Jan. 28, 1947. J. W. CRAIG 2,415,060

PUMPING SYSTEM

Filed Oct. 31, 1942 4 Sheets-Sheet 1

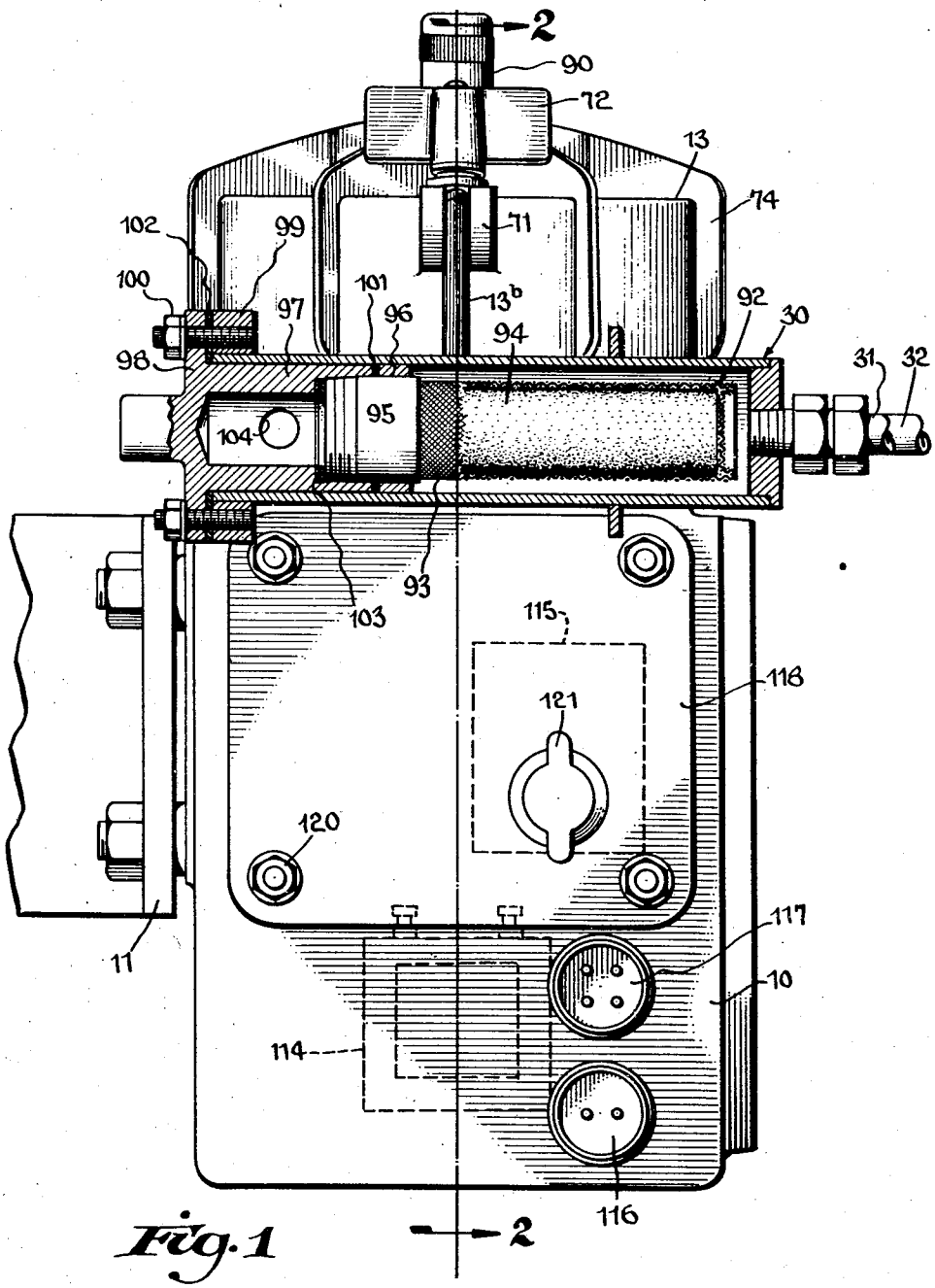


Fig. 1

INVENTOR.
JOHN W. CRAIG
BY Alden D. Redfield
ATTORNEY

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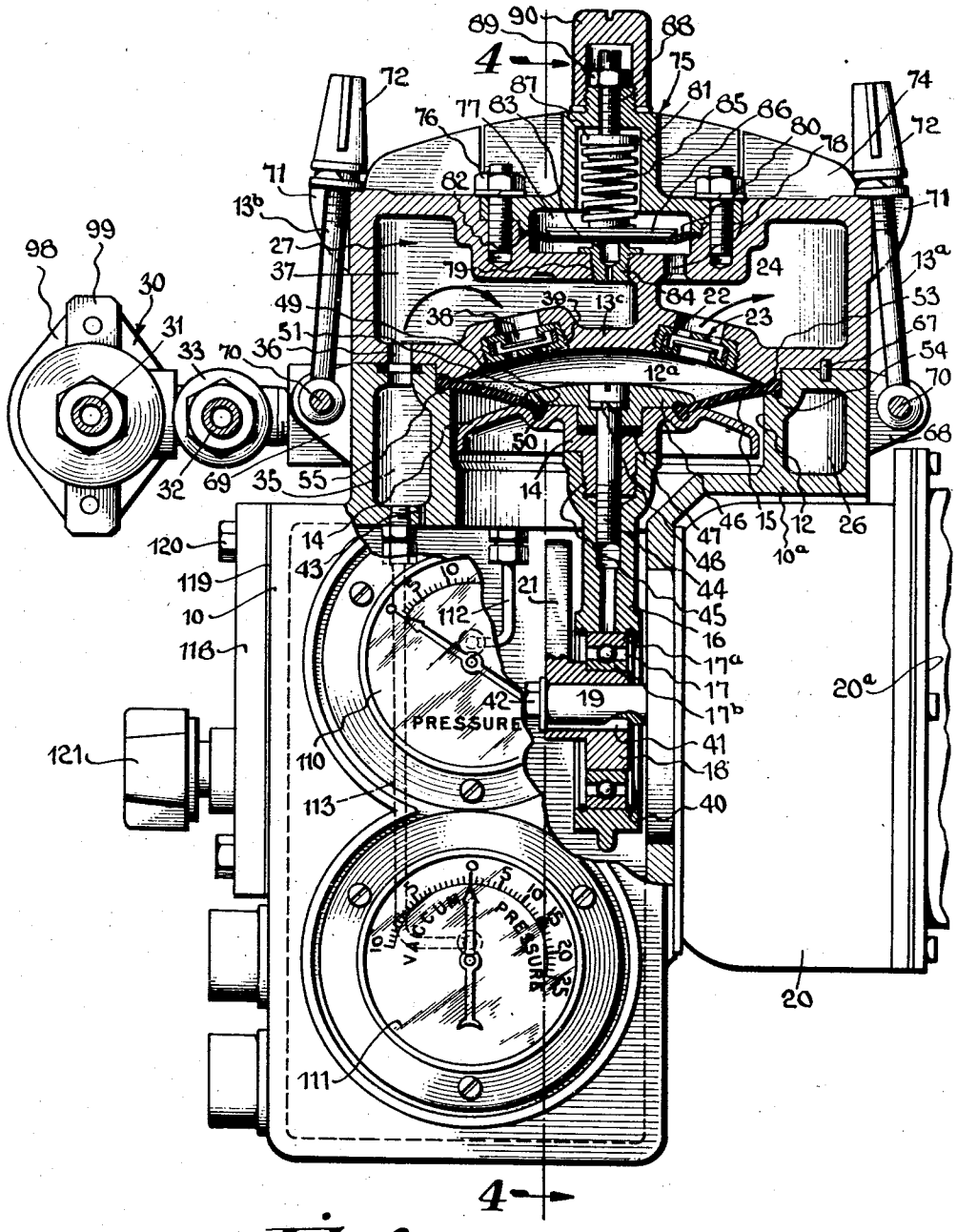


Fig. 2

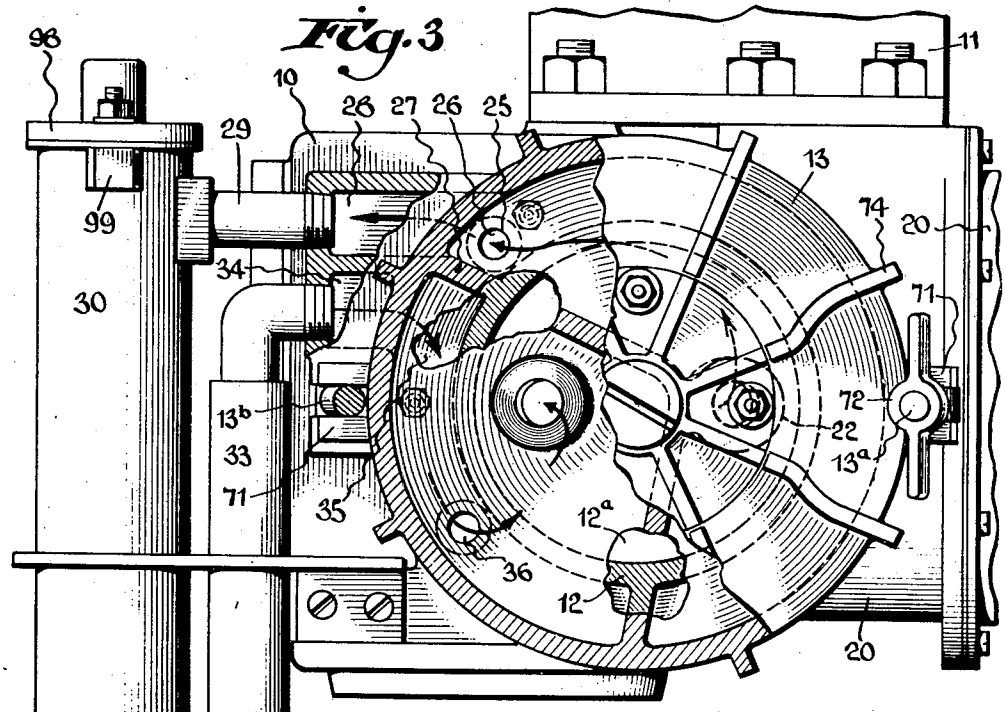
INVENTOR.
JOHN W. CRAIG
BY Alden D. Redfield
ATTORNEY.

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PUMPING SYSTEM

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Fig. 3



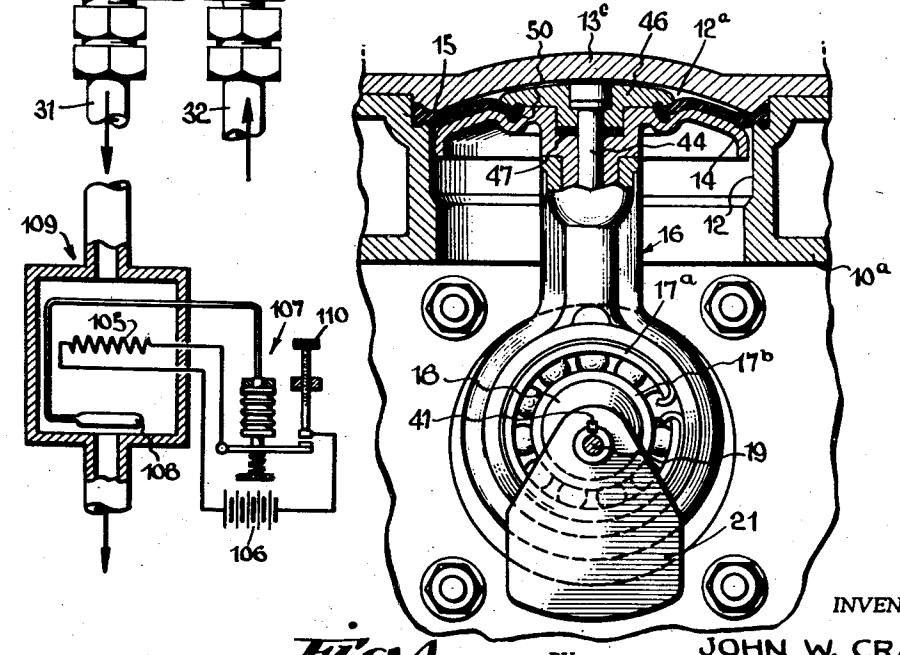


Fig. 4

INVENTOR.
JOHN W. CRAIG
BY Alden V. Redfield
ATTORNEY.

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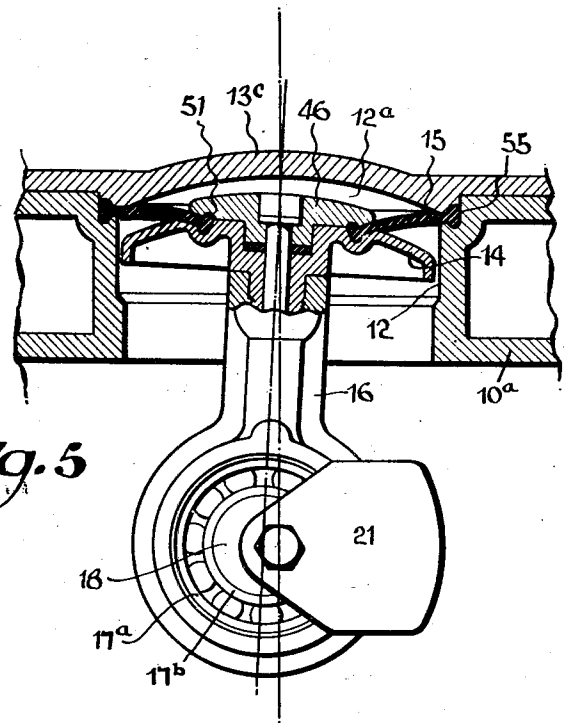


Fig. 5

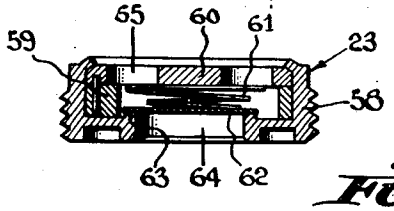


Fig. 7

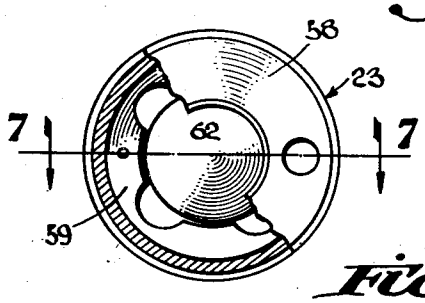


Fig. 6

INVENTOR.
JOHN W. CRAIG
BY Alden D. Redfield
ATTORNEY

Patented Jan. 28, 1947

2,415,060

UNITED STATES PATENT OFFICE

2,415,060

PUMPING SYSTEM

John W. Craig, Cincinnati, Ohio, assignor to The Crosley Corporation, Cincinnati, Ohio, a corporation of Ohio

Application October 31, 1942, Serial No. 464,066

3 Claims. (Cl. 230—170)

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The invention relates to pumps of the reciprocating, single stroke, diaphragm type and is particularly concerned with pumping systems which will produce a rapid and substantially constant fluid flow at relatively low pressures. While pumps embodying the invention may be useful in pumping liquids, their primary purpose is for pumping compressible fluids such as gases and gas mixtures. The invention has particular application to the generation of a rapid and substantially constant air flow for the purpose of rotating turbines at high speed.

By the use of the pumping system of the present invention it is possible to obtain substantially uniform speeds of the order of 10,000 R. P. M. from a prime mover rotating at speeds of the order of 1700 or 1800 R. P. M.

An object of the invention is to provide a simple and effective pump having long life which will produce a rapid and constant flow of gas or gas mixtures which I shall subsequently refer to as air in order to achieve uniform turbine speeds.

Another object is to provide a device by which the air is sealed within a closed system and maintained in a substantially constant state of dehydration and is therefore unaffected by changes in pressure and humidity of the atmosphere in which the system is used.

A further object is the provision of means to control the temperature of the air so that the fluctuations in pressure necessarily produced by the action of the pump may be maintained within relatively narrow limits.

A further object is to provide a pump which has such a small stroke and whose moving parts are of such small size and weight that it can be effectively driven direct from an electric motor or other power source.

A further object is to provide a pump of the reciprocating type which requires no wrist pin or bearing joining the connecting rod to the piston and which carries the head of the piston on a flexible diaphragm.

A further object is to provide a flexible diaphragm of long life which serves the three-fold purpose of providing a piston or pressure surface for compressing air, acting as a bearing to hold the top of the piston follower and sealing the compression chamber from those parts of the device which produce and apply power to the piston.

A further object is to provide a diaphragm pump of the nature described having a long life and being capable of easy servicing in the field by inexperienced personnel.

A further object is to provide interior, integrally formed chambers serving as surge tanks and facilitating the smooth flow of air without pulsations.

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A still further object is to provide a pressure regulator integrally built into the hermetically sealed system in order to maintain accurate control of the pressure within the system.

A still further object is to provide an air-tight, water-tight and explosion-proof crank case constructed so that it will house accessory parts and which can be operated under water.

The novel features that I consider characteristic of my invention are set forth in the appended claims; the invention itself, however, both as to its organization and its method of operation together with additional objects and advantages thereof will best be understood from the following description of a specific embodiment when read in conjunction with the accompanying drawings, in which

Figure 1 is a side elevation of a device embodying the advantages of the invention,

Figure 2 is a front elevation thereof with parts broken away to show parts in section, taken along line 2—2 of Figure 1 showing the pump piston at the lower end of its stroke,

Figure 3 is a plan view of the illustrative device, with parts broken away to show parts in section,

Figure 4 is a partial section taken along lines 4—4 of Figure 2, showing the piston at the upper end of its stroke,

Figure 5 is a partial section similar to Figure 4, showing the piston at a position 90° removed from those shown in Figures 2 and 4,

Figure 6 is a bottom view of an exhaust valve which may be used to permit the compressed air to move out of the compression chamber of the cylinder, and

Figure 7 is a section taken on line 7—7 of Figure 6.

Briefly described, the illustrated device comprises a housing 10 suitably mounted as on a bracket 11. To the top portion of the housing which may be of cast steel and preferably integrally formed therewith, is a cylinder block 10*a* having passages formed in its outer portions and containing cylinder 12 and compression chamber 12*a*. A head 13 is secured, as by dogs 13*a* and 13*b* to the top of block 10*a*. Within the cylinder 12 is a piston follower 14 which has a flexible diaphragm 15, preferably made of synthetic rubber, secured thereto. I have found that a synthetic rubber sold under the trade name "Neoprene," is particularly suitable for the purposes of the invention. The follower 14 is secured to a connect-

ing rod 16 the lower end of which is provided with a ball bearing 17, preferably of the permanently lubricated type. Suitably secured to the inner race 17b of the bearing is an eccentric 18 which may be keyed to shaft 19 of a motor (not shown) contained in split housings 20 and 20a. Integrally formed with eccentric 18 is a counterweight 21 designed to counter balance the weight of the connecting rod and piston assembly.

The cylinder block and head are provided with valves and passageways which will be referred to in the following portion of this brief description of the operation of the system.

Oscillation of the piston causes air to flow from compression chamber 12a through an opening 22 in head 13, said opening containing exhaust valve 23, passageway 24, opening 25 (see Fig. 3) and down into a chamber 26 located within the cylinder block 10a. This chamber can be seen in the brokenaway part of Fig. 3 and is behind the partition 27 shown in Figures 2 and 3. Chamber 26 communicates with casing 30 which contains a dehydrating agent such as plaster of Paris through chamber 28 and conduit 29 and leaves the casing through conduit 31, which is connected to the turbine or other device to be driven by the flow of air through the system.

Upon its return to the pump the air flows through conduits 32 and 33 into chamber 34, which communicates with chamber 35 in cylinder block 10a, up through opening 36 into chamber 37 in head 13 and thence thru intake valve 38 fitted into opening 39 back to the chamber 12a.

It will be apparent that valves 23 and 38 are of the spring controlled type and may be set to open and close at such times as the piston 15 moves up and down within the cylinder 12. I have found that with a piston stroke of somewhat less than ½'' (governed by the eccentricity of member 18) and a motor turning at about 1720 R. P. M. I can secure an air flow up to 2 cu. ft. per minute at very low head pressures (no load conditions). With these constants the pump will operate most efficiently, however, under load conditions calculated to give a pressure of from about 5 to 8 lbs. per sq. inch, producing, at these pressures, a constant and uniform flow in the neighborhood of 1½ cubic feet per minute.

With the above brief description of the construction and operation of the illustrative device I shall proceed to a more detailed description.

The piston assembly may be very simply constructed, as shown in Figure 2 by attaching bearing 17 to the connecting rod by fitting the bearing snugly within the opening provided at the lower end of the rod and snapping it in place by snap rings 40. Eccentric 18 is suitably connected to the inner race of bearing 17 and is secured to shaft 19 by a key 41 in suitable keyways. Shaft 19 is preferably intervally threaded to provide for locking the eccentric or cam structure in place by bolt 42.

The upper end of connecting rod 16 has secured thereto by bolt 44, the piston follower 14. The follower may be threaded to the rod as at 45. Cap 46 fitted over soft washer 47 and provided with lock washer 48 may be conveniently provided to lock the assembly together, suitable recesses 49, 50 provided in members 14 and 46 in order securely to hold the bead 51 on diaphragm 15 and to form a fluid-tight connection.

The top of compression chamber 12a formed by partition 13c of head 13, is arched as shown in Figures 2, 4 and 5 and is of such contour as to follow closely the upper contour of the structure

15, 46 when the piston is at the upper limit of its stroke, but sufficiently spaced therefrom to permit the edges of the cap 46 to clear the top of the arch as it inclines before and after the maximum upper limit of the stroke is reached.

Partition 13a is recessed at 53 and cylinder block 10a has a complementary recess 54 into which are fitted bead 55 of diaphragm 15 in order to form a sealed fluid-tight joint.

It will be noted that the diaphragm 15 in the construction shown serves the three-fold purpose of forming the working surface which compresses the air, acting as a bearing for the upper end of the piston assembly, and of sealing the pressure side of the system. More than this, the structure obviates the necessity of a wrist pin between the connecting rod and the piston.

The valves 38 and 23 may be substantially similar although of course each one works in a direction opposite to that of the other. Exhaust valve 23 is typical and is shown in Figures 6 and 7. It comprises a casing 58 containing a ring 59 which positions a spider 60 the center of which secures a spring 61 attached to valve 62 cooperating with valve seat 63. Lip 23a is conveniently swaged down to retain the valve structure within casing 58. Egress from chamber 12a is had thru opening 64, over the valve seat and up thru openings 65, the pressure in chamber 12a causing the valve member 62 to lift against the pressure of spring 61 upon the up or working stroke of the piston 15. Valve 23 may be threaded in opening 22 as shown in Figure 2.

Valve 38, threaded in opening 39 is mounted oppositely to valve 23 in order that it may close on the up stroke of the piston and open as the piston moves down.

Both the cylinder block 10a and the head 13 are partitioned as shown in order to provide the passageways and chambers previously described. Head 13 is located in the proper position by pin 67. The dogs 13a and 13b are pivotally mounted on lugs 68 and 69 secured to block 10a and ears 71 provided with slots for the reception of the threaded ends of the dogs. Wing nuts 72 are provided for removably securing the head 13 to block 10a. It will be apparent that the construction shown permits easy access to the diaphragm 15, valves 23 and 38, pressure release 75, etc. in the event servicing is required in the field by inexperienced personnel.

Head 13 is preferably formed with fins 74 as shown in order to enhance cooling of the same by external air. Within the head is removably secured an adjustable constant pressure valve 75 in the manner shown in Figure 2. The valve is mounted as by bolts 76 against the upper recess 77 of head 13, which recess communicates with chamber 24 by openings 78 and 79. A diaphragm 80 extends across recess 77 and is secured in place by the pressure of member 81 against the seat 82 in head 13, the diaphragm seating upon seat 83 of nipple 84. A spring 85 secured to disc 86 and supporting member 87 maintains a selected pressure on diaphragm 80, the spring support 87 being carried by threaded shaft 88 in the uppermost part of member 81. Adjusting nut 89 is provided and is preferably protected by cap 90.

It will be apparent from the above described structure that when the pressure within chamber 24 exceeds that set on spring 85 by nut 89 the diaphragm 80 will be moved upwardly and the pressure within chamber 24 released thru opening 79 into the low side of the system, thus

providing an accurate control of pressure depending upon the setting of nut 89. In addition the structure described serves as a safety release. Thus in the event the system becomes clogged for any reason and undue pressures are built up in the cylinder head, thus overloading the motor and otherwise creating hazards, the safety valve simply by-passes the excess pressure to the low side of the sealed system, maintaining the total quantity of dry air within the system.

The adjustable constant pressure valve 75 is integrally formed within the cylinder head and promotes simplicity of design, saving of space and the elimination of outside fillings and lines.

A filter 92, as shown in Figure 1, may be removably located within casing 30 and may consist of a screen 93 containing a suitable dessicant 94 such as plaster of Paris. The screen may conveniently be inserted within the casing 30 and held in proper position by shoulder 95 seated in opening 96 and held in place by bushing 97 having a flange 98 held against lugs 99 by bolts 100, lugs 99 being secured to casing 30. Gaskets 101, 102 and 103 may be provided to maintain the system fluid tight. An opening 104 in bushing 97 communicates with conduit 29 and guides the air into the front end (not shown) of the screen 94.

In order that the air within the system may be maintained at a substantially constant temperature I may provide at a suitable place therein, for instance between the exhaust conduit 31 and the mechanism to be driven by the air flow (see Fig. 3) a heat controlling device generally indicated at 109 containing one or more electrical heaters 105 connected to a source of electric power 106 thru a thermostatic switch 107, adjustable at 110, for instance of the well-known bellows type having an element 108 which is sensitive to temperature and which upon cooling will contract a liquid within the bellows and cause a contact to close, thus energizing at least one heater circuit. When the air within the system becomes too cool the switch will be operated to cause the heaters to be energized, thus heating the air until sufficiently warm to cause the bellows to expand and open the contacts, thus opening the circuit. I have found that many types of air-driven turbines, particularly those designed to operate gyroscopes, must be run at a very accurately controlled and uniform speed, and that such speed is affected more by low temperatures than by high. This makes it desirable to keep the air which acts as the motive power at fairly high temperatures such as 100°–150° F. Accordingly the provision of a controlled heating device of the nature described, in conjunction with a sealed system containing dry air, is of particular utility in insuring that these temperatures and conditions are maintained and the operation of the turbine maintained at substantially uniform speeds.

In order to follow the operation of the system I may provide within the casing 10 a pair of gauges 110 and 111 connected respectively to the high and low pressure sides of the system, as by connecting tubes 112 and 113. It may be desirable to ensure that the pressure within crank case 10 be allowed to equalize with the low side of the system and for this purpose a small hole 43 may be provided (see Fig. 2). This prevents the possibility of inaccurate readings on gauges 110 and 111 on account of increase in pressure in crank case 10 due to temperature rises.

It should be noted that the passages and chambers 24, 25 and 26 are integrally formed in the cylinder head and block and are of sufficient volume to act as surge tanks, in the high or pressure side of the system, thereby damping out pulsations and permitting uniform air flow.

Within the casing 10 may also be provided accessory equipment such as a transformer 114, fuses and connections (not shown) and a switch 115. This provides an air-tight, water-tight and explosion-proof space for such equipment, which is of distinct advantage in connection with the air turbine and the device or devices driven thereby and obviates the necessity of separate protective casings for the accessory equipment. 116 is a terminal for bringing power into the transformer thru a plug connector (not shown) and 117 is output terminal connection for taking out different voltages, say 110 and 6, thru a plug connector, (not shown). A cover 118 removably secured against a gasket 119 by bolts 120 may conveniently be provided for maintaining the interior of casing 10 fluid-tight and for obtaining access thereto. A switch handle 121 is shown for actuating switch 115.

It will be understood that the invention has been described in connection with an illustrative embodiment and that many modifications, adaptations and changes in the structure shown may be made as will be apparent to those skilled in the art, without departing from the spirit of the invention.

Having thus described my invention, I claim:

1. A pumping system comprising a cylinder block, a cylinder head, a crank, a flexible diaphragm secured between said block and head, a piston follower secured centrally of said diaphragm, a connecting rod fixedly secured at one end to said follower and pivotally secured at the other end to said crank, said cylinder block and head containing passages in the high or pressure side of the system, said passages being integrally formed therein, and serving as a surge tank to ensure the smooth flow of fluid through the system.

2. An hermetically sealed pumping system comprising, in combination, a reciprocating pump comprising a piston, piston actuating means, a cylinder block and a cylinder head, said piston comprising an annular flexible diaphragm having beaded peripheries and a pair of members securely clamping the interior bead of said diaphragm, the cylinder block and the cylinder head cooperating securely to clamp the exterior bead of said diaphragm, accessories including a gauge and a switch, said cylinder block having an hermetically sealed chamber therein, said accessories being housed therein whereby said system is maintained water-tight.

3. An hermetically sealed pumping system comprising, in combination, a reciprocating pump comprising a piston, piston actuating means, a cylinder block and a cylinder head, said piston comprising an annular flexible diaphragm having beaded peripheries, a pair of members securely clamping the interior bead of said diaphragm, the cylinder block and cylinder head cooperating securely to clamp the exterior bead of said diaphragm, and means for removably securing said head to said block including lugs on said block and dogs on said lugs whereby said cylinder head may be removed and easy access to said piston may be had.

JOHN W. CRAIG.