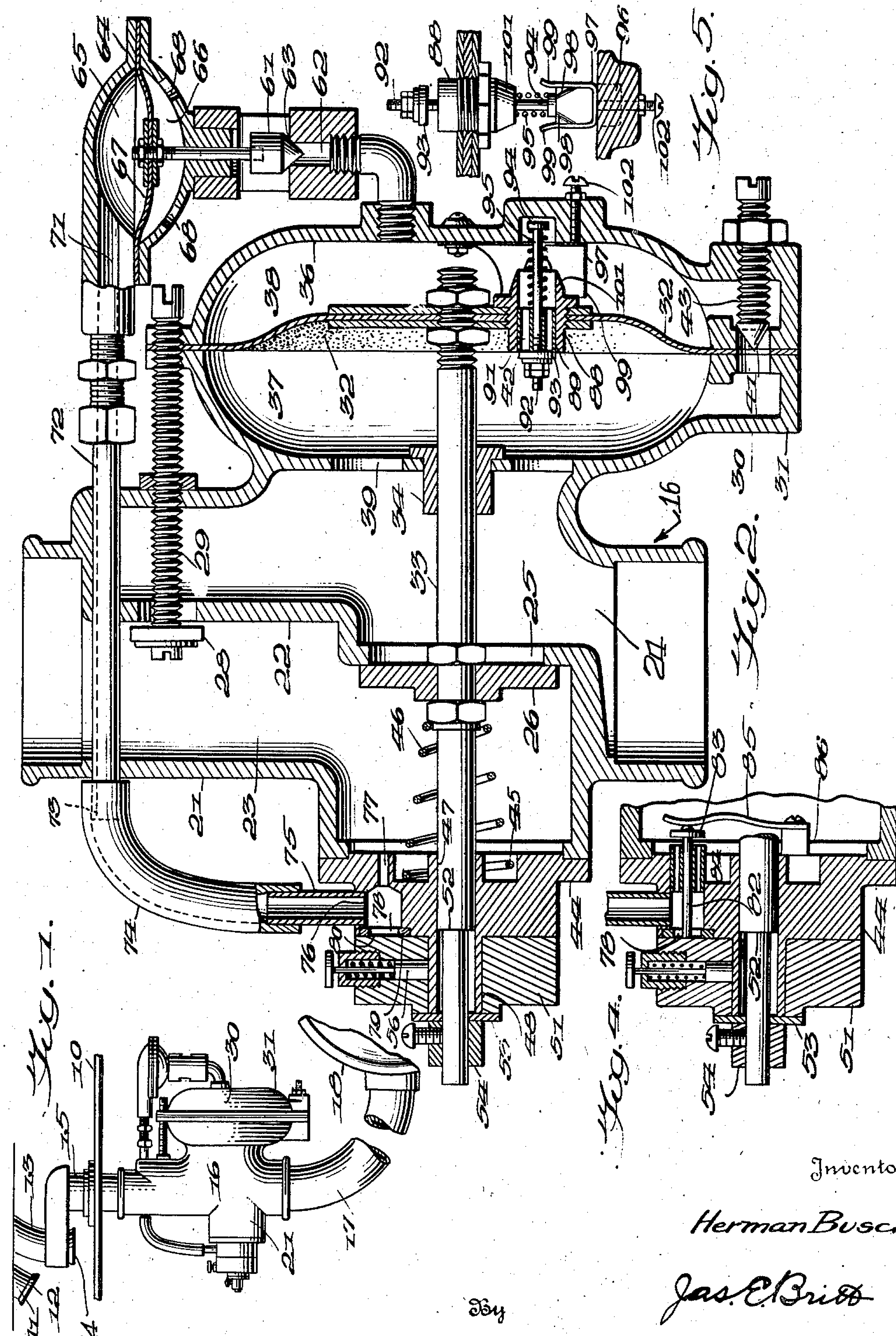
Aug. 2, 1938. H. BUSCH 2,125,601

PNEUMATIC POWER CONTROL

Filed Feb. 2, 1937 2 Sheets-Sheet 1



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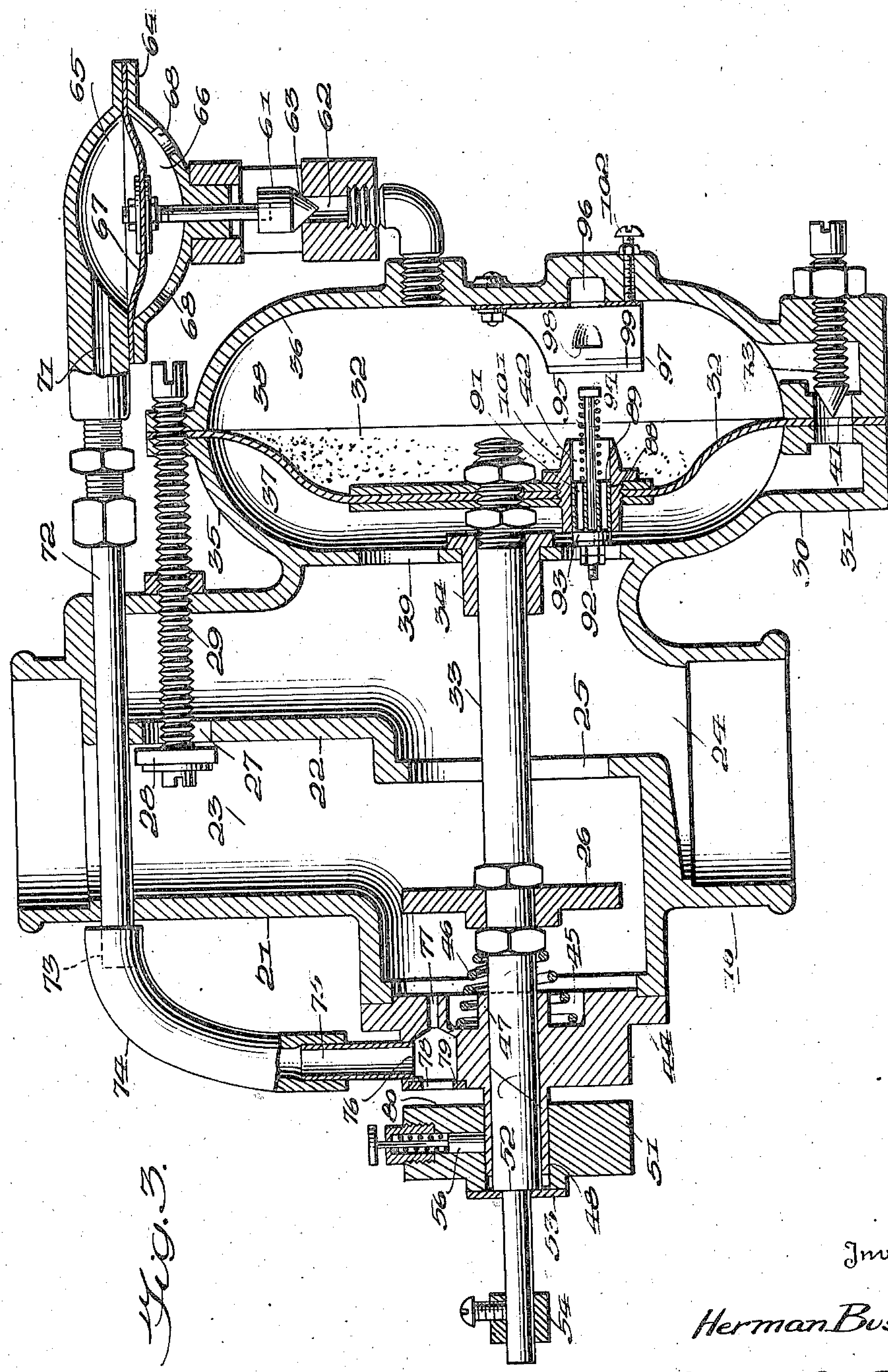

Fig. 3.

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PNEUMATIC POWER CONTROL

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12 Claims. (Cl. 243—15)

This invention relates to power or motive fluid controllers for pneumatic conveyor systems and more particularly to the general type of controllers, the purpose of which is to reduce the total amount of motive fluid or power required to operate such systems. An early prior art controller of this type is disclosed in Patent No. 968,576 granted to Libby on August 30, 1910.

In the Libby type of controller a main motive fluid valve opens for a period during which transmission is accomplished and closes at the end of the period, remaining closed until transmission is again desired. During this period of no transmission a so called "minimum flow" of fluid is maintained in the transmission line by means such as a by-pass around the main valve. For accomplishing the opening of the valve at the beginning of a transmission period pneumatic means designed to respond to pressure changes in the transmission line opens a port to admit operating fluid to a motor which in turn opens the main valve. When the main valve reaches full open position the pressure responding means is rendered inoperative, whereupon the main valve closes by movement over a time interval determined by leakage of the operating fluid from the motor. As the main valve reaches closed position the response means is reconditioned or restored for the next transmission cycle.

The primary object of this invention is to provide an improved form of power control for carrying out an operative cycle similar to the Libby valve but with simplified mechanism operating in a smoother and more positive manner.

Although Libby has been widely acknowledged as having disclosed the basic principles of the type of power controller for pneumatic systems known as the "minimum flow" type, the Libby valve has never been widely used.

Another object of this invention is to overcome some of the difficulties experienced with the Libby valve by equalizing the pressures in the pressure response or control pneumatic at the end of the opening stroke of the main valve at atmospheric pressure instead of at sub-atmospheric pressure.

Another object is to provide a positive and accurate pilot vent valve operation so that a more sensitive and accurate balance on the response diaphragm becomes practical.

Another object is to provide a power control apparatus employing a pneumatically operated control valve which, with its operating diaphragm, is biased toward closed position and responsive to the presence of a carrier in the transmission line to open the valve against the bias and means operative by the movement of the main valve at the end of its opening stroke for equalizing the pressures on the opposite sides of the diaphragm by the displacement of line pressure on the response side of the diaphragm with atmospheric pressure for permitting the valve to close under action of the bias means.

Another object is to arrange the atmospheric and transmission line ports close together so that they may be located remotely from the response pneumatic and communicate therewith through a single passageway.

A further object is to provide a single passageway for connecting the closed chamber of the response pneumatic to the atmospheric and transmission line ports.

A still further object is to provide a simplified form of means for conditioning or controlling the action of the auxiliary or response pneumatic.

Still another object is to provide an improved form of quick closing valve.

These and other objects will be apparent from the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a diagrammatic view of a single conveyor line including a control mechanism;

Fig. 2 is a sectional view showing the parts when the main valve is in closed position;

Fig. 3 is a sectional view showing the parts in the position they assume when the main valve is in full open position;

Fig. 4 is a fragmentary view of a modification of the invention with parts in normal position, similar to Fig. 2; and,

Fig. 5 is a detail view of the quick closing valve trip before the valve is tripped.

While the use of this invention is not necessarily restricted to conveyor systems of the pneumatic carrier type employing a tube through which carriers are transmitted by the flow of an air current through the line either under pressure or vacuum, this invention will be described for illustrative purposes as applied to the vacuum type of pneumatic carrier system.

The term "pneumatic" as employed herein is used to signify a pneumatic motor and appurtenances including a housing enclosing a flexible diaphragm which divides the housing into two chambers with means for connecting the diaphragm to structure to be operated thereby or a motor performing the equivalent functions.

Referring now to Fig. 1 of the drawings, that portion of a pneumatic carrier system pertaining to a single conveyor line is diagrammatically illustrated. From a central station desk 10 dispatch lines extend out to various sub-stations. A single line employing a control device comprises a sending tube 11 having a dispatch terminal 12 and a return tube 13 provided with the usual delivery terminal 14. From the latter terminal an extension tube 15 passes down through the central desk 10 and connects with the power control device 16. A suction tube 17 connects with the usual suction or header 18 in which a vacuum is continuously maintained by means of a suitable exhauster, not shown. In other words, the exhauster is the common power source and the device 16 controls the power expended in a single line. A continuous air passage or conduit is formed by the parts enumerated from the dispatch terminal 12 through the dispatch and return tubes 11 and 13 and the controller 16 to the exhauster.

Referring to Figs. 2 and 3, the controller 16 comprises a casing 21 divided by a septum 22 into two chambers, 23 and 24. Chamber 23 is in communication with the transmission line and chamber 24 is in communication with the suction line. The septum 22 is provided with two ports, a large port 25 which is controlled by a main valve 26 and a small port 27 which is controlled by an auxiliary valve 28. The auxiliary valve is opened by a screw threaded stem 29 and is set normally off its seat to provide a small air passage through which is maintained a continuous stream of air flowing from the transmission line. This continuous flow of air will be hereinafter referred to as the "minimum flow".

A motor 30 enclosed in a housing 31 is provided at the side of casing 21 for operating the main valve 26. This motor is comprised of diaphragm 32 connected to the main valve by means of a stem 33 which reciprocates through a bearing 34 in the inner wall of the motor housing. The housing 31 comprises a saucer shaped base section 35 and a similar shaped cap 36 attached to the base with the rim of the diaphragm 32 held between these two elements.

The diaphragm divides the housing into inner and outer chambers 37 and 38. The inner chamber 37 communicates freely with the suction or low pressure chamber 24 through a relatively large unrestricted opening 39. The chamber 38 communicates with chamber 37 through a restricted port 41 and a valved port 42, hereinafter more fully described. The size of the opening of port 41 is regulated by needle valve 43. This port constitutes a continuous leakage connection between chambers 37 and 38 by means of which the closing time of the main valve is determined as will hereinafter appear.

As already indicated the stem 33 extends through the main valve 26. At its outer end the stem is carried in the central opening of a boss member 44 disposed at what is the rear of the structure viewed as it is ordinarily installed in service. This boss, as will presently be described, carries a pilot valve which is employed to introduce atmospheric pressure into and cut it off from the closed chamber of the control pneumatic to condition it for proper sequence of operation. The inner face of boss 44 carries a recess 45 in which is seated the outer end of compression spring 46. The inner end of the spring is secured to stem 33 and exerts a force sufficient to hold valve 26 normally on its seat.

The central opening 47 of boss 44 forms a bearing for the outer end of stem 33 and extends through a sleeve 48 formed at the outer face of the boss. A plate 51 is mounted to reciprocate upon this sleeve. The outer end of the stem 33 is turned down to a smaller diameter to form shoulder 52 thereupon. When the stem moves to its extreme left position, the shoulder 52 moves outwardly beyond the end of sleeve 48 a short distance as shown in Fig. 3. In valves constructed according to this invention for experimental use the shoulder moves out a distance of about ⅛ of an inch or less. At the outer face of plate 51 a disc 53 surrounds the reduced portion of the stem. Normally this disc is positioned at the outer end of sleeve 48. When the stem moves outwardly the disc is engaged by shoulder 52 moving plate 51 out a distance corresponding to the protrusion of the shoulder. The outer end of the stem extends beyond disc 53 and carries an adjustable collar 54. This collar is set so that when the main valve 26 is moved to its seat the plate 51 is brought against the face of the boss 44. It will be noted that shoulder 52 and collar 53 form a lost motion connection between the stem and plate 51. A spring pressed plunger 56 set in one side of plate 51 bears upon sleeve 48 to form a friction bearing for the plate to limit its movement to that imparted to it by stem 33 through the lost motion connection.

The valve opening movement of motor 31 is determined by a control valve 61 disposed to normally close a passage 62 leading from atmosphere through valve seat 63 to chamber 38. This control valve may be biased toward closed position either by gravity, as shown, or by a loading spring or both. The valve is lifted by auxiliary motor 64 and the bias effects reclosing when the lifting force of the motor is removed. This motor comprises a casing which is divided into two chambers 65 and 66 by means of a small diaphragm 67, the latter being connected through a suitable operating stem to valve 61. In the gravity biased form shown, the amount of bias is changed or regulated by exchanging washers of different weights at the upper end of the stem of the valve 61. This provides adjustment and at the same time enables the retention of the desirable characteristic of gravity bias which makes for extremely sensitive operation.

The lower chamber 66 is continuously open to the atmosphere through ports 68. The upper chamber 65 has a passage 71 leading therefrom through tube 72 which passes through the valve housing 21 and forms a nipple 73 at the back. The passage continues from this nipple through a flexible tube 74 such as rubber and through nipple 75 to a recess 76 provided in boss 44.

Recess 76 is provided with two ports, port 77 constantly open to chamber 23 carrying transmission line pressure and valved port 78 normally closed by plate 51 but when open admitting atmosphere to the recess. Port 78 is made large in relation to port 77 so that when the former port is opened, air passing through port 77 to the vacuum space will be ineffectual to maintain a reduced pressure in the recess 76. While port 77 is shown to be smaller than the passageway 71 the size of the opening does not impose any appreciable restriction upon the speed with which a change in pressure in chamber 23 will be transmitted through the passageway 71 to chamber 65 when the atmospheric port 78 is opened or closed. The response of diaphragm 67 is always substantially instantaneous to any change in pressure sufficient to move it. The purpose of the proportion or relation of size of the ports 77 and 78 is merely that port 77 shall be effectively restricted only with respect to atmospheric port 78. The use of chamber 76 located in the boss 44 enables the ports 77 and 78 to be located close together so that they may communicate with the diaphragm chamber 65 by a single passageway. In addition this also facilitates the arrangement for controlling both ports by valves as shown in Fig. 4 and later to be described.

The port 78 is preferably faced with a soft resilient ring 79 which may be live rubber or the like. This ring is preferably of sufficient thickness to be slightly compressed when plate 51 is brought into engagement with the face of the boss 44 as the main valve reaches closed position.

With plate 51 acting as the valve and the ring 79 acting as the valve seat the pilot valve, already referred to, is formed and acts to open and close port 78 in accordance with the position given plate 51 by the movement of valve stem 33 as the valve opens and closes. The pilot valve thus formed will hereinafter be referred to as pilot valve 80.

It is now desired to point out some of the particular advantages of the form of pilot valve and its manner of operation. In the first place, the pilot valve is opened and closed by movement in a plane perpendicular to its seat. In other words, it is a poppet valve type of movement, opening along the entire perimeter of its seat. This means that considerable flow area can be opened up with a relatively small movement of the valve disc 51. Another feature is that the valve is large in proportion to the flow through it. These two features combined make it possible to accomplish effective pilot valve action with a small movement of plate 51. With only a small movement required it has been found feasible according to this invention to use a direct lost motion connection with the main valve for movement in both directions so that the pilot valve is moved with the main valve for a small part of its stroke at the end of its movement.

With this arrangement, by the time the pilot valve is sufficiently closed for the transmission line pressure to begin to become established in control diaphragm chamber 65 the main valve will sufficiently close to reduce the flow to substantially minimum flow. This enables the weight of the assembly of the control diaphragm 67 and control valve 61 to be adjusted to respond to a pressure only slightly below minimum flow pressure providing a very sensitive control. This in turn makes practical a very low minimum flow with a maximum saving of power.

It has been found that this type of pilot valve arrangement provides effective control without the use of the quick closing arrangement later to be described. Nevertheless, the quick closing of the main valve enables the pilot valve to function with increased effectiveness. On the other hand, as it will hereinafter appear, the primary advantage of the quick closing feature is to cut down the period of flow restriction due to the closing of the main valve under conditions in which the valve must reopen to complete the transportation of the carrier or carriers in the line.

Fig. 4 shows a modified form of boss structure providing for a valve controlled transmission line port as well as a valve controlled atmospheric port. In this form the port 77 is enlarged to receive a bushing 81. This bushing is provided with a central opening to receive stem 82 of a valve 83 and one or more other openings 84 acting as ports or passages through the bushing. The valve 83 is arranged to seat upon the outer end of the bushing so as to close the passages 84 and is carried to its seat as plate 51 approaches its outward position by a leaf spring 85 secured to a boss 86 and having its outer end bearing upon the head of the valve. It is opened by the valve stem 82 being of such a length as to engage the face of plate 51 and carry the valve 83 off its seat a short distance when the plate comes to its normal position of rest upon the face of the boss 44.

With this arrangement the atmospheric port will be closed while the transmission line port is open and vice versa. In other words, in their normal position, with the main valve closed, the atmospheric port 78 is closed while the transmission line ports 84 are open. Then when the main valve moves outward to open position and the shoulder 52 moves the plate 51 outward, ports 84 are closed as port 78 opens.

The advantage of this modified form will more fully appear in the description of the operation but may briefly be stated as follows: First, there is no air intake through the transmission line ports or passages 84 while the vent valve 80 including port 78 is open. This among other things lessens the likelihood of the accumulation of lint and dust in the passages which might restrict the air flow therealong. A second advantage is that the flow area through the passages in bushing 81 may be increased beyond the strict relation to atmospheric port 78 required in the other form, thus making dust accumulations in the passages less serious.

Another feature of this invention is the auxiliary leak or quick closing valve 42 controlling a passage through the diaphragm 32 constituting an auxiliary connection between the chambers 37 and 38. This passage is provided by an outer bushing 88 arranged to pass through the diaphragm 32. This carries an inner bushing 89 which is similar in construction to bushing 81 shown in Fig. 4. One or more passages 91 provide the flow area through the bushing while the stem 92 of valve 93 passes through a control opening in the bushing. In closed position the valve 93 seats over the outer end of passage 91. The outer end of the valve stem 92 is provided with a head 94 and a compression spring 95 surrounding the stem of the valve and resting against the head to normally hold the valve closed.

Fig. 2 illustrates the position of the leak valve when the main valve 26 is closed. In this position the head 94 of the valve stem extends into a recess 96 in the casing and is disposed between the sides of a trip member 97. The trip member 97 is preferably made of thin flat spring steel or the like shaped as illustrated in Figs. 2 and 5. On the inner sides of the trip member perches 98 project inwardly and are spaced apart at a distance slightly less than the width of the head 94. The upper edges 99 of the trip member as viewed in Fig. 5 are flared outwardly so that when they are engaged by the conical portion 101 of the bushing 88 they will move outwardly to trip the auxiliary valve closed by separating the perches sufficiently to permit the head 94 of the valve stem to pass through. The point of tripping is regulated by screw 102. The sequence of the operation of the various parts of the leak valve just described will be set forth in detail in the general description of operation to follow.

Assuming the parts to be in their normal or non-operated position as shown in Fig. 2 the operation of the control valve may be described substantially as follows:

The main valve is closed, the control valve 61 closed, the pilot valve 80 closed, the auxiliary lead valve 42 closed and the minimum flow valve 28 adjusted slightly open. The drag or friction of the slight or minimum flow of air through the line reduces the pressure in the end of the line adjacent to the control valve to a sub-atmospheric pressure. In practice the amount of minimum flow is determined by first opening valve 28 until the drag of the minimum flow air is sufficient to lift the control diaphragm 67 and valve 61 off its seat with the main valve closed, then by closing the minimum flow off until the control diaphragm and valve remain down after each operating cycle until a carrier is introduced.

With this adjustment made, upon the introduction of a carrier in the line the minimum flow of air will be blocked off and the air ahead of the carrier exhausted through the minimum flow port. This causes in the line a reduction in pressure which is transmitted from chamber 23 through port 77, recess 76 and passage 71 to chamber 65 raising diaphragm 67, lifting valve 61 and admitting atmospheric air through passage 62 to chamber 38. Chamber 37 being at the reduced pressure or vacuum of the exhaust line, diaphragm 32 is drawn inwardly as atmosphere enters chamber 38.

As the diaphragm begins to move it carries the parts including stem 33, main valve 26, collar 54, and auxiliary leak valve stem 92 to the left. In its outward movement valve stem head 94 will engage the back sloped surfaces of perches 98 springing them apart as it passes through.

As the valve stem approaches the end of its leftward or opening stroke the shoulder 52 engages collar 53 and begins to move the plate 51 away from the face of boss 44. As soon as the plate has moved away a distance which will permit more atmospheric air to enter port 78 than is being withdrawn through port 77, atmospheric pressure will be established in recess 76 and through communicating passage 71 in chamber 65 also.

As soon as chamber 65 reaches substantially atmospheric pressure, the lower chamber 66 being constantly at atmospheric pressure, the pressures on opposite sides of diaphragm 67 are equalized permitting the gravity bias on the diaphragm and valve 61 to close the latter. As soon as valve 61 is closed stem 33 ceases its opening movement and begins its closing movement. Plate 51 is held in its outward position by the frictional engagement of spring pressed pin 56 with sleeve 48.

The time of the closing movement of the initial portion of the closing stroke is determined by the setting of the leakage screw 43. The valve will continue its closing movement at this rate until the head 94 of the stem of the auxiliary leak valve 42 engages the trip perches 98. At this point the travel of the stem 92 and the member 93 in the direction of diaphragm 32 ceases and the valve 42 is opened by the continued movement of the diaphragm. This opens the auxiliary leak port 91 suddenly increasing the leakage rate or the rate of the pressure equalization between chambers 37 and 38. With the additional leak thus provided, the main valve will travel with a quick movement to the end of its stroke. Just before the main valve reaches the end of its stroke the conical section 101 of the auxiliary valve housing engages the flared portions 99, spreading apart perches 98 and permitting the head 94 urged by spring 95 to drop through, closing the auxiliary leak valve. The point in the main valve closing stroke at which the auxiliary leak valve begins to open is determined by the length of the stem 92 as adjusted by the lock nuts behind the valve. The point at which the auxiliary leak valve is tripped closed is determined by the setting of the screw 102 which adjusts the trip member 97 inwardly and outwardly so that the conical section 101 engages it earlier or later in the stroke.

In addition to the above functions performed as the main valve 26 approaches the end of its closing stroke pilot valve 80 is closed by collar 54 engaging disc 53 on plate 51 and carrying them to the right until the face of the plate covers port 78. This does not take place until the main valve practically becomes seated. The closing time of the valve is set so that under normal conditions the carrier will have completed its travel through the line and will have been discharged by the time the valve has closed. Therefore, the line being open, the pressure in chamber 23 will have substantially reached the minimum flow pressure. As the pilot valve closes, this minimum flow pressure is transmitted to chamber 65. However, since diaphragm 67 responds only to pressures below minimum flow it will remain seated. On the other hand, if due to some abnormal condition the carrier has not been discharged, the pressure on the transmission line side of the valve in chamber 23 will not reach the minimum flow pressure and the diagram 67 will be raised as soon as the pilot valve is closed, immediately initiating the reopening of the main valve, whereupon it will follow through another closing cycle.

It is to be noted that since the auxiliary leak valve 42 is always closed at the end of the closing stroke of the main valve the opening response of the main valve will be of the same character as though the auxiliary leak valve were not employed. In other words, if the type of leak valve which, according to this invention, is tripped closed at the end of the closing stroke of the main valve were not used, at the beginning of the opening stroke both the auxiliary leak port and the main leak port would be open and air would escape through both of these ports at substantially the same rate as that at which it escaped to cause the quick closing. This must necessarily be a considerable flow, easily sufficient to cause the opening action of the main diaphragm to be sluggish without the use of a relatively large atmospheric flow passage 62 necessitating a correspondingly large valve 61. This is undesirable because the valve 61 when seated is being drawn toward its seat by the reduced pressure below the seat and a large atmospheric port valve entails considerable difficulties in producing sensitive operating means for opening the valve. Therefore, the employment of a quick closing or auxiliary leak valve such as disclosed in this invention which does not effect the opening stroke of the main diaphragm provides a highly desirable type of valve operation.

The operation of the modified form of structure for valve-closing both the atmospheric and transmission line ports entering recess 76 as shown in Fig. 4 will now be described. When the controller is provided with the form of structure shown in Fig. 4, the other parts of the mechanism operate in substantially the same manner as in the form shown in Figs. 2 and 3. The parts of the modified form illustrated in Fig. 4 also operate in substantially the same manner except that then the plate 51 is moved outwardly at the end of the opening stroke of the main valve to open the pilot port 78, the valve 83 moves simultaneously to the left under the influence of spring 85 until the valve is seated over the inner end of the transmission line passages 84; the length of the valve stem 82 being such as to permit valve 83 to become seated at or before the end of the outward movement of the plate 51. Another differentiation is that while the main valve is closing and until the plate 51 is engaged by collar 54, the passages 84 remain closed and no air is being drawn through the transmission line ports during this time. As the plate 51 is moved back to its normal position closing port 78, the stem 82 of the valve 83 is engaged by the face of the plate 51 and moved to the right again opening the passages 84.

It will be seen, therefore, that with this form only a relatively small amount of air is drawn through the transmission line ports or passages and therefore the likelihood of these passages becoming clogged with lint and dust is considerably reduced. In addition, as already pointed out, the employment of a valve for the transmission line port as well as for the atmospheric port makes it unnecessary to make the transmission line port smaller than the atmospheric port as in the other form.

From the above description it will be seen that an improved form of power control mechanism constructed according to this invention has been provided employing the basic principles of the Libby type of valve embodied in an extremely simple form of mechanism arranged for convenient adjustment and effective operation. In addition the form of structure here employed overcomes many of the difficulties inherent in the Libby structure giving a controller which will operate effectively over long periods of time with the minimum of adjustment and repair. It is to be understood that this invention may be embodied in many other forms of apparatus and it is desired, therefore, that only such limitations shall be placed thereon as are imposed by the prior art or by the claims appended hereto.

What I claim is:

1. Power control apparatus for a pneumatic conveyor having a transmission line, an exhaust line and a casing therebetween enclosing a main valve for controlling the line fluid flow, means for opening and closing the main valve, means for establishing a minimum flow of air through the line when the main valve is closed, and means for controlling the opening and closing of the main valve in response to the introduction of a carrier in the line, said controlling means including a control diaphragm normally responsive to said carrier introduction, a recess in said casing disposed remotely from said diaphragm and a single passageway establishing communication between said recess and said diaphragm, said recess being provided with two ports, one of said ports leading to the transmission line, the other port to the atmosphere, valve means for the atmospheric port, said valve means being normally closed for rendering said diaphragm normally responsive to the introduction of a carrier in the line and movable to open position for rendering the diaphragm unresponsive, and means operated by the movement of the main valve at the end of its opening and closing strokes for opening and closing said atmospheric port.

2. Power control apparatus for a pneumatic conveyor having a transmission line, an exhaust line and a casing therebetween enclosing a main valve for controlling the line fluid flow, means for opening and closing the main valve, means for establishing a minimum flow of air through the line when the main valve is closed, and means for controlling the opening and closing of the main valve in response to the introduction of a carrier in the line, said controlling means including a control diaphragm normally responsive to said carrier introduction, constantly exposed on one side to atmospheric pressure and in a predetermined position with reference to said casing, a recess in said casing disposed remotely from said diaphragm and communicating with the unexposed side thereof through a single passageway, two ports in said recess, one of said ports leading to the transmission line, the other port being of a size suitable for quickly transferring atmospheric pressure to the diaphragm and leading to the atmosphere, the atmospheric port being sufficiently larger than the transmission port to establish atmospheric pressure in the recess when it is open, and valve means operated by the movement of the main valve at the end of its opening and closing stroke for opening and closing the atmospheric port.

3. Power control apparatus for a pneumatic conveyor having a transmission line, an exhaust line and a casing therebetween enclosing a main valve for controlling the line fluid flow, means for establishing a minimum flow of air through the line when the main valve is closed, and means for controlling the opening and closing of the main valve in response to the introduction of a carrier in the line, said controlling means including a control diaphragm normally responsive to said carrier introduction, constantly exposed on one side to atmospheric pressure and associated with said casing, a recess in said casing disposed remotely from said diaphragm, a passage leading directly from said recess to the transmission line, said recess normally having transmission line pressure therein, and means operated by the movement of the main valve as it approaches the end of its opening stroke for establishing atmospheric pressure in said recess and similarly operated at the end of the closing stroke of the main valve for reestablishing transmission line pressure and a single passageway for communicating the pressures obtaining in said recess to the unexposed side of said diaphragm.

4. Power control apparatus for a pneumatic conveyor having a transmission line, an exhaust line and a casing therebetween enclosing a main valve for controlling the line fluid flow, means for opening and closing the main valve, means for establishing a minimum flow of air through the line when the main valve is closed, and means for controlling the opening and closing of the main valve in response to the introduction of a carrier in the line, said controlling means including a diaphragm normally sensitive to transmission line pressure, said diaphragm being constantly exposed on one side to atmospheric pressure, means forming a chamber at the other side including the diaphragm as a wall thereof, means providing a first and a second port communicating with said chamber, said first port means opening to the transmission line, said second port means opening to the atmosphere, alternately seated valves for closing and opening said port means, the valve for the first port means being normally open and the other normally closed for sensitizing the diaphragm, and means operated by the movement of the main valve as it approaches the end of its opening stroke for moving the port valves to close

the first port and open the second for desensitizing said diaphragm, and as the main valve approaches the end of its closing stroke for reversing the closing action of the valves for resensitizing said diaphragm.

5. In a power control apparatus for a pneumatic conveyor line, a valve for controlling the flow of motive fluid in the line, resilient means tending to close said valve, a fluid motor arranged so that when fluid is admitted thereto the motor moves to open said valve, means for closing the valve including means for leaking out the admitted fluid at a predetermined rate for a part of the closing stroke, means for automatically increasing said leakage rate as the valve approaches the end of its closing stroke, and means for restoring the leakage means to its condition of minimum leakage as the valve reaches the end of its closing stroke.

6. A pneumatic motor for use in pneumatic conveyor systems comprising a housing having a motive fluid chamber therein, a diaphragm forming one wall of the chamber arranged to make forward and return strokes, a pair of leak ports for discharging the motive fluid from said chamber upon the return stroke, one of said ports being continuously open, means for opening the other port during the latter part of the return stroke, and means for closing the same again at the end of the return stroke.

7. In combination, a main valve for controlling the flow of motive fluid through a pneumatic conveyor line or the like, a resilient means tending to hold said valve closed, a fluid motor arranged to open the valve against the action of said resilient means, said motor comprising a housing embodying a motive fluid chamber having a movable side wall and means for operatively connecting said wall and the valve, a controlled inlet port for admitting motive fluid to said chamber for opening the valve, a continuously open regulatable leak port for bleeding the motive fluid out of said chamber at a determined rate for permitting the valve to close, a supplementary leak port through said movable wall, a valve housing carried by said wall and including said supplementary port and a spring closed leak valve therefor, a stem for said valve extending in the direction of the travel of said wall as the main valve closes, a movable perch arranged to intercept said stem as the wall approaches the end of its inward stroke for opening said supplementary leak port, and means for tripping out said perch at the end of the closing stroke to permit said valve to close.

8. A pneumatic motor for use in pneumatic conveyor systems comprising a housing having a motive fluid chamber therein, a diaphragm forming one wall of the chamber arranged to make forward and return strokes, a pair of leak ports for discharging the motive fluid from said chamber upon the return stroke, one of said ports being continuously open, means for opening the other port during the latter part of the return stroke, means for closing the same again at substantially the end of the return stroke and means for adjusting the point at which said reclosure occurs.

9. In a power control apparatus for a pneumatic conveyor having a transmission line, an exhaust line, and a casing therebetween enclosing a main valve for controlling the line air flow, means for establishing a minimum flow of air through the line when the main valve is closed, means for opening the main valve in response to the presence of a carrier in the transmission line, and time controlled means for closing the valve, said response means including a main pneumatic for moving the main valve and an auxiliary control pneumatic for initiating the opening and closing strokes of the main pneumatic, said auxiliary pneumatic being sensitizable to the presence of a carrier in the transmission line by having a diaphragm constantly exposed on one side to atmospheric pressure, and having a chamber at the other side provided with a passageway leading therefrom, said passage having a first port communicating with atmosphere and a second port communicating with the transmission line, a valve for the atmospheric port normally closed for establishing transmission line pressure at said other side of the auxiliary diaphragm to sensitize the same, means operable by the movement of the main valve at the end of its opening stroke for opening said atmospheric valve for establishing atmospheric pressure in said chamber for desensitizing said diaphragm and at the end of the closing stroke for closing said atmospheric valve for resensitizing said diaphragm, a valve for the transmission line port, and means for operating it in conjunction with the atmospheric valve for closing the transmission line port while the atmospheric port is open for segregating the transmission line pressure from said passageway while the atmospheric port is open.

10. Power control apparatus of the minimum flow type for a pneumatic conveyor line having a transmission tube and an exhaust tube and a main valve between said tubes for controlling carrier propelling air flow through the line, means for establishing a minimum flow of air through the line when the main valve is closed, a main pneumatic for operating the main valve and an auxiliary pneumatic responsive to the introduction of a carrier into the line for initiating the operation of the main pneumatic and means for conditioning the response pneumatic including a continuously open passage communicating from the latter to the transmission line and a valve controlled atmospheric port along said passage, and means for operating said valve from the main valve.

11. Power control apparatus of the minimum flow type for a pneumatic conveyor line having a transmission tube and an exhaust tube and a main valve between said tubes for controlling carrier propelling air flow through the line, means for establishing a minimum flow of air through the line when the main valve is closed, a main pneumatic for operating the main valve and an auxiliary pneumatic responsive to the introduction of a carrier into the line for initiating the operation of the main pneumatic and means for conditioning the response pneumatic including a continuously open passage communicating from the latter to the transmission line and a valve controlled atmospheric port along said passage and means for operating said valve from the main valve including means for opening said valve at the end of the opening stroke of the main valve and for closing it at the end of the closing stroke of the main valve.

12. In a power control apparatus for a pneumatic conveyor having a transmission line, an exhaust line, and a casing therebetween enclosing a main valve for controlling the line air flow, means for establishing a minimum flow of air through the line when the main valve is closed, means for opening the main valve in response to the presence of a carrier in the transmission line, and time controlled means for closing the valve,

said response means including a main pneumatic for moving the main valve and an auxiliary control pneumatic for initiating the opening and closing strokes of the main pneumatic, said auxiliary pneumatic being sensitizable to the presence of a carrier in the transmission line by having a diaphragm continuously exposed on one side to a constant pressure, and having a chamber at the other side provided with a passageway leading therefrom, said passageway having a first port communicating with said constant pressure and a second port communicating with the transmission line, a valve for the constant pressure port normally closed for establishing transmission line pressure at said other side of the auxiliary diaphragm to sensitize the same, means operable by the movement of the main valve at the end of its opening stroke for opening said constant pressure valve for establishing the constant pressure in said chamber for desensitizing said diaphragm and at the end of the closing stroke for closing said constant pressure valve for resensitizing said diaphragm, a valve for the transmission line port, and means for operating it in conjunction with the constant pressure valve for closing the transmission line port while the constant pressure port is open for segregating the transmission line pressure from said passageway while the constant pressure port is open.

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