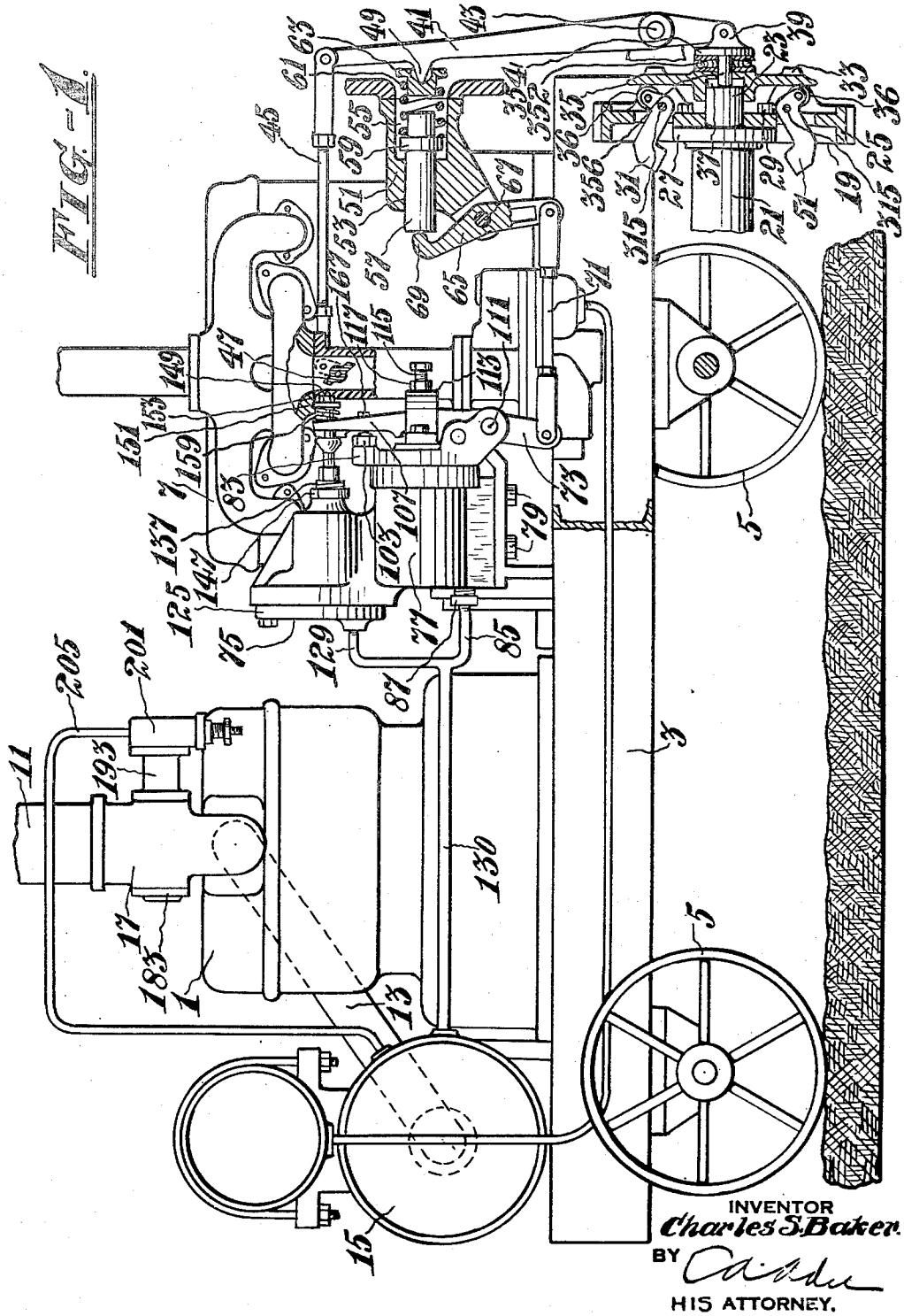
Aug. 29, 1939. C. S. BAKER 2,171,285

COMPRESSOR REGULATOR

Filed Aug. 25, 1937 2 Sheets-Sheet 1

FIG. 1.



Aug. 29, 1939. C. S. BAKER 2,171,285

COMPRESSOR REGULATOR

Filed Aug. 25, 1937 2 Sheets-Sheet 2

FIG. -2.

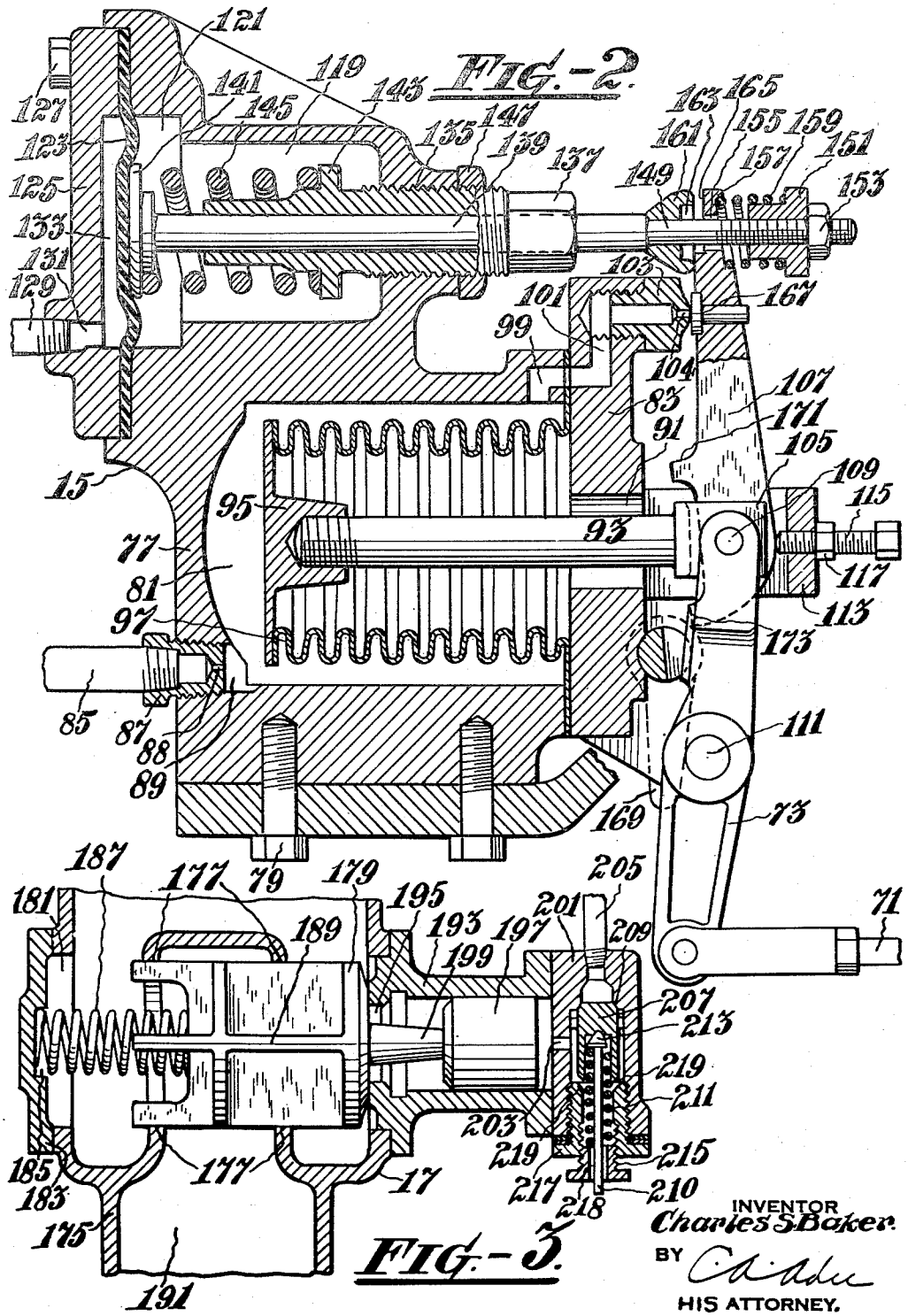


FIG. -3.

INVENTOR
Charles S. Baker
BY
HIS ATTORNEY.

Patented Aug. 29, 1939 2,171,285

UNITED STATES PATENT OFFICE

2,171,285

COMPRESSOR REGULATOR

Charles S. Baker, Corning, N. Y., assignor to Ingersoll-Rand Company, Jersey City, N. J., a corporation of New Jersey

Application August 25, 1937, Serial No. 160,819

32 Claims. (Cl. 230—4)

This invention relates to regulators for motor driven fluid compressors, and more particularly to regulator for varying the speed of the motor to conform generally to the required output of the fluid compressor.

A portable compressor unit usually consists of a fluid compressor and an internal combustion engine adapted to drive the compressor. The compressor delivers fluid under pressure to a receiver tank which forms a part of the unit, until a predetermined high fluid pressure is built up in the receiver tank. When this pressure is reached a device provided on the compressor stops the discharge of fluid from the compressor to the receiver tank (commonly termed unloading) and at the same time slows the engine to idling, usually the minimum rated, speed. The unit functions in the above manner until the pressure of the fluid in the tank drops to a predetermined low pressure, whereupon the device operates to permit the compressor to again discharge fluid to the receiver tank (commonly termed reloading) and to accelerate the engine until it is operating at its normal governed, usually the maximum rated, speed. If the load is light, the compressor will unload and reload at frequent intervals, and each time the compressor begins to reload, the engine accelerates to its maximum speed. The result is that the engine continually swings back and forth between its idling speed and its maximum rated speed making the operation of the unit unsteady and uneconomical.

It is an object of the present invention to provide means whereby the compressor unit may reload when the load is light without immediately accelerating to the maximum engine speed.

Another object is to provide means whereby the compressor unit may accelerate to and run at any motor speed between minimum and maximum to maintain corresponding rates of discharge of air into the receiver.

It is a further object to provide a means which will, under the ordinary loading, unloading and reloading, make it impossible to reload the receiver at high speed when a predetermined low pressure in the receiver is reached and which will permit the motor to accelerate toward maximum speed when a predetermined low receiver pressure is reached after a predetermined delay.

It is still another object to provide a device which will delay acceleration of the driving motor after reloading to accommodate a light load at low motor speed and somewhat later to permit acceleration of the engine when reloading occurs under a heavy load.

Still another object is to provide a regulating mechanism which will regulate the speed setting of the governor in accordance with variations of the pressure in the receiver.

These and other objects will be readily apparent in the following specification of which the drawings form a part.

Similar reference numerals refer to similar parts in the drawings.

Figure 1 is a view partly in elevation and partly in section illustrating the present invention as applied to a portable compressor unit. The governor is increased in size in order to show the details more clearly.

Figure 2 is a view in section of the regulating device shown in Fig. 1 constructed in accordance with the principles of this invention, and

Figure 3 shows in longitudinal section the unloading device shown in Fig. 1.

The portable compressor unit is shown in Figure 1 and consists of a fluid compressor 1 mounted on a frame 3 supported by wheels 5. An internal combustion engine 7 drives the compressor 1. The inlet pipe 11 supplies the fluid to be compressed to the compressor 1 and the conduit 13 delivers the compressed fluid from the compressor to the receiver tank 15. An unloading and reloading device is interposed between the pipe 11 and the compressor 1. The details of this unloader are illustrated in Fig. 3 and will be explained hereinafter.

The speed of the internal combustion engine 7 is regulated by the governor, generally indicated at 19, and consists of a shaft 21 which is directly connected to the cam shaft (not shown) of the engine and has an extension 23. A gear 25 is secured to a flange 27 on the shaft 21 by the bolts 29. Weights 31 are fulcrumed at 315 on ears 33 which form a part of the gear 25. As the speed of the engine increases the centrifugal force moves the weights to their outermost position. As the weights move to this position, the plate 35 having a recess 37 surrounding the shaft extension 23 moves out from the shaft extension 23. Since the rollers 36 mounted on the levers supporting the weights 31 move outwardly as the governor spring is compressed, motion of the plate 35 is transmitted through an antifriction bearing 352 to a plate 354 formed integrally with a pin 356 slidably mounted in the shaft extension 23 and coaxial therewith.

The plate 354 has a clevis 39 surrounding and pinned to a lever 41 which is fulcrumed on the base of the motor 7 at 43. At the opposite end of the lever 41 is a tie-rod 45 controlling the butterfly

valve 47 in the fuel intake of the engine. When the speed of the motor is to be decreased, the plate 35 is moved out from the shaft, pivoting the lever 41 about its fulcrum and moving the butterfly valve 47 by means of the rod 45 toward the closed position to throttle the motor. Conversely, when the speed of the engine is to be increased, under the influence of the weights 31, the lever 41 and rod 45 will move the butterfly valve 47 toward its open position to increase the fuel supply to the motor. The lever 41 is provided with a projection 49 intermediate the fulcrum and tie-rod end.

As is customary in centrifugal governors the weights 31 are resiliently held in their retracted position and to this end a spring 61 is provided. A casing 51 having a bore 53 extending therethrough and communicating at one end with a recess 55 is secured to the frame of the motor 7. The plunger 57 extends through the bore 53 and has a flange 59 within the recess 55. Spring 61 rests on the shoulder 59 at one end and pushes a member 63 against the projection 49 on the lever 41. Fulcrumed on the casing 51 at 67 is a lever 65 which has a hooked portion 69 bearing on the external end of the plunger 57. The clevised tie-rod 71 is pinned to the other end of the lever 65 and connects this lever with the regulator lever 73. The regulating mechanism indicated generally at 75 regulates the position of the regulator lever 73 which in turn regulates the tension on the spring 61 and thus the speed setting of the governor.

The details of the regulating mechanism are best illustrated in Fig. 2. With reference thereto it will be noted that it consists of a casing 77 secured to the motor frame by the bolts 79 and is provided with a bellows chamber 81 closed by a head 83. The interior of the bellows chamber 81 is connected directly to the receiver tank by a conduit 85 secured to an orificed bushing 87 which is in turn secured in the passage 89 leading directly into the bellows chamber. The bushing 87 is provided with an orifice 88 to restrict the fluid coming from the receiver.

Extending through a passage 91 in the head 83 into the bellows chamber is a plunger rod 93. A piston member 95 is secured to the end of the shaft within the bellows chamber. One end of a bellows 97 is secured to the piston 95 in airtight relationship, and the opposite end of the bellows is secured in airtight relationship between the casing 77 and the head 83, in order that no media in the bellows chamber 81 may pass into the bellows proper.

Near the head 83, in the casing 77, is a passage 99 communicating with a passage 101 in the head 83. A bushing 103 is secured by threads to the head 83 and has an orifice 104, which is larger in area than the orifice 88, for restricting the flow of fluid leaving the bellows chamber 83. On the external end of the plunger rod 93 is a clevis 105 which is rotatably fastened to the lever 107 by the pin 109. The pin 109 also serves to connect the regulator lever 73, fulcrumed on an extension provided on the head 83 at 111, to the plunger rod 93. With this pin connection it is, therefore, possible to have relative rotation between the levers 73 and 107 and the plunger rod 93. A guard 113 forms a part of the head 83 and extends around the connection between the levers 73 and 107 and the end of the plunger rod 93. In order to regulate the outward movement of the shaft a bolt 115 threadedly engages the guard 113 and may be locked in position by the lock nut 117.

In the upper part of the casing 77 is a recess 119 having an enlarged portion 121 in which is secured a diaphragm 123 by a plate 125 attached to the casing by any suitable means, such as the bolts 127. A conduit 129 joins the conduit 85 and is connected to the receiver tank 15 by a conduit 130, shown in Fig. 1. This conduit 129 is secured in a passage 131 opening into the diaphragm chamber 133. It will thus be seen that the pressure existing in the receiver tank 15 will also be maintained in the diaphragm chamber 123. The casing 77 has a threaded bore 135, leading into the recess 119 adapted to receive a guide bushing 137, for a plunger 139 which extends into the recess and has secured thereto a follower 141 bearing against the diaphragm 123.

Within the recess, the bushing 137 has a flange 143 on which a spring 145 rests, the opposite end of the spring bearing against the follower 141. The bushing 137 is provided with a lock nut 147 in order to maintain it in a fixed position. The plunger 139 extending outside the bushing 137 has a portion 149 of reduced diameter, the outer end of which is threaded to receive a regulating bushing 151 and a locking means such as the nut 153. The lever 107 is provided with a passage 155 through which the reduced portion 149 of the shaft 139 passes, and a seat 157 to receive a spring 159 bearing against the lever and the bushing 151.

Resting on the shoulder formed on the plunger 139, where the reduced portion 149 begins, is a slidable abutment 161 freely movable on the shaft extension 149 and having a bored-out recess 163. The lever 107 is normally pushed against the abutment 161 by the spring 159. In order to permit free movement of the lever 107 about the pin 109, and a constant contact point between that lever and the abutment 161, a recessed surface 165 is formed on the end of the lever 107 which prevents the tip end of the lever from touching the abutment. On the lever 107, intermediate the shaft 149 and the fulcrum 109, is a button valve 167 which is so placed with respect to the orifice 104 in the metering bushing 103 that under normal conditions the button obstructs the orifice and at least to some degree prevents escape of fluid from the bellows chamber.

In order to lock the apparatus in certain positions a locking cam and handle 169 is pivotally mounted on the head 83 and may be moved into position to lock lever 73 in position whereby maximum tension in the governor spring 61 is assured.

The lever 107 is provided with projecting lugs 171 and 173 adapted to bear against the head 83 and to draw the button valve 167 entirely away from orifice 104, the purpose of which will be apparent when the operation of the regulator is described.

Referring now more particularly to Fig. 3 the unloading and reloading device 17 at the inlet to the compressor consists of a casing 175 which connects at its upper end to the pipe 11 (Fig. 1) and at its lower end leads directly to the compressor 7. A portion of the casing 175 extends within the outer walls thereof and forms valve seats 177 and a guide for the cylindrical unloading valve 179.

An opening 181 in the casing is closed by the plate 183 provided with a recess 185 in which the spring 187 rests. The other end of spring 187 bears against the valve 179 normally tending to

maintain the valve in the open position shown in Fig. 3. In this position the fluid may enter from the pipe 11 and pass around the ribs 189 into the passage 191 leading directly to the compressor.

A piston chamber 193 is secured to the casing 175 and communicates with the opening 195 provided in the wall of the casing and forms a seat for the valve 179 when the valve is in its open position. In slidable engagement with the wall of the piston chamber is a piston 197, adapted to transmit its motion to the valve 179 by the shaft 199 formed integrally with valve 179.

An auxiliary valve body 201 closes the open end of the piston chamber 193 and has a passage 203 leading into the piston chamber. The pipe 205 connects the interior of the auxiliary valve chamber 201 with the receiver tank. The auxiliary valve 207 normally rests on the seat 209 provided in the valve chamber and prevents the entrance of fluid under pressure from the receiver tank to the piston chamber through the passage 203. Normally the valve 207 is maintained on its seat by the member 210 which transmits the pressure of the spring 211 compressed between the head 213 on the shank of member 210 and the bushing 215. The bushing 217 threadedly engages the auxiliary valve chamber 201 and provides an adjustable seat 219 against which the valve 207 bears when the pressure in the receiver tank is sufficient to move the valve against the compression of the spring. The bushing 215 which threadedly engages the bushing 217 is provided with a passage 218 of larger diameter than the diameter of the member 210 so that any pressure existing in the valve chamber may be relieved to atmosphere.

Operation of the device will now be described.

Generally speaking, the motor driven compressor resembles prior arrangements for regulating in that when the discharge pressure of the compressor 1 reaches a predetermined maximum, the unloading mechanism 17 operates to check the compressor intake, and upon a drop in pressure in the receiver 15 to a predetermined minimum, the unloading mechanism 17 operates to reopen the intake to permit the compressor 1 to resume pumping.

The manner in which this is effected is as follows:

Pressure fluid conveyed through the pipe 205 from the tank 15 exerts force against the upper face of the valve 207 at the seat 209, which is sufficient to overcome slightly the force of the spring 211. The instant the valve 207 starts to move under the influence of this force, the entire diameter of the valve 207 is exposed to the full discharge pressure and the valve 207 is thereby caused to move quickly to its lower seat 219 in which position it is held until the pressure drops sufficiently to be overcome by the compression of the spring 211. Upon assuming its position at the lower seat 219, pressure fluid is conducted through the port 203 to move the piston 197 and valve 179 against the tension of the spring 187 to the closed position of valve 179. In this position the valve 179 has completely checked the flow of air or other gas to the passage 191 and the compressor 1 is unloaded.

Upon release of the valve 207 to the position at which it rests on the seat 209, the motor fluid escapes through the passage 203 to atmosphere by way of the passage 218 in the bushing 215 about the member 210. The accompanying reduction in pressure permits the piston 197 to return to the position shown in Fig. 3 and under the influence of the spring 187, valve 179 returns to its open position permitting air or gas to flow into the intake passage 191. In this position of the valve 179, the compressor is said to be loaded.

In this embodiment the engine is constantly under the control of the governor 19, the function of which is to control the intake butterfly valve 47. As is evident from the description hereinbefore, the shaft 21 connected to the cam shaft of the engine 7 rotates the weights 31 which are thrown outwardly by centrifugal force and cause corresponding outward movement of the rollers 36 to press the plate 35 longitudinally of the shaft. This longitudinal movement is transmitted through anti-friction bearing 352 to the clevis 39, which causes the lever 41 to rotate about its pivot 43 and through the link 45 to operate the butterfly valve 47.

Since a spring 61 is provided to oppose the outward throw of the weights 31 of the governor, the speed of the engine 7 varies accordingly with the characteristics of the spring 61.

It is the function of the regulating mechanism to change the characterstics of the governor spring 61 so as to produce a certain cycle of operation which, in this instance, is a function of the receiver pressure and the speed of the motor. Briefly stated, this cycle is as follows: Starting with a predetermined minimum pressure in the receiver 15 at which the mechanism 17 operates to load the compressor 1 in the manner above described, motor 7 is adapted to speed up from an idling speed to its maximum permissible speed, assuming that the pressure in the receiver 15 does not increase. Upon an increase of pressure in the receiver 15 the engine 7 slows down progressively until a predetermined maximum pressure is reached in the receiver 15, at which point the speed of the engine reaches its minimum permissible speed and the mechanism 17 operates to unload the compressor 1. The regulating mechanism thereupon holds the engine 7 at its minimum speed, while the pressure drops to a value at which the valve 201 operates to reload the compressor by means of the loading and unloading valve 17 as above described.

It is most desirable that at this point in the cycle a delay should occur in the speed-up of the engine. In this instance the delay is a function of a further drop in the receiver pressure 15. During this predetermined further drop in pressure the engine continues to maintain its minimum speed. Thereupon the engine is accelerated under the control of the regulating mechanism 75. Its speed varies inversely as the pressure in the receiver 15; that is to say, as the pressure in the tank 15 rises the speed of the engine drops. At the predetermined minimum pressure at which the compressor loads, the motor does not speed up unless the pressure actually decreases. This is due to the holding device. The compressor will not unload unless the air demand is less than the compressor output at minimum speed and until the demand increases the loading and unloading cycle will be maintained at minimum speed. At such time as the air demand increases the pressure will begin to drop and at a predetermined pressure the regulating mechanism will unlock and the motor will speed up and momentarily equal or approach maximum speed, but will immediately stabilize at a speed (and pressure) where the compressor output equals the air demand. In other words, the speeding up does not occur when the compressor loads up,

nor does the compressor unload when minimum speed is reached, but rather at a slightly higher pressure. It is possible for the pressure to build up to the locking point and if the air demand increases slightly the pressure will begin to fall and the motor stay at minimum speed until the speed up pressure is reached. Each time that the pressure in the tank 15 reaches its predetermined maximum, this cycle will be repeated.

To produce this action the regulating mechanism 75 operates in the following manner:

Diaphragm 123 is always exposed to the receiver pressure being connected to the receiver 15 by the pipes 129 and 130. The diaphragm is always balanced by the tension of the spring 145 which, of course, will vary with the pressure on the opposite side of the diaphragm. Accordingly, the plunger 139 moves into and out of the chamber 121 pulling with it the end 157 of the lever 107. Motion of the lever 107 brings the button valve 167 closer to or farther from the escape orifice 104, restricting it more or less, depending upon a drop or rise respectively in the receiver pressure. There is constantly a small amount of air from the receiver 15 leaking into the chamber 81 through the orifice 88 and its escape from the chamber 81 depends upon the restriction at the orifice 104 caused by the valve 167. Thus, if such restriction is relatively great a considerable pressure can build up in the chamber 81. In that case the flexible bellows 97 is compressed causing the rod 105 to move outwardly and to actuate the lever 73 and link 71 attached to the bell crank 69 to move the plunger 57 in a direction to compress the governor spring 61. This changes the characteristics of the governor in that it has the effect of stiffening the spring 61 and tends to open the butterfly valve 47 to increase the power of the engine and cause a corresponding speed-up.

Inasmuch as speeding up the engine 7 will increase the pumping capacity of its direct connected compressor 1 there should be either an increase in pressure in the tank 15 or a slowing up in the dropping of pressure therein, depending upon the demand for air or rate at which it is being used. Simultaneously, as the rod 105 moves outwardly, there is some slight tendency for the button valve 167 to uncover the orifice 104, which tends to reduce the pressure in the chamber 81 and prevents the bellows 97 from continuing to collapse indefinitely or, at least, to the extent permitted by the stop screw 115.

From this it will be seen that the movement of the rod 105 at one end of the lever 107 and the plunger 139 at the other end of that lever, have a partially neutralizing effect which is resolved into a certain tension in the governor spring 61 to correspond to any given receiver pressure. This is as it should be, inasmuch as the receiver pressure is the measure of the demand for air and the speed, and within certain ranges the speed of the engine 7 controls the production of compressed air by the compressor 1. These conditions are accordingly entirely under the control of and automatically adjusted by the regulating mechanism 75.

Under certain conditions of very light load, it is impossible to lower the speed of the engine to correspond with the demand for air, inasmuch as it is impractical to reduce the speed of the engine beyond certain limits as is well known. Accordingly, the tension of the governor spring 61 is adjusted so that its minimum tension (when the plunger 57 has retracted to its limit) slows the engine down to its idling speed or thereabout. Assuming that the demand for air is such that the pressure still continues to rise to the predetermined maximum allowable pressure, then it is the function of the unloading mechanism 17 with its associated valve 201 to shut off the intake thereby preventing the compressor 1 from continuing to compress air.

As has been described above in connection with the cycle of operation, it is desirable to maintain the speed of the engine 7 at a minimum as the pressure in the receiver tank 15 drops to some value less than that at which the mechanism 17 acts to reload the compresser. For this purpose the regulator mechanism 75 is adapted to lock, as it were, the lever 107 temporarily so that the valve 167 no longer affects the orifice 104 thereby maintaining substantially a constant pressure within the chamber 81. This has the effect of maintaining the plunger rod 93 inactive temporarily, so that the minimum pressure is maintained at the governor spring 61. This locking effect is produced as follows:

When the aforesaid predetermined maximum pressure exists in the chamber 133, it pushes the plunger 139 outwardly to its most extreme position, at which point the abutment 161 pushes the lever 107 to open wide the orifice 104. Air is thus evacuated from the chamber 81 to a value which has substantially no effect upon the bellows 97. The governor spring 61 reacts upon the plunger 57, bell crank 69, link 61 and lever 73 to retract the plunger rod 93 and pull the end of lever 107 adjacent the pin 109 up against the face of the plate 83. The abutment 171 acts as a fulcrum to then pull the button valve 167 still farther away from the orifice 104 and simultaneously to compress the spring 159. This outward motion of the valve 167 is limited by the provision of lug 173, which also bears against the face of plate 83. In this position the regulator mechanism is entirely out of action and stays so because there is no further control of the orifice 104. Such control can only be effected by such a reduction in pressure in the chamber 133, which will cause the spring 145 to pull the plunger 139 and the nut 151 against the end of the lever 107 with sufficient force to overcome the force of the governor spring against the pin 109 tending to hold the valve 167 away from the orifice 104. The tension in the spring 145 controls this operation and it is regulated by the degree to which its guide bushing 133 is screwed into or out of the casing 77.

The minimum pressure at which the lever 107 will be pulled down to cause the valve 167 to again control the orifice 104 is determined by the position of the nut 151 which is adapted to pull against the recessed end 159 of that lever. If it is desired to lower this minimum pressure, the nut 151 is unscrewed.

As has been indicated above, it is desirable that the pressure at which the valve 167 begins to control the orifice 104 so as to change the engine speed, should be some value less than that at which the mechanism 17 is set to reload the compressor 1. This permits the compressor 1 to start pumping at a low engine speed which in many instances is sufficient to carry existing load. One advantage of this delay is that the engine does not so frequently speed up to rebuild the receiver pressure to its predetermined maximum and a saving in fuel is effected thereby.

When starting the engine cold it is desirable to have some means to maintain some extra pres-

sure in the governor spring 61 and this is provided by the cam 169, which when rotated forces the lever 73 to a position in which the plunger 57 is pushed against the end of the spring 61, allowing the engine to operate at a relatively high speed.

It is understood that the construction above described is a preferred embodiment of the invention and that many changes which do not depart from the scope and spirit of the invention will occur to those skilled in the art.

I claim:

1. A regulator for a motor driven fluid compressor having a speed governor, a pressure responsive device for controlling and varying the speed setting of the governor in accordance with the variations of the discharge pressure of the compressor while the compressor is loaded, means to unload the compressor at a predetermined maximum discharge pressure and to reload the compressor at a predetermined low discharge pressure, and means to lock said pressure responsive device at a predetermined high discharge pressure of the compressor until a predetermined minimum discharge pressure is reached.

2. A regulator for a motor driven fluid compressor comprising a pressure responsive device for controlling and varying the speed setting of the governor in accordance with the variations of the discharge pressure of the compressor while the compressor is loaded, means to unload the compressor at a predetermined maximum discharge pressure and to reload the compressor at a predetermined low discharge pressure, and means to lock said pressure responsive device inoperative with respect to the governor at a predetermined high discharge pressure of the compressor and until a predetermined low discharge pressure is reached below said reloading pressure.

3. A regulator for a motor driven fluid compressor having a governor, means responsive to variations in the discharge pressure of the compressor to control and vary the governor while the compressor is loaded, means to unload the compressor at a predetermined maximum pressure and to reload the compressor at a predetermined low discharge pressure, and means to lock the first said means to render it inoperative to control the governor within a predetermined range of discharge pressures.

4. A regulator for a motor driven fluid compressor having a governor, a pressure responsive device for controlling and varying the speed setting of the governor in accordance with the variations in the discharge pressure of the compressor while the compressor is loaded, means to unload the compressor at a predetermined maximum pressure and to reload the compressor at a predetermined low pressure, means to render the pressure responsive device inoperative at a predetermined high pressure and operative at a predetermined minimum pressure, and adjustable means to regulate the pressure range within which the last said means operates.

5. A regulator for a motor driven fluid compressor having a governor, a pressure responsive device for controlling and varying the speed setting of the governor in accordance with variations in the discharge pressure of the compressor while the compressor is loaded, means to unload the compressor at a predetermined maximum pressure and to reload the compressor at a predetermined low pressure, adjustable means to predetermine the pressures at which the last said means operates, means to render the pressure responsive device inoperative at a predetermined pressure not exceeding the predetermined maximum pressure and until a predetermined minimum pressure is reached, and adjustable means to regulate the pressures at which last said means operates.

6. A regulator for a motor driven fluid compressor having a governor, a pressure responsive device for controlling and varying the speed setting of the governor in accordance with variations in the discharge pressure of the compressor while the compressor is loaded, means to unload the compressor at a predetermined maximum discharge pressure and to reload the compressor at a predetermined low discharge pressure, adjustable means to determine the pressure at which the last said means operates, and means to render the pressure responsive device inoperative at a predetermined pressure not exceeding the predetermined maximum discharge pressure and until a predetermined discharge pressure is reached.

7. A regulator for a motor driven fluid compressor having a governor, a pressure responsive device for controlling and varying the speed setting of the governor in accordance with variations in the discharge pressure of the compressor while the compressor is loaded, means to unload the compressor at a predetermined maximum discharge pressure and to reload the compressor at a predetermined low discharge pressure, and means to render the pressure responsive device inoperative.

8. A regulator for a motor driven fluid compressor having a governor, pressure responsive means to control and vary the speed setting of the governor in accordance with variations of the discharge pressure of the compressor while the compressor is loaded, means to unload and reload the compressor within a predetermined range of compressor discharge pressures, and means to lock the first said means to render it inoperative within a different predetermined discharge pressure range.

9. In a regulator for a motor driven fluid compressor having a governor, means responsive to variations of the discharge pressure of the compressor to control and vary the speed setting of the governor while the compressor is loaded, means to unload and reload the compressor, and means to lock the first said means to render it inoperative within a predetermined range of the discharge pressure of the compressor.

10. A regulator for a motor driven fluid compressor having a governor comprising means to unload and reload the compressor, and a pressure responsive means to control and vary the speed setting of the governor adapted to maintain the governor while the compressor is loaded at a minimum speed setting within a predetermined range of discharge pressures of the compressor to permit the compressor to reload at a minimum motor speed.

11. A regulator for a motor driven fluid compressor having a governor comprising a pressure responsive device for controlling and varying the speed of the governor in accordance with variations in the discharge pressure of the compressor while the compressor is loaded, means to unload the compressor at a predetermined maximum pressure and to reload the compressor at a predetermined low pressure, means to lock the pressure responsive device to render it inoperative at a predetermined high pressure to permit the governor to maintain the motor speed at a minimum and unlock the pressure responsive means to

permit the governor to accelerate the speed of the motor to a maximum when a predetermined minimum pressure is reached.

12. A regulator for a motor driven fluid compressor having a governor comprising a pressure responsive device having various controlling positions for controlling and varying the speed setting of the governor in accordance with variations in the discharge pressure of the compressor while the compressor is loaded, means to unload the compressor at a predetermined maximum pressure and to reload the compressor at a predetermined low pressure, means to maintain the pressure responsive device in one controlling position at certain predetermined discharge pressures, and means to control operation of the last said means.

13. In a governor speed setting regulator for a motor driven compressor comprising casings having chambers therein, pressure responsive means in each chamber, separate means to transmit movement of the pressure responsive means, means connecting the separate means, venting means for one chamber, means on the connecting means to render the venting means ineffective, and means to connect the connecting means to the governor.

14. In a governor speed regulator for a motor driven compressor comprising a casing having chambers subjected to the discharge pressure of the compressor, pressure responsive means in each chamber, separate means to transmit movement of the pressure responsive means, means to relieve the pressure in a chamber, and means actuated by said separate means to render the pressure relieving means inoperative.

15. In a motor driven fluid compressor, a governor to control the speed of the motor, a pressure responsive device for controlling the characteristics of the governor in accordance with variations in the discharge pressure of the compressor, means to vent said pressure responsive device, and means controlled by said pressure responsive device to render the venting means ineffective.

16. In a regulator for a motor driven fluid compressor having a governor and means to unload and reload the compressor at predetermined discharge pressures and a pressure responsive device to control the speed setting of the governor in accordance with the variation of the discharge pressure of the compressor having chambers therein and including pressure responsive means in said chambers, inter-connected levers associated with the pressure responsive means and movable thereby, venting means in one of said chambers, a valve to open and close said venting means controlled by one of said levers, and means to connect said inter-connected levers to the governor.

17. In a regulator for a motor driven fluid compressor having a governor and means to unload and reload the compressor at predetermined discharge pressures, and a pressure responsive device to control the speed setting of the governor in accordance with the variation of the discharge pressure of the compressor having chambers therein, means to vent one of said chambers, and means to close said vent when the discharge pressure of the compressor reaches a predetermined minimum pressure.

18. In a regulator for a motor driven compressor having a governor, means to unload the compressor at a predetermined high discharge pressure of the compressor, a pressure responsive device to control the speed setting of the governor in accordance with variations of the discharge pressure of the compressor having chambers and including means to vent a chamber, pressure responsive means in all said chambers, and means controlled by said pressure responsive means to prevent said means from venting said chamber when the discharge pressure of the compressor reaches a predetermined minimum pressure.

19. In a regulator for a motor driven fluid compressor having a governor, means to unload the compressor at a predetermined maximum discharge pressure to reload the compressor at a predetermined low discharge pressure of the compressor, and a device to control the speed setting of the governor in accordance with variations of the discharge pressure of the compressor having chambers subject to the discharge pressure of the compressor and including venting means for a chamber, pressure responsive means in said chambers, means associated with said pressure responsive means to prevent venting by said venting means when the discharge pressure of the compressor reaches a predetermined minimum pressure and assure venting by said venting means when the discharge pressure of the compressor reaches a predetermined high pressure, adjustable means to regulate the pressures at which said last means operates, and means connected with said venting preventing means to directly control the governor speed setting.

20. In a regulator for a motor driven fluid compressor having a governor, means to unload the compressor at a predetermined maximum discharge pressure and to reload the compressor at a predetermined low discharge pressure of the compressor, and a device to control the speed setting of the governor in accordance with variations of the discharge pressure of the compressor having chambers subject to the discharge pressure of the compressor and including means to vent a chamber, pressure responsive means in each said chambers, means associated with said pressure responsive means to transmit movement thereof to the governor, and means controlled by the last said means to open and close said venting means.

21. In a regulator for a motor driven fluid compressor having a governor, a loading device to unload the compressor at a predetermined maximum discharge pressure and to reload the compressor at a predetermined low discharge pressure of the compressor, means to predetermine the unloading and reloading discharge pressure, and a device to control the speed setting of the governor having chambers subject to the discharge pressure of the compressor, pressure responsive means in said chambers, plungers controlled by said pressure responsive means, inter-connected levers connecting said plungers, means to transmit movement of said levers to the governor to vary the speed setting thereof, venting means for a chamber, means associated with said levers to open and close said venting means in accordance with variations of the discharge pressure of the compressor in said chambers, and means to predetermine a minimum discharge pressure at which said last means will maintain said venting means closed.

22. In a regulator for a motor driven fluid compressor having a governor and a receiver to which the compressor discharges, a device in communication with the receiver to unload the compressor at a predetermined maximum pressure in the receiver and to reload the compressor at

a predetermined low pressure in the receiver, means to adjust the predetermined unloading and reloading pressures, and a device to control the speed setting of the governor having chambers in communication with the receiver, pressure responsive means in each chamber, plungers moved by said pressure responsive means, means associated with said plungers to predetermine the receiver pressure at which said pressure responsive means move said plungers, and means to transmit movement of said plungers to the governor to vary the speed setting thereof.

23. In a regulator for a motor driven fluid compressor having a governor and a receiver to which the compressor discharges, a device in communication with the receiver to unload the compressor at a predetermined maximum pressure in the receiver and to reload the compressor at a predetermined low pressure in the receiver, means to adjust the predetermined unloading and reloading pressures, and a device to control the speed setting of the governor having two chambers in communication with the receiver and including a diaphragm in one chamber, a bellows in the other chamber, a series of levers, a plunger in the diaphragm chamber movable by said diaphragm, a plunger rod in said bellows chamber movable by said bellows, a vent in said bellows chamber, a series of inter-connecting levers connecting said plungers, a valve on one of said levers to open and close said vent, means to connect one of said levers to the governor to vary the speed setting thereof in accordance with movements of the plunger and plunger rod, and means to adjust the pressure at which said plunger will move to thereby vary the pressure at which said vent is opened and closed.

24. In a regulator for a motor driven compressor having a governor and a receiver to which the compressor discharges fluid under pressure, a device acting in response to variations of the pressure of the fluid in the receiver to unload the compressor at a predetermined maximum pressure and to reload the compressor at a predetermined low pressure, means to predetermine the unloading maximum and the reloading low pressure, and a device to control the speed setting of the governor having two chambers in constant communication with the receiver and including a pressure responsive means in each chamber, movable means in each chamber controlled by the respective pressure responsive means, means connecting said movable means, venting means in one of said chambers, controlling means on said connecting means for said venting means, means associated with said connecting means to vary the speed setting of the governor in accordance with the relative movements of said movable means, and adjustable means on one of said movable means to regulate said controlling means.

25. In a motor driven fluid compressor, a governor to control the speed of the motor, a governor spring, and a pressure responsive device for controlling the characteristics of the governor spring while the compressor is loaded comprising a member operable in response to changes in the discharge pressure of the compressor, pressure operated means for regulating the tension of said governor spring, and means jointly controlled by said member and said pressure operated means for controlling the pressure for operating said pressure controlled means.

26. In a motor driven fluid compressor, a governor to control the speed of the motor, and a pressure responsive device for controlling the characteristics of the governor in accordance with variations in the discharge pressure of the compressor while the compressor is loaded.

27. In a governor speed setting regulator for a motor driven compressor comprising a casing having chambers therein, pressure responsive means in each chamber, separate means to transmit movement of the pressure responsive means, means to connect one of the last said means to the governor, venting means for one of the chambers, and means associated with the separate means transmitting movement of the pressure responsive means in the other chamber to open and close the venting means.

28. In a governor speed regulator for a motor driven compressor comprising a casing having chambers therein, pressure responsive means in each chamber, means to connect one of said pressure responsive means to the governor, means to vent one of said chambers, and means controlled by the pressure responsive means in the other chamber to regulate opening and closing of the venting means.

29. In a governor speed regulator for a motor driven compressor comprising a casing having chambers therein, pressure responsive means in each chamber, means to connect one of said pressure responsive means to the governor, means to vent the chamber containing the pressure responsive means connected to the governor, and means controlled by the pressure responsive means in the other chamber to regulate opening and closing of the venting means.

30. In a governor speed setting regulator for a motor driven compressor comprising casings having chambers therein, pressure responsive means in each chamber, means to connect one of said pressure responsive means to the governor, means to control movement of the pressure responsive means connected to the last said means, and means associated with the pressure responsive means in the other chamber to actuate the last said means.

31. In a regulator for a motor driven fluid compressor including a governor comprising a casing having chambers each subjected to a different pressure, pressure responsive means in each chamber, inter-connected movable levers to connect the governor to one of said pressure responsive means, means to vent one of said chambers to the atmosphere, and a valve to open and close the last means controlled by the pressure responsive means in the unvented chamber.

32. In a regulator for a motor driven fluid compressor including a governor comprising a casing having chambers each subjected to a different pressure, pressure responsive means in each chamber, inter-connected movable levers to connect the governor to one of said pressure responsive means, means to vent the chamber having the pressure responsive means connected to the governor, means to transmit movement of the pressure responsive means in another chamber, and a valve on the last said means to open and close the venting means.

CHARLES S. BAKER.