore having a valve seat, a second valve member normally engaging the valve seat of said outlet bore, resilient means carried by said outlet valve means and normally urging said second valve member against the valve seat in said outlet bore, an outlet manifold communicating with said outlet bore, said governor including a body mounted on said cylinder head and having an axial bore closed at one end, cap means closing the other end of said body, post means mounted at one end on said cap means and extending into the axial bore of said governor body, a third piston slidably mounted within said governor body, said third piston having an axial bore with a generally concentric counterbore extending inwardly from one end, the bore of said third piston slidably receiving the other end of said post means, said counterbore being in communication with the outlet manifold of said cylinder head, a third valve member normally closing the bore of said third piston, said third piston having an internal groove communicating with the axial bore in predetermined spaced relationship with said counterbore, said groove communicating with one end of said second piston, said post means having an annular recess spaced from said other end and being of a length greater than the distance between the internal groove of the third piston and the counterbore thereof, and said post means having a diameter slightly less than the diameter of the bore of the third piston between said other end and said annular recess, whereby fluid under atmospheric pressure is introduced through said inlet valve means into said cylinder during the suction stroke of said first piston and is compressed and

9

discharged through said outlet valve means and said outlet manifold during the pressure stroke of said first piston and fluid under pressure from said outlet manifold is introduced into the counterbore of said third piston and leaks past the other end of said post means to the internal groove of said third piston when the third valve member is initially opened so that a buildup of

10

pressure occurs at said second piston and continued movement of the third piston causes the annular recess of said post to extend into the counterbore of said third piston and permit free flow of fluid under pressure to the second piston to move said second piston and open said first valve member.

* * * * *

10

15

20

25

30

35

40

45

50

55

60

65