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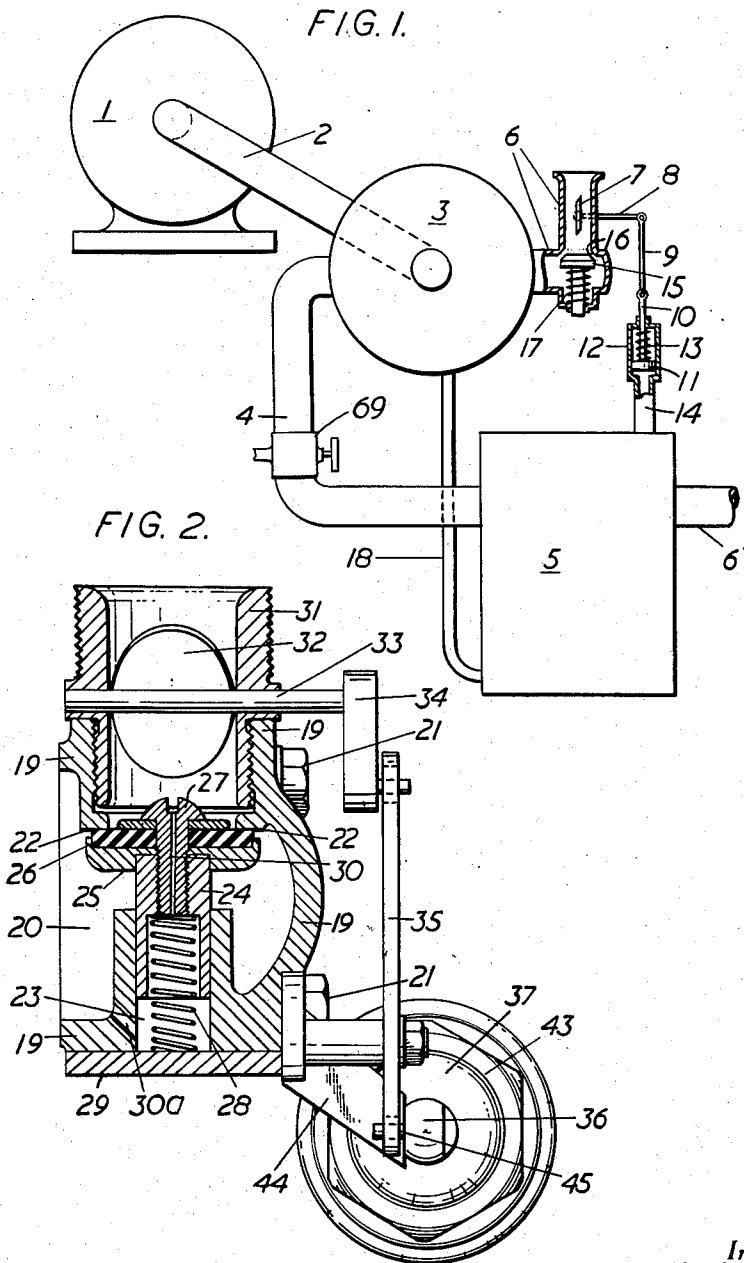
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INSTALLATIONS FOR COMPRESSING AIR OR GAS

Filed March 21, 1956

2 Sheets-Sheet 1



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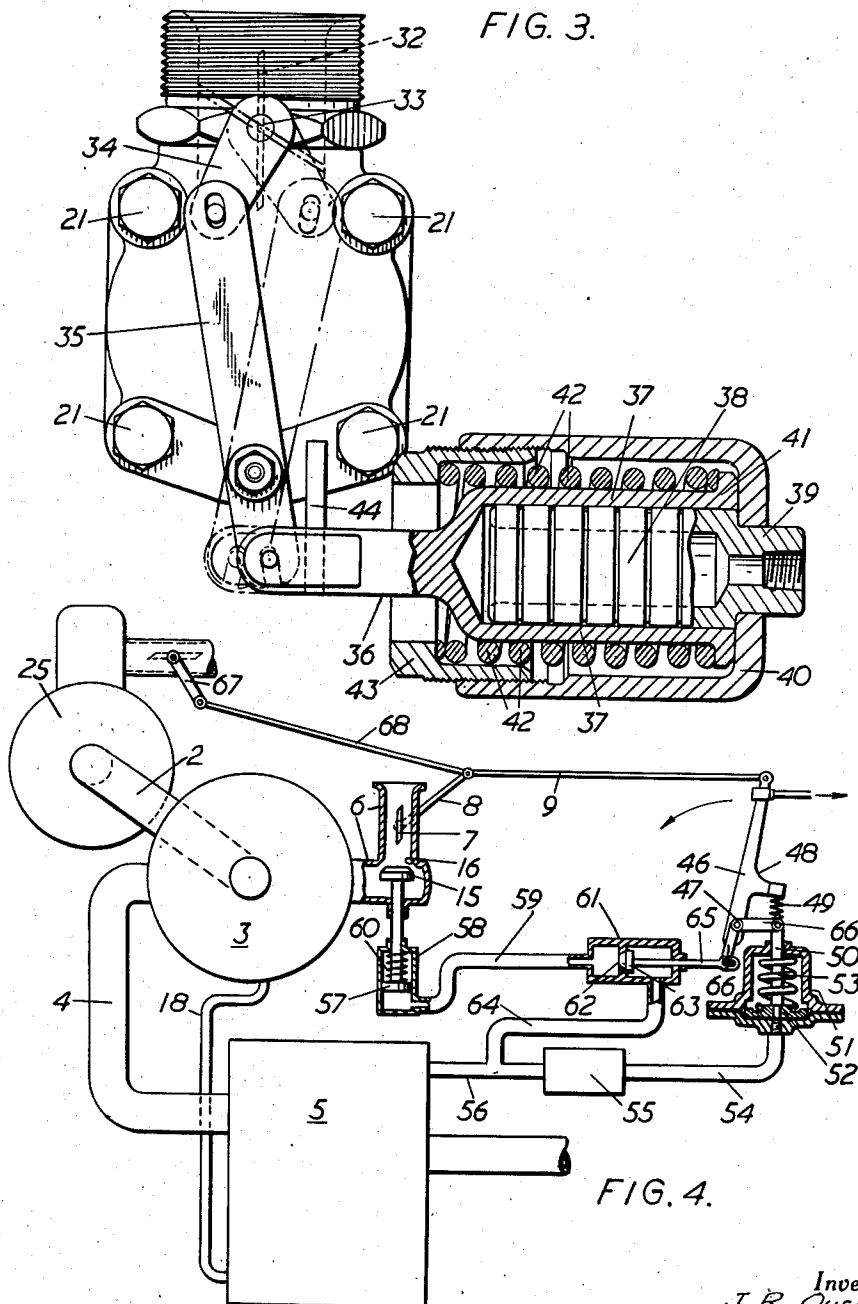
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INSTALLATIONS FOR COMPRESSING
AIR OR GAS

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4 Claims. (Cl. 230—19)

This invention relates to installations for compressing air or gas comprising a compressor driven by some form of prime mover and delivering its output of compressed air or gas to a receiver, and has for its object to provide an improved manner of controlling the delivery of compressed air or gas by the compressor to the receiver so as to maintain the pressure within the receiver within predetermined limits, for example approximately constant, under fluctuations of withdrawal of compressed air or gas therefrom and under the usual variations of operating conditions.

In prior installations of this nature, for example that described in United States Patent Application of Clarence Edward Cox and Richard Leland Nash, Serial No. 428,942, filed May 11, 1954, corresponding to British Patent 776,097, it has been customary to control the mass of air delivered by the compressor to the receiver by governing the speed of the prime mover in dependence upon the pressure of air or gas in the receiver. According to the present invention the mass of air or gas delivered by the compressor is controlled by progressively throttling the inflow of air or gas through the intake of the compressor in response to progressive increase of the pressure of air or gas in the receiver above some predetermined value.

Accordingly the invention consists in the combination with a compressor for air or gas and a receiver of compressed air or gas of means for progressively throttling the inflow of air or gas through the intake of the compressor and means responsive to the progressive increase of pressure in the receiver above some predetermined value for actuating the throttling means. It is, of course, necessary that the speed of the prime mover should also be controlled in some manner, unless the prime mover is of the type of which the speed is inherently substantially constant. Thus the speed of the prime mover may be controlled by the means responsive to the progressive increase of pressure in the receiver or by a separate governor.

The invention, although not so restricted, is of particular value in connection with installations in which the prime mover that drives the compressor is of a kind the speed of which cannot be conveniently varied, such as an electric induction motor. Accordingly a feature of the invention consists in an installation for supplying compressed air or gas comprising a prime mover of a kind of which the speed cannot be conveniently varied, a compressor driven thereby and a receiver of compressed air or gas receiving the output of the compressor, wherein the inflow of air or gas through the intake of the compressor is progressively throttled in dependence upon progressive increase of pressure in the receiver above some predetermined value.

It is not always easy and economical so to construct means for progressively throttling the inflow of air or gas through the intake of a compressor in such a manner that the intake can be substantially completely closed or sealed thereby. According to a feature of the invention, therefore, the intake of the compressor may be, additionally, equipped with valve means adapted to close or to seal the intake completely or substantially. This valve means may be actuated by a device responsive to excess of pressure in the receiver over some predetermined level.

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When the compressor is of the liquid-flooded type having a rotor eccentrically mounted within a chamber of circular cross-section and equipped with circumferentially spaced blades constrained to sweep the boundary of the chamber, a reflux of liquid is liable to take place from the intake of the compressor when the compressor is stopped. In order to avoid such reflux, the valve means previously mentioned may be such or so arranged as to be closed when the compressor comes to rest, and so as to be reopened when the compressor is restarted. Alternatively, a non-return valve may be disposed in the compressor intake between the throttling means and the compressor. In either case a small by-pass for the valve means may be provided in order to maintain a small intake of and flow of air or gas through the compressor and thus to prevent over-flooding of the compressor with liquid.

For the better understanding of the invention certain elementary embodiments of it will now be described with reference to the accompanying drawings in which:

FIG. 1 is a purely diagrammatic representation of an air-compressor installation incorporating the invention in one form;

FIG. 2 is an elevation, partly in section, of the compressor intake assembly shown diagrammatically in FIG. 1;

FIG. 3 is an elevation partly in section, in a plane perpendicular to that of FIG. 2;

FIG. 4 is a purely diagrammatic representation of an air-compressor installation incorporating the invention in another form.

Like reference numerals indicate like parts, where applicable, through the several figures of the drawings.

Referring now to the drawings, it will be appreciated that FIGS. 1 and 4 show diagrammatically only those elements strictly germane to the invention, all other elements that may be necessary or desirable in a practical compressor installation being omitted.

The installation shown in FIG. 1 of the drawings comprises a prime mover 1 of any type that is inherently adapted to, or is arranged as by means of a governor to, operate at a substantially constant speed irrespective of load. This prime mover may, for example, be an electrical induction motor or other electric motor the speed of which cannot be conveniently varied, or it may be a governed internal combustion engine. The prime mover 1 drives directly through a shaft 2 a compressor 3 of the liquid-flooded type having a rotor eccentrically mounted within a chamber of circular cross-section and equipped with circumferentially spaced blades constrained to sweep the boundary of the chamber. It may, for example, be of the kind disclosed and shown in the specification of United States patent application Serial No. 428,942, previously referred to. The compressor 3 delivers compressed air, accompanied by the flooding liquid, usually oil, through a pipe 4 to a combined receiver and liquid-separator 5 which may, again, be of the kind described and shown in the specification of the United States patent application Serial No. 428,942. Compressed air is delivered to a load through a delivery pipe 6'. The flooding liquid, under the pressure of the receiver, is separated from the compressed air therein and is recirculated through a pipe 18.

The air intake 6 of the compressor 3 is equipped with means for progressively throttling the inflow of air to the compressor in the form of a pivoted butterfly valve 7. The spindle of the butterfly valve 7 is provided with an external actuating lever 8, the free end of which is articulated by a link 9 to a piston rod 10. The piston rod 10 equipped with a piston 11 cooperating with a cylinder 12. A compression spring 13 is interposed between the piston 11 and the end of the cylinder 12 through which the piston rod 10 extends. The opposite end of the cylinder

12 is connected by a pipe 14 to the receiver 5, so that pressure within the receiver 5 is applied to the piston 11 and tends to raise the latter and thus to close the butterfly valve 7. The stiffness and precompression of the spring 13 are so adjusted that the piston 11 rises from its lowermost position and commences to close the butterfly valve 7 only when the pressure within the receiver 5 exceeds some predetermined value, and continues to close the butterfly valve 7 in response to further rise of pressure in the receiver 5 at a suitable rate. Progressive closure of the butterfly valve 7 in response to progressive increase of pressure in the receiver 5 progressively limits the rate of induction of air into the compressor 3 and thus limits the rate of discharge of compressed air to the receiver 5 so preventing the pressure in the receiver 5 rising unduly when the demand through the delivery pipe 6 is reduced.

When the fluid-flooded compressor 3 is stopped the flooding liquid in it will be still subject to the pressure of the receiver 5, and there is therefore a tendency for reflux of the liquid through the air intake 6. In order to minimize or to obviate this reflux, the air intake 6, is also equipped with means for closing it completely or substantially so in response to stoppage of the compressor. In the example shown in FIG. 1, this means consists of a resiliently loaded non-return check valve, comprising a valve member 15 cooperating with a seating 16. The valve member 15 is lightly biased to the closed position by a spring 17. So long as the compressor 3 is operating, the pressure is lower at the compressor side of the valve member 15 than at the side of the butterfly valve 7, and the valve member 15 is held open against the bias of the spring 17. When, however, the compressor 3 is stopped, the pressure beneath the valve member 15 rapidly becomes higher than that above it owing to the slight back-leakage from the receiver 5 through the compressor 3, and the valve member 15 is closed, so that reflux of liquid is precluded.

Referring now to FIGS. 2 and 3, a compressor intake assembly that may be utilized in the installation diagrammatically shown in FIG. 1 comprises a body portion 19 having an opening 20 to mate with the inlet of the compressor proper, to which the assembly is secured by bolts. The body portion 19 has an internal valve seating 22, and, opposite to the coaxial therewith, a bore 23. A hollow valve stem 24 slides in the bore 23 and carries a valve head 25 and gasket 26 secured to it by a screw 27, a washer being interposed beneath the head of the screw. The hollow stem 24 is biased by a spring 28 bearing against a cover-plate 29 toward the seating 22. Small by-pass passages 30 and 30a are provided so that, when the valve gasket 26 is abutted against the seating 22, a small amount of air can pass through the passages 30 and 30a and through the compressor, and excessive flooding of the compressor by liquid is precluded.

A bush 31 is screwed into the body portion 19 coaxially with the valve seating 22, and a butterfly valve 32 is mounted on a diametrical spindle 33 within the bush. The spindle 33 is provided with a crank 34 which is articulated by a link 35 to a rod 36. The rod 36 is fixed to a hollow cylinder 37 surrounding a hollow piston 38. The hollow piston 38 is provided with a spigot 39 which protrudes through an outer casing 40 and is connected to the pipe 14 of FIG. 1. A compression spring 42 bears between a shoulder 41 of the cylinder 37 and a ring 43 screwed into the opening of the casing 40, and urges the shoulder 41 towards the opposite end of the casing. A stop finger 44 is mounted by means of two of the bolts 21 upon the body portion 19 and cooperates with the shoulder terminating a flat face 45 of the rod 36 to limit the outward movement of the cylinder 37 and rod 36.

The normal position of the butterfly valve 32, crank 33 and link 35 is shown in full lines in FIG. 3, the throttle being then fully open. When the pressure within the

receiver 5 of FIG. 1 rises above some value predetermined by the strength of and precompression by the ring 43 of the spring 42, the cylinder 37 is urged to the left in FIG. 3 and the butterfly valve 32 is progressively closed as the pressure rises further, thus decreasing the weight of air induced by, and therefore delivered by, the compressor, until the pressure difference on opposite side of the valve seating 22 is reduced to such a value that the force of the spring 28 is sufficient to close the non-return valve against its seating 22, whereafter only sufficient air is admitted through the passage 30 to prevent the compressor from becoming over-flooded. Likewise, when the compressor is stopped, the valve 24, 25, 26 is immediately forced against the seating 22, whereby substantial reflux of liquid through the intake is prevented. A manually operable pressure relief valve 69 is included between the compressor outlet and the receiver 5 whereby the latter may be relieved of pressure manually, and the pressure through the compressor gradually reduced to atmospheric pressure through the passage 30. When the compressor is restarted, the pressure beneath the valve seating 22 is rapidly decreased below atmospheric pressure and the valve 24, 25, 26, is reopened, so that control of the induction of air by the butterfly valve 32 is restored.

In the installation diagrammatically illustrated in FIG. 4, the compressor 3 is driven through the shaft 4 by an internal combustion engine 25. The external actuating lever 8 of the butterfly valve 7 is articulated by the link 9 to a lever 46 fulcrumed about a pivot 47 and coupled by an auxiliary arm 48 and compression spring 49 to a rod 50 that enters a housing 51 and bears against a diaphragm 52 which separates the interior of the housing 52 into two chambers. The rod 50 and diaphragm 52 are loaded by a compression spring 53. The lower of the two chambers, that beneath the diaphragm 52, is connected by a pipe 54 to a pressure-change amplifier or relay 55 which is in turn connected by a pipe 56 to the receiver 5. The pressure change relay serves to eliminate from the pipe 54 the mean static pressure within the pipe 56 and receiver 5, but to transmit with amplification changes of pressure within the receiver.

Instead of being a resiliently loaded non-return or check valve, the valve member 15 is operated by a piston 57 cooperating with a cylinder 58 and loaded by a spring 60. The cylinder 58 is connected by a pipe 59 to a control or relay valve. The latter comprises a housing 61 having two compartments separated by a valve seating 62 and valve 63. The pipe 59 is connected with one compartment and the other compartment is connected by a pipe 64 to the pipe 56 and is thus subject to the pressure within the receiver 5. The valve 63 is normally closed but may be actuated to the open position by a stem 65 having a lost motion connection with a bell crank lever 66 that is fulcrumed on the pivot 47 and one arm of which is connected to the rod 50.

The internal combustion engine 25 may be governed to run at a substantially constant speed irrespective of load by any suitable form of governor, or alternatively its speed may be regulated, as shown by a throttle valve the actuating lever 67 of which may be connected for example through a rod 68 and the link 9, to the lever 46.

In the operation of the installation shown in FIG. 4, under normal conditions when there is a demand for compressed air from the receiver 5 and the pressure therein is below some predetermined level, the rod 50 is in its lowermost position and the butterfly valve 7 is fully open. On the occurrence of increasing pressure in the receiver 5, the load applied by the spring 53 is overcome and the rod 50 is raised, so that the butterfly valve 7 commences to close. Further increases of pressure in the receiver 5 cause progressive closing of the butterfly valve 7 so that the intake of air by the compressor 3 is decreased as the pressure in the receiver rises above the predetermined value. When the pressure in the re-

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ceiver reaches a maximum predetermined value the lost-motion between the stem 65 and bell crank lever 66 is taken up and the valve 63 is separated from its seating 62, so that air under pressure is admitted to the cylinder 58 and the piston 57 is raised to close the valve 15 in the compressor intake 16. When the pressure in the receiver 5 drops below the upper limit by a predetermined amount, the lost motion between the stem 65 and the bell crank 66 is taken up in the reverse sense and the valve 15 is reopened, the butterfly valve 7 also being progressively reopened as the pressure in the receiver 5 continues to fall.

As has been stated only those elements strictly germane to the present invention are included in the installations illustrated diagrammatically in FIGS. 1 and 4.

What I claim is:

1. In a compressor installation including a compressor for air, an intake passage at the low pressure side of the compressor, and a receiver connected to the high pressure side of the compressor, the improvement comprising an automatic regulator for first gradually and then suddenly throttling inflow through the said intake passage in response to rise in receiver pressure, the regulator comprising a first throttle valve in the intake passage movable from open to closed condition, air pressure amplifier means having an inlet connection with the receiver and having a discharge outlet, a pressure air operated motor of the expansible chamber type, passage means connecting the motor with the discharge outlet of the amplifier means for communicating operating pressure air to expand the chamber of the motor, motion transmitting means operatively connecting the first throttle valve with the motor for moving the said valve progressively toward closed condition in response to progressive expansion of the chamber of the motor; and final throttle valve means comprising a second throttle valve in the intake passage of the compressor, pressure air operated piston means connected to the second throttle valve for moving it suddenly to closed condition, passage means associating the piston means with the receiver for supplying operating pressure air to the piston means, a control valve in the latter passage means normally shutting off flow of operating pressure air to the piston means, and means for opening the control valve upon a pre-

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determined rise in receiver pressure and following a predetermined movement of the motion transmitting means.

2. In a compressor installation according to claim 1, wherein the motion transmitting means includes a lever pivotable by the motor, and linkage operatively connecting the first throttle valve with the lever; and wherein the means for opening the control valve includes linkage connected with the control valve having a lost motion connection with the lever.

3. In a compressor installation according to claim 1, wherein the first throttle valve is a butterfly valve pivoted in the intake passage above the second throttle valve, and the second throttle valve is an annular beveled head at one end of the piston means, a complementary seat being provided in the intake passage for the latter valve.

4. In a compressor installation according to claim 3, wherein a light spring load acting upon the second throttle valve urges the latter to open condition during operation of the compressor, and wherein back pressure from the receiver into the compressor acting upon the second throttle valve when the compressor is stopped forces the latter valve to closed condition against the said spring load.

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