W. C. MAYO & J. HOULEHAN.

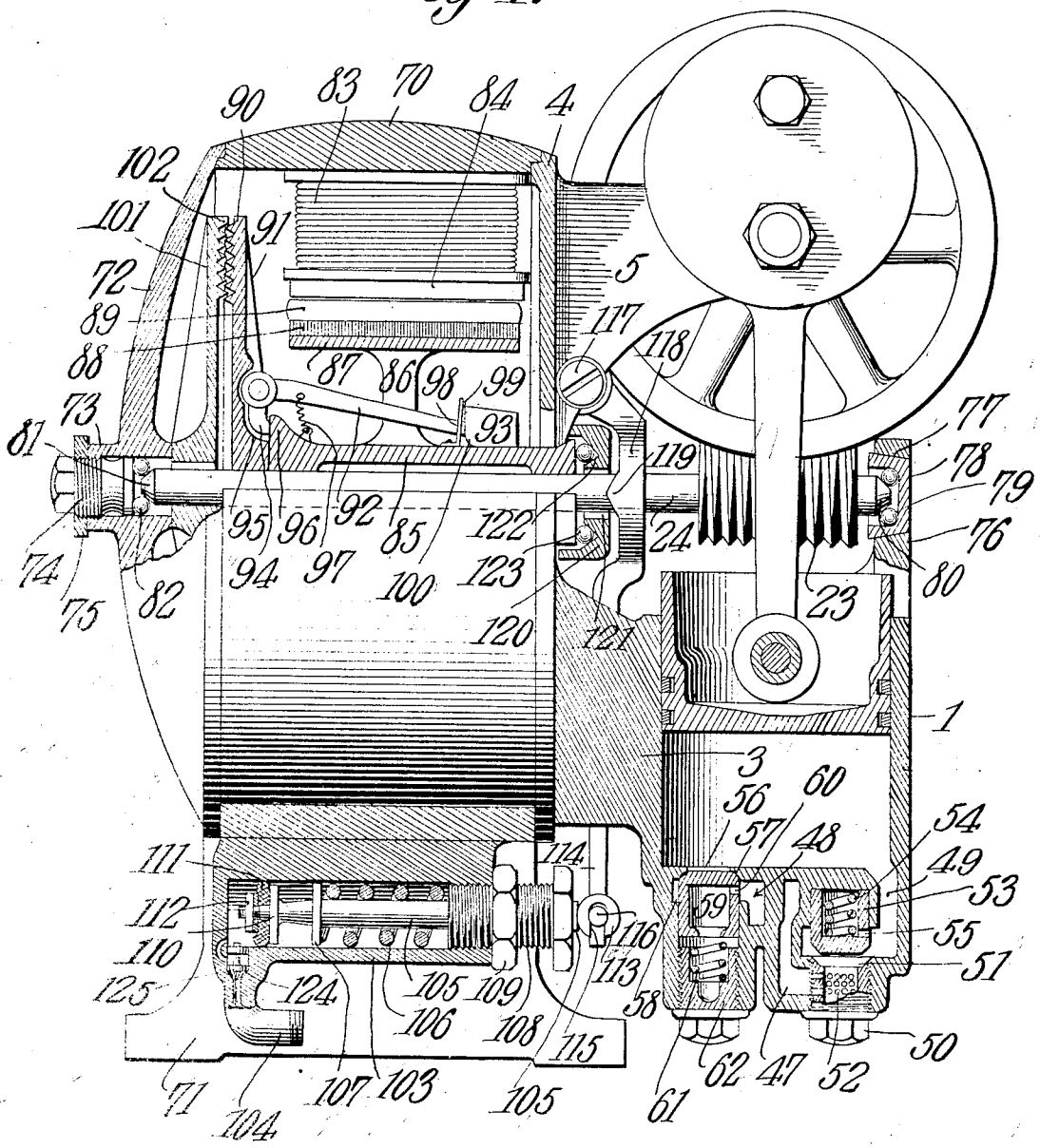
AIR CLEANING SYSTEM.

APPLICATION FILED FEB. 24, 1908.

918,574. Patented Apr. 20, 1909.

3 SHEETS—SHEET 1.

Fig. 1.



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Witnesses

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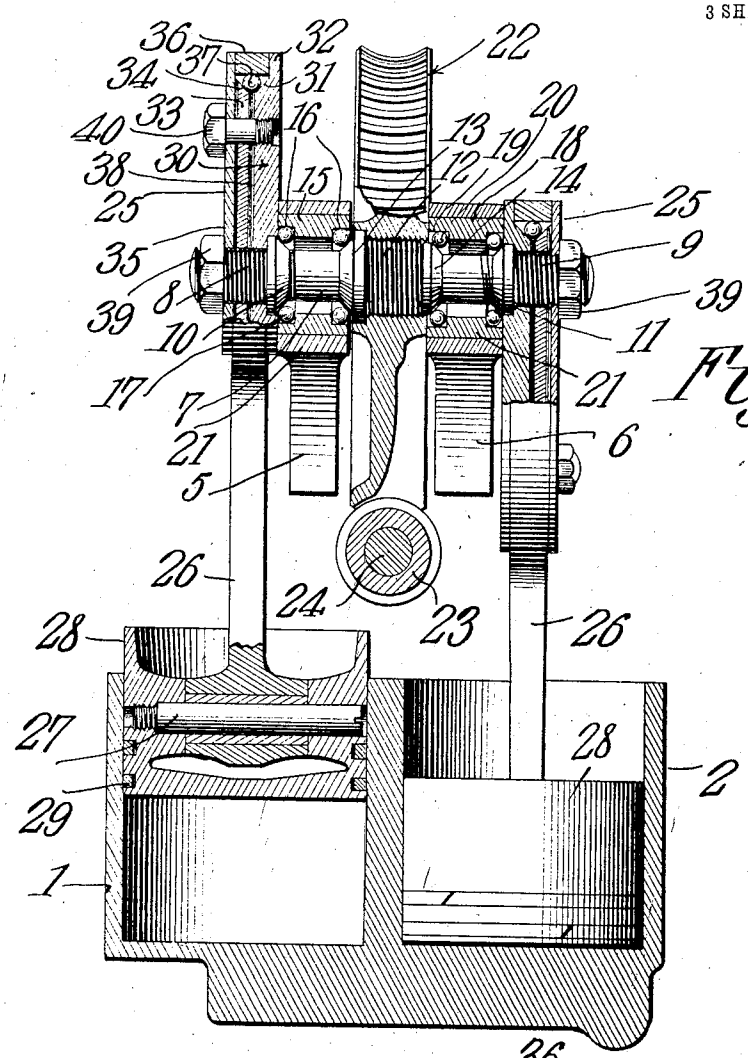


Fig. 2.

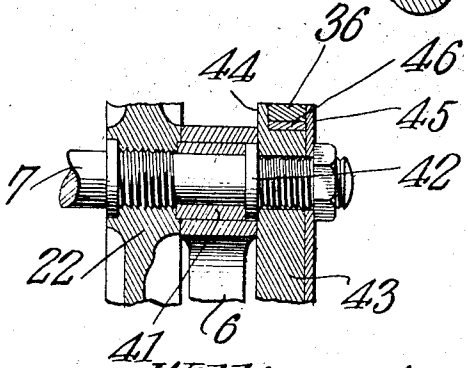


Fig. 3.

Witnesses

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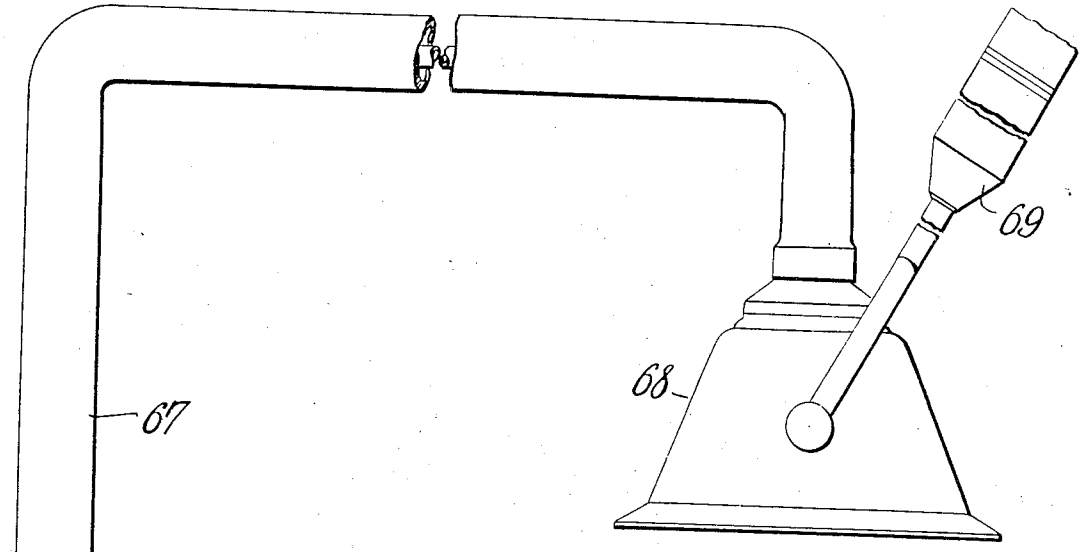
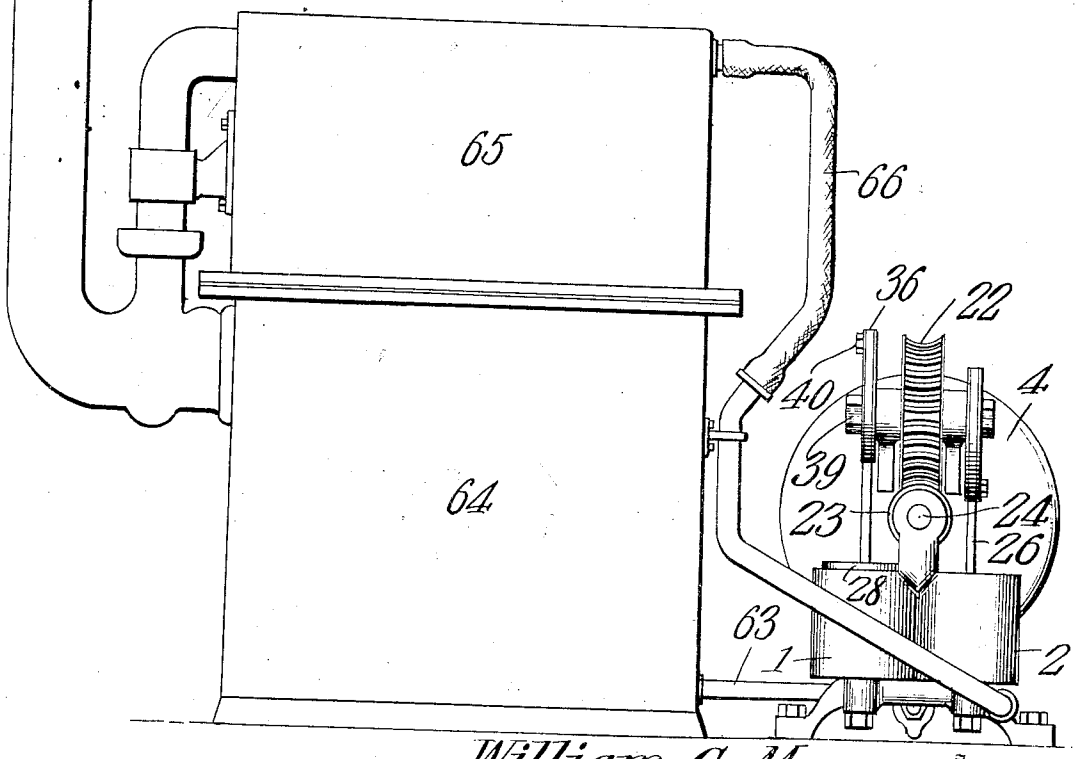


Fig. 4



Witnesses

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UNITED STATES PATENT OFFICE.

WILLIAM C. MAYO AND JOHN HOULEHAN, OF EL PASO, TEXAS, ASSIGNORS OF ONE-THIRD TO GEORGE E. BRIGGS, OF BARSTOW, TEXAS.

AIR-CLEANING SYSTEM.

No. 918,574. Specification of Letters Patent. Patented April 20, 1909.

Application filed February 24, 1908. Serial No. 417,382.

To all whom it may concern:

Be it known that we, WILLIAM C. MAYO and JOHN HOULEHAN, citizens of the United States, residing at El Paso, in the county of El Paso, State of Texas, have invented a new and useful Air-Cleaning System, of which the following is a specification.

This invention has reference to improvements in air cleaning systems designed more particularly for use in dwellings or in other places where it is advantageous to have the air-cleaning mechanism in small units which may be readily moved from room to room and which may be made in domestic sizes.

The present invention is directed more particularly to the air pump and driving means therefor to operate in conjunction with a suitable tank and cleaning head, the tank serving both as an air reservoir and as a means for separating the dust and dirt collected by the current of air from said air current so that the same air may be again used for the pump.

The present invention comprises an air pump together with a motor for driving it, which motor is preferably in the form of an electrically driven motor, although not necessarily confined thereto. In the case of single phase and other induction motors having a low starting torque provision is made whereby the motor will always reach approximately full speed before it is coupled up to the pumps, and again should there be an over-load tending to abnormally reduce the speed of the motor, then this over-load, due to accumulated pressure in the tank, will disconnect the pumps from the rotor of the motor so that the motor is neither overloaded on starting nor can it be overloaded after having attained its speed. Consequently, there is no danger of burning out either the field or armature of any type of motor liable to such accidents, even though the motor be under the direction and control of a person ignorant of the management of an electric motor. These features are particularly advantageous in connection with the system under consideration since the cleaning apparatus is designed for use in dwellings and other places where it is to be used by domestics and other help unskilled in the management of electric apparatus.

The particular type of electric motor is not essential to the present invention but may be either of the alternating current type or of the continuous current type, according to the current available for its operation.

Because of the conditions under which the apparatus is to be used it is made entirely automatic so that the operator has but to turn an electric switch to start or stop the apparatus while the running will require no attention whatsoever during indefinite periods of time. In order to permit the motor to run up to speed before the load is placed upon it, provision is made for operating a friction clutch between the motor and the pump so that the friction clutch members are held out of operation until the speed closely approaches the maximum speed, when the friction members are permitted to engage and will remain so engaged until the motor is nearly or quite stopped. The capacity of the reservoir but little exceeds the demand for compressed air, and the pumps are made to work with but little clearance. Under these conditions should the air outlet to the reservoir be suddenly closed the pump will tend to enormously increase the pressure. This of course means a heavy load upon the motor with the consequent slowing down of the same. In the case of the induction motor there is a rush of current through the fields due to the reduction of the counter electro motive force when the armature slows down, resulting in the burning out of the fields and the possible injury to the squirrel cage of the armature. In the continuous current motor the rush of current under similar conditions results in the burning out of the armature.

In the present invention an increase of air pressure above a certain predetermined maximum reacts upon the clutch mechanism to pull one member away from the other and thus cut out the pump until the pressure is again reduced, and this is accomplished without in any way affecting the speed of the motor, so that in the case of the single phase motor it is not pulled out of synchronism with the current.

The invention will be best understood by a consideration of the following detailed description taken in connection with the accompanying drawings forming part of this specification, in which drawings,—

Figure 1 is a section, partially in elevation, of the improved pumping mechanism. Fig. 2 is a section through the pump cylinders at right angles to the section of Fig. 1, with some parts in elevation and other parts omit-

ted. Fig. 3 is a detail view of a modified form of the mounting for the pump-driving cams. Fig. 4 is an elevation of the complete structure somewhat diagrammatically illustrated.

Referring to the drawings, and more particularly to Figs. 1 and 2, there is shown two pump cylinders 1—2 formed in one casting and connected by brackets 3 to an end plate 4 of the motor casing, to be described. Formed on the plate 4 are other brackets 5—6 above the pumps which serve to support the journals of a shaft 7 carrying the means for driving the pump pistons, as will presently appear. The shaft 7 is threaded at each end, as shown at 8—9, and upon the threaded ends are two cone collars 10—11. At the intermediate portion of the shaft there is also a threaded section 12, at each end of which is formed an annular cone shoulder 13 and 14, respectively. Surrounding the shaft 7 between the cones 10 and 13 is a collar 15 having annular end recesses 16, which recesses coact with the cone faces of the cones 10 and 13 to constitute ball races for a series of anti-friction balls 17. Surrounding the shaft between the collars 11 and 14 is a collar 18 having annular end recesses or grooves 19 co-acting with the conical faces of the cones 11 and 14 to form ball races for the series of antifriction balls 20. The sleeves 15 and 18 are housed in suitable heads 21 formed on the respective brackets 5 and 6.

Fast upon the intermediate threaded portion 12 of the shaft 7 is a large worm wheel 22 in mesh with and driven by a worm 23, on a drive-shaft 24 to be referred to. Mounted eccentrically upon the threaded ends 8 and 9 of the shaft 7 are two eccentric heads 25 connected to pitmen 26, each of which is journaled by a pin 27 to a piston 28 of the ordinary trunk type, which piston has a suitable number of packing rings 29 and is made to fit in the cylinder 1 or 2, as the case may be. Each eccentric 25 consists of a disk 30 having an annular conical shoulder 31 beyond which the disk is formed with a radial flange 32. Matching the disk 30 up to the shouldered portion thereof, is another disk 33 having a peripherally beveled shoulder 34, and outside of this last-named disk is a face-plate 35 of the same diameter as the outside diameter of the radial flange 32 of the disk 30. Between the flange 32 and plate 35 there is housed an eccentric strap 36 formed on the end of the pitman 26. The shoulders 31 and 34, together with the strap 36, coact to form a ball-race for a series of anti-friction balls 37. Between the plates 30 and 33 are a number of laminæ 38 of paper or other suitable material which, as the parts wear, may be removed sheet by sheet to permit the taking up of the wear.

The shaft end 8 or 9, as the case may be, passes through the disk 25 eccentric thereto, and the perforation for the passage of the shaft is counterbored in the disk 30 to form a seat for the cone 10, and a nut 39 applied exterior to the plate 35 serves to clamp the structure firmly to the shaft. In order that the parts may be held together without danger of spreading, a bolt 40 is passed through the plates or disks 33 and 35, and is threaded into the disk 30. This bolt is located at a point diametrically opposite the shaft and equidistant from the center of the respective cam-heads. It will be observed that the right hand end of the shaft 7, as viewed in Fig. 2, is made smaller than the left hand end, and the cones are likewise smaller. This is for the purpose of passing the shaft through the bearing in the bracket 5 and through the worm wheel 22.

It will be seen from an inspection of Fig. 2 that all the moving parts between the shaft and its bearings and between the shaft and the pitmen move upon balls so that the several parts are all provided with anti-friction bearings, and while there is practically no power consumed in these bearings they have the further advantage of requiring very infrequent attention, and by using a suitable lubricant they will not need further lubrication for many months.

In Fig. 3 there is shown a modification of the structure shown in Fig. 2, in so far as the bearings are concerned, since in this case the ordinary rubbing bearings are provided and ball bearings are omitted. In each bracket 5 or 6 a sleeve 41 of brass or phosphor bronze or Babbitt metal is introduced between the bracket and the shaft and may be confined in place by a loose collar or washer 42. The disk or plate 30 is replaced by a thicker disk 43 provided on one side with a radial peripheral flange 44 between which and the face plate 45 is confined a ring 46 of some suitable metal, such as named with respect to the sleeve 41. Exterior to this ring 46 is the eccentric strap 36, as before.

The valve structure for each cylinder is shown in Fig. 1. Below each piston and in the same casting with the cylinder there is formed an intake chamber 47 and an outlet chamber 48. The inlet chamber 47 communicates with the bottom of the respective cylinder through a passage 49, and in this passage is the hollow stem of a plug 50 formed at its upper end into a valve seat 51, and having its walls provided with numerous perforations 52. In operative relation to the valve seat 51 is a valve 53 in the form of a cup seated in a suitable socket formed in the casing below the bottom of the cylinder, and this valve is urged to its seat by a helical spring 54 housed in the valve 53. In order to avoid dash-pot action of the valve there are one or more perforations 55 through its

walls. Formed in the bottom of the cylinder is a port 56 leading to a valve seat 57 at the upper end of a valve chamber 58 communicating with the outlet chamber 48. This valve seat 57 receives a valve 59 similar to the valve 55 and having one or more perforations 60 through its walls to prevent dash-pot action. The valve 59 is urged to its seat by a helical spring 61 contained in a hollow plug 62 screwed into the casing from below. These valves act in the usual manner and are made in practice of ample size to admit the flow of the air streams without undue friction. The perforations 52 in the plug 50 act after the manner of a strainer to prevent any obstructions reaching the valve seat 51 or the valve seat 57 and thereby preventing the respective valves from properly seating therein. The outlet chamber 48 is connected by a conduit 63 with a reservoir tank 64, which may carry a suitable separator 65 for taking out the dust and dirt from the air before reaching another conduit 66 which may connect with the intake chamber 47, so that under certain conditions of operation the same body of air is used over and over again. The reservoir 64 and separator 65 are connected by a conduit 67 to a cleaning head 68, provided with a manipulating handle 69, but as the construction of these several parts forms no part of the present invention but are made the subject-matter of another application, these parts are neither shown nor described in detail herein and are only shown in order that the operation and purposes of the pump and driving mechanism therefor may be apparent.

The end plate 4, together with the pumps and the parts connected directly therewith is carried by a cylindrical casing 70 mounted upon a suitable foot or base 71 which may be cast in one piece with the cylinder 70. The end of the cylinder 70 opposite the plate 4 is closed by a cap-plate 72 formed at its center with a hub 73 in which is fitted a screw-plug 74 locked in place by a suitable lock-nut 75.

Extending upward from a point midway between the two cylinders is a post 76 having a tapered opening 77 in which is seated a taper-cup 78 housing a series of balls 79 held in the cup by the conical end 80 of the shaft 24. The other end of this shaft 24 has a conical end 81 engaging a series of antifriction balls 82 held by the shaft in the interior of the hub 73 against the screw-plug 74. The cup 78 with the balls 79 and the hub 73 with the screw-plug 74 and balls 82 constitute anti-friction bearings for the two ends of the shaft 24 and wear may be readily taken up by means of the screw-plug 74.

Mounted upon the casing 70 and directed radially inward are a suitable number of field coils 83 having pole pieces 84. Upon the shaft 24 is an extended hub 85 engaging the shaft near the ends only of the hub, and this hub has cast on it radial arms or spokes 86 supporting a cylinder 87 upon which are mounted the armature laminæ 88 carrying the bars 89 of the usual squirrel cage type of armature, the showing in the drawing being that of an alternating current motor of the squirrel cage type.

Mounted upon the shaft 24 at one end of the hub 85 is a friction member in the form of a disk 90 which may have radial ribs 91 formed thereon for purposes of strength. Journaled on the disk 90 on the ribbed side thereof are a number of bell-crank levers 92, only one of which is shown. Each lever has a long arm terminating in a weight 93, said long arm extending between two of the spokes 86. The short arm 94 of the lever 92 is normally housed in a recess 95 in the clutch member 90 and is shaped to engage in a correspondingly placed projection 96 on the hub 85. The bell-crank lever 92 is constrained toward the hub 85 by a spring 97. Upon the hub 85 is mounted a spring arm 98 terminating at its free end in a rounded lug 99. This spring arm is so placed that when the weight 93 rests upon the hub 85 the lug 99 engages over the upper edge of the weight while the corresponding lower edge is rounded, as shown at 100. Fast upon the shaft 24 is another disk-clutch member 101 in operative relation to the clutch member 90. The contiguous faces of the two clutch members 90 and 101 are each formed with a series of annular ribs 102 so arranged that the ribs on one clutch member will intermesh with the ribs on the other clutch member. These ribs are preferably of V-shape and may conform in cross section to the cross section of the standard screw thread. Now, let it be assumed that the motor is started and continuously picks up speed until it is finally running at full speed, which under load will be close to synchronism with the current. As the motor increases in speed, the weighted ends of the bell-crank levers tend to fly outward under centrifugal force. This is prevented, however, by the engagement of the latch lug 99 of the latch spring 98 over the weight 90. Ultimately, however, the centrifugal force is sufficient to cause the latch arm 98 to recede from engagement with the weight 93, and the latter will then immediately fly out against action of the spring 97 and by the engagement of the arm 94 of the lever 92 with the extension 96 of the hub 85 move the clutch member 90 into engagement with the clutch member 101. The parts are so timed in operation that the two members of the clutch are not brought into engagement until the motor has attained practically full-load speed. Thus the motor may be started under no load and brought up to speed and then the load is placed upon the motor automatically. By this means it is impossible for an operator unskilled in the management

of electric motors to stall the motor by loading the same at the start or at some point where its torque is low. When the motor is stopped the springs 97 will bring the several bell-crank levers 92, with the weights, into engagement with the hub 85, in which position they will be locked by the latch spring 98.

When the motor is clutched to the clutch member 101 the shaft 24 is caused to rotate, and through the worm 23 and worm gear wheel 22 the pump pistons are set in motion and working alternately as a duplex pump, supply a steady stream of air to the reservoir 64. The air in the reservoir passes to the cleaning head 68 and is there directed forcibly against the part to be cleansed, loosening up the dirt which, together with the air, is removed from the head to the deposit chamber 64 where the air is cleansed from the matters it carries and ultimately returns to the pump through the conduit 66.

While we have described the operation of the device as working with a combination of air pressure and vacuum, means may be provided whereby the vacuum system only may be used, and in some cases it may be advantageous to use the air pressure only. The means for these operations forms the subject-matter of another application and therefore are neither shown nor described herein.

While we have described the use of an alternating current induction motor in connection with a pump, a continuous current motor may be used where such currents are available, and while a great variation of load is permissible with a straight current motor, still it is advisable to fully load, or approximately fully load, only when they have attained speed, for otherwise the rush of current under full load at low speed may be sufficient to burn out the armature. With the small size of motor used in connection with the domestic sizes of the apparatus, a continuous current motor may be safely started under no load without the use of starting resistances, and with the means which we have devised for applying the load automatically only after the motor has attained speed makes it entirely feasible to place such motors in the hands of persons unskilled in the use of electric apparatus. Supposing, now, that the operator should close the air valve, which latter though not shown is presumed to be present in the conduit 67, and the air should accumulate in the reservoir 64. Unless there be provision to prevent such contingency this air pressure will rise to such an extent as to overload the motor. With a continuous current motor of the shunt wound type this might mean a burned out armature, and with an alternating current induction motor it may mean a burned out field and other injuries due to the slowing down of the rotor of the motor.

In order to prevent injury to the motor when the air pressure in the reservoir accumulates beyond the normal pressure, there is provided a cylinder 103 which may be located below the motor casing 70, and this cylinder is connected to a pipe 104 which may be connected to the pressure side of the pump or to the air reservoir. Within the cylinder is a piston rod 105 surrounded by a helical spring 106 engaging at one end a head 107 of the piston rod and at the other end abutting against a bushing 108 screwed into the open end of the cylinder and held in any adjusted position by a lock-nut 109, the bushing serving to regulate the strength of the spring 106. The inner end of the rod 105 is formed with another head 110 against which a leather piston 111 is held by a lock-nut 112 and washer. The piston rod 105 extends beyond the bushing 108 and is there formed into a head 113 embracing the lower end of a lever 114 and provided with radial slots 115 engaging the bushing eyes of a pin 116 passed laterally through the lever. The upper end of the lever 114 is pivotally secured to the end plate 4 by a pivot screw or screw pin 117, and adjacent to the pivoted end of the lever is formed into a head 118 surrounding the shaft 24 and formed with diametrically-opposite V projections 119. Surrounding the shaft 24 between the head 118 and the corresponding end of the hub 85 is a cup 120 having a central perforation 121 of sufficient size to permit the passage of the shaft without touching the same. This cup is engaged by the V projections 119 on one face and on the other face is formed with an annular V groove 122 receiving a series of antifriction balls 123 in engagement with the corresponding end face of the hub 85.

The pipe 104 is of small bore and at the point where it leads into the cylinder 103 there is a valve 124 of comparatively large area, and opening into the cylinder on that side of the piston remote from the spring 106. The valve 124 is provided with a leak groove 125. Now, suppose that the spring 106 is adjusted by means of the bushing 108 to yield when air at a pressure of, say one hundred pounds per square inch, is brought to bear upon the reservoir side of the piston 111. As soon as the pump is started the air pressure accumulates on the pressure side of the piston 111 since it has free access thereto by the comparatively large valve 124 so that the air pressure in the cylinder 103 is at all times substantially that of the reservoir. The pump speed is so adjusted that at maximum speed it will pump air but slightly in excess of the capacity of the largest cleaning head. Suppose that the spring 106 is adjusted to one hundred pounds, as before assumed, and the air used in the normal operation of the device is to be used at a pressure of ninety pounds and the apparatus is in op-

eration. Now, the operator shuts off the air flowing to the cleaning head in order that the head may be removed to another part of the room or to some other location to there recommence operations. During this interval the pump is still in operation and of course the pressure runs up rapidly until one hundred pounds is reached, when the spring 106 yields and the piston rod is projected from the bushing 108. Because of the friction between the piston 111 and the walls of the cylinder 103 more power is required to start the piston in motion than to keep it in motion. Therefore when once started it will make a full traverse of the cylinder 103 against the action of the spring 106 until a point is reached where the maximum compression of the spring stops further movement of the piston. The parts are so designed that this movement will carry the lever 114 on its pivot to an extent which will more than relieve the hub 85 from the pressure of the cup 120.

The hub 85 is free to move longitudinally upon the shaft 24 and the pressure of the spring 106, when in its normal position, is sufficient to move the armature slightly to one side of the true magnetic position, that is, the armature is moved slightly toward the clutch member 101 which is fast upon the shaft 24. Now, upon the compression of the spring 106 by the superior air pressure, the pull of the field upon the armature will move it away from the clutch member 101, and the clutch member 90 will participate in this movement sufficiently to free it from contact with the other member 101. The armature continues to run freely under no load since it is uncoupled from the pumps and no more accumulation of air can occur in the reservoir. Suppose the operator again starts the cleaning head into operation and the pressure in the reservoir will of course drop. The valve 124 at once seats and there remains, therefore there is an excess of air pressure on the power side of the piston 111. This excess of pressure however, gradually equalizes through the leak groove 125, which latter is of such dimensions, considering the size of the reservoir and the flow of air through the cleaning head, that the air in front of the piston 111 will reach a sufficiently low pressure, say about ninety-five pounds, so that the spring 104 will act about the time the pressure in the reservoir has reached ninety pounds. Now, the head 118 has been resting idly against the corresponding end of the hub 85, and even if loosely engaging the same the balls 123 cannot escape from the cup 120 because the walls of the cup closely embrace the end of the sleeve, as seen in Fig. 1. As soon as the spring 106 acts, the cup 120 is pressed against the end of the hub and forces the same longitudinally upon the shaft until ultimately the member 90 of the clutch is brought into engagement with the member 101. This action, however, is comparatively slow and, therefore, the clutch is brought gently into engagement and the pump is more or less gradually brought into action. Now, since the pump is capable of supplying air to the reservoir a little in excess of the demand, the pressure again gradually rises until it reaches about one hundred pounds and the pump is again cut out as before. This peculiar action of the valve 125 prevents excessive wear of the friction disks and the slow gain of the pump over the amount of air used permits the pump to be cut in and out only at stated time intervals, and while the action is gentle still it is positive.

While we have described the prime mover as an electric motor other types of motors may be used and the means which we have described for cutting the motors into and out of connection with the pump, either on starting or when running, may be used with such other types of motors with such changes in structural details as may be necessary to adapt these means to the particular condition under which they may be called upon to operate.

It is a feature of the present invention that the motor of whatever type shall attain full speed, or approximately full speed, and then shall be automatically coupled up to the pump. Further, should the load become excessive or above a predetermined maximum, then without affecting the speed of the motor the latter will be uncoupled from the pump to again come into action when the load is approximately diminished. Also in the normal action of the device the arrangement is such that the pump gains slowly and progressively upon the demand for air. In other words, the supply is slightly in excess of the demand and cumulative so that the motor is relieved from the load only when the accumulation of load has reached a certain maximum and is again cut in when the reduction of load has reached a predetermined minimum.

What is claimed is:—

1. In an air cleaning system, the combination of an air pump, a prime mover therefor, means for coupling the prime mover to the pump, and means for locking the coupling means against active movement until the prime mover has attained approximately its full speed.

2. In an air cleaning system, the combination of an air pump, an electric motor for driving the same, means responsive to centrifugal action for coupling the motor to the pump, and means opposing the action of centrifugal force for rendering the coupling means inactive until the motor has attained approximately its full speed and then yieldable to centrifugal force.

3. In an air cleaning system, the combination of an air pump, a prime mover for said pump, a shaft for transmitting motion from the prime mover to the pump, a clutch member fast upon the shaft, another clutch member actuated by the prime mover, a centrifugal member for moving the clutch member carried by the motor into engagement with the clutch member upon the shaft, and means for locking the centrifugal member against active motion until the motor has attained a predetermined speed.

4. In an air cleaning system, the combination of an air pump, a motor for driving the same, a friction clutch having one member in constant operative relation to the pump and the other member in operative relation to the motor, and means for moving the clutch members into operative relation comprising centrifugal members carried by one of the clutch members and acted upon by the motor, and the latch for each centrifugal member comprising a spring arm having a cam-acting enlargement locking the centrifugal member against action until the centrifugal force reaches a predetermined maximum.

5. In an air cleaning system, the combination of an air pump, a prime mover for the same, a coupling between the prime mover and the pump responsive to a predetermined centrifugal force for coupling the prime mover and pump when the said prime mover has attained a predetermined speed, and means responsive to predetermined overload conditions for uncoupling the motor from the pump.

6. In an air cleaning system, the combination of an air pump, a motor for driving the same, a friction clutch between the motor and pump, centrifugal clutch operating means, a lock for the centrifugal clutch operating means responsive to a predetermined centrifugal force, and means acting upon the clutch to uncouple the same and responsive to a predetermined air pressure above the working pressure supplied by the pump.

7. In an air cleaning system, the combination of an air pump, a motor for driving the same, a clutch between the motor and pump, means under the control of the motor for operating the clutch to couple the said motor to the pump, said motor having a normal tendency to operate the clutch to uncouple the motor from the pump without reducing the speed of the motor, and means for normally holding the motor against its tendency to operate the clutch to the uncoupled position and to release the motor to cause it to move the clutch to the uncoupled position when the load exceeds a predetermined maximum, comprising a piston, a spring acting thereon in one direction, connections to the pressure side of the pump for supplying compressed air to that side of the piston remote from the spring, and connections between the piston and the motor for releasing the same to uncouple the motor and pump when the air pressure is sufficient to overcome the action of the spring.

8. In an air cleaning system, the combination of an air pump, an electric motor for driving the same, the said motor having its armature movable longitudinally under the pull of the field, a clutch interposed between the motor and pump and having one member movable with the motor armature, a spring tending to maintain the clutch members in operative engagement and to shift the motor armature to one side of the magnetic plane of the field against the pull of the field, and means for overcoming the spring when the air pressure exceeds a certain predetermined maximum to permit the disengagement of the clutch members by the longitudinal movement of the motor armature under the pull of the field

9. In an air cleaning system, the combination of an air pump, an electric motor having an armature movable axially with relation to the field under the pull of the field, a clutch member connected to the pump, another clutch member carried by said armature and movable with the same away from the other clutch member under the pull of the field, an air cylinder, a piston in said cylinder, connections between the piston and the motor armature, a spring acting on said piston and tending to maintain the clutch members in engagement against the pull of the field, and connections between the pressure side of the pump and that side of the piston remote from the spring whereby air pressure may act upon the piston in opposition to the spring and in the direction of the pull of the field to unclutch the armature from the pump.

10. In an air cleaning system, the combination of an air pump, an electric motor having an armature movable axially with reference to the field of the motor under the pull of the field, a clutch member connected to the pump, another clutch member connected to the armature and movable therewith under the pull of the field away from the first clutch member, a lever engaging the end of the armature remote from the clutch, an air cylinder, a piston in said cylinder, a piston rod connected to said piston and to the free end of the lever, a spring acting on the piston to move the lever in a direction to maintain the clutch in engagement against the pull of the field, and air connections from the pressure side of the pump to that side of the piston remote from the spring to move the piston in opposition to the spring to uncouple the clutch when the air pressure exceeds a predetermined maximum.

11. In an air cleaning system, the combination of an air pump, an electric motor hav-

ing an armature movable axially with relation to the motor fields, a shaft connected to the pump and carrying an armature, a clutch member fast upon the shaft, another clutch member rotatable with the armature but movable longitudinally with relation thereto, centrifugal operating means for the clutch member carried by the armature for moving the said clutch member into engagement with the other clutch member, said centrifugal means being responsive only to a predetermined centrifugal force due to the rotation of the armature, a lever engaging the end of the armature remote from the clutch, an air cylinder, a piston therein, a piston rod connected to the piston and to the free end of the lever, a spring acting on the piston rod and tending to move the lever in the direction to bring the clutch members into engagement, and connections between the pressure side of the pump and the face of the piston remote from the spring.

12. In an air cleaning system, the combination of an air pump, a motor for driving the pump, centrifugally operated means for coupling the motor to and uncoupling it from the pump, means responsive to a predetermined air pressure above the working pressure and acting on the coupling means independent of centrifugal action for uncoupling the motor from the pump, and means for causing the sluggish return of the last named means to normal position.

13. In an air cleaning system, the combination of an air pump, a motor for driving the same, a clutch between the motor and air pump, an air cylinder, a piston therein, connections between the piston and the clutch, a spring acting on the piston to maintain the clutch members in engagement, air connections between the air pressure side of the pump and the side of the piston remote from the spring, and a valve in said air connection closing to the return of air from the cylinder toward the air pump, said valve being provided with a leak passage for the gradual discharge of air from the cylinder toward the pressure side of the pump.

14. In an air cleaning system, the combination of an air pump, a motor for driving the same, a clutch between the motor and air pump, an air cylinder, a piston in said cylinder, connections between the piston and one of the clutch members, a spring tending to maintain the clutch members in engagement, means for adjusting the tension of the spring, air connections between the pressure side of the pump and that side of the piston remote from the spring, and a valve in said air connections closing to the return of air from the cylinder toward the pump, and provided with a leak passage from the piston side of the valve toward the pump side thereof.

15. In an air cleaning system, the combination of an air pump, an electric motor for driving the same having its armature movable axially with reference to the field of the motor, a shaft upon which the armature is mounted and which shaft is connected to the air pump, a friction clutch member secured to said shaft, another friction clutch member mounted upon the shaft but rotatable and movable longitudinally thereon, centrifugal members mounted on the clutch member, and engaging the armature when moved under the action of centrifugal force to cause the second-named clutch member to engage the first-named clutch member, means for preventing the centrifugal members from acting until the armature attains a predetermined speed, a lever acting on the end of the armature from the clutch, an air cylinder, a piston therein, a piston rod carrying said piston and connected to said lever, a spring acting on the piston to cause the lever to maintain the clutch members in engagement, air connections between the pressure side of the pump and that side of the piston remote from the spring, and a valve in said air connection provided with a leak passage and closing to the return of the air from the cylinder toward the pump.

16. In an air cleaning system, the combination of an air pump, an electric motor for driving the pump, means normally active at a speed below the full working speed of the motor for coupling the pump to the motor, and restraining means for the first named means responsive to a higher speed than the said first named means for releasing the latter when the motor has reached approximately full working speed.

In testimony that we claim the foregoing as our own, we have hereto affixed our signatures in the presence of two witnesses.

WILLIAM C. MAYO.
JOHN HOULEHAN.

Witnesses for Mayo:
WM. ADAMS,
J. H. BUCHANAN.
Witnesses for Houlehan:
MARY B. BUCHANAN,
A. M. WALTHALL.