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APPARATUS FOR CONTROLLING A PLURALITY OF COMPRESSORS

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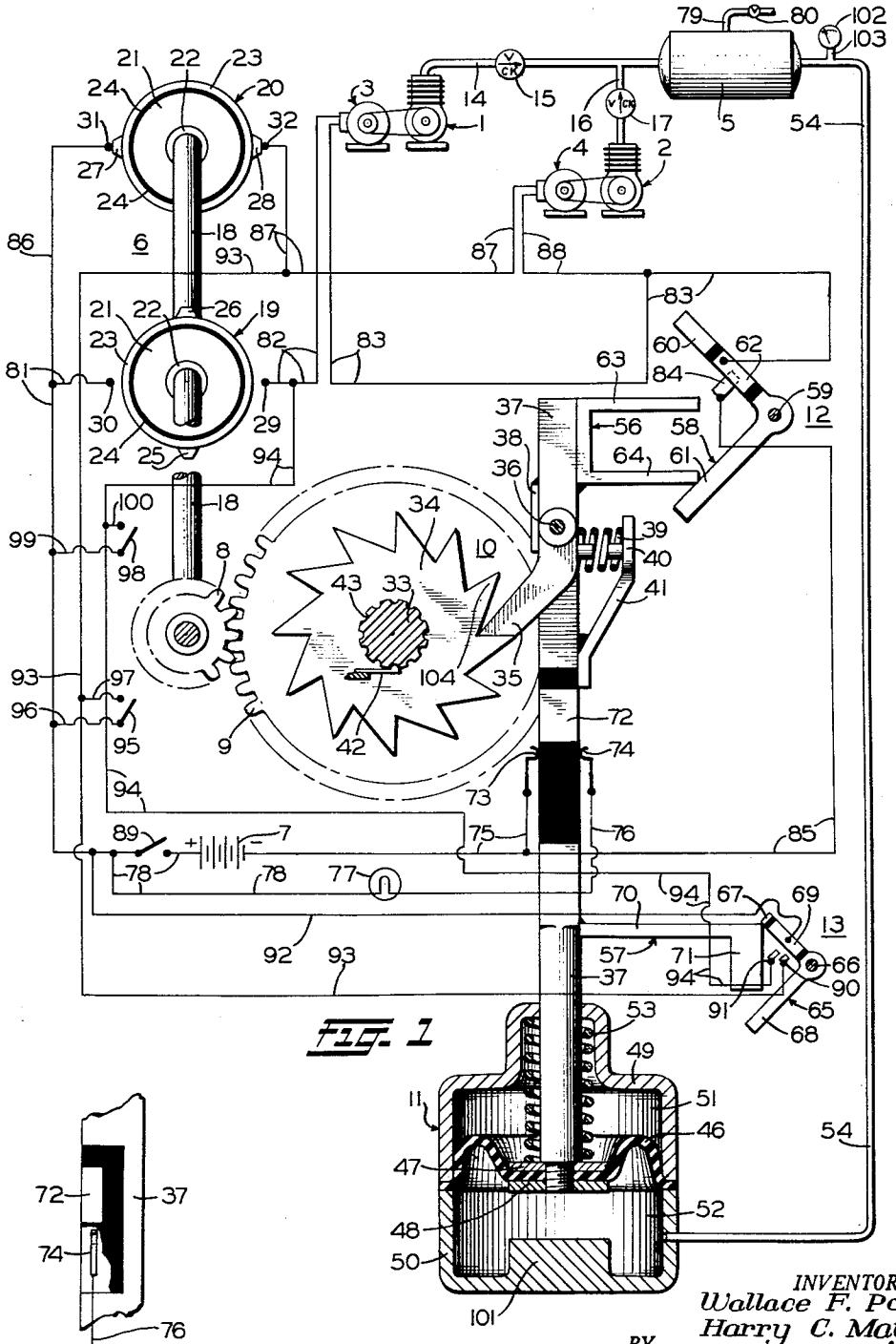


FIG. 1

FIG. 2

INVENTORS
Wallace F. Poore
Harry C. May
BY
Adelbert O. Steinmiller
ATTORNEY

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APPARATUS FOR CONTROLLING A PLURALITY OF COMPRESSORS

Wallace F. Poore and Harry C. May, East McKeesport, Pa., assignors to Westinghouse Air Brake Company, Wilmerding, Pa., a corporation of Pennsylvania

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This invention relates to control apparatus for a plurality of power driven air compressor units that supply fluid under pressure to a common storage reservoir and more particularly to such control apparatus for automatically starting and stopping the compressor units.

The demand for compressed air from a storage reservoir may vary from nothing to the combined maximum output of a plurality of compressor units. In some compressed air installations the demand for compressed air in excess of the capacity of a single compressor may occur only occasionally and at various spaced intervals of time, yet, in such installations, it is necessary to install a sufficient number of compressor units to provide the required amount of compressed air when the periods of peak demand occur.

In order to avoid undesired prolonged periods of idleness of any one of a plurality of compressor units in a multiple compressor installation, the present invention provides control apparatus operative automatically to sequentially effect operation of the different compressor units during periods of normal air demand and to effect operation of all of the units during periods of peak demand.

The control apparatus of this invention for use with a plurality of electric motor driven air compressor units delivering compressed fluid to a fluid pressure storage reservoir comprises a rotary switch device operable sequentially to a plurality of different positions for controlling the power supply circuits from a source of electric power to the motors of the compressor units in such a manner that the units are operated in alternate sequence for approximately equalizing wear on the motor and compressor of each unit, a driving mechanism for operating the rotary switch device comprising a gear train and a pawl and ratchet mechanism, a fluid motor operable in response to variations in pressure in the storage reservoir to effect operation of the driving mechanism, and a pair of cut-in and cut-out switches in which the cut-in pressure of one is greater than the cut-out pressure of the other for controlling the starting and stopping of the electric motors, these switches being operable to their different positions by the fluid motor.

In the accompanying drawings, FIG. 1 is a diagrammatic view, partly in section, showing one embodiment of the above-described invention; and FIG. 2 is a fragmentary side view, showing details of a signal lamp switch employed in the embodiment of FIG. 1.

Description

Referring to FIG. 1 of the drawing, there is shown a compressed air installation comprising two motor-driven compressor units having fluid compressors **1** and **2**, and two electric motors **3** and **4** respectively, for driving the compressors **1** and **2**, a storage reservoir **5**, a rotary switch device **6** for controlling the power supply circuits from a source of electric power, such as a battery **7**, to the motors **3** and **4**, a gear drive for the switch device **6** consisting of a pinion **8** and gear wheel **9**, a pawl and ratchet mechanism **10**, a fluid motor **11** operable in response to variations in pressure in the storage reservoir **5** to effect operation of the pawl and ratchet mechanism **10**, a first cut-off and cut-in switch **12** for controlling the stopping and the starting of the motors **3** and **4** when

they are operating sequentially, and a second cut-off and cut-in switch **13** for, in cooperation with the switch **12** when switch **12** is in its closed position, controlling the simultaneous starting and stopping of the motors **3** and **4**, when the pressure in the reservoir **5** is reduced a chosen degree below the cut-in pressure of the switch **12** in response to the demand for fluid under pressure from the reservoir exceeding the capacity of a single compressor.

The fluid compressed by the compressor **1** is conducted to the storage reservoir **5** through a pipe **14** having therein a check valve **15** to prevent backflow from the reservoir **5**. The fluid compressed by the compressor **2** is likewise conducted to the storage reservoir **5** through a pipe **16** connected to the pipe **14** and having therein a second check valve **17** for preventing backflow of fluid under pressure from the reservoir **5**.

The rotary switch device **6** which controls the power supply circuits to the electric motors **1** and **2** comprises a rotary shaft **18**, suitably mounted in bearings (not shown), upon which is mounted in spaced-apart relationship for rotation therewith two rotary contact discs **19** and **20**. Each of the contact discs **19** and **20** comprises an inner metallic disc **21** having a hub **22** press-fitted to the shaft **18**, an outer metallic ring **23**, and an intermediate ring **24** of suitable insulation material, such as rubber, to which the inner and outer rings are bonded.

The outer ring **23** of the contact disc **19** is provided with two switch contact bosses **25** and **26** arranged 180 degrees apart about the periphery of the ring. The outer ring **23** of the contact disc **20** is likewise provided with two switch contact bosses **27** and **28** arranged 180 degrees apart about the periphery of the ring and arranged 90 degrees circumferentially from the contact bosses **25** and **26** respectively, on the outer ring of the rotary contact disc **19**.

The bosses **25** and **26** are adapted to contact a pair of stationary switch members **29** and **30** in alternate sequence as the shaft **18** is rotated counterclockwise in a manner hereinafter explained. Likewise, the bosses **27** and **28** are adapted to contact a second pair of stationary switch members **31** and **32** in alternate sequence as the shaft **18** rotates counterclockwise.

Shaft **18** is rotarily driven by means of the pinion **8** secured thereto. Pinion **8** meshes with the gear wheel **9** which is press-fitted to a shaft **33** suitably mounted for rotation in a spaced-apart parallel relationship to the shaft **18**. In order to provide for rotation of each of the contact discs **19** and **20** through an angle of 90 degrees each time the pawl and ratchet mechanism **10** is operated, the gear ratio between the pinion **8** and gear wheel **9** may be such as 1 to 3. Therefore, pinion **8** may have 16 teeth and gear **9** may have 48 teeth to provide the proper gear ratio.

The pawl and ratchet mechanism **10** comprises a ratchet wheel **34** having such as 12 teeth arranged 30 degrees apart, and a pawl **35**. The ratchet wheel **34** is press-fitted to the shaft **33** into a position adjacent to the gear wheel **9**.

The pawl **35** is pivotally mounted, as by a pin **36**, on a rod **37** adjacent one end thereof. The pawl **35** is constantly biased in the direction of the teeth on the ratchet wheel **34** and a stop **38**, welded or otherwise secured to the rod **37**, by a spring **39** disposed between the pawl and an arm **40** of a bracket **41** which is secured to the rod **37**, as by welding.

Longitudinal oscillation of rod **37** causes step-by-step advancement of the ratchet wheel **34**. A stationary detent **42** is provided for engaging peripherally spaced notches **43** on the shaft **33**, the notches corresponding in number and angular location to the number of teeth on the ratchet wheel **34**, to thereby hold the ratchet wheel against reverse rotation in a counterclockwise di-

rection from each position to which the ratchet wheel is advanced in a clockwise direction by the pawl 35.

The end of the rod 37 opposite the end carrying the pawl 35 is operatively connected to the center of a diaphragm 46 of the fluid motor 11 by means such as a diaphragm follower 47 and a nut 48 having screw-threaded engagement with the end of the rod. The outer periphery of the diaphragm 46 is clamped between two casing sections 49 and 50 comprising the body of the fluid motor 11. These casing sections are secured together by any suitable means (not shown).

The diaphragm 46 cooperates with the casing sections 49 and 50 to form within the fluid motor 11 and on opposite sides of the diaphragm, two chambers 51 and 52. Disposed within the chamber 51 between the casing section 49 and the diaphragm follower 47 and in surrounding relation to the rod 37 is a spring 53 for biasing the rod 37 and the diaphragm 46 in a downward direction. The chamber 52 on the lower side of the diaphragm 46 is connected by a pipe 54 to the storage reservoir 5.

Arranged in spaced-apart relationship along the length of the rod 37 are two switch operating members 56 and 57 for operating respectively, the switches 12 and 13.

The first cut-off and cut-in switch 12 comprises a bell crank 58 pivotally mounted on a pin 59 and having a pair of arms 60 and 61 disposed at right angles to each other. The arm 60 of the bell crank 58 carries, in insulated relationship thereto, a segment 62.

The switch operating member 56 is U-shaped and has two legs 63 and 64 of equal length which are adapted to contact respectively, the arms 60 and 61 of the bell crank 58 to open and close the switch 12 as the rod 37 is oscillated upward and downward in response to changes in pressire in the chamber 52 and the reservoir 5 between a first cut-off pressure and a first cut-in pressure a chosen degree lower than the first cut-off pressure.

The second cut-off and cut-in switch 13 comprises a bell crank 65 pivotally mounted on a pin 66 and having a pair of arms 67 and 68 disposed at right angles to each other. The arm 67 of the ball crank 65 carries, in insulated relationship thereto, a segment 69.

The switch operating member 57 is L-shaped and has two legs 70 and 71 of unequal length. The longer leg 70 is secured to the rod 37, as by welding, and the opposite ends of the shorter leg 71 are adapted to contact respectively, the arms 67 and 68 to open and close the switch 13 as the rod 37 is oscillated upward and downward an in response to changes in pressure in the chamber 52 and the reservoir 5 between a second cut-off pressure, a chosen degree lower than the hereinbefore first mentioned cut-in pressure, and a second cut-in pressure a chosen degree lower than the second cut-off pressure.

Carried on the rod 37 in insulated relationship thereto, is a segment 72 which, when the rod 37 is moved downward by the spring 53 to a certain position in response to the pressure in the chamber 52 and reservoir 5 reducing to a certain pressure, which is less than the hereinbefore mentioned first cut-in pressure for the cut-off and cut-in switch 12 and greater than the hereinbefore mentioned second cut-off pressure for the cut-off and cut-in switch 13, is adapted to engage a pair of leaf spring contacts 73 and 74 disposed on opposite sides of the rod 37. The contact 73 is connected by a wire 75 to the negative terminal of the battery 7. The contact 74 is connected by a wire 76 to one terminal of an indicating lamp 77, the other terminal of which is connected through a wire 78, to the positive terminal of the battery 7. When lamp 77 is lighted, it is an indication that the pressure in the reservoir 5 and chamber 52 has fallen to the above-mentioned certain pressure which is less than the normal cut-in pressure at which one or the other compressor units is started but is above the pressure at which the second cut-off and cut-in switch 13 is closed.

The reservoir 5 is provided with an outlet pipe 79 for conducting fluid under pressure from the reservoir to a place of use. Disposed in the pipe 79 is a manually operated valve 80 for controlling the flow of fluid under pressure from the reservoir 5 to the place of use.

In order to provide for the supply of power from the battery 7 to the electric motor 3, the stationary switch member 30 is connected by a wire 81 and the wire 78 to the positive terminal of the battery 7, and the stationary switch member 29 is connected by a wire 82 to one terminal of the motor 3. The other terminal of the motor 3 is connected by a wire 83 to the segment 62 carried on arm 60 of bell crank 58. Disposed in the arc of movement of the segment 62 and in a position so as to have sliding contact therewith, is a stationary switch member 84 which is connected to the negative terminal of the battery 7 by a wire 85 and the wire 75.

When the switch 12 occupies its cut-in position, in which position it is shown in the drawing, the segment 62 is in a circuit-closing relationship with the stationary switch member 84.

In order to provide for the supply of power to the electric motor 4, the contact 31 is connected by a branch wire 86 to the wire 81, and the contact 32 is connected by a wire 87 to one terminal of the motor 4. The other terminal of the motor 4 is connected by a wire 88 to the wire 83 which is connected through the switch 12 and wires 85 and 75 to the negative terminal of the battery 7 as has been hereinbefore explained. A normally closed manually operated shut-down switch 89 is placed in the wire 78 between the positive terminal of the battery 7 and the junction of the wire 81 with the wire 78 to provide for cutting off the supply of electric power from the battery 7 to the indicating lamp 77 and the electric motors 3 and 4 under any and all conditions.

In order to provide for simultaneously supplying power to both electric motors 3 and 4, independently of the rotary switch device 6, there is disposed in the arc of movement of the segment 69 carried on the arm 67 of the bell crank 65 in a spaced-apart relationship and in a position to have sliding contact therewith, a pair of stationary switch members 90 and 91. The position of the stationary switch members 90 and 91 is such that they are out of the path of movement of the leg 71 of the switch operating member 57. The segment 69 is connected to the wire 81 by a wire 92. The stationary switch member 90 is connected by a wire 93 to the wire 87 and the stationary switch member 91 is connected by a wire 94 to the wire 82.

Under certain conditions of operation to be hereinafter described, it is necessary that the supply of electric power be continued to one or both of the electric motors 3 and 4 when the segment 69 carried on the arm 67 of the bell crank 65 is rocked by the leg 71 of the switch operating member 57 to a position in which this segment is out of sliding contact with the stationary switch members 90 and 91. Therefore a first normally open manually operable switch 95 has one terminal thereof connected by a branch wire 96 to the wire 81 and the other terminal connected by a branch wire 97 to the wire 93, and a second normally open manually operable switch 98 has one terminal connected by a branch wire 99 to the wire 81 and the other terminal connected by a branch wire 100 to the wire 94.

The casing section 50 is provided with a stop 101 which is so arranged with respect to the position in which the diaphragm 46 and diaphragm follower nut 48 are shown in the drawing as to insure that, either the switch contact bosses 25 and 26 of the rotary contact disc 19 will be in contact with the respective stationary switch members 29 and 30 or 30 and 29, or the switch contact bosses 27 and 28 of the rotary contact disc 20 will be in contact with the respective stationary switch members 31 and 32 or 32 and 31, when, upon the absence of fluid under pressure in the chamber 52 and reservoir 5, the spring 53 is effective to deflect the diaphragm 46 downward until the

nut 48 is brought into contact with the stop 101. In other words the rotary switch device 6 will always be in a position to establish a power supply circuit for one of the motors when the equipment is shut down and chamber 52 and reservoir 5 are at atmospheric pressure.

Operation

In operation, let it be assumed that the electric motors 3 and 4 which drive the compressors 1 and 2 respectively, are stopped, the reservoir 5 and chamber 52 are at atmospheric pressure, and the manually operated switches 89, 95 and 98 are all open. In the absence of fluid under pressure in chamber 52, the spring 53 acting through casing section 49 and diaphragm follower 47, will be effective to move the rod 37, the pawl 35, and the switch operating members 56 and 57 from the position in which they are shown in the drawing downward until the diaphragm follower nut 48 contacts the stop 101 formed on the casing section 50. The stop 101, as has been hereinbefore explained, is so located with respect to the position in which the diaphragm follower nut 48 is shown in the drawing that the pawl 35 will rotate the ratchet wheel 34 clockwise through an angle of 30 degrees as the follower nut 48 and rod 37 move from the position in which they are shown in the drawing to the position in which the follower nut 48 contacts the stop 101.

Since the ratchet wheel 34 and the gear 9 are both press-fitted onto the shaft 33, the gear 9 will also rotate clockwise through an angle of 30 degrees. The clockwise rotation of the gear 9 will drive the pinion 8 to rotate in a counterclockwise direction through an angle of 90 degrees since the gear ratio between the pinion and the gear is 1 to 3. Therefore the rotation of the pinion 8 counterclockwise through an angle of 90 degrees will rotate the rotary contact discs 19 and 20 of the rotary switch device 6 counterclockwise from the positon in which they are shown in the drawing to a position in which the switch contact bosses 25 and 26 on the rotary contact disc 19 are brought into contact with the stationary switch members 29 and 30 respectively, and the switch contact bosses 27 and 28 on the rotary contact disc 20 are moved out of contact with the stationary switch members 31 and 32 respectively. As the switch operating member 56 is moved downward along with the rod 37, the leg 64 is effective to rock bell crank 58 counterclockwise about pin 59 until the arm 61 of the bell crank is moved out of the vertical path of movement of the legs 63 and 64 of the member 56. In this position of the bell crank 58 the segment 62 carried on the leg 60 of the bell crank is still in contact with stationary switch member 84. Therefore, the cut-in and cut-out switch 12 remains in its closed position to connect wire 83 to wire 85.

As the switch operating member 57 is moved downward as explained above, the short leg 71 thereof first moves downward away from the arm 67 of bell crank 65 and then into contact with the arm 68 whereupon the bell crank is rocked counterclockwise about pin 66 to bring the segment 69 carried by arm 67 into contact with the stationary switch members 90 and 91.

With the compressor units stopped, the reservoir 5 and chamber 52 at atmospheric pressure, the diaphragm follower nut 48 in contact with the stop 101, the rotary switch device 6 in the position in which rotary contact disc 19 connects wire 81 to wire 82, the switches 89, 95 and 98 open and the cut-off and cut-in switches 12 and 13 closed, as explained above, both compressor units may be started simultaneously by manually closing the switch 89. One or the other of the switches 95 and 98 should also be closed at this time for a reason hereinafter made more apparent.

Let it be assumed that the switches 89 and 95 are manually closed. When the switches 89 and 95 are closed, two power supply circuits are established to each of the motors 3 and 4.

The first power supply circuit for the motor 3 extends from the positive terminal of the battery 7 through wire 78, and now closed switch 89, wire 81, stationary switch member 30, switch contact boss 26, of rotary contact disc 19, outer ring 23 and switch contact boss 25 of the rotary contact disc 19, stationary switch member 29 and wire 82 to the motor 3 which is connected to the negative terminal of the battery 7 through wire 83, segment 62, stationary switch member 84 of the now closed switch 12, and the wires 85 and 75.

The second power supply circuit for the motor 3 extends from the positive terminal of the battery 7 through wire 78 and now closed switch 89, wire 92, segment 69 and stationary switch member 91 of the now closed switch 13, and thence through wires 94 and 82 to the motor 3 which is connected to the negative terminal of battery 7 as explained for the first power supply circuit.

The first power supply circuit for the motor 4 extends from the positive terminal of the battery 7 through wire 78 and now closed switch 89, wire 81, branch wire 96, now closed switch 95, branch wire 97, wire 93 and wire 87 to the motor 4 which is connected by the wire 88 to to the wire 83 and thence to the negative terminal of battery 7 as has been explained.

The second power supply circuit for the motor 4 extends from the positive terminal of the battery 7 to the segment 69 of the switch 13 as explained for the second power supply circuit for the motor 3. The second power supply circuit for the motor 4 continues from the segment 69 of the now closed switch 13 to the stationary switch member 90 and thence through wire 93 and wire 87 to the motor 4 which is connected to the negative terminal of battery 7 as previously explained.

When electric power is thus simultaneously supplied to the motors 3 and 4 they will operate the compressors 1 and 2 respectively, to deliver fluid under pressure through the check valves 15 and 17 and pipes 14 and 16 respectively, to the storage reservoir 5.

As the fluid under pressure compressed by the compressors 1 and 2, respectively, is delivered to the storage reservoir 5, the pressure in the reservoir 5 and in the chamber 52 will increase. The pressure in chamber 52 acts on the effective area of diaphragm 46 in opposition to the force of the spring 53. Therefore, when compressors 1 and 2 have supplied sufficient fluid under pressure to the reservoir 5 and chamber 52 to increase the pressure therein acting on diaphragm 46 to a value sufficient to overcome the force of the spring 53 acting on the opposite side of the diaphragm, this pressure, acting on the effective area of the diaphragm, will deflect the diaphragm and move the rod 37 upward against the force of the spring 53.

As the rod 37 is moved upward in response to the increasing pressure in chamber 52, the switch operating members 56 and 57, and pawl 35 are moved upward with the rod. After the switch operating member 57 is thus moved upward a chosen distance, the shorter leg 71 thereof is effective through arm 67 to rock bell crank 65 clockwise about pin 66 until the segment 69 carried by arm 67 of the bell crank is moved out of contact with the stationary switch members 90 and 91 and this occurring when the pressure in the chamber 52 and reservoir 5 corresponds to the hereinbefore mentioned second cut-off pressure. This cut-off pressure will be registered on a pressure gauge 102 connected to the pipe 54 by a branch pipe 103.

At the time the segment 69 carried by arm 67 of bell crank 65 of switch 13 moved out of contact with stationary switch members 90 and 91, the hereinbefore mentioned second power supply circuits for the motors 3 and 4 respectively are opened. However, the hereinbefore mentioned first power supply circuits for the motors 3 and 4 remain closed. Consequently, the motors 3 and 4 will continue to operate the compressors 1 and 2 respectively to deliver fluid under pressure to the reservoir 5.

As the fluid under pressure compressed by the com-

pressors 1 and 2 continues to be delivered to the reservoir 5, the pressure in the reservoir and chamber 52 will continue to increase. As the pressure in the chamber 52 increases above the hereinbefore mentioned second cut-off pressure, the rod 37 will be moved upward until the leg 63 of switch operating member 56 is moved into contact with arm 60 of bell crank 58 of the cut-off and cut-in switch 12. Further increase in the pressure in chamber 52 and reservoir 5 continues to move the rod 37 upward to effect clockwise rocking of the bell crank 58 about pin 59 until the segment 62 carried on arm 60 of the bell crank is moved out of contact with the stationary switch member 84 segment to open the hereinbefore mentioned first power supply circuits for the motors 3 and 4 to stop these motors and the compressors 1 and 2, respectively. The pressure in the chamber 52 and the reservoir 5 required to move the segment 62 out of contact with the stationary switch member 84 corresponds to the hereinbefore mentioned first cut-off pressure and is the highest pressure ever obtained and desired in the reservoir 5.

As the rod 37 is moved upward, as hereinbefore explained, the pawl 35 will ratchet over the teeth on the ratchet wheel 34 since the detent 42 engages one of the notches 43 on shaft 33 to prevent counterclockwise rotation of the shaft and ratchet wheel, and, at the time the switch 12 is opened, will be in a position in which the lower end thereof is disposed above the tooth that occupies the same position as a tooth 104 shown on the drawing.

After the pressure in the reservoir 5 has been raised to the maximum pressure desired by operation of both compressors 1 and 2, and the cut-off and cut-in switch 12 has been operated to its open position by the leg 63 of the switch operating member 56, an operator in charge of the air compressing equipment will open the switch 95 in order that subsequent fluid under pressure supplied to the reservoir 5 will be compressed by one or the other of the compressors 1 and 2 operating sequentially so long as the demand for fluid under pressure from the reservoir 5 does not exceed the capacity of one compressor.

It may be noted that the switch 95 may be opened, if desired, after the cut-in and cut-out switch 13 has opened, to allow only the compressor 1 to continue to supply fluid under pressure to the storage reservoir 5. However, if the switch 95 is opened at this time, a longer period of time will be required to raise the pressure in the storage reservoir 5 to the cut-off pressure of the switch 12 than if the switch 95 remains closed and both compressors continue to operate to supply fluid under pressure to the storage reservoir until the pressure therein reaches this cut-off pressure.

With the storage reservoir 5 charged to the pressure required to effect opening of the cut-off and cut-in switch 12, switches 95 and 98 open, the rotary contact disc 19 of the rotary switch device 6 in the position to connect the wire 81 to the wire 82, and both compressor units idle, let it be assumed that the operator opens the valve 80 in the outlet pipe 79 to permit fluid under pressure to flow from the reservoir 5 through the valve 80 and the pipe 79 to the place of use. This flow of fluid under pressure from the reservoir 5 will cause a reduction in the pressure therein and in chamber 52 of the fluid motor 11. Therefore, when the valve 80 is opened and fluid under pressure begins to flow from the reservoir 5 to the place of use, the force acting upward on the lower side of the diaphragm 46 in opposition to the force of spring 53 acting downward on the upper side is reduced. As the force acting upward on the diaphragm 46 thus reduces in response to the use of fluid under pressure from the reservoir 5, the force of spring 53 moves rod 37, pawl 35, and switch operating members 56 and 57 in a downward direction.

As the rod 37 is moved downward in response to the reduction in pressure in chamber 52, the pawl 35 will first contact the end of the tooth on the ratchet wheel 34 that occupies the position of the tooth 104 shown on the drawing and thereafter impart clockwise rotation to the ratchet wheel 34, gear 9 and shaft 33.

The switch operating member 56 is moved downward simultaneously with the pawl 35, and when the pressure in chamber 52 and reservoir 5 has been reduced to substantially the hereinbefore mentioned first cut-in pressure, the leg 64 of switch operating member 56 will move into contact with the arm 61 of the bell crank 58 and rotate the bell crank counterclockwise to bring the segment 62 into circuit closing relationship with the stationary switch member 84.

As can be seen from the drawing, the various parts of the equipment are so proportioned that, when the rod 37 has been moved downward a distance sufficient for leg 64 of switch operating member 56 to rock bell crank 58 counterclockwise until segment 62 has been brought into circuit closing relation with the stationary switch member 84, the pawl 35, by reason of its contact with the tooth that occupied the same position as the tooth 104 shown in the drawing, will have rotated the ratchet wheel 34 and gear 9 clockwise through an angle of 30 degrees. Since the gear ratio between the pinion 8 and gear wheel 9 is 1 to 3, when the gear 9 is rotated clockwise through an angle of 30 degrees, the pinion 8 is rotated counterclockwise through an angle of 90 degrees. It will be remembered that when the compressor units were started, it was assumed that the rotary switch device 6 was in the position in which rotary contact disc 19 connected wire 81 to the wire 82. Therefore, when the pinion 8 is rotated counterclockwise through an angle of 90 degrees as just explained, the shaft 18 and rotary contact discs 19 and 20 of the rotary switch device 6 are also rotated counterclockwise through an angle of 90 degrees to bring the rotary contact discs 19 and 20 into a position in which the switch contact bosses 27 and 28 of the rotary contact disc 20 contact respectively, the stationary switch members 32 and 31 to connect the branch wire 86 to the wire 87 and the rotary contact disc 19 is effective to disconnect the wire 81 from the wire 82.

When the rotary contact disc 20 is thus rotated to the position to connect branch wire 86 to the wire 87, a power supply circuit is established for the motor 4 since the bell crank 58 is simultaneously rocked to a position in which the segment 62 is in contact with the stationary switch member 84. This circuit extends from the positive terminal of the battery 7 through wire 78 and now closed switch 89, wire 81, branch wire 86, stationary switch member 31, switch contact boss 28 of rotary contact disc 20, outer ring 23 and switch contact boss 27 of the rotary contact disc, stationary switch member 32, wire 87 to the motor 4 which is connected to the negative terminal of the battery 7 through wire 88, wire 83, segment 62, stationary switch member 84 of the now closed switch 12 and wires 85 and 75.

When a power supply circuit to the motor 4 is thus established, this motor will start and drive the compressor 2 to supply fluid under pressure to the storage reservoir 5 through the pipes 16 and 14, and the check valve 17. As the fluid under pressure compressed by the compressor 2 is delivered to the reservoir 5, the pressure in the reservoir and in the chamber 52 of the fluid motor 11 will increase. The fluid motor 11 will operate in response to the increasing pressure in chamber 52 to move the rod 37 upward until the pressure in the reservoir 5 and chamber 52 reaches the hereinbefore mentioned first cut-off pressure at which time switch 12 is opened in the manner hereinbefore explained. When the switch 12 is opened, the supply of power from the battery 7 to the motor 4 is cut off. Consequently, the motor 4 and compressor 2 are stopped to discontinue the supply of fluid under pressure to the reservoir 5 and chamber 52.

As the rod 37 is moved upward in response to the increasing pressure in chamber 52, the pawl 35 and switch

operating members 56 and 57 are moved upward with it. Consequently, when the rod 37 and switch operating member 56 have been moved upward far enough to effect opening of the switch 12, the pawl 35 will have been moved upward far enough to ratchet over one tooth on the ratchet wheel 34.

Subsequently, as fluid under pressure is used from the reservoir 5 after the compressor 2 has stopped, the pressure in the reservoir 5 and chamber 52 will be reduced until its value reaches that of the hereinbefore mentioned first cut-in pressure. As the pressure in the reservoir 5 and chamber 52 is reduced from the hereinbefore mentioned first cut-off pressure to the hereinbefore mentioned first cut-in pressure, the rod 37 will be moved downward by the spring 53 far enough for the pawl 35 to rotate the ratchet wheel 34 and gear 9 clockwise through an angle of 30 degrees, and for the leg 64 of the switch operating member 56 to rock the bell crank 58 counterclockwise until the segment 62 is brought into contact with the stationary switch member 84 to connect the wire 83 to the wire 85.

Clockwise rotation of the gear 9 through an angle of 30 degrees effects counterclockwise rotation of the pinion 8, and rotary contact discs 19 and 20 of the rotary switch device 6 through an angle of 90 degrees, as has been hereinbefore explained. Therefore, the rotary contact disc 19 will be in a position in which its switch contact bosses 25 and 26 contact the stationary switch members 29 and 30 respectively, to connect the wire 81 to the wire 82 and the rotary contact disc 20 will be in a position in which the branch wire 86 will be disconnected from the wire 87.

With the rotary contact disc 19 now in a position in which the wire 81 is connected to the wire 82, and wire 83 connected to wire 85, as explained above, power will be supplied from the battery 7 to the motor 3 through its hereinbefore mentioned first power supply circuit. When power is thus supplied to the motor 3, the motor will start and drive the compressor 1 to supply fluid under pressure to the reservoir 5 through the pipe 14 and check valve 15. The compressor 1 will operate to supply fluid under pressure to the reservoir 5 and chamber 52 until the pressure therein reaches the hereinbefore mentioned first cut-out pressure at which time the switch 12 is operated to disconnect wire 83 from wire 85 and open the power supply circuit for the motor 3 to stop the motor and compressor 1.

Since the pawl 35 is ratcheted over a tooth on the ratchet wheel 34 each time the fluid motor 11 is operated in response to an increase in pressure in the chamber 52 from the hereinbefore mentioned first cut-in pressure to the hereinbefore mentioned first cut-off pressure, a subsequent reduction in the pressure in the reservoir 5 and chamber 52 to the hereinbefore mentioned first cut-in pressure, as fluid under pressure is used from the reservoir, will effect operation of the pawl and ratchet mechanism 10 and rotary switch device 6 to establish the power supply circuit to the motor 4 so that the motor 4 will now drive the compressor 2. The output of compressor 2 will be supplied to the reservoir 5 until the pressure therein again reaches the hereinbefore mentioned first cut-off pressure at which time the compressor 2 and motor 4 will be stopped.

From the foregoing description of operation of the motors 3 and 4 and compressors 1 and 2 respectively, it is apparent that the two compressor units are started sequentially as the pressure in the reservoir 5 and chamber 52 successively reduces to the hereinbefore mentioned first cut-in pressure of switch 12 so long as the demand for fluid under pressure from the reservoir does not exceed the capacity of a single compressor.

Now let it be assumed that the demand for fluid under pressure from the reservoir 5 is in excess of the output capacity of a single compressor unit. Since it has been assumed that the demand for fluid under pressure from the reservoir 5 exceeds the capacity of a single compressor, it is evident that the pressure in the reservoir 5 and chamber 52 will continue to reduce after the fluid motor 11 operates the switch 12, pawl and ratchet mechanism 10 and rotary switch device 6 to start one of the compressor units. Since the fluid motor 11, rod 37, pawl 35, and switch operating members 56 and 57 occupy the position in which they are shown in the drawing when the pressure in chamber 52 and reservoir 5 corresponds to the hereinbefore mentioned first cut-in pressure, it is apparent that, as the pressure in chamber 52 is reduced below this cut-in pressure in response to the demand for fluid under pressure from the reservoir 5, exceeding the output capacity of a single compressor, the spring 53 will be effective to move the rod 37 and diaphragm 46 downward from the position in which they are shown in the drawing as the pressure in reservoir 5 and chamber 52 reduces below this cut-in pressure.

As the rod 37 is thus moved downward from the position in which it is shown in the drawing, the pawl 35 carried by the rod 37 will be effective to operate the pawl and ratchet mechanism 10 and rotary switch device 6 to open the power supply circuit to that one of the motors to which a power supply circuit was established when the rod 37, and pawl 35 occupied the position in which they are shown in the drawing.

Since the rod 37 is moved downward by the spring 53 as the pressure in reservoir 5 and chamber 52 reduces, the segment 72 carried by the rod 37 will be brought into contact with the stationary contacts 73 and 74 when the pressure in chamber 52 and reservoir 5 is reduced to the hereinbefore mentioned certain pressure which is less than the hereinbefore mentioned first cut-in pressure. When the segment 72 is brought into contact with the stationary contacts 73 and 74 a power supply circuit is established for the lamp 77. The supply of power to the lamp 77 lights the lamp which is an indication to the operator in charge of the compressor units that fluid under pressure is being used from the reservoir 5 faster than it is being replenished.

As the pressure in chamber 52 continues to be reduced after the lamp 77 is lighted in response to the demand for fluid under pressure from the reservoir 5 exceeding the output capacity of a single compressor, the spring 53 will continue to move the rod 37, pawl 35, and the switch operating members 56 and 57 downward until the short leg 71 of the switch operating member 57 contacts the arm 68 of the bell crank 65. Upon further reduction in the pressure in the chamber 52 and reservoir 5 to the hereinbefore mentioned second cut-in pressure, the short leg 71 is effective to rock the bell crank 65 counterclockwise about pin 66 to bring the segment 69 carried by the arm 67 of the bell crank into contact with the stationary switch members 90 and 91.

When the segment 69 is brought into contact with the stationary switch members 90 and 91, the hereinbefore mentioned second power supply circuits for the motors 3 and 4 are established. Consequently, power will be supplied from the battery 7 to the motors 3 and 4 whereupon these motors will start and drive the compressors 1 and 2 respectively. Both compressors will now operate to supply fluid under pressure to the reservoir 5 and chamber 52 to increase the pressure therein.

As the fluid under pressure compressed by both compressors continues to be delivered to the reservoir 5, the pressure in the reservoir and in chamber 52 will increase. The increasing pressure in chamber 52 acts on the effective area of diaphragm 46 in opposition to the force of the spring 53 and moves the rod 37 and the switch operating member 57 upward. As the switch operating member 57 is thus moved upward, the short leg 71 of member 57 is moved upward away from the arm 68 of bell crank 65. The rod 37 and switch operating member 57 will continue to move upward in response to the increasing fluid pressure in chamber 52 until the pressure in chamber 52 reaches substantially the hereinbefore men-

tioned second cut-off pressure at which time the short leg 71 of the switch operating member 57 contacts the arm 67 of the bell crank 65 to rock the bell crank clockwise about pin 66 until the segment 69 carried by arms 67 of the bell crank is moved out of contact with the stationary switch members 90 and 91.

When the segment 69 is moved out of contact with the stationary switch members 90 and 91, the hereinbefore mentioned second power supply circuits for the motors 3 and 4 respectively, are opened to stop these motors and the compressors 1 and 2 respectively.

Both compressor units will now remain idle until the pressure in the reservoir 5 and chamber 52 has been reduced, in response to the demand for fluid under pressure from the reservoir, to the hereinbefore mentioned second cut-in pressure, at which time the segment 69 is moved into contact with the stationary switch members 90 and 91 to reestablish the hereinbefore mentioned second power supply circuits for the motors 3 and 4. The motors 3 and 4 will then drive the compressors 1 and 2 respectively, until the pressure in the reservoir 5 and chamber 52 again reaches the hereinbefore mentioned second cut-off pressure whereupon the power supply circuits to the motors are opened to stop the compressor units.

From the above, it is apparent that, upon the demand for fluid under pressure from the reservoir 5 exceeding the capacity of a single compressor, both compressors will be automatically brought into operation to maintain reservoir pressure between the hereinbefore mentioned second cut-off pressure lower than the hereinbefore mentioned first cut-in pressure, and the hereinbefore mentioned second cut-in pressure.

It may be noted that if the demand for fluid under pressure is constant and substantially equal to the combined capacity of the two compressor units, both compressors will remain in operation without the pressure in the reservoir 5 and chamber 52 increasing to the hereinbefore mentioned second cut-off pressure and operating switch 13 to stop the compressor units. Consequently, both compressor units will operate to meet the demand for fluid under pressure as long as the demand remains constant and equal to the combined capacity of the two compressor units.

Now let it be supposed that after both compressor units have been operating simultaneously to meet a demand for fluid under pressure from the reservoir 5 that is in excess of the capacity of a single compressor unit, the demand is reduced until it is substantially equal to or less than the capacity of a single compressor unit.

The operator in charge of the fluid compressing equipment will have knowledge of the slowing down or stopping of the various fluid pressure operated devices using fluid under pressure from the reservoir 5. Consequently, when he has ascertained that the demand for fluid under pressure has been reduced to or below the capacity of a single compresser unit, he will manually close either of the switches 95 or 98 or both of them.

Let it be assumed that the operator closes the switch 98. When the switch 98 is closed, a power supply circuit for the motor 3 is established which is independent of the cut-in and cut-out switch 13. This independent power supply circuit extends from the positive terminal of the battery 7 through wire 78 and now closed switch 89, wire 81, branch wire 99, now closed switch 98, branch wire 100, wire 94 and wire 82 to the motor 3 which is connected to the negative terminal of battery 7 through wire 83, now closed switch 12, wire 85, and wire 75.

With the above-described independent power supply circuit for the motor 3 established, this motor will continue to drive the compressor 1 after the pressure in the reservoir 5 and chamber 52 reaches the hereinbefore mentioned second cut-off pressure and the switch 13 is opened to stop the motor 4 when the segment 69 is moved out of contact with the stationary switch members 90 and 91.

The continued operation of the motor 3 and compressor 1 will increase the pressure in the reservoir 5 and chamber 52 to effect upward movement of rod 37, pawl 35, and switch operating members 56 and 57 until the pressure in the chamber 52 reaches substantially the hereinbefore mentioned first cut-off pressure at which time switch 12 is opened to disconnect wire 83 from wire 85 and stop the motor 3. At this time the operator will open switch 98 to provide for subsequent sequential operation of the compressor units.

If it be assumed that switches 95 and 98 are both closed, when the demand is reduced to the capacity of a single compressor, instead of only the switch 98, then an independent power supply circuit is established for each of the motors 3 and 4 and these motors will continue to drive the compressors 1 and 2 respectively after the pressure in the reservoir 5 reaches the hereinbefore mentioned second cut-off pressure and moves the segment 69 of switch 13 out of contact with the stationary switch members 90 and 91. Consequently, the pressure in the reservoir 5 and chamber 52 can be raised to the hereinbefore mentioned first cut-off pressure in less time than is required when only one compressor is operating. After the switch 12 is opened in response to the pressure in the reservoir 5 and chamber 52 increasing to the hereinbefore mentioned first cut-off pressure as a result of the operation of both compressors, the operator will manually open the switches 95 and 98 to provide for subsequent sequential operation of the compressor units.

As the rod 37 is moved upward in response to the increasing pressure in chamber 52 as a result of single or multiple operation of the compressors, the pawl 35 is moved upward with the rod and is ratcheted over the teeth on the ratchet wheel 34 so that at the time the switch 12 is opened, the lower end of the pawl 35 occupies a position just above the tooth on the ratchet wheel which occupies the position of the tooth 104 shown on the drawing.

Furthermore, as the rod 37 is moved upward, the segment 72 carried by the rod is moved out of contact with the stationary contacts 73 and 74 to extinguish the lamp 77.

Now, with both compressor units stopped, the switches 95 and 98 open and the reservoir 5 charged to the hereinbefore mentioned first cut-off pressure, if fluid under pressure is used from the reservoir 5 at a rate that does not require the operation of both compressor units to meet the demand for fluid under pressure, the motor and compressor 1 will be started when the pressure in the reservoir 5 and chamber 52 is reduced to the hereinbefore mentioned first cut-in pressure, and thereafter, the two compressor units will be operated sequentially to maintain the pressure in the reservoir 5 between the hereinbefore mentioned first cut-in pressure and first cut-out pressure as long as the demand does not exceed the capacity of a single compressor. If, however, the demand for fluid under pressure is increased beyond the capacity of a single compressor, both compressor units will be brought into operation automatically when the pressure in the reservoir 5 and chamber 52 is reduced to the hereinbefore mentioned second cut-in pressure. Both compressor units will then operate simultaneously, either continuously or intermittently depending on the demand, to maintain the pressure in the reservoir 5 and chamber 52 at the hereinbefore mentioned second cut-in pressure or between the hereinbefore mentioned second cut-in pressure and second cut-off pressure accordingly as the demand for fluid under pressure is substantially the same as the combined capacities of the two compressors or in excess of the capacity of a single compressor but less than the combined capacities of the two compressors.

It may be noted that, if the operator in charge of the air compressing equipment has knowledge that the demand for compressed air does not exceed the capacity of

a single compressor, the lighting of the lamp 77 will be an indication that the compressor unit last started has stopped due to some cause or defect before it has raised the pressure in the storage reservoir 5 and chamber 52 to the hereinbefore mentioned first cut-off pressure and the pressure in the reservoir and chamber has fallen below the hereinbefore mentioned first cut-in pressure but is still in excess of the hereinbefore mentioned second cut-in pressure. Therefore, upon the stoppage of a compressor unit due to some defect, the operator in charge of the equipment will be alerted by the lighting of lamp 77 that one of the compressor units is no longer operative whereupon he may manually control the operation of the other compressor unit by means of the switch 95 or 98, depending on which of the compressor units is defective, until the defective unit has been repaired and is ready for sequential operation again.

The motor circuits illustratively shown as controlled directly by the rotary switch device 6 may be controlled indirectly by the rotary switch device through low voltage control circuits containing relays or contactors whereby to enable the customary voltage or current in the motor circuit to be controlled by the relays and thus avoiding excessive arcing at the contacts of the rotary switch device.

In order to reduce or prevent excessive arcing, a snap acting type of relay may be used if desired.

Also it will be apparent that the rotary switch device may be utilized to control the starting and stopping of other devices than electric motors employed to drive the compressors.

Having now described the invention, what we claim as new and desire to secure by Letters Patent is:

1. A multi-compressor installation comprising a reservoir for storing air under pressure, a plurality of air compressors, conduit means connecting each of said air compressors to said reservoir via which compressed air is conducted for charging said reservoir with air under pressure, separate power means for driving each of said compressors, a source of power, rotary control means sequentially operated to a plurality of positions for, in each different position, effecting the supply of power from said source of power to a corresponding one of said separate power means, and an air motor operated responsively to successive reductions of the air pressure in said air pressure storage reservoir from a first chosen air pressure to a second chosen air pressure, lower than said first chosen air pressure, to operate said rotary control means sequentially into the said plurality of different positions to cause sequential operation of said air compressors to charge said reservoir.

2. A multi-compressor installation comprising a reservoir for storing air under pressure, a plurality of air compressors, conduit means connecting each of said air compressors to said reservoir via which compressed air is conducted for charging said reservoir with air under pressure, separate electric power means for driving each of said compressors, a source of electric power, rotary switch means sequentially operated to a plurality of positions, in each different one of which positions it effects the supply of electric power to a correspondingly different one of said separate electric power means, and an air motor operated responsively to successive reductions of air pressure in said storage reservoir from a first chosen air pressure to a second chosen air pressure, lower than said first chosen air pressure, to operate said rotary switch means to a succeeding position whereby to cause sequental operation of said air compressors to charge said reservoir.

3. A multi-compressor installation comprising a fluid pressure storage reservoir, a plurality of fluid compressors, conduit means connecting each of said fluid compressors to said fluid pressure storage reservoir via which compressed air is conducted for charging said fluid pressure reservoir, separate motive power means for driving each of said compressors, a source of power, rotary switch means sequentially operated to a plurality of positions, in each different one of which positions it effects the supply of power from said source to a correspondingly different one of said separate motive power means driving a corresponding one of said compressors, a fluid motor operated responsively to successive reductions of fluid pressure in said storage reservoir from a first chosen fluid pressure to a second chosen fluid pressure, lower than said first chosen fluid pressure to effect operation of said rotary switch means to a succeeding position whereby to cause sequential operation of said fluid compressors, and start and stop control switch means operated by said fluid motor to a power cut-off position to cut off the supply of power from said source of power to said motive power driving means for said plurality of compressors in response to the fluid pressure in said storage reservoir increasing to said first chosen fluid pressure and to a power cut-in position to effect the supply of power from said source of power to said motive power driving means for said plurality of compressors in response to the fluid pressure in said storage reservoir reducing to said second chosen fluid pressure.

4. A multi-compressor unit installation comprising a reservoir for storing air under pressure; a plurality of compressor units each consisting of an air compressor, motor means for driving said air compressor, and conduit means connecting the air compressor of each respective compressor unit to said reservoir via which compressed air is conducted to effect the delivery of compressed air to said storage reservoir; a source of power; a rotary sequence control member having a plurality of different control positions; circuit means established in each different one of said control positions for supplying power from said source of power to the motor means of a corresponding compressor unit; means for advancing said rotary sequence control member in a step-by-step manner sequentially to said different control positions and in repeated cycles; and means responsive to variations of the air pressure in said storage reservoir for controlling said advancing means.

5. A multi-compressor unit installation comprising a fluid pressure storage reservoir; a plurality of compressor units each consisting of a fluid compressor, motor means for driving said fluid compressor, and conduit means connecting the fluid compressor of each respective compressor unit to said fluid pressure storage reservoir via which compressed fluid is conducted to effect the delivery of compressed fluid to said fluid pressure storage reservoir; a source of power; a rotary sequence control member having a plurality of different control positions; circuit means established in each different one of said control positions for supplying power from said source of power to the motor means of a corresponding compressor unit; means for advancing said rotary sequence control member in a step-by-step manner sequentially to said different control positions and in repeated cycles; and means responsive to variations of the fluid pressure in said fluid pressure storage reservoir for controlling said advancing means, said circuit means including limit control switch means responsive to variations of the fluid pressure in said fluid pressure storage reservoir for interrupting the supply of power to one of said motor means when the unit fluid pressure in said fluid pressure storage reservoir attains a chosen high value and operative, in cooperation with said rotary sequence control member, to reestablish said circuit means to effect the supply of power to another one of said motor means when the fluid pressure in said fluid pressure storage reservoir is reduced to a chosen lower value.

6. In combination, a plurality of fluid compressors, a plurality of electric motors, one for driving each of said fluid compressors, a fluid pressure storage reservoir, conduit means connecting each of said fluid compressors to said fluid pressure storage reservoir via which compressed fluid compressed by said fluid compressors is conducted

for charging said fluid pressure storage reservoir, a source of electric power, a power supply circuit for each of said electric motors through which electric power is supplied from said source of electric power, a power supply control means for each of said power supply circuits for controlling the supply of power through each of said circuits to the respective electric motor, an operating means for all said power supply control means for concurrently actuating them so that only one connects said source of electric power to one of said electric motors at any one time, fluid motor means subject to the fluid pressure in said fluid pressure storage reservoir, and pawl and ratchet means connected to and actuated by said fluid motor means in response to repeated decreases in the fluid pressure in said fluid pressure reservoir from a first chosen value to a second chosen value for operating said operating means in only one direction in a step-by-step manner to provide for sequential establishment of said power supply circuits to effect operation of the motors one at a time.

7. In combination, a plurality of fluid compressors, a plurality of electric motors, one for driving each of said fluid compressors, a fluid pressure storage reservoir, conduit means connecting each of said fluid compressors to said fluid pressure storage reservoir via which fluid under pressure compressed by said fluid compressors is conducted for charging said fluid pressure storage reservoir, a source of electric power, a power supply circuit for each of said electric motors through which electric power is supplied from said source of electric power, an actuating shaft, a separate control switch for each of said power supply circuits mounted in spaced-apart relationship on said actuating shaft and arranged such that their circuit closing positions bear a definite angular relationship to each other, a gear train having a given gear ratio for driving said actuating shaft, a ratchet wheel operatively connected to said gear train for rotation therewith and having a plurality of teeth the number of which bears a definite relation to the number of teeth on the gears in said gear train to provide for rotation of said actuating shaft and control switches through an angle equal to the definite angular relationship between said control switches upon rotation of said ratchet wheel through an angle equal to the angle between two adjacent teeth on said ratchet wheel, a pawl for said ratchet wheel, start and stop control switch means for controlling the starting and stopping of each and all of said electric motors, and a fluid motor subject to the unit fluid pressure in said fluid pressure storage reservoir and operatively connected to said pawl and to said start and stop control switch means to, respectively, move said pawl over one tooth on said ratchet wheel and to condition said start and stop control switch means for effecting stopping of any and all of the electric motors in response to the supply of compressed fluid to the storage reservoir increasing the fluid pressure therein to a first chosen pressure, and to effect rotation of said ratchet wheel by said pawl through said angle whereby said control switches are sequentially operated to their circuit closing positions and to condition said start and stop control switch means to provide for starting the electric motors in response to the withdrawal of compressed fluid from said fluid pressure storage reservoir decreasing the fluid pressure therein to a second chosen unit fluid pressure, less than the first chosen unit fluid pressure, subsequent to each operation of one of the motor driven compressors to increase the fluid pressure in said fluid pressure storage reservoir to the first chosen unit fluid pressure.

8. In combination, a plurality of fluid compressors, a plurality of electric motors, one for driving each of said fluid compressors, a fluid pressure storage reservoir, conduit means connecting each of said fluid compressors to said fluid pressure storage reservoir via which fluid under pressure compressed by said fluid compressors is conducted for charging said fluid pressure storage reservoir, a source of electric power, a power supply circuit for each of said electric motors through which electric power is supplied from said source of electric power, an actuating shaft, a separate control switch for each of said power supply circuits mounted in spaced-apart relationship on said actuating shaft and arranged such that their circuit closing positions bear a definite angular relationship to each other, a gear train having a given gear ratio for driving said actuating shaft, a ratchet wheel operatively connected to said gear train for rotation therewith and having a plurality of teeth the number of which bears a definite relation to the number of teeth on the gears in said gear train to provide for rotation of said actuating shaft and control switches through an angle equal to the definite angular relationship between said control switches upon rotation of said ratchet wheel through an angle equal to the angle between two adjacent teeth on said ratchet wheel, a pawl for said ratchet wheel, start and stop control switch means for controlling the starting and stopping of each and all of said electric motors, a low pressure alarm means, and a fluid motor subject to the unit fluid pressure in said storage reservoir and operatively connected to said pawl, said start and stop control switch means and said alarm means to, respectively, successively effect simultaneous rotation of said ratchet wheel by said pawl whereby one of said control switches is operated to a circuit closing position and conditioning said start and stop control switch means whereby one of said electric motors may be started, to effect further rotation of said ratchet wheel by said pawl whereby said one control switch is operated to a circuit opening position, and to operate said alarm means to effect an alarm in response to a decrease in the unit fluid pressure in the reservoir from a first chosen unit fluid pressure to a second chosen unit fluid pressure less than the first chosen unit fluid pressure, and then to a third chosen unit fluid pressure less than the second chosen unit fluid pressure.

9. In combination, a plurality of fluid compressors, a plurality of electric motors one for driving each of said fluid compressors, a fluid pressure storage reservoir, conduit means connecting each of said fluid compressors to said fluid pressure storage reservoir via which fluid under pressure compressed by said fluid compressors is conducted for charging said fluid pressure storage reservoir, a source of electric power, a first and a second power supply circuit for each of the electric motors through which power is supplied from said source of electric power, a first power supply control switch for each of said first power supply circuits for controlling the supply of power through each of said first power supply circuits to the respective motor, an operating means for concurrently actuating all said first power supply control switches so that only one of them connects said source of electric power to one of said motors at any one time, a second power supply control switch for simultaneously controlling the supply of power through all of said second power circuits to all of the respective electric motors, said second power supply control switch being arranged in by-passing relationship to all of said first power supply control switches, start and stop control switch means so disposed as to be in series with each of said first power supply control switches and with said second power supply control switch to thereby control both of said power supply circuits for each electric motor, and a fluid motor subject to the unit fluid pressure in said storage reservoir and operatively connected to said operating means, said second power supply control switch and said start and stop control switch means to first effect operation of said operating means whereby one of said separate control switches is operated to a circuit closing position and then to effect conditioning of said start and stop control switch means to cause starting of one of said electric motors in response to a decrease in the unit fluid pressure in said storage reservoir

from a first chosen unit fluid pressure to a second chosen unit fluid pressure, and to effect operation of said operating means whereby said one separate control switch is operated from its circuit closing position to its circuit opening position and operation of said second power supply control switch to a circuit closing position to effect the simultaneous supply of power through each of said second power supply circuits to each of said electric motors in response to a decrease in the unit field pressure in said fluid pressure storage reservoir from the second chosen unit fluid pressure to a third chosen unit fluid pressure less than the second chosen unit fluid pressure.

10. Control apparatus as defined in claim 9, further characterized in that each of said electric motors has a third power supply circuit through which power is supplied from said source, and further includes a manually operative control switch for each of said third power supply circuits for manually controlling the respective motor independently of said first power supply control switches and said second power supply control switch, and a manually operated master power control switch controlling the supply of power from said source of power to all three circuits for each of said electric motors to permit emergency shutdown of each and all motors.

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