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UNLOADER CONTROL FOR A ROTARY COMPRESSOR

Original Filed May 11, 1954

4 Sheets-Sheet 1

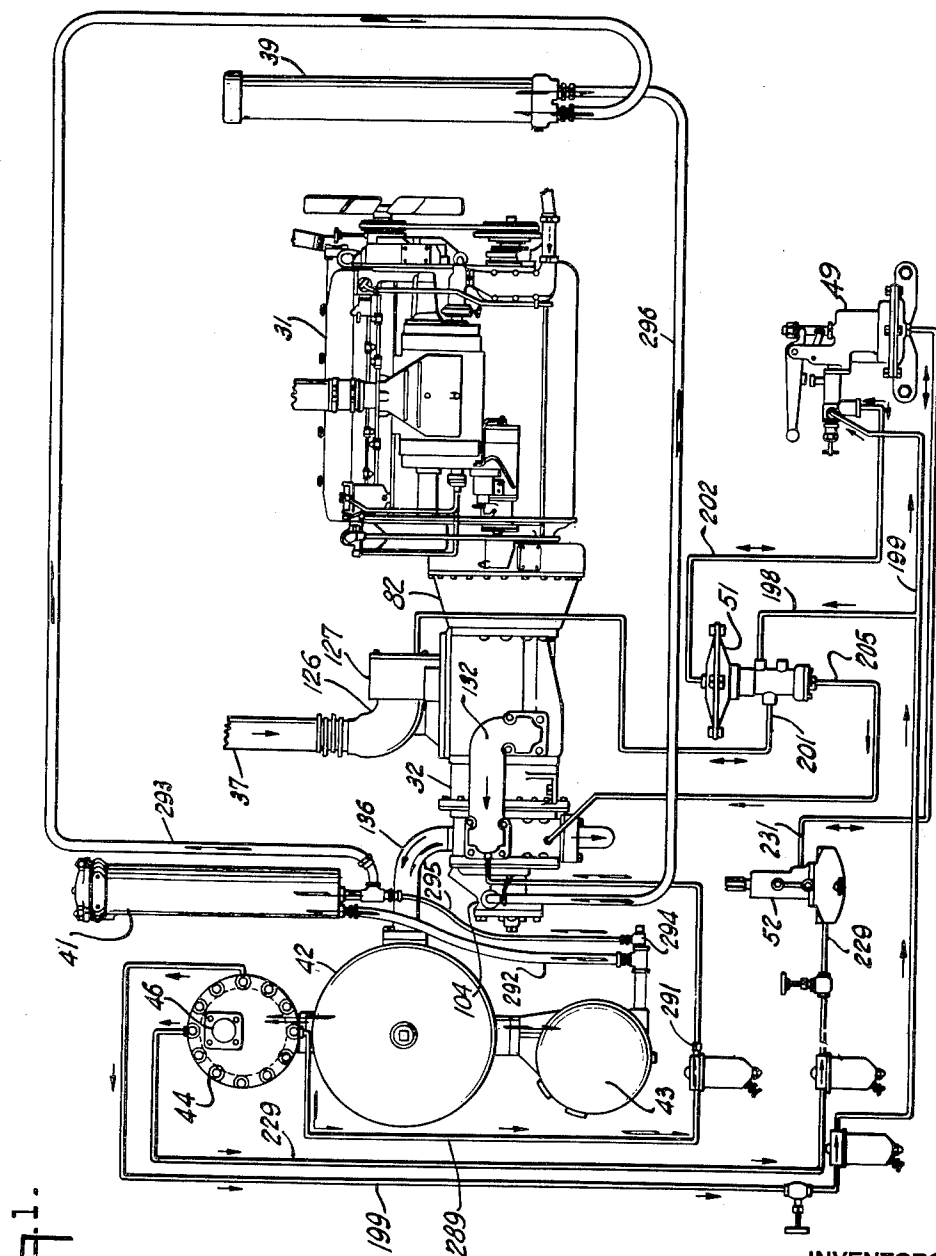


Fig. 1.

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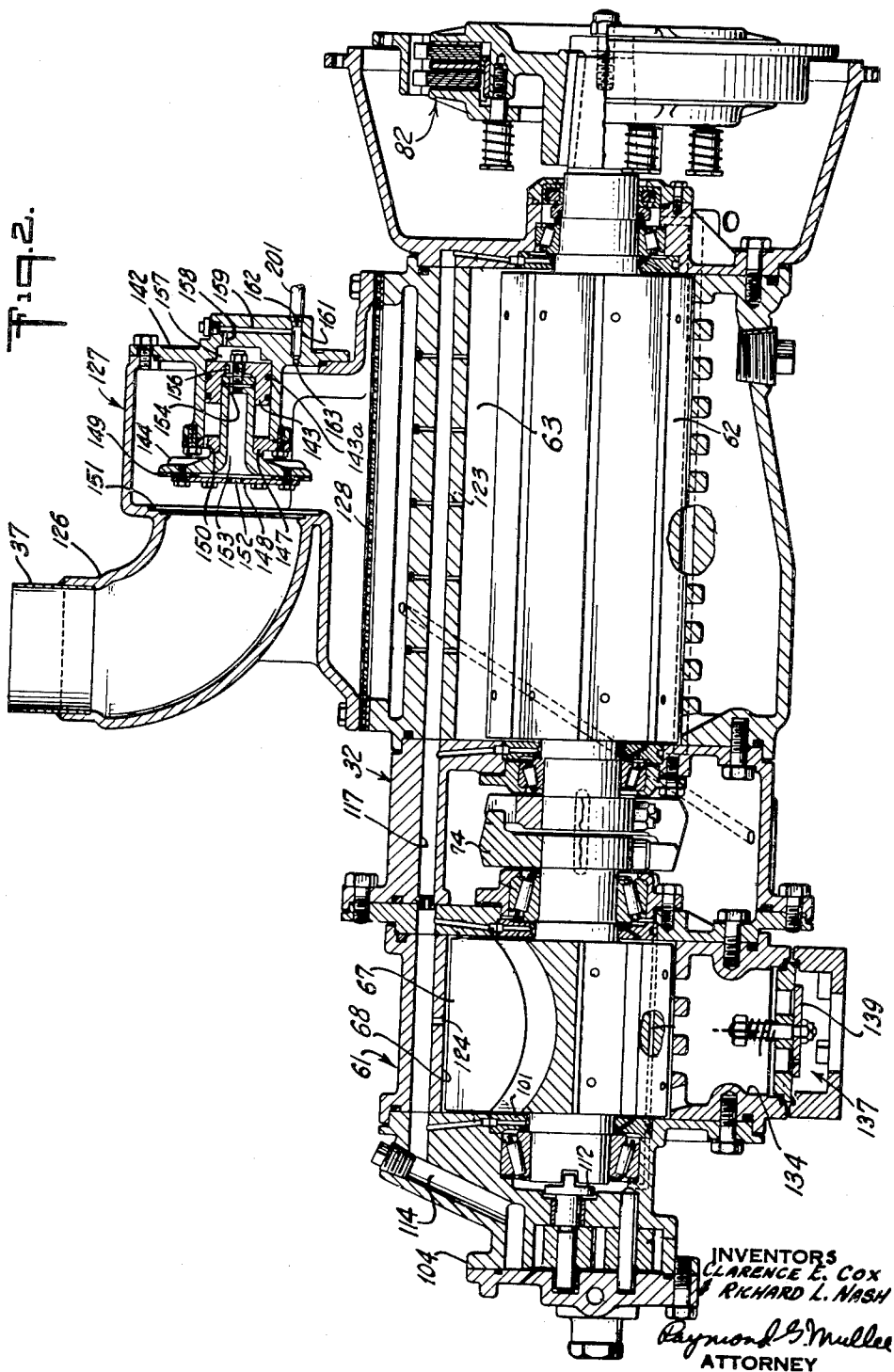
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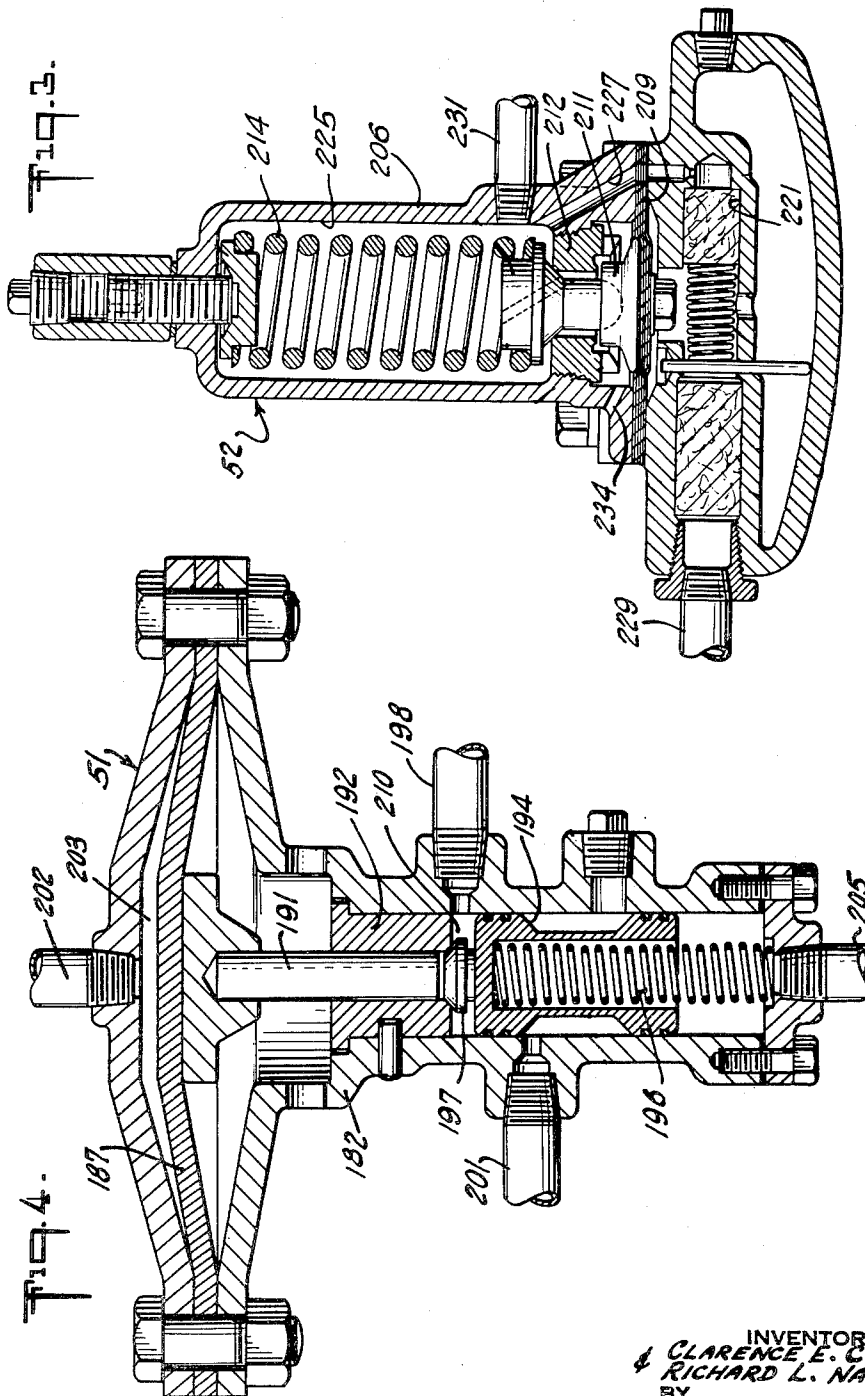
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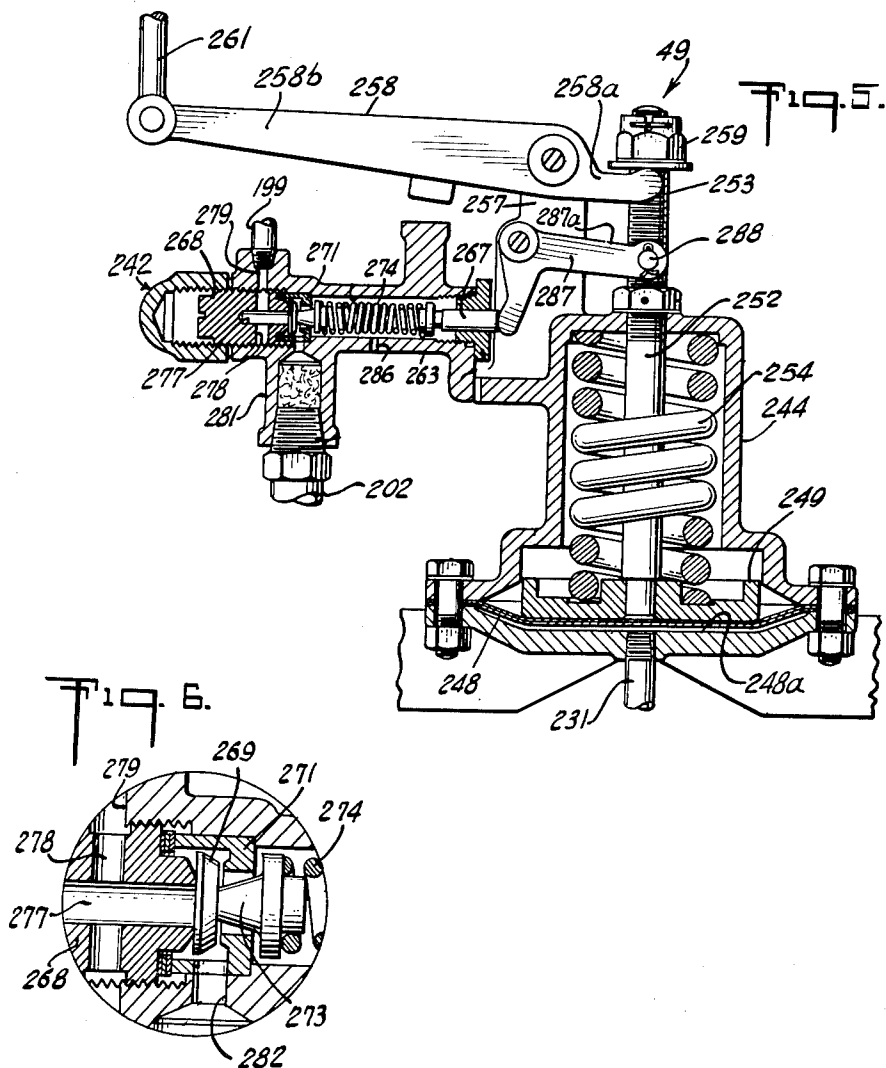
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UNLOADER CONTROL FOR A ROTARY COMPRESSOR

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Original application May 11, 1954, Ser. No. 428,942. Divided and this application Sept. 14, 1960, Ser. No. 55,959

2 Claims. (Cl. 230—31)

This application is a division of our pending application bearing Serial Number 428,942, filed May 11, 1954 for a Rotary Fluid Compressor, now abandoned.

This application is directed to unloader control means for a rotary compressor.

A general object of this invention is to provide practical and efficiently operating unloader control means for a rotary compressor.

Another object of the invention is to provide unloader control means which will function first to slow down the rotating speed of the compressor when the pressure of air discharged from the compressor exceeds a predetermined initial value, and which will function subsequently to further slow down the speed of the compressor and cut off intake air to the latter when the pressure of air discharged from the compressor rises to a predetermined higher value.

A further object of the invention is to provide an improved piston type unloading intake valve assembly for a rotary compressor.

A still further object of the invention is to provide practical means to prevent flooding of the compression chamber of a rotary compressor with oil after the engine has stopped running.

A feature of the unloading intake valve assembly is a by-pass arrangement which facilitates opening of the valve by suction action of the compressor when the compressor starts up; which permits flow of a narrow stream of demand pressure air for re-circulation through the compressor system so as to scrub the latter of oil after intake air flow has been cut off and while the compressor is running unloaded; and which permits flow of demand pressure air into the compressor system after the engine has stopped and the intake air flow has been cut off, so as to counterbalance back pressure of air in the receiver acting upon an oil sump and as a consequence to avoid oil flooding of the compressor.

The foregoing and other objects and features of the invention will appear more fully hereinafter from a consideration of the detailed description which follows, taken together with the accompanying drawings, wherein an embodiment of the invention is illustrated. It is to be expressly understood, however, that the drawings are for purpose of illustration and description, and are not to be construed as defining the limits of the invention.

In the drawings:

FIG. 1 is a schematic illustration of the composite machine embodying the invention;

FIG. 2 is a longitudinal sectional view of the rotary compressor unit of the machine of FIG. 1;

FIGS. 3, 4 and 5 are vertical sectional views, respectively of the transformer, relay, and combined unloader and throttle control device; and

FIG. 6 is an enlarged detail of the disc valve arrangement disclosed in FIG. 5.

For a more detailed understanding of the invention reference is directed to the several figures of the drawings, and now especially to FIGS. 1 and 2, wherein there is shown an engine 31 coupled to drive through clutch mechanism 82 a double stage air compressor 32 of the rotary vane type, the compressor comprising a low stage

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rotary compressor 62 drivingly coupled at 74 to a high pressure stage rotary compressor 67. When the engine is running, air is drawn by suction of the low compressor stage 62 through an intake pipe 37 past an unloading valve assembly 127 and a screen 128 into the chamber 63 of the low compressor stage. Air compressed in the latter is passed through an interstage pipe connection 132 into the high compression chamber 68. The compressed air is then discharged from a discharge end 134 of the high compression chamber 68 through a spring loaded one way check valve 139 of a discharge valve assembly 137 to piping 136 connected to a receiver tank 42. The apparatus further includes an oil sump tank 43 disposed below and in communication with the receiver 42. Oil flows from the sump 43 under receiver pressure through pipe 292, a connected oil cleaner 41, and a pipe 293 to an oil cooler 39. A relief valve 294 is arranged to by-pass oil around the oil cleaner 41 by way of a pipe 295 directly into pipe 293. This by-pass arrangement assures flow of oil in the oil circulatory system in the event the oil cleaner 41 should fail, or become so clogged with dirt that oil could not flow therethrough at the desired rate. A pipe 296 conducts the oil from the cooler 39 to the inlet (not shown) of a gear pump 104 drivingly connected at 112 to the compressor drive. The oil is forced by the pump into passages 114 and 117 from which it issues through restricted ports 124 and 123 in a fine spray into the compressor chambers 68 and 63 to cool the air in process of compression. The compressed air that is piped to the receiver 42 is accordingly charged with oil. The compressed air flows from the receiver to a connected oil separator or demand supply tank 44 disposed directly above the receiver. Most of the oil settles out of the air in the receiver and drops down into the sump. Residual oil separated from the air by the separator tank is returned from the latter over restricted piping 289 and a choke 291 to the interstage piping 132 where it is drawn by suction of the high compressor stage into the high compression chamber 68.

The operating speed of the compressor, and the flow of air through the intake 37 to the compressor are controlled by a suitable unloading control system. The latter, in general, includes the unloading valve assembly 127, a transformer 52, a relay 51, and a combined throttle and unloading device 49.

A pipe 229 connects the separator 44 with a chamber 221 of the transformer 52 (FIG. 3). Chamber 221 is separated from an upper chamber 225 of the transformer by a diaphragm 209 having affixed to its upper face a valve 211 which is held by a spring load 214 clear of an open end or valve seat 212 of chamber 225. Air having a pressure not exceeding 85 p.s.i. flowing from the separator 44 over line 229 to chamber 221 is prevented from moving the diaphragm 209 to seat the valve 211 because of the greater resistance of the spring load 214. The pressure air entering chamber 221 flows through a narrow passage 227 formed in the body 206 of the transformer to chamber 225. Some of this air entering chamber 225 is vented to atmosphere through the open end 212 and a connected vent 234; and some of the air flows from chamber 225 over a line 231 to the underside of a diaphragm 248 forming the upper wall of a chamber 248a in the body 244 of the device 49 (FIG. 5).

The upper face of diaphragm 248 abuts a tail head 249 of a plunger pin 52. The upper portion of the latter projects externally of the body 244. A nut 259 threaded upon the upper end of pin 252 overlies a short tail end 258a of a pivotally supported throttle control lever 258. An opposite and considerably longer end 258b is connected by throttle control linkage 261 to the compressor engine 31. A heavy spring 254 within the body 244 of the device 49 loads the diaphragm 248 and pin 252 to a nor-

mal position wherein the nut 259 holds the throttle lever 258 pivoted in a clockwise operative position as in FIG. 5. When the pressure of separator air flowing over line 229 to the chamber 221 of the transformer 52 rises above 85 p.s.i., it acts to move the diaphragm 209 against the load of spring 214 so as to close the valve 211 upon the seat 212, thus preventing venting of air from chamber 225 to vent 234. Whereupon, air pressure builds up in chamber 225, in line 231, and in chamber 248a at the underside of diaphragm 248 of device 49. The pressure increase in chamber 248a causes the diaphragm 249 to carry pin 252 upwardly, thus moving nut 259 away from the tail 258a of the throttle lever, whereupon the latter pivots at its opposite end downward or counterclockwise (FIG. 5) to slow down the engine and the speed of the compressors; and, as a consequence, reduces the quantity of air being drawn into the compressors through the intake pipe 37.

Means is provided to actuate the unloading valve assembly 127 to cut off flow of air from the intake pipe 37 to the compressor as the separator pressure rises above 85 p.s.i. to a selected value.

The unloading valve assembly 127 (FIG. 2) includes a closing cylinder 142 which is affixed to and within a housing 126, a piston 143 slidably positioned in cylinder 142, a plunger or valve 144 having the rear end thereof affixed to the piston, a cylinder head 147 secured to the end of closing cylinder 142, and an orifice plate 148 fastened to the end of the plunger 144, all as best seen in FIG. 2. The piston 143 is arranged to slide forwardly in the cylinder 142, and move the plunger 144 so that a forward end of the latter having a leather disc 149 will close upon a valve seat 151 formed within the intake valve assembly housing 126. Such action takes place during compressor unloading, as will later be described, and cuts off flow of air from the intake pipe 37 to the compressor. The piston 143 is provided with suitable piston rings 143a to provide a substantially fluid-tight seal between it and the wall of cylinder 142.

A passage 150 is formed in the cylinder head 147 to vent the underside of piston 143. An orifice 152 is provided in orifice plate 148, while a bore 153 is formed in the plunger 144. Extending from the bore 153 is a passage 154 which is in alignment with a passage 156 formed in the piston 143. A chamber 157 is provided between the piston 143 and cylinder 142, the chamber being connected by a passage 158 to a vertically extending passage 159 formed in the cylinder 142. Passage 159 connects with a horizontal passage or by-pass 161 formed in the cylinder 142, the passage 161 having a threaded opening 162 at one end with which is connected a pipe 201 leading from the relay device 51 (FIG. 4); the other end of passage 161 has a restricted orifice 163 opening into the intake housing 126 in the region above the intake screen 128 of the low compression chamber 63.

Relay 51 has a chamber 210 in a body section 182. Connected with an upper area of this chamber is an end of a pipe 198 which is a branch off line 199 and communicates through the latter with the separator 44. Connected with a lower area of chamber 210 is an end of pipe 201. A piston valve 194 slidable in chamber 210 normally blocks off flow of air from pipe 198 through chamber 210 to pipe 201. The piston valve is held in this normal condition by a spring load 196 supplemented by pressure of air communicated to the bottom end of the chamber 210 below the piston valve by a pipe line 205 which is connected with the discharge end 134 of the high compression chamber. The upper end of the piston valve supports a piston rod 191 which projects with a slide fit through a fixed bushing 192. The projecting end of the piston rod abuts a diaphragm 187 which defines the lower wall of a chamber 203 formed at the upper end of the relay. A collar 197 near the lower end of rod 191 seats against the underside of bushing 192 so as to space the upper end

of valve 194 a short distance below the bushing 192 and clear of the inlet of pipe 198. Chamber 203 is connected by means of a pipe 202 with an outlet 281 of an unloader section 242 of the device 49 (FIG. 5).

The unloader section 242 (FIGS. 5 and 6) includes a body 263 in which is fitted a valve seat 268 having a bore 277 connected at a dead end thereof by radial ports 278 with an inlet port 279 with which pipe 199 is connected. An opposite open end of bore 277 is normally closed by a slide disc valve 269 which is guided in its movement relative to the valve seat by a surrounding bushing 271. A radial port 282 from the bushing connects through the body 263 with the outlet 281. A spring load 274, compressed between a conical valve holder 273 abutting the disc valve 269 and a plunger 267 abutting an arm of a bellcrank 287, holds the disc valve seated over the open end of bore 277 of seat 268 against pressure of air in pipe 199, thus closing communication of pipe 199 from pipe 202. Pipe 202 is normally vented through the bushing 271 and about the coned valve holder 273 to a vent 286. The bellcrank 287 is pivoted to a fixed member 257, and has an arm 287a pivoted at 288 to the external portion of pin 252.

In the operation of the apparatus, when air pressure in the separator 44 rises above 85 p.s.i., pressure air, as explained earlier herein, flowing from the transformer 52 (FIG. 3) over line 231 to the device 49 acts upon the diaphragm 248 to elevate the pin 252 against the load of spring 254 to actuate lever 258 to throttle and slow down the engine. In this action the bellcrank 287 will be pivoted by pin 252 counterclockwise relative to the plunger 167 causing relaxing of spring 274. But as long as the separator pressure in pipe 199 does not exceed a predetermined value above 85 p.s.i. the spring load 274 will not be relaxed sufficiently to allow the disc valve 269 to move to open condition from seat 268. However, when the separator air pressure does exceed a predetermined value above 85 p.s.i., the pin 252 will be caused to rise further relative to the throttle arm 258 to cause the engine to further slow down, and will cause the bellcrank 287 to pivot further counterclockwise to relax the spring load 274 sufficiently so that pressure of separator air in line 199 will unseat the disc valve and flow through pipe line 202 to the relay chamber 203 (FIG. 4) to act upon the diaphragm 187. This pressure on the diaphragm 187 aided by relaxation of pressure in pipe line 205 due to slowing down of the engine and relaxing of compressor pressure in the discharge end 134 of the compressor chamber above the check valve 141, causes the piston valve 194 to drop so that pipe line 198 communicates through chamber 210 with pipe 201.

Following the latter action, pressure air flows through pipe 201 to the unloading valve assembly 127 and passes through ports 162, 159 and 158 to chamber 157 so that intake air through pipe 37 is cut off. The compressor thereupon runs unloaded at a reduced speed, with the result that no further compressor air is delivered to the receiver 42. Any air that may leak into the compressor past the intake valve 149 is compensated for by a small amount of air which is blown back into the intake pipe 37 under pressure of air in pipe 201 from chamber 157, passages 156, 154, 153, and orifice 152. This feature prevents rise in the pressure of air in the separator 42 during the time that no air is being drawn from an outlet manifold 46 of the latter. The air under pressure in pipe 201 also passes at a restricted rate through passage 161 and orifice 163 into the intake end of the low compression chamber 63. This air is compressed as it passes through the low and high stage compression chambers and is discharged into the receiver 42. The air passing through the orifice 163 is merely recirculated through the compressor system; it serves to scrub oil through the

compressor passages. After the intake air has been cut off, the machine continues to run unloaded, and at a reduced speed until a predetermined drop occurs in the separator pressure to cause the machine to reload.

Reloading occurs automatically as the pressure over pipe 231 acting on the underside of the diaphragm 243 of the device 49 relaxes, and the arm 258 and bellcrank 287 are progressively restored as the pin 252 returns to normal. As the engine speed again increases, suction created by the compressor causes air to be vented from the chamber 157 at the rear of the piston 143 over the by-pass 163 whereupon intake air in pipe 37 slides the valve 149 to open position and enters the compressor.

The control system above described also includes means to prevent flooding of the chambers of the compressor with oil in the event the machine should shut down due to an emergency or because of lack of fuel. The possibility of flooding could arise while the machine is stopped. In this event, back pressure of air in the receiver 42 acting on the oil in the sump 43 would tend to force the oil through the gear pump 104 and passages 114 and 123 back into the compressor chambers. This flooding is avoided due to a pressure drop in the discharge end of the high compression chamber 134 above the discharge check valve 139, occurring when the engine stops. Since pipe 205 connects this end of the high pressure chamber with chamber 210 at the underside of piston 194 in the relay 51 (FIG. 4), a consequent drop of pressure of air acting on the piston 194 will occur. Whereupon, the greater pressure of separator air from pipe 198 acting in chamber 210 on the top side of piston 194 will cause the latter to drop and thus put pipe 198 in communication with pipe 201. Pressure air will then flow over pipe 201 and orifice 163 of the valve assembly 127 into the compressor chambers where it will build up and counterbalance the back pressure of air from the receiver 42 acting on the oil sump.

While an embodiment of the invention has been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. Various changes can be made in the design and arrangement of the parts without departing from the spirit and scope of the invention, and it is intended, therefore, to claim the invention not only as shown and described but also in all

such forms and modifications thereof as may be construed to fall within the spirit of the invention and the scope of the appended claims.

Subject matter disclosed in the specification but not claimed herein is described and claimed in our co-pending applications as follows: Serial No. 141,559, filed September 13, 1961 for A Machine for Compressing Fluids; and Serial No. 60,748, filed October 5, 1960 for a Rotary Fluid Compressor.

What is claimed is:

1. A compressor control comprising an unloading valve of the intake type, said valve being mounted in the intake passageway leading into the compressor, said passageway being provided with a seat which divides it into an external portion and an internal portion, a disc valve movable axially on and off said seat and being disposed within the internal portion of the intake passageway so that suction developed by the compressor will tend to keep it in open position away from the seat, said valve being carried by a piston extending axially away from said seat and slidably mounted in a cylinder disposed in the internal portion of said intake passageway, said piston projecting from the inner end of said cylinder to carry said disc valve, means for subjecting one end only of said piston to compressor discharge pressure of a selected amount, said means acting on the end of the piston opposite to that which carries the disc valve and comprising a pilot valve connected to the outer end of said cylinder by a pressure passageway, and a by-pass connecting said outer end of the cylinder with the internal portion of said intake passageway to permit venting of said outer end of the cylinder and the action of suction developed by said compressor upon the said opposite end of the piston.

2. A compressor control according to claim 1 in which piston rings are mounted on the piston for providing a substantially fluid-tight seal between it and the wall of the cylinder.

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