

Jan. 11, 1938.

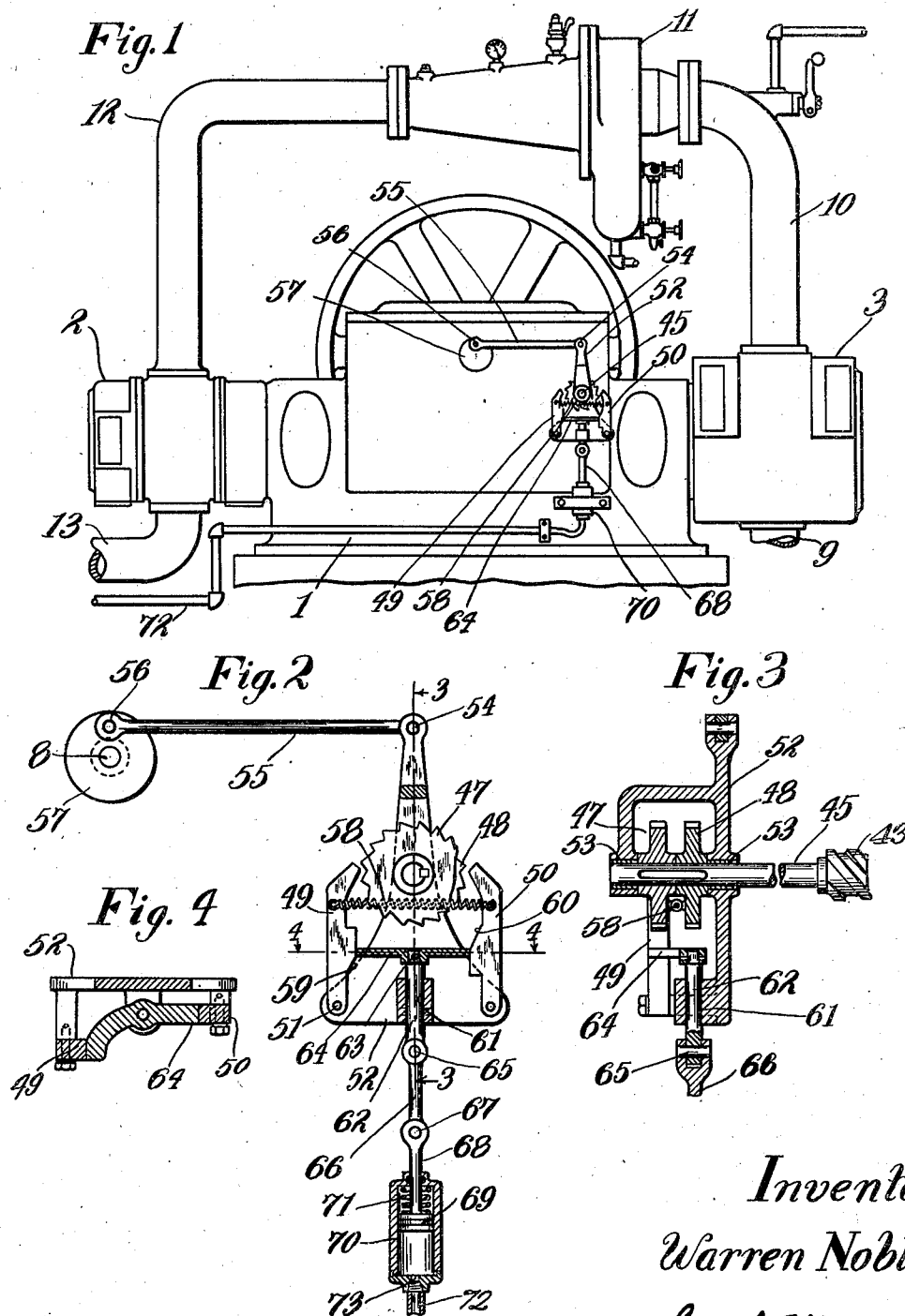
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2,105,093

PUMPING DEVICE

Filed Sept. 20, 1934

4 Sheets-Sheet 1



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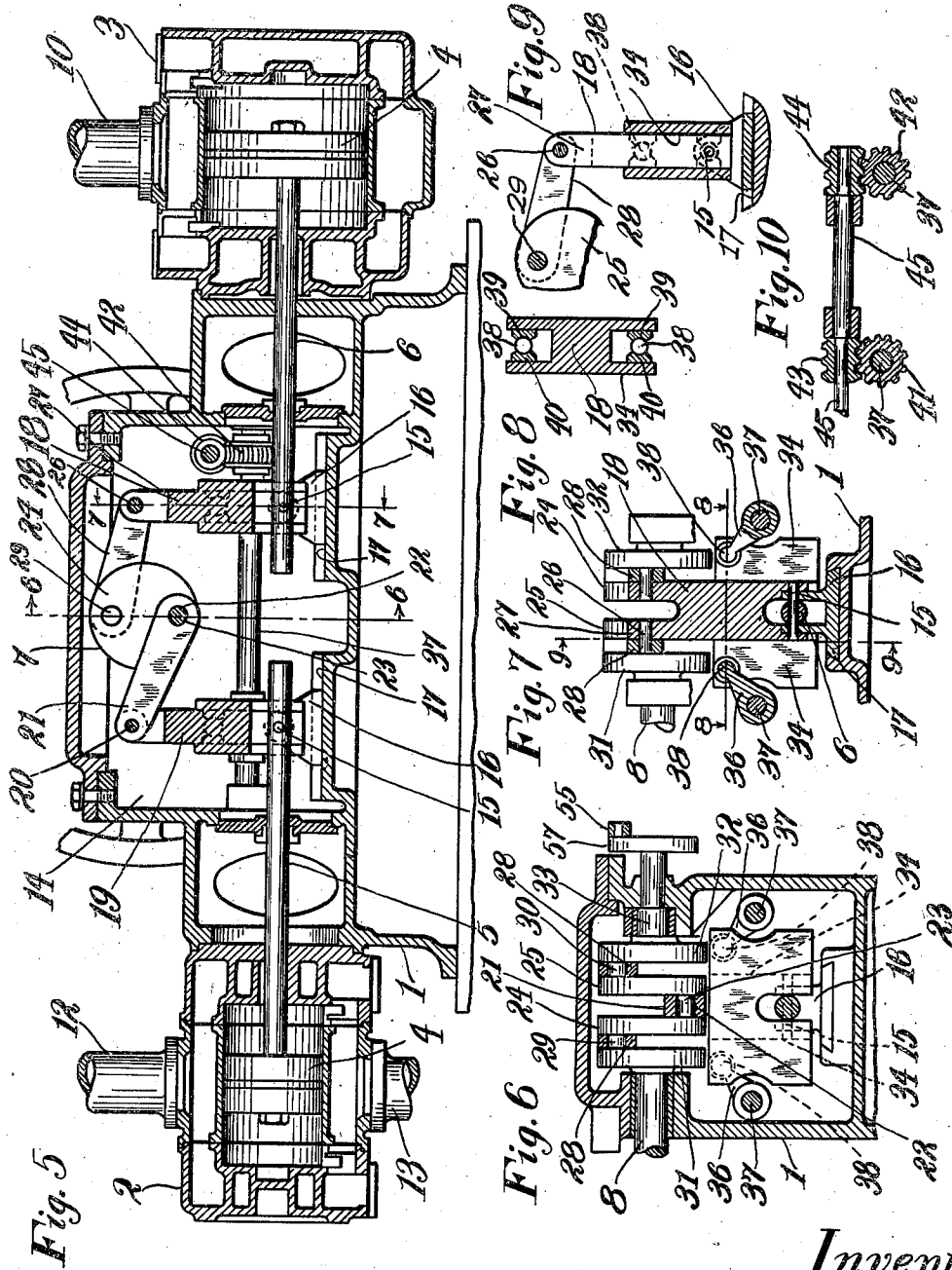
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PUMPING DEVICE

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4 Sheets-Sheet 2



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2,105,093

PUMPING DEVICE

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4 Sheets-Sheet 3

Fig. 11

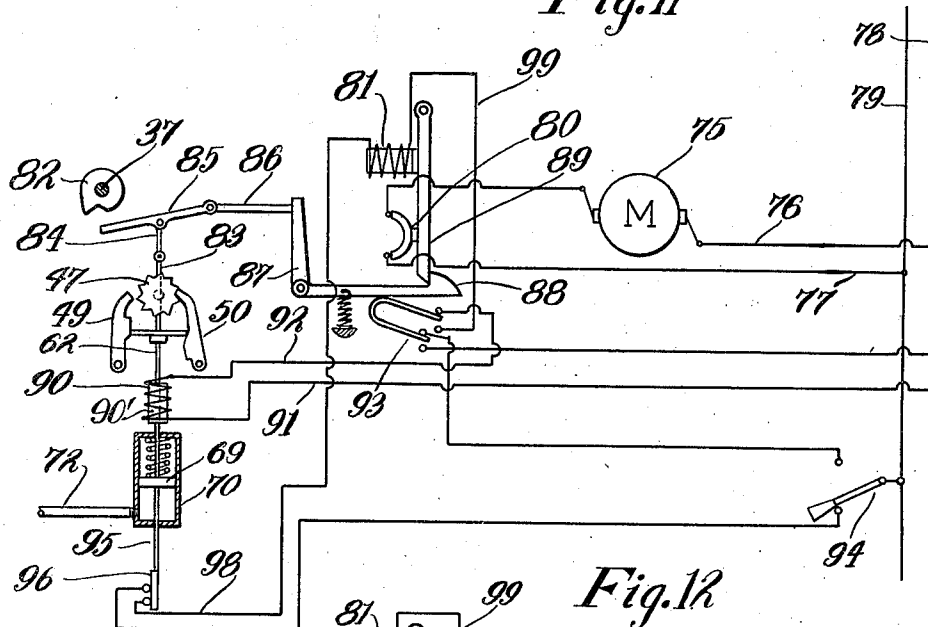
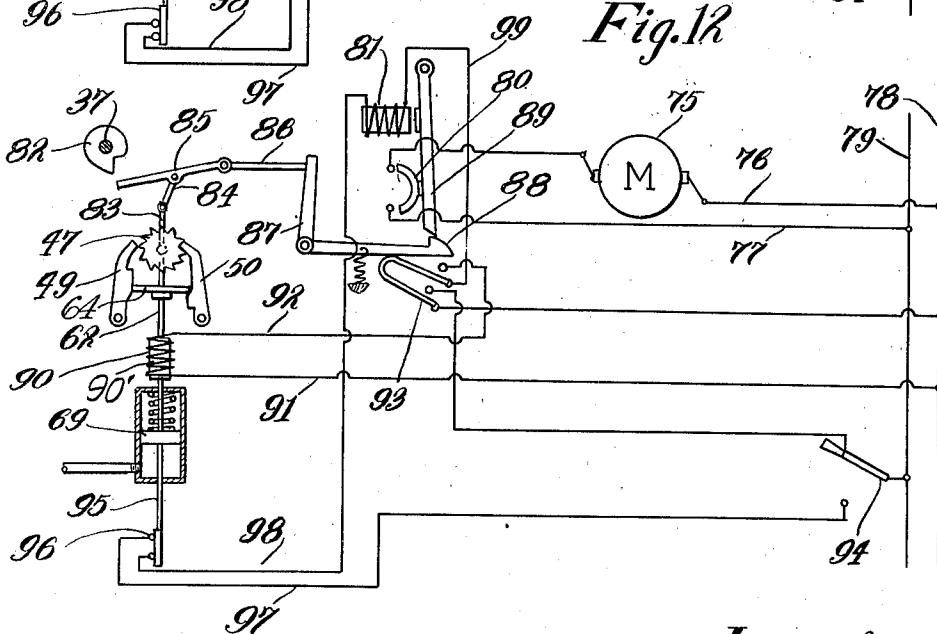


Fig. 12



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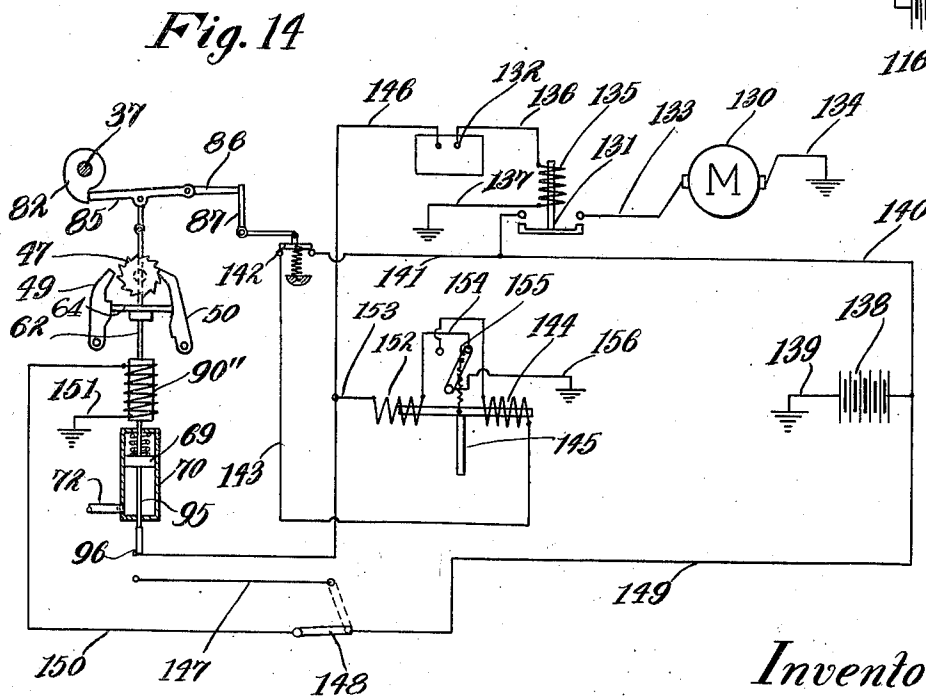
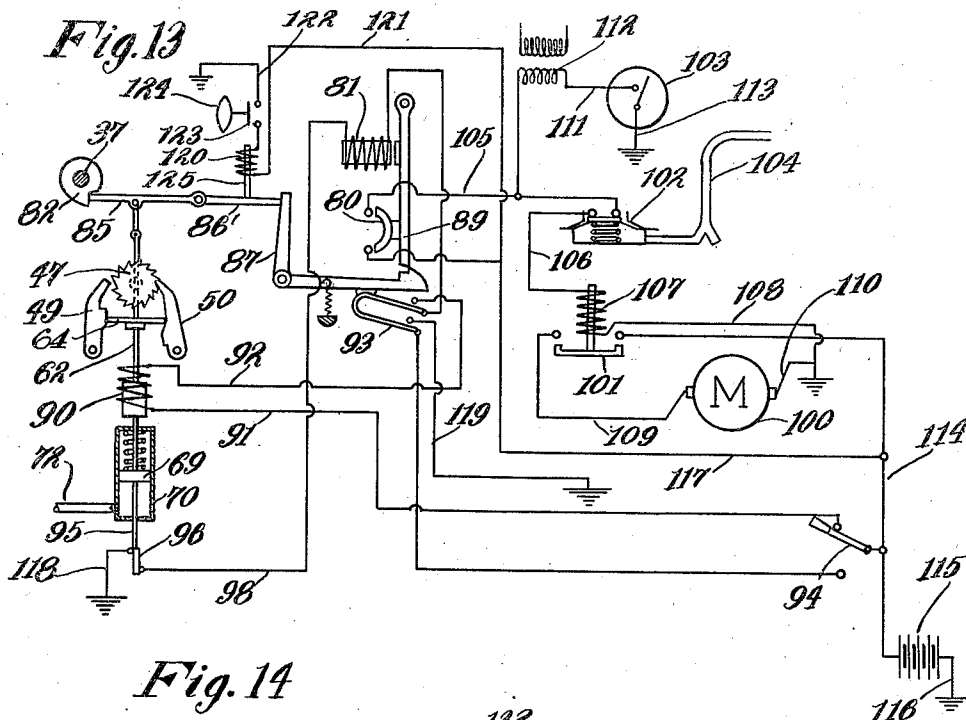
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2,105,093

PUMPING DEVICE

Filed Sept. 20, 1934

4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,105,093

PUMPING DEVICE

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Application September 20, 1934, Serial No. 744,838

2 Claims. (Cl. 103—38)

This invention relates to variable stroke mechanisms, and more particularly to improvements in variable stroke mechanism especially designed to use with air compressors or pumps.

5 An object of this invention is to provide an improved variable stroke mechanism. Another object of this invention is to provide an improved variable stroke mechanism for air compressors or pumps, and of a type especially designed for use in compressors or pumps of the reciprocating piston type. A further object is to provide an improved stroke changing mechanism for a compressor or pump of the reciprocating piston type and improved control means for such a mechanism. Still another object is to provide an improved control mechanism for such a variable stroke mechanism whereby the operation of the compressor or pump is automatically regulated in accordance with the load thereon. Another object is to provide an improved variable stroke mechanism for a reciprocating type compressor or pump whereby, as the load of the compressor or pump varies, the piston stroke is automatically varied. Yet another object is to provide an improved automatic control means for a variable stroke mechanism of the above character, whereby, when the compressor is relieved of its load, the variable stroke mechanism automatically assumes a no-load or neutral position. These and other objects and advantages of the invention will, however, hereinafter more fully appear.

In the accompanying drawings there are shown for purposes of illustration one form and several modifications thereof which the invention may assume in practice.

In these drawings:—

Fig. 1 is a side elevational view of a compressor or pump with which the illustrative form of the improved variable stroke mechanism is associated.

Fig. 2 is a detail view of a portion of the improved control means.

Fig. 3 is a vertical sectional view, taken substantially on line 3—3 of Fig. 2.

Fig. 4 is a detail sectional view, taken substantially on line 4—4 of Fig. 2.

Fig. 5 is an enlarged, central, longitudinally extending, vertical view, taken through the compressor as shown in Fig. 1, and its associated variable stroke mechanism.

Fig. 6 is a vertical cross sectional view, taken substantially on line 6—6 of Fig. 5.

Fig. 7 is a vertical cross-sectional view, taken substantially on line 7—7 of Fig. 5.

Fig. 8 is a detail sectional view, taken on line 8—8 of Fig. 7.

Fig. 9 is a fragmentary side elevational view of a portion of the mechanism shown in Fig. 7.

Fig. 10 is a detail sectional view illustrating a portion of the variable stroke adjusting mechanism.

Fig. 11 is a diagrammatic view showing the improved automatic control mechanism.

Fig. 12 is a view similar to Fig. 11, showing parts in a different position.

Fig. 13 is a view similar to Fig. 11, showing a modified form of automatic control means.

Fig. 14 is a view similar to Fig. 11 showing a still further modified form of automatic control means.

In this illustrative embodiment of the invention the improved variable stroke mechanism is shown embodied in an air compressor, although it will be evident that the same may have application in various types of machines. The air compressor shown is of the two-stage, straight line type, comprising a base frame 1, having mounted in alinement thereon high and low, double acting pressure cylinders 2 and 3, each having reciprocable therein a piston 4. These pistons have alined piston rods 5 and 6 respectively, operatively connected through the improved variable stroke mechanism generally designated 7, to the motor driven crank shaft 8 of the compressor. The fluid to be compressed is conducted to the low pressure cylinder 3 through an intake pipe 9, and is discharged from this cylinder through a discharge pipe 10 to a suitable intercooler device 11 from which fluid is discharged through a pipe 12 connected to the intake of the high pressure cylinder 2. The compressed fluid is discharged from this cylinder through a discharge pipe 13. As shown most clearly in Fig. 5, the inner ends of the piston rods project from their cylinders inwardly within a chamber 14 formed in the base frame 1, and within which the improved variable stroke mechanism 7 is arranged. Each of these piston rods 5, 6 is connected by a pin 15 to a sliding cross-head 16 arranged in a longitudinal guideway 17 formed on the base frame. Pivotally mounted on each of the pins 15 is a swingable member in the form of a pivoted arm, these members being designated 18 and 19 and arranged to swing in vertical planes extending parallel to the piston rod axes and at right angles to the crank shaft axis in the manner shown. The swingable member or arm 19 is pivotally connected at 20 to a link or connecting arm 21, in turn pivotally connected at 22 to a crank pin 23, 55

formed between the crank discs 24 and 25 of the crank shaft. As shown in Fig. 7, pivotally connected to pins 26, mounted within spaced lugs 27 formed on the swingable member or arm 18 are parallel links 28, 28 in turn pivotally connected at 29 and 30 respectively to crank pins formed between the crank discs 24 and 31 and crank discs 25 and 32 of the crank shaft. The crank shaft 8 is suitably journaled within the frame 1, in the manner shown in Fig. 6. Each of the swingable members or arms 18 and 19 is provided at its opposite sides with upstanding guideways 34 and 34 extending radially with respect to the axial line of the pivot pins 15 and 26. In this illustrative construction the swingable members or arms 18 and 19 are provided with adjustable fulcrum points and the means for adjusting the fulcrums of these members comprises arms 36, 36, secured to parallel rods 37, 37, arranged longitudinally of the compressor in parallel relation to the piston rod axes and at opposite sides of the latter. Each arm 36 is provided at its extremity with a spherical head 38 mounted in concave bearing surfaces 39 formed in sliding friction blocks 40 engaging the inner side walls of the guideways 34, as shown in Fig. 8. The rods 37, 37 are common to the arms of both of the swingable members or arms 18, 19 and have secured thereto worm gears 41 and 42 meshing respectively with worms 43, 44 secured to a horizontal control shaft 45 herein arranged transversely of the base and suitably journaled therein. The worm gearing has self-locking teeth for holding the fulcrum changing arms in their different positions of adjustment and is so constructed as to cause the shafts 37, 37 to rotate oppositely to each other at equiangular rates.

It will thus be seen that when the control shaft 45 is rotated the parallel shafts through the worm gearing are simultaneously rotated in opposite directions, swinging the arms 36, 36 oppositely about their pivots, thereby moving the extremities of these arms and their co-operating friction blocks 40 relative to the guideways 34, 34 on the swingable arms. When the extremities of these arms lie in a position in a horizontal plane including the axes of the pivot pins 15 and the crank shaft 8 is rotated, the members 18 and 19 are swung back and forth about the axes of the pivot pins 15 by the crank discs and links while the piston rods 5 and 6 remain stationary as regards reciprocatory movement. As the fulcrum changing arms 36 are swung upwardly within the guides 34, 34 the members 18, 19 swing about the extremities of these arms 36 as fulcrums, the swinging range thereof being gradually increased as the arms 36 are swung upwardly, thereby causing the piston rods 5 and 6 to be reciprocated at gradually increasing strokes until the extremities of the arms 36 assume their uppermost position, wherein the piston rods are reciprocated their full stroke. It will therefore be evident, as the extremities of the fulcrum changing arms 36, 36 are swung within the guides 34, the stroke of the piston rods may be varied from zero position to a predetermined maximum or full stroke position with equal stroke variations at opposite sides of a uniform mid-stroke position.

Now referring to the improved automatic control means for the fulcrum changing arms 36, 36 for automatically varying the piston stroke in accordance with the load on the compressor, it will be noted that the control shaft 45 at one end projects outwardly from one side of the

frame 1 and has keyed thereto ratchet wheels 47 and 48 having reversely directed ratchet teeth, and cooperating respectively with the teeth of these ratchet teeth are pawls or dogs 49 and 50 pivotally mounted at 51 at their lower ends on a lever 52 in turn pivotally mounted at 53 on the projecting end of the control shaft 45. The upper end of this lever 52 is pivotally connected at 54 to a link 55 in turn pivotally connected at 56 to a crank disc 57 keyed to a projecting end of the crank shaft 8. As shown in Fig. 2, the pawls or dogs 49, 50 are constantly urged toward their ratchet teeth engaging position by a coil spring 58 and the inner sides of these pawls have formed thereon projecting lugs having cam surfaces 59 and 60. Guided at 61 on the bottom portion of the lever 52 is a reciprocatory non-rotatable plunger 62 having fixed thereto at its upper end 63 a member 64 having oppositely projecting arms engageable with the cam surfaces 59 and 60 on the pawls. Pivotally connected at 65 to the lower end of the plunger 62 is a link 66 in turn pivotally connected at 67 to a piston rod 68 of a piston 69. This piston is reciprocally mounted in a cylinder 70 suitably mounted at the side of the base frame 1 and this piston is constantly urged toward its lowermost position by a coil spring 71. Compressor discharge pressure is adapted to be conducted from the pressure discharge pipe 13 through a pipe 72 communicating through a passage 73 with the lower end of the cylinder 70, beneath the piston 69.

It will thus be evident that when the member 64 is in its neutral or pawl releasing position, shown in Fig. 2, both pawls 49 and 50 are maintained released from the teeth of the ratchet wheels 47, 48. The lever 52 is constantly oscillated through the connections 55, 57 driven by the compressor crankshaft and as the compressor discharge pressure rises, this pressure is transmitted through the pipe 72 to the cylinder 70 to act on the piston 69 to move the latter upwardly, and due to the shape of the cam surface 60, the pawl 50 is allowed gradually to swing inwardly. Thus, as the lever 52 is oscillated, the pawl 50 engages the teeth of the ratchet wheel 48, and as a result the shaft 45 is rotated gradually to move the fulcrum varying arms 36 downwardly within the guides 34, 34, thereby gradually decreasing the length of the piston stroke until the fulcrum varying arms 36, 36 assume a position wherein the pistons no longer reciprocate. As the compressor discharge pressure gradually drops, the coil spring 71 causes the piston 69 to move downwardly so that the member 64 rides on the cam surface to throw out the pawl 50 and gradually cause the pawl 49 to move inwardly into engagement with the ratchet wheel 47, and as a result the direction of the rotation of the control shaft 45 is reversed, thereby moving the fulcrum varying arms 36, 36 upwardly within their guides 34, 34 gradually to increase the piston stroke. It will thus be seen that the stroke of the pistons is varied automatically in accordance with the compressor discharge pressure.

Now referring to the improved controlling mechanism for controlling operation of the compressor, including means for automatically effecting movement of the fulcrum adjusting elements of the variable stroke mechanism into their "no-stroke" position so that the motor may start when the compressor is in no-stroke condition, it will be observed that Fig. 11 shows the apparatus in running condition, and Fig. 12

shows the apparatus in stopped condition. Referring first to Fig. 11, it will be noted that the motor for driving the crankshaft 8 of the compressor is indicated at 75, and current is supplied to the motor through conductors 76 and 77, respectively connected to the main line conductors 78 and 79, the current supply being controlled by an automatic switch 80 controlled by the solenoid 81. Upon energization of the solenoid 81, as later described, the switch 80 is closed and the motor 75 started. When the switch 80 reaches closed position it is latched in such position by a spring-pressed latch 88, so that the switch may be held closed and the motor operated despite de-energization of the solenoid 81.

Means for positively releasing the latch 88 is actuated by a cam 82, actuated by one of the control shafts 37 of the variable stroke control mechanism, and serves to release the latch as "no-stroke" condition is attained. The plunger 62 of the pawl control means has connected thereto a rod 83, which is pivotally connected through a link 84 to a rod 85, and the latter is pivotally connected to a plunger 86 which is engageable with an arm 87 rigidly fixed to the latch 88, previously mentioned, which cooperates with the control arm 89 of the switch 80. The cam 82, when the rod 83 is in top position, will, as the shaft 37 attains "no-stroke position", actuate the rod 85 and through it the plunger 86, and release the latch 88 and permit opening of the "normally-open-type" switch 80. A solenoid 90 is connected by a conductor 91 to the main line 78, and is connectible through a conductor 92, a switch 93, later more fully discussed, connected with the latch 88 for movement with the latter, and a switch 94, also further later described, with the line 79. An armature 90' is movable by the solenoid upon energization of the latter, and is connected with the plunger 62, which it is adapted to raise upon energization of the solenoid. To energize solenoid 90, switch 94 must be in its lower ("starting") position and switch 93 in the position it occupies when the motor 75 is stopped. A depending rod 95 is connected to the piston 69 at the lower side of the latter, and carries a switch element 96 which cooperates in the lower position of the element 96 to connect a conductor 98 leading from the solenoid 81 to a conductor 97 connectible by the switch 94, in one position of the latter, to the line 79. The other end of the solenoid 81 is connected by conductor 99 with the switch mechanism 93.

With this explanation, the mode of operation will be readily understood by referring to Figs. 11 and 12. In the position of the parts shown in Fig. 11, the motor 75 is driving the compressor and the length of the piston strokes is subject to the control of the compressor discharge pressure which is acting through the pipe 72 upon the bottom of the piston 69. The switch 80 is in closed position, being so held by the latch 88. The solenoid 81 is not energized, for the switch 93 is breaking the circuit at the end of the conductor 99. The solenoid 90 is not energized because of the position of switch 94.

To stop the motor the switch 94 is raised into its upper position, that is, the position it is shown as occupying in Fig. 12. Bearing in mind that at the moment this occurs the other parts of the apparatus are all in the position which they occupy in Fig. 11, it will be appreciated that the solenoid 90 will be energized immediately. This will draw up armature 90' and, by raising

the plunger 62 to top position, will cause the stroke varying means to act to bring the variable fulcrum devices to "no-stroke" position. When the shaft 37 of the variable fulcrum means has rotated approximately to "no-stroke" position, the cam member 82 will coast with the raised rod 85 and through the plunger 86 and bell crank lever arm 87 will positively open the latch 88 and allow the switch 80 to swing to open position. Releasing of the latch 88 will swing the switch 93 to the position shown in Fig. 12, and interrupt the circuit through the solenoid 90 so that the spring 71 will move the plunger 69 downward to the position corresponding to the compressor discharge line pressure then existing. (The motor is now not running, so the fulcrum devices will not be affected.) Now, since the movement of the switch 93 has broken the circuit established by the switch 94 in its upper position, the parts will all remain in the position shown in Fig. 12 except as reduction in discharge line pressure may permit still further downward movement of piston 69 and associated parts.

When it is desired to start the compressor again, the operator will swing the switch 94 to bottom position, and, viewing all the remaining parts as they stand in Fig. 12, which is their position when the compressor drive was discontinued, the operations will readily be understood. The movement of the switch 94 to its bottom position will create a circuit from the line 79 through the conductor 97, switch 96, conductor 98, solenoid 81, conductor 99 and switch 93, and back to the line 78. This will energize the solenoid 81 and close the switch 80 and start the motor. Closing of the switch 80 will permit its operating spring to move the latch 88 upwardly and swing the switch 93 into the position shown in Fig. 11. This will break the circuit just described through the solenoid 81, but the latch 88 will hold the switch 80 in closed position. The solenoid 90 will not be energized, because the conductor 92 will not be connected with the line 79, due to the position of switch 94. The motor will obviously have begun to revolve with the variable fulcrum devices in no-stroke position, and the fulcrums will be promptly brought to the positions corresponding to the compressor discharge pressure, as the motor operates. The complete cycle of running, stopping, and restarting has now been described.

The piston 69, if compressor discharge pressure gets too high, will move up and open switch 96 and hold it open while excessive pressure exists. It will also move the parts to a position in which switch 82 will move latch 88 to permit switch 80 to open. This will stop the motor. When the pressure falls, and switch 96 recloses, the magnet 81 will again close switch 80, because switch 93 will then be in position to permit completion of the circuit. If switch 94 be moved to its upper position after the compressor is started, this automatic stop and restart feature will not be effective.

In the modification shown in Fig. 13, the improved automatic control means is shown associated with a gasoline engine. In the diagrammatic view shown the gasoline engine starting motor is indicated at 100, the starting motor control switch at 101, an automatic starting device at 102, and an ignition, make-and-break device for the engine at 103. The device 102 is herein of the type commonly known as a "Startex", and is connected through a pipe 104 to the intake manifold of the gasoline engine. One contact of the automatic switch 80 is connected through

a wire 105 to a contact on the "Startex" device, while the other "Startex" stationary contact is connected by a wire 106 to the solenoid 107 of the starting switch 101, the other end of solenoid 107 being grounded through a wire 108. The stationary contacts of the "Startex" device are connected together when the motor is not running and remain connected until the motor comes up to speed. The wire 109 leads from a contact of the switch 101 to the windings of the motor 100 and the motor windings are grounded at the other side through a wire 110. The ignition make-and-break device 103 is connected by a wire 111 to the primary 112 of the spark coil, and the other end of the primary is connected to the wire 105. The make-and-break switch is also grounded at its other side through a wire 113. The main line wire 114, which corresponds to one of the main lines of the form of the invention shown in Fig. 11, leads at one end to a battery 115, and the other end of the battery is grounded through a wire 116. The other contact of the switch 80 is connected by a wire 117 to the main line wire 114. One contact of the automatic stop and start switch 96 is grounded through a wire 118, while one contact of the horseshoe switch 93 is grounded through a wire 119. A thermostatic device may be provided for maintaining the compressor unloaded, that is, with the pistons thereof stationary, while the gasoline engine is becoming sufficiently warmed up to operate efficiently. This device may include a solenoid 120 connected by a wire 121 to the wire 117, the other side of the solenoid being grounded through a conductor 122 connected with the solenoid by a switch 123, which is controlled by the thermostatic element 124 which opens the switch 123 when the engine is at normal operating temperature. The coil of the solenoid 120 is connected through a rod 125 to the element 86' of the controller mechanism. When solenoid 120 is energized 86' is raised and acts through 85 to maintain the parts 49 and 50 in neutral position, that is, neither effective to operate the fulcrum control apparatus. Thus pumping is not started until the engine is duly warmed up.

Fig. 13 shows the parts in the position occupied when the gasoline engine driving compressor has just been stopped. Switch 80 is open. The "Startex" is closed. Switch 101 is open. Switch 96 is closed, and switch 123 is open. The operator, to start the compressor again, moves the switch 94 to its bottom position. This closes a circuit from the line 114 through the switch 93, through the coil 81 of the solenoid which closes the switch 80, through the conductor 98, switch 96 and conductor 118 to ground. Closing of the switch 80 energizes the make-and-break device, supplying current to the primary of the spark coil. Current is supplied also through the "Startex" and through the coil 107 to close motor starting switch 101. Motor 100 therefore turns over the engine and effects starting thereof. When the engine has produced a sufficient vacuum in its intake 104, the "Startex" 102 is opened, breaking the circuit through the solenoid 107, and allowing the switch 101 to open and thereby stop the engine starting motor. Further operation of the apparatus will be readily understood from what has been previously said with respect to Figs. 11 and 12, it being noted that closing of switch 80 results in a reversal in position of switch 93, and the establishment of a circuit relation such that the return of switch 94

to the full line position shown will effect stopping of the apparatus.

In the modification shown in Fig. 14, a Diesel engine driving system is shown. The Diesel engine starting motor is indicated at 130; the starting motor control switch at 131; the automatic starting device, whose construction is familiar to those skilled in the Diesel engine art, at 132. The starting motor is connected to one of the stationary contacts of the switch 131 by a conductor 133. Its other side is grounded through the conductor 134. The other stationary contact of the switch 131 is connected to a conductor 140 leading to a battery 138 whose other terminal is grounded at 139. The operating solenoid for the switch 131 is grounded at one end by the conductor 137 and its other end is connected by a conductor 136 with the starting device 132. The other terminal of the automatic starting device 132 is connected by a conductor 146 through the switch 96 to a conductor 147 which is connectible through a switch 148, in one position of the latter, to a conductor 149 which receives current from the battery 138. Switch 148 in its other (shown) position is adapted to connect the battery through the conductor 149 and a conductor 150 to an operating armature 90'' whose core is connected to the plunger 62 and associated mechanism, said solenoid 90'' being connected to ground at its other end through a conductor 151. A branch conductor 153 connects the conductor 146 to a magnet 152 whose other end is connected by a conductor 154 to one of a pair of spaced stationary contacts of a trigger switch 155. The other contact of the trigger switch is connected to an aligned magnet 144 whose other end is connected by a conductor 143 to a "normally open" switch device 142, which, when closed, connects the conductor 143 through a further conductor 141 to the conductor 140 connected to the battery 138. The movable element of the trigger switch 155 is connected to ground through a conductor 156. Fig. 14 shows the parts in shut-down condition. 145 is the fuel pump controlling lever which, in the position of the parts shown, is in engine stopping position. Its position is changed by the magnets 152 and 144. To start the engine, the switch 148 will be thrown to the dotted line position. This will break the circuit through the magnet 90'' and will result in freeing of the bell crank 87 and opening of the switch 142. The starting position of the switch 148 will also establish a circuit through conductor 149, switch 148, conductor 147, switch 96, which will close when 90'' is deenergized, conductor 146; the starting apparatus 132, conductor 136, solenoid 135 and conductor 137, to the ground. This will effect closing of the starting switch 131 and establish a circuit from the battery 138 through the conductor 140, switch 131, conductor 133, motor 130 and conductor 134 to the ground. The engine will thereupon be turned over. Current will also be supplied through the conductor 153 and magnet 152 to move the fuel pump controlling lever 145 to running position. It will be noted that the trigger switch each time it is thrown breaks the circuit through the magnet which effected its movement. After the motor is started, the automatic starting mechanism 132 causes the starting motor switch 131 to be thrown out, stopping the motor 130. The method of stopping the compressor will be obvious from what has been previously described, it being noted that when the stroke varying devices approach no-stroke position, the switch 142 will be closed.

In each form of the apparatus the automatic stopping and re-starting under control of the compressor discharge pressure may obviously be effected.

5 As a result of this invention it will be noted that a novel stroke changing mechanism is provided for a compressor, together with means for automatically changing the piston stroke in accordance with the load on the compressor. It will
10 further be noted that an improved control mechanism is associated with the stroke changing mechanism whereby when the compressor is stopped the stroke changing mechanism automatically assumes a no-load position and when
15 the compressor is started it is gradually placed under load after the driving motor has come up to speed. These and other uses and advantages of the invention will, however, be clearly apparent to those skilled in the art.
20 While there are in this application specifically described one form and several modifications thereof which the invention may assume in practice, it will be understood that these forms of the same are shown for purposes of illustration and that the invention may be modified and embodied in various other forms without departing
25 from its spirit or the scope of the appended claims.

What I claim as new and desire to secure by Letter Patent is:—

1. In combination, in a pump, a crank shaft, a cylinder, a piston therein, operative driving connections between said crank shaft and said piston
5 including mechanism adjustable to effect different lengths of piston stroke, and means governed by the terminal pressure of said pump, actuated by said crank shaft and having an operative connection with the latter independent
10 of said operative driving connections first mentioned for adjusting an element of said mechanism to change the length of piston stroke.

2. In a compressor or pump, a cylinder having a reciprocating piston, said piston having a piston
15 rod, a driving element, variable stroke mechanism actuated thereby for imparting to said piston strokes of desired lengths between zero and a predetermined maximum and operatively connected to said piston rod, and control means for
20 said variable stroke mechanism including a control shaft arranged parallel with said piston rod, connections between said control shaft and said variable stroke mechanism, and means operable
25 by said driving element for moving said control shaft.

WARREN NOBLE.

CERTIFICATE OF CORRECTION.

January 11, 1938.

Patent No. 2,105,093.

WARREN NOBLE.

It is hereby certified that error appears in **the** printed specification of the above numbered patent requiring correction as follows: Page 4, second column, line 27, for the word "armature" read coil; and same line, for "core" read, armature; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 1st day of March, A. D. 1938.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)