Oct. 22, 1968 D. H. THORBURN 3,406,928

PNEUMATIC TUBE SYSTEM

Filed July 25, 1967 5 Sheets-Sheet 1

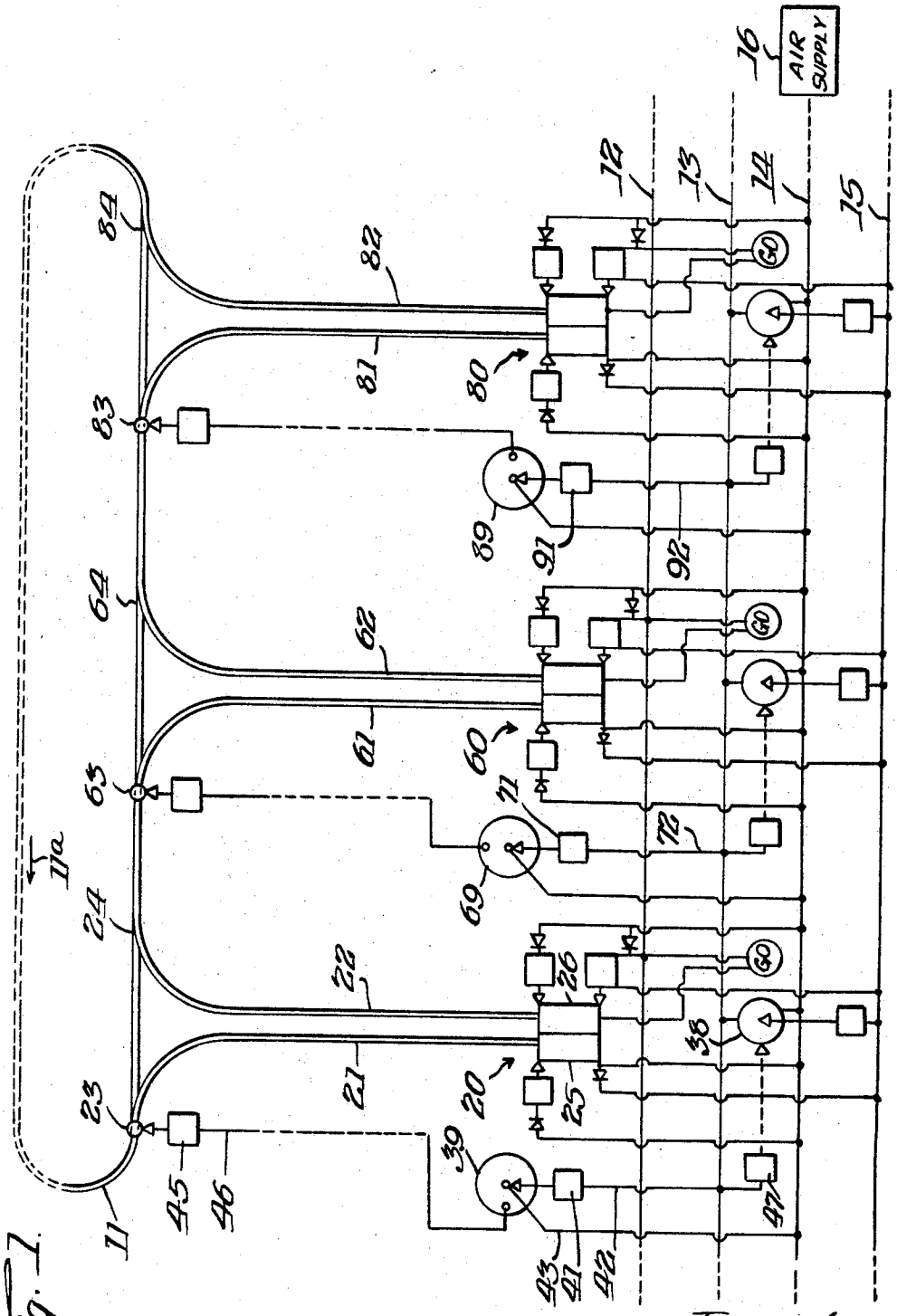


Fig. 1

Inventor.
David H. Thorburn.
By Hume, Clement, Hume, & Lee.
Attys.

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PNEUMATIC TUBE SYSTEM

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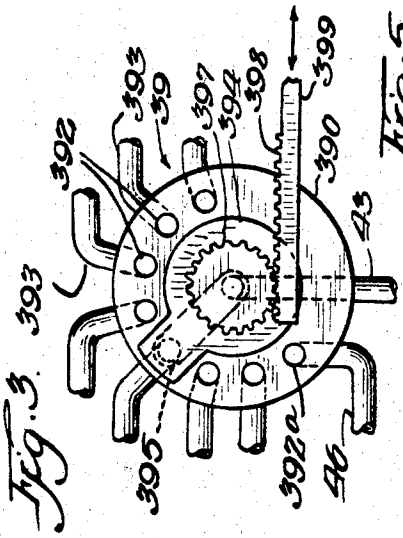


Fig. 3.

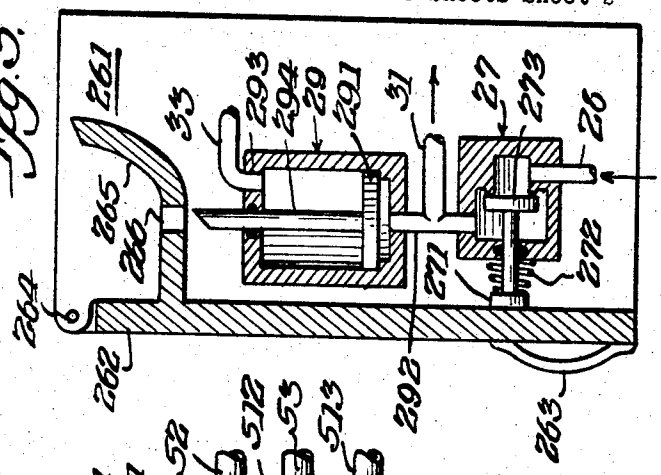


Fig. 5.

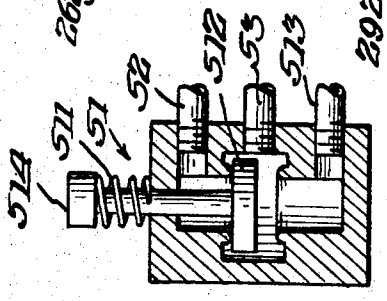


Fig. 6.

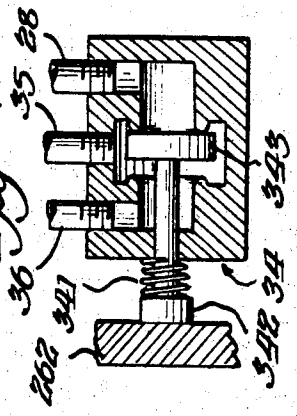


Fig. 4.

Fig. 2.

Inventor.
David H. Thorburn.
By Hume, Clement, Hume & Lee.
Attys.

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PNEUMATIC TUBE SYSTEM

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Fig. 7.

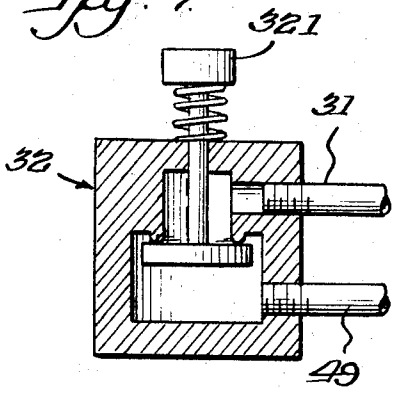


Fig. 8.

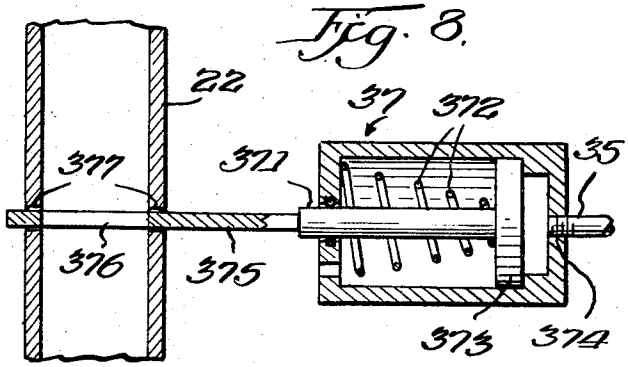


Fig. 9.

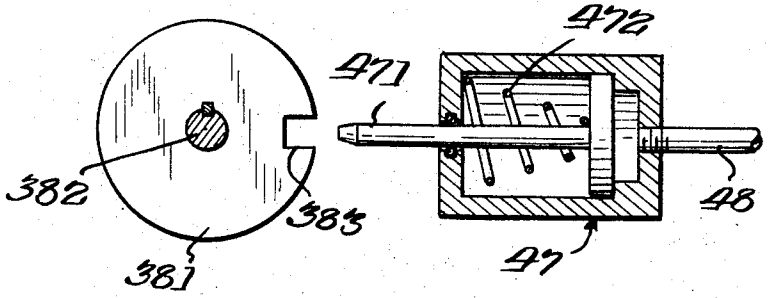
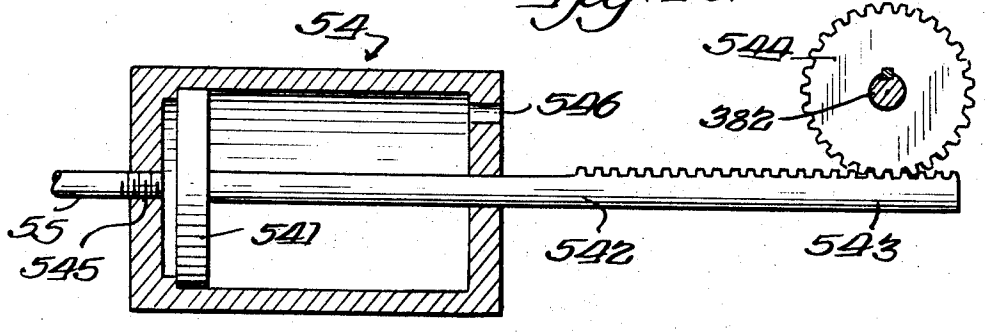


Fig. 10.



Inventor.
David H. Thorburn.
By Hume, Clement, Hume & Lee.
Attys.

Oct. 22, 1968 D. H. THORBURN 3,406,928

PNEUMATIC TUBE SYSTEM

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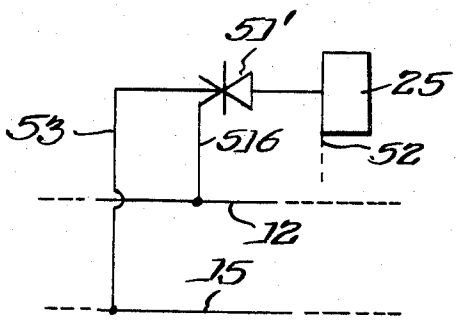


Fig. 11.

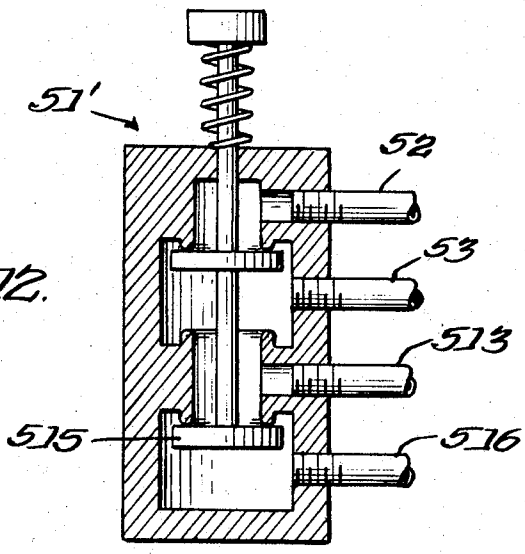


Fig. 12.

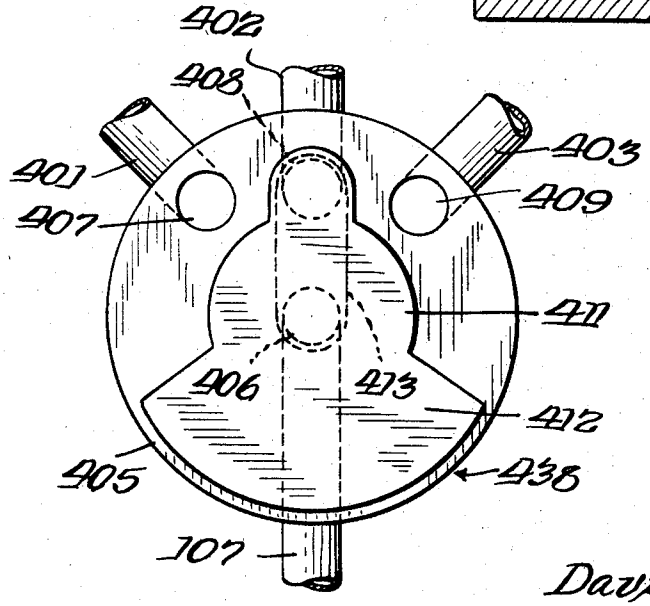


Fig. 14.

Inventor:
David H. Thorburn.
By. Hume, Clement, Hume & Lee.
Attys.

Oct. 22, 1968 D. H. THORBURN 3,406,928

PNEUMATIC TUBE SYSTEM

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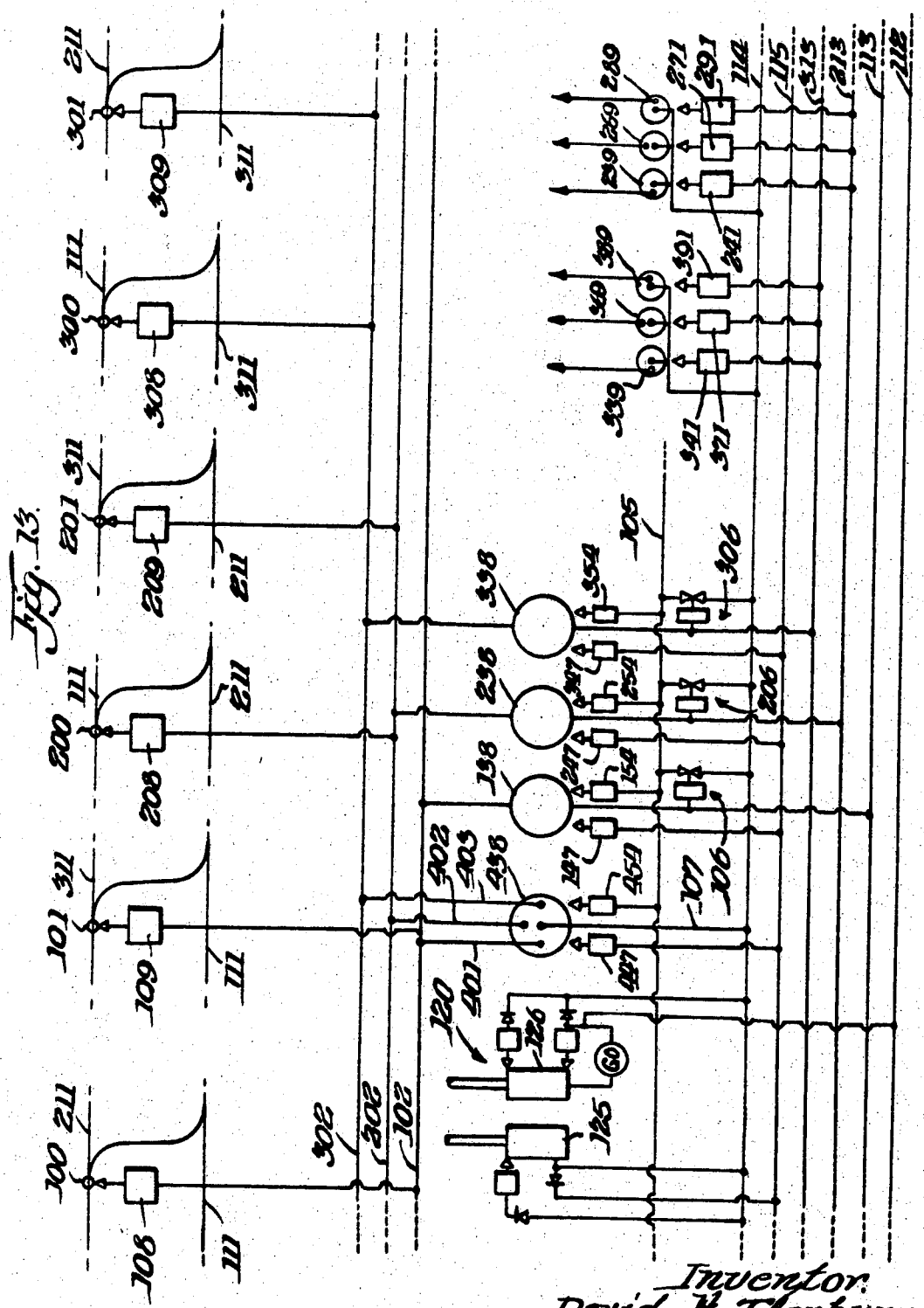


Fig. 13.

Inventor:
David H. Thorburn.
By Hume, Clement, Hume, & Lee
Attys.

United States Patent Office

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PNEUMATIC TUBE SYSTEM

David H. Thorburn, Oak Park, Ill., assignor to The Powers Regulator Company, Skokie, Ill., a corporation of Illinois

Filed July 25, 1967, Ser. No. 655,843
8 Claims. (Cl. 243—5)

ABSTRACT OF THE DISCLOSURE

A pneumatic tube system including carrier dispatch stations and carrier destination stations in which the diverter switch Y's for routing a carrier to a particular station are pneumatically operated. In the single-loop system, manually operated pressure selector switch dial unit is provided at each dispatch station for providing a selected one of a plurality of output pressures which are respectively indicative of the addresses of the destination stations. Pressure responsive means located at each of the destination stations actuates the switch Y associated with its particular destination station only upon receipt of pneumatic fluid at the pressure indicative of the address of the particular destination station. A dial signal conduit connects each of the pressure selector switch dial units in common with each of the pressure responsive means. Thus, when a carrier is dispatched, it travels to the particular destination station the address of which corresponds to the selected pressure provided by the pressure selector switch dial unit. Also disclosed are station dial interlock means, dispatch station door interlock means, station dial reset means, and means for preventing upset of pressure conditions in the main conveying tube when a station door is open. A multi-loop system is additionally disclosed.

This invention relates to pneumatic tube systems and, in particular, to a pneumatic tube system in which pneumatic fluid under pressure operates the control devices as well as providing the means for propelling carriers through the pneumatic tube system.

It is a primary object of the present invention to provide a pneumatic tube system which includes a pneumatic control system offering the simplicity, reliability and ease of operation of pneumatic-fluid-operated control devices.

It is another object of the present invention to provide a pneumatic tube system in which dispatch propulsion speed of the carrier may be independent of conveying system pressure.

It is still another object of the present invention to provide a pneumatic tube system which is versatile in terms of the number of stations and loops which can be used in the system, accommodation of additional functions, and further system expansion.

It is a further object of the present invention to provide a pneumatic tube system which is characterized by relatively low manufacturing, installation and maintenance costs and which makes use of a low cost form of carrier.

It is yet another object of the present invention to provide a pneumatic control system embodying pneumatically operated control elements which includes interlock arrangements for preventing simultaneous operation of more than one sending station apparatus and react arrangements for returning send station apparatus to standby condition.

It is still another object of the present invention to provide a pneumatic tube system featuring automatic means for preventing upset of pressure conditions in the main pneumatic conveying tube when station door is open.

Briefly described, the pneumatic tube system of the present invention includes a supply line for providing pneumatic fluid under pressure, a main carrier conveying tube provided with circulating fluid medium, at least one carrier dispatch station connected to the main carrier conveying tube by a dispatch branch tube and a plurality of carrier destination stations, each connected to the main carrier conveying tube by a destination branch tube. Also included are diverter means disposed at the junction of each of the destination branch tubes and the main carrier conveying tube for diverting the carrier to an associated destination branch tube when the diverter means is in actuated condition. A manually-operated pressure selector switch dial unit is associated with the dispatch station and connected to the supply line for providing a selected one of a plurality of output pressures respectively indicative of the addresses of the destination stations. Pressure responsive means are provided at each of the destination stations for actuating the diverter means associated with a particular designation station only upon receipt of pneumatic fluid at a pressure indicative of the address of the particular destination station, and a dial signal conduit is provided for connecting each of the pressure responsive means in common to the pressure selector switch. Thus, when a carrier is dispatched from the dispatch station it travels to the destination station the address of which corresponds to the selected pressure level provided by the pressure selector switch dial unit. The pneumatic tube system also preferably includes means for isolating each station send or receive chamber from the main conveying tube when the chamber door is open, means for automatically locking closed the doors of other dispatch stations when the door to the dispatch station to be used is opened, means for automatically disabling the selector switch dial units at other dispatch stations when the selector switch dial unit at a particular dispatch station is operated, and means for automatically resetting the selector switch dial units and unlocking the dispatch station doors when a carrier is received at a destination station. In multi-loop installations, each loop is provided with a separate dial signal conduit, and a loop selector switch is provided for actuating diverter means to the selected loop and also pressurizing the station selector dial units connected to the dial signal conduit associated with the selected loop.

These and other features and objects of the present invention will be better understood by reference to the following detailed description and to the accompanying drawings.

In the drawings:

FIGURE 1 is a schematic illustration of a preferred form of single loop pneumatic tube system in accordance with the present type of invention.

FIGURE 2 is a schematic illustration of a typical dispatch station and destination station combination of the single loop system shown in FIGURE 1.

FIGURE 3 is an elevational view of a selector switch and drive assembly suitable for use in providing actuation of a selected one of several diverters.

FIGURE 4 is a partially cross-sectional view of one form of three-way switch valve suitable for use in per-

forming certain switching functions in accordance with the present invention.

FIGURE 5 is a side view partially in elevation and partially in cross-section illustrating certain component portions associated with each dispatch station in the system according to the present invention.

FIGURE 6 is a partially cross-sectional view of one form of three-way switch valve suitable for use in performing additional switching functions in accordance with the present invention.

FIGURE 7 is a partially cross-sectional view of one form of two-way switch valve suitable for use in performing further switching functions in accordance with the present invention.

FIGURE 8 is a partially cross-sectional view of a wind gate arrangement and wind gate drive cylinder for use in the present invention.

FIGURE 9 is a view partially in elevation and partially in cross-section of a station dial locking assembly for use in the present invention.

FIGURE 10 is an elevational view of a station dial reset assembly for use in the present invention.

FIGURE 11 is a schematic illustration of a portion of FIGURE 2 with modified circuit connections.

FIGURE 12 is a partially cross-sectional view of a four-way switch valve for use in providing the modified circuit connections of FIGURE 11.

FIGURE 13 is a schematic illustration of a multi-loop pneumatic tube system in accordance with the present invention.

FIGURE 14 is an elevational view of a loop selector switch suitable for use in accordance with the present invention.

Single loop system

Referring now to FIGURE 1, there is shown a single loop pneumatic tube system according to the present invention. The pneumatic tube system includes a main carrier conveying tube means **11** which is conventional and therefore will not be described with particularity. In conventional manner the main pneumatic tube would have an air intake and an air exhaust means (not shown) so as to provide circulating air moving in the direction indicated by the arrow **11***a* for propelling carriers introduced into the main carrier conveying tube **11**. In FIGURE 1, the single loop system is shown with three sending and receiving stations **20**, **60**, and **80**. This is by way of illustration only and the exact number of stations will depend upon the particular installation requirements and the equipment capacity. For example, **12** or more sending and receiving stations might be used in a single loop system. It will be noted that the stations **20**, **60**, and **80** are respectively connected to the main carrier conveying tube by destination branch tubes **21**, **61**, and **81**, respectively, and by dispatch branch tubes **22**, **62**, and **82**, respectively. The destination branch tubes **21**, **61**, and **81** receive carriers addressed to their associated stations **20**, **60**, and **80**, respectively. For this purpose, the destination branch tubes **21**, **61**, and **81** are connected to the main carrier conveying tube **11** by switch Y's **23**, **63**, and **83**, respectively. The dispatch branch tubes **22**, **62**, and **82** transmit the carriers from their associated stations **20**, **60**, and **80**, respectively, into the main carrier conveying tube **11** and, hence, are joined to the main carrier conveying tube **11** at junctions **24**, **64**, and **84**.

Interconnecting the stations **20**, **60**, and **80** are four lines or conduits **12**, **13**, **14** and **15**. The respective functions of these four conduits will be described in detail further on. At this point, however, it may be noted that the conduit **12** is a closed circuit conduit for transmitting dispatch station door lock pressure signals; the conduit **13** is a closed circuit conduit for transmitting station dial and station interlock pressure signals; the conduit **14** is an air supply line for providing pneumatic fluid under pressure to various elements in the control system; and the conduit **15** is a closed circuit conduit for transmitting dial reset and dispatch door unlock pressure signals. The air supply line **14** is connected at one end to conventional compressed air supply source **16**. At its opposite end, the supply line **14** is dead-ended.

Since each of the sending and receiving stations is identical to one another in terms of the functions performed by their component elements, a description of these elements and their functions in relation to station **20** shown in enlarged view in FIGURE 2 will simplify and shorten this detailed description. In FIGURE 2 it will be noted that the send-and-receive station **20** includes a receive chamber **25** at the end of the destination branch conduit **21** and a send chamber **26** at the beginning end of the dispatch branch conduit **22**. Both chambers may be defined by any suitable or conventional casing which includes a normally closed door to seal the chamber from atmosphere. Referring additionally to FIGURE 5, there is shown in elevation a casing **261** for cooperating with a pivotal door **262** to define an interior station dispatch chamber such as **26** in FIGURE 2. The door **262** may, for example, extend outwardly beyond the sides of the casing **261** in order to provide projecting portions of the door for actuating or cooperating with certain control elements which will be described further on. In FIGURE 5, the door **262** is shown in cross-section as projecting outwardly from the drawing. The door includes a handle **263** and is pivoted about a hinge **264**. The hinge **264** may be spring loaded to maintain the door **262** normally closed. A similar arrangement may be used for defining the receive chamber **25** of FIGURE 2.

When the door of the dispatch chamber **26** is opened, a switch valve **27** is mechanically actuated to pass air at supply pressure from a conduit **28** connected to the air supply line **14**, to the local dispatch door lock cylinder **29**, and also to the dispatch station door lock conduit **12** and to a GO switch valve **32**. In FIGURE 5, the switch valve **27** and the local door lock cylinder **29** are shown in cross-section. As seen, the switch valve **27** is a two-way switch valve, spring biased normally open. As soon as the door **262** is opened, the plunger **271** is moved forwardly by the bias spring **272**, unseating the poppet **273**. The door lock cylinder **29** includes a latch member **294** affixed to a free piston **291**, an inlet port **292** below the piston **291**, and a port **293** located above the piston **291** and connected via conduit **33** to the dial reset and door unlock line **15**. The dispatch door **262** contains a curved projection **265** having a locking aperture **266**. Accordingly, when the dispatch station door **262** is opened for insertion of a carrier, the switch valve **27** is opened passing compressed air through the switch valve to the cylinder **29**, port **292**, and the conduit **31**, thereby pressurizing the door lock cylinder **29**, the door lock signal line **12**, and the GO switch **32**. The door latching member **294** will be urged upwardly but since the door **262** is open, the latching member **294** will not be received within the locking aperture **266** but rather will bear against the member **265** until the door is closed. However, since the dispatch chamber door and all other send-and-receive stations will be in their normally closed position, their corresponding latching apertures will be in alignment with their latching members, and the pressure in the conduit **12** will cause all such dispatch station doors to lock. This will occur relatively quickly so that the chance of two dispatch chamber doors being opened simultaneously is minimal.

In FIGURE 2 it will be noted that there is a further switch valve **34** connected via the conduit **28** to the supply line **14**. This switch valve is shown in FIGURE 4. As seen, it is a spring-biased three-way switch valve having an inlet conduit **28** and an outlet conduit **35**. The third conduit **36** is an exhaust conduit to atmosphere. The switch valve **34** is positioned so that when the dispatch door **262** is closed, the plunger **342** is forced inwardly against the force of the compression spring **341** so that

the poppet **343** prevents communication between the inlet conduit **28** and the outlet conduit **35** and permits exhaust of the outlet conduit **35** via the conduit **36**. In FIGURES 2 and 8 it is seen that the outlet conduit **35** from the switch valve **34** is connected to a wind gate cylinder **37**. The wind gate cylinder **37** includes a piston rod **371** which is biased into retracted position by a compression spring **372** bearing into retracted position by a compression spring **372** bearing against the piston **373**. The conduit **35** connects to an inlet port **374** in the cylinder chamber on the opposite side of the piston **373** from the spring **372**. On the outer end of the piston rod **371** there is mounted a wind gate **375** which may comprise, for example, a plate having a circular opening **376** therein which is equal to or slightly larger than the interior diameter of the dispatch branch tube **22**. The wind gate **375** is positioned to reciprocate transversely of the dispatch tube **22** in a suitable opening **377** provided in the dispatch branch tube. With the piston rod **371** completely retracted, the circular aperture **376** in the wind gate is in a substantially concentric position with respect to the interior of the branch tube **22** so as not to interfere with the passage of carriers through the dispatch branch tube **22**. However, when the piston rod **371** is caused to move to its fully extended position by the presence of supply pressure admitted into the cylinder chamber from the conduit **35**, the wind gate interrupts the flow of air in the dispatch conduit **22**. The function of this arrangement of switch valve **34** and wind gate cylinder **37** is to prevent the main conveying tube **11** pressure from being drastically upset when the dispatch station door is open. The switch valve **34** simply acts to pressurize the wind gate cylinder **37** whenever the dispatch station door is open and to exhaust the wind gate cylinder **37** whenever the dispatch door is closed.

With the carrier inserted into the dispatch station chamber **26**, the address of the destination station for the carrier may be manually dialed on the dial unit **38**. The station dial unit is a standard pneumatic device known as a positioning switch, such as the positioning switch manufactured by The Powers Regulator Company and described in The Powers Regulator Company Bulletin 61(b) and Form T–75. As is well known, a positioning switch has an inlet adapted to be connected to a source of supply pressure and an outlet adapted to be connected to a untilization device of some form. The function of a positioning switch is to enable manual selection of the pressure supplied to a utilization device through the positioning switch. In the present invention, the positioning switch forming the station dial **38** has its inlet connected directly to the air supply line **14** and its outlet connected directly to the station dial and dial interlock conduit **13**. It it is important to note that the addressing system of the present invention identifies each station receiving chamber by a preselected, unique pressure level. For example, the receiving chamber **25** of station **20** might be assigned an address pressure level of 3 p.s.i. The receiving chamber of station **60** might be assigned an address pressure level of 4 p.s.i., and the receiving chamber of station **80** might be assigned an address pressure level of 5 p.s.i. and so on. A receiving station is dialed then by rotating the positioning switch dial unit to a position whereby the station dial and dial interlock conduit **13** will be provided with a pressure level corresponding to the pressure level assigned to the desired station receiving chamber. For this purpose suitable indicia may be applied on the face of the positioning switch dialer **38**.

Associated with each of the receiving portions of the send and receive stations in FIGURE 1 is a selector switch drive cylinder. The selector switch drive cylinder associated with the station **20** is identified by the reference numeral **41**; the corresponding cylinder associated with the station **60** is identified by the reference numeral **71**; and the corresponding cylinder associated with the station **80** is identified by the reference numeral **91**. The cylinders **41**, **71**, and **91** are single acting, spring return cylinders capable of proportional movement, such as the Powerstroke motors manufactured by The Powers Regulator Company and described in The Powers Regulator Company Bulletin 44(a). The Powerstroke motor is a force-balanced device, and the position of its operating shaft is directly related to the pressure applied to its inlet. The function of each of the selector switch drive cylinders **41**, **71**, and **91** is to rotate selector switches **39**, **69**, and **89**, respectively, an equal amount dependent upon the dialed pressure level in the dial and dial interlock conduit **13** which is submitted to the cylinders **41**, **71**, and **91** by conduits **42**, **72**, and **92**, respectively. The selector switches **39**, **69**, and **89** are similar in operation to standard pneumatic selector switches such as the selector switch manufactured by The Powers Regulator Company and described in The Powers Regulator Company Bulletin 61(a) and form P–79. The selector switch **39** associated with the station **20** is typical and is shown in elevation in FIGURE 3.

The selector switch **39** comprises a disc structure **390** provided with a plurality of radially disposed ports **392** in the disc **390**. For the sake of explanation, each of the ports **392** is shown provided with an outlet conduit **393**. A poppet **394** is rotatably mounted centrally of the disc structure **390** so as to rotate or step from one port **392** to another. When the selector switches are installed in the system, one of the outlet ports **392** will be the unique switch Y activating port for the particular station at which the particular selector switch is installed, and an outlet conduit connected to the switch Y cylinder will be coupled to the unique outlet port **392**. The remaining ports would preferably be stopped up or plugged. For example, in FIGURES 2 and 3 the port **392***a* is selected as the outlet port to operate the switch Y **23** associated with the station **20** receive chamber **25** and is coupled by a conduit **46** to switch Y cylinder **45** as shown in FIGURE 2. At station **60** the unblocked outlet utilization port may be the next port in angular succession to the port **392***a*, and at station **80** the unblocked outlet or utilization port may be in turn the second port in angular succession from the port **392***a*. The rotating poppets of each of the selector switches is connected by a conduit to the supply pressure line **14**. Thus in FIGURES 2 and 3, a conduit **43** from the supply line **14** connects the central poppet **394** to the air supply line **14**. The rotatable poppet **394** includes an inner channel **395** for connecting the ports **392** to the conduit **43** in succession as the poppet **394** rotates. In order to rotate the poppet **394**, a rack and pinion gear arrangement is provided with the pinion gear **397** mounted to turn integrally with and drive the poppet **394**. The rack **398** is formed on a push rod **399** which, in turn, is integral with the operating shaft of the selector switch cylinder **41**. As previously indicated, when a station dial unit (such as a station dial unit **38**) is employed to address a carrier to a particular station receiving chamber, a unique pressure level is applied to the signal dial and dial interlock line **13**, and all of the selector switch cylinders respond to this pressure level to rotate the poppets of their associated selector switches the same angular amount. As each port in the selector switches is passed over, it is promptly exhausted to atmosphere, and when the poppet of the selector switch stops at a particular outlet port as directed by the pressure level in the conduit **13**, only the station at which that port is connected via a conduit to a switch Y cylinder responds. For example, if the address is the receiving chamber **25** of station **20**, the poppet **394** stops at port **392***a* connecting the conduit **46** to supply pressure thereby actuating the switch Y cylinder **45**. The switch Y **23** would thus be activated to divert the carrier from the main conveying tube **11** to the destination branch tube **21**. The switch Y **23** is conventional in structure and is mechanically actuated by the cylinder **45**. The cylinder **45** is preferably a large capacity piston type pneumatic motor such as the LC motor manufactured by The Powers Regulator Company and described in The

Powers Regulator Company product data sheet 44(b) and form P–81.

The present invention contemplates a station dial interlock arrangement whereby once destination dialing has been manually initiated at one of the station dial units (such as the dial unit **38**), the dial units at all other stations will be locked to prevent multiple address signals and consequent misdirection of carriers. This is achieved by providing at each station a dial locking cylinder such as the dial locking cylinder **47** in FIGURE 2. The dial locking cylinder **47** is connected via a conduit **48** to the station dial and dial interlock conduit **13**. Referring to FIGURE 9, it is seen that the cylinder **47** is similar to the cylinder **37** in FIGURE 8 and constitutes a single-acting, spring-return cylinder. The operating shaft **471** of the cylinder is adapted to act as a latching member. In order to enable locking of the dial unit **38**, a generally circular cam **381** is splined or otherwise mounted on the operating shaft **382** of the dialing unit so as to rotate integrally with the shaft **382**. The spring rate of the compression spring **472** is such that the first one or two p.s.i. of pressure submitted to the station dial and dial interlock conduit **13** will be sufficient to extend the latching member **471** into locking engagement with a peripheral notch **383** in the circular cam **381**. In this way all station dial units would be locked against rotation except the station dial unit which has already been rotated to introduce the one or two p.s.i. actuating pressure into the conduit **13**. Hence, if the dial unit **38** were the unit initiating the dial interlock pressure signal the stem **382** would have been rotated a sufficient angular amount so that the notch **383** would no longer be in alignment with the latching member **471** and pressurization of the cylinder **47** would cause the latching member **471** to bear against the rim of the cam **381** permitting further rotation of the stem **382** until the dialing selection had been completed.

Upon completion of address dialing at the sending station causing the destination station switch *y* to operate and locking all other dial units against manual operation, the carrier is ready for dispatch to the main conveying tube **11**. The carrier is dispatched by depressing the GO switch valve **32** to provide a burst of compressed air to propel the carrier through the sending branch conduit **22** into the main conveying tube **11**. The switch valve **32** is shown in FIGURE 7. As seen, it is a normally-closed two-way switch valve having an inlet connection to conduit **31** and an outlet connection to a conduit **49**. It is manually operated by depressing the plunger knob **321**. Referring to FIGURE 2 it is seen that by depressing the switch valve **32**, the compressed air trapped in the dispatch station door locking cylinder **29** and in the conduit **12** and in the other dispatch station door locking cylinders will be partially or entirely exhausted in propelling the carrier from the dispatch chamber **26** to the main conveying tube **11**.

Turning now to a consideration of the elements associated with the receiving chamber **25** in FIGURE 2, a three-way, spring-biased switch valve **51** is positioned so as to respond to receipt of a carrier by the chamber **25**. The switch valve **51** is shown in FIGURE 6. It includes a compression spring **511** which biases the poppet **512** into engagement in a position closing communication between inlet **52** and outlet conduit **53** and permitting communication between outlet conduit **53** and a venting conduit **513**. The switch valve **51** is preferably located in the floor of the casing defining the carrier destination chamber **25** so that a carrier arriving in the chamber **25** will rest upon and depress the plunger knob **514** causing the switch valve to close communication between the signal conduit **53** and the venting conduit **513** and open communication between the supply conduit **52** and the signal conduit **53**. From FIGURE 2 it will be noted that the supply conduit **52** is connected directly to the air supply line **14** whereas the signal conduit **53** is connected directly to the dial reset and door unlock conduit **15**. Thus, receipt of the carrier from the chamber **25** pressurizes the conduit **15**. The pressurization of the conduit **15** acts as a dispatch door unlock signal and station dial reset signal. Each of the dispatch station door lock cylinders, such as the cylinder **29** in FIGURE 2, is connected via a conduit, such as the conduit **33** in FIGURE 2, to the conduit **15**. By referring briefly to FIGURE 5, it will be seen that the presence of supply pressure transmitted through the conduit **33** to the dispatch door locking cylinder **29** functions to provide positive movement of the piston **291** to withdraw the latching member **294** from the locking recess **266**. In this way the dispatch station doors at all stations are unlocked. Also connected to the dial reset and dispatch station door unlock conduit **15** at each station is a dial reset cylinder **54**. The dial reset cylinder **54** is shown in FIGURE 10. As seen, it comprises a single acting cylinder without spring return. It includes a piston **541** connected to an operating shaft **542**. At its opposite end, the operating shaft **542** provides a rack **543** of a rack and pinion gear arrangement. The pinion **544** is splined or otherwise connected to the shaft **382** of the station dial unit to rotate integrally therewith. The conduit **55** connects the conduit **15** to an inlet port **545** on the side of the piston **541** opposite the operating shaft **542**. On the operating shaft side of the piston **541**, the cylinder **54** is vented to atmosphere by vent **546**. Accordingly, since conduit **15** is always vented except when there is a receiver in one of the station destination chambers, the no compression resistance to movement of the piston **541** is presented to interfere with station dialing. However, when a carrier is received in the chamber **25**, the conduit **15** is pressurized causing the piston **541** to be moved forwardly. This extends the shaft **542** causing rotation of the pinion **544** and, hence, reset of the station dial unit **38** to stand by position. Reset of the station dial unit to stand by also causes reduction of the pressure level in the station dial and dial interlock line **13** so as to return all switch Y selector switches to stand by position by reducing the pressure in the selector switch cylinders. In addition, the reduction in pressure in the conduit **13** relieves the station dial lock cylinders (such as the cylinder **47** in FIGURE 2) thereby unlocking all station dial units.

Also associated with each of the destination chambers is a wind gate switch valve such as the switch valve **56** in FIGURE 2 and wind gate cylinder such as the wind gate cylinder **57** in FIGURE 2. The wind gate switch valve **56**, the wind gate cylinder **57** and the associated wind gate itself are structurally and functionally the same as the switch valve **34**, the wind gate cylinder **37** and the associated wind gate shown in FIGURES 4 and 8, respectively, and previously described. Briefly, whenever the door of the destination chamber **25** is open, the switch valve **56** pressurizes the wind gate cylinder **57** to isolate the main conveying tube **11** from the chamber **25** to prevent radical upset of the pressure in the main conveying tube **11**. When the door of the chamber **25** is again closed after removing the carrier, the wind gate is opened.

Referring now to FIGURE 11, there is shown a modification of the single loop system wherein a modified carrier receipt switch valve **51'** is used. The modified switch valve **51'** is a two-poppet, four-way switch valve instead of a single poppet three-way switch valve. The modified switch valve **51'** is shown in FIGURE 12. As can be seen from FIGURES 11 and 12, the connections to conduits **52** and **53** remain the same, and the operation of the valve in controlling communication between the supply conduit **52** and the signal conduit **54** and between the signal conduit **53** and the exhaust conduit **513** remains identical with the operation of the switch valve **51** shown in FIGURE 5 and previously described. However, the switch valve **51'** includes an additional popet **515** which controls communication between the exhaust conduit **513** and a new inlet conduit **516** which is connected directly to the dispatch station door lock signal conduit **12**. The

function of this modification is to insure that the conduit **12** is exhausted to atmosphere when a carrier is received by the chamber **25**, thereby insuring that all dispatch chamber doors are unlocked in systems in which the depression of the GO switch valve dose not itself sufficiently unload the dispatch station door locking cylinders when a carrier is dispatched by depression of the switch valve **32**.

Operation of single loop system

In a brief review, the operation of the single loop system is as follows:

Dispatch.—To dispatch a carrier from the send-and-receive station **20**, FIGURE 2, the dispatch door of the dispatch chamber **26** is opened. This action opens the dispatch door switch valve **27**, pressurizing the dispatch station door interlock line **12** and thereby locking the dispatch station doors at all other stations. Opening the dispatch station door at station **20** also actuates the wind gate switch valve **34** to pressurize the wind gate cylinder **37** so as to isolate the chamber **26** from the dispatch branch conduit **22** to prevent drastic upset of the pressure conditions in the main conveying tube **11**. When the carrier has been inserted in the dispatch chamber **26** and the chamber door closed, the switch valve **27** closes, trapping compressed air in the door lock cylinder **29** and in the conduit **12**. Closing the chamber **26** door also exhausts the wind gate cylinder **37** through the switch valve **34**, thereby opening the wind gate for ultimate passage of the carrier from the chamber **26** through the dispatch conduit **22** to the main conveying tube **11**. The destination station is dialed on the dial unit **38**. As the dial unit **38** is dialed, the station dial interlock and station dial signal conduit **13** is pressurized, actuating the dial interlock cylinders at all stations to prevent simultaneous dialing. As the conduit **13** is pressurized, the selector switch cylinders at all receiving stations begin to extend, rotating their associated selector switches so that all selector switches in the system step or rotate in a synchronous manner. When the pressure level in the conduit **13** reaches the unique pressure level which is indicative of the destination station address, the switch Y cylinder at the destination station will be connected to the supply pressure line through the destination station selector switch thereby defining a diversion path out of the main conveying tube **11** to the destination station. The carrier is now ready to be dispatched. Dispatch is accomplished by depressing the GO switch valve **32** to provide a burst of compressed air from the dispatch door lock cylinder **29** and the conduit **12** to propel the carrier from the dispatch chamber through the dispatch branch conduit into the main conveying tube **11**.

Receipt of a carrier.—Assuming a carrier has been addressed to the chamber **25** in FIGURE 2 and has been diverted from the main conveying tube **11** by the switch Y **23** through the destination branch conduit **21** and into the chamber **25**, the carrier receive switch valve **51** is actuated by the weight of the carrier, providing a pressure signal in the station dial reset and dispatch door unlock line **15** to provide positive unlocking of all dispatch station doors and actuation of the dial reset cylinders at all stations to return all dial units to stand-by condition. Opening the chamber **25** door to remove the carrier actuates the wind gate cylinder **57** to isolate the chamber from the main conveying tube **11** while the door is open. When the carrier has been removed and the door again closed, the wind gate switch valve **56** exhausts the wind gate cylinder **57** to open the associated wind gate. This completes an operational cycle of the single loop system.

Structure and operation of multi-loop system

Referring now to FIGURE 13, there is shown a partial schematic diagram of a three loop pneumatic tube system according to the present invention. The tubes **111**, **211**, and **311** represent, respectively, the main conveying tubes for the first, second, and third loops. The means for providing circulating air for propelling carriers through these loop main conveying tubes are conventional and will not be further described. Three loop interchange tubes **101**, **201**, and **301** are shown in FIGURE 13. The interchange tube **101** cooperates with the switch Y **103** to divert carriers from the third loop to the first loop; the interchange tube **201** cooperates with the switch Y **203** to divert carriers from the first loop to the second loop; and the interchange tube **301** cooperates with the switch Y **303** to divert carriers from the second loop to the third loop.

As in the single loop system, the three loop system includes air supply line **114** which is common to all send-and-receive stations, a dispatch chamber door interlock conduit **112** which is common to all stations, and a dial reset and dispatch chamber door unlock conduit **114** which is common to all stations. However, unlike the single loop system, the three loop system does not have a single conduit for transmitting station dial and dial interlock signals. Instead, the dial interlock signals are transmitted via a conduit **105** which is common to all stations, and the station dial pressure signal is transmitted over a selected one of three possible dial signal trunk lines **113**, **213**, and **313**. The dial signal trunk line **113** is common only to the stations in the first loop; the dial trunk line **213** is common only to the stations in the second loop; and the dial trunk line **313** is common only to the stations in the third loop.

A send-and-receive station **120** is shown in FIGURE 13. The station **120** may be considered as one of the stations in the first loop having a carrier receive chamber **125** and a carrier dispatch chamber **126** as previously described in reference to the single loop system. The control elements associated with the station **120** are the same as previously described with respect to station **20** in FIGURES 1 and 2 with the exception of certain differences necessary in the multi-loop system. For the sake of brevity, the differences will be described, and the similarities with the single loop station will not be further described.

Instead of a single station dial unit, each send-and-receive station in the multi-loop system includes a station dial unit for each loop in the system. Hence, in FIGURE 13 the station **120** is provided with a dial unit **138** for dialing stations in loop **1**, a dial unit **238** for dialing stations in loop **2**, and a dial unit **338** for dialing stations in loop **3**. In addition, a four-port loop selector switch **438** is provided at the station **120**. It is manually operated and is preferably provided with indicia on its face for indicating the loop selection positions of the switch. Selector switch **438** has its inlet port connected to the air supply pressure conduit **114** via a conduit **107**. The first loop outlet port is connected via a conduit **401** to the loop pressure conduit **102**; the second loop outlet port is connected via a conduit **402** to the second loop pressure conduit **202**; and the third loop outlet port is connected via conduit **403** to the third loop pressure conduit **302**. Referring briefly to FIGURE 14, there is shown an elevational view of the loop selector switch **438** that includes the base plate structure **405** having central inlet port **406**, a first outlet port **407** connected to the conduit **401**, the second outlet port **408** connecting with the conduit **402**, and a third outlet port **409** connecting with the conduit **403**. Rotatably mounted on the base plate is a poppet and port closure member **411**. The selector switch poppet member **411** preferably has a stop or stand-by position which would be 180 degrees of that shown in FIGURE 14, such that the flanged portion **412** would seal off the three outlet ports **407**, **408**, and **409** when the loop selector switch, the member **411**, is manually rotated to bring the interior connecting channel **413** over the desired outlet port for loop selection. The member **411**, as seen, is preferably arranged so that the non-selected ports will now be vented to prevent any possibility of erroneous loop addressing.

When the loop selector has been set, the corresponding loop pressure line is brought to supply pressure, causing its associated switch Y's to close. For example, of the second loop is dialed on the loop selector, the loop pressure line **202** would be brought to supply pressure, thereby pressurizing the loop switch Y cylinders **208** and **209** so that all carriers regardless of where introduced into the system will pass to the second loop carrier conveying tube **211**. In addition, loop dialing also pressurizes one of the three station dial units **138**, **238**, or **338** for station dialing. Hence, if the second loop were dialed on the loop selector **438**, only the station selector **238** would be provided with pressure via the loop pressure line **202**. Now, dialing the station dial unit **238** will introduce a pressure level into the station dial trunk line **213** which uniquely corresponds to a receiving station in the second loop. This completes the destination addressing. It may be noted at this point that because only one of the three trunk lines **113**, **213**, and **313** is used at any one time, the same pressure level may be assigned to one station in each of the three loops; for example, 4 p.s.i. may be the pressure level assigned to the second station in each of the three loops.

Associated with each of the station dialers **138**, **238**, and **338** are isolation relays **106**, **206**, and **306**, respectively. These relays are connected to the outlets of the respective associated station dialers **138**, **238**, and **338**, and are also interconnected between the air supply pressure line **114** and the station dial interlock line **105**. The function of each isolation relay is to sense the appearance of pressure at the outlet of its associated station dialer to provide supply pressure to the station dial interlock line **105** from the air supply line **114**. For this purpose, a multi-purpose relay such as the relay described in Product Data Sheet 62B–1 of The Powers Regulator Company may be used. In this manner, all station dial lock cylinders (such as cylinders **154**, **254**, and **354** in FIGURE 13) are pressurized, and all loop selector dial lock cylinders (such as cylinder **454** in FIGURE 13) are pressurized.

The station dial signal causes one of the stations on its associated loop to be activated to complete the addressing of the carrier. For example, the signal from the station dial unit **238** transmitted to the station dial trunk line **213** would cause simultaneous rotation of the station selector switches **239**, **269**, and **289**, resulting in selection of one receiving station in the same manner as previously described with reference to the single loop system. The three station selector switches **339**, **369**, and **389** would not rotate.

Station door lock functioning is the same as in the single loop system. Station dial reset functioning is also the same as in the single loop system except that the selector dials reset cylinders such as cylinder **447** in FIGURE 13 are provided. The selector dial reset cylinders operate in the same manner as the station dial reset cylinders **154**, **254**, and **354**.

The modification shown in FIGURES 11 and 12 may also be applied to the multi-loop system.

In all respects not mentioned, the multi-loop system operates in the same manner as the single loop system.

While certain forms of the present invention have been described and illustrated, it is to be understood that this is merely by way of example and is not to be construed in any manner as a limitation. It is contemplated that modifications will be made by those skilled in the art within the scope of the claims without departing from the spirit of the invention.

What is claimed is:

1. A pneumatic tube system comprising: a main carrier conveying tube supplied with circulating fluid medium; at least one carrier dispatch station connected to said main conveying tube by a dispatch branch tube; a plurality of carrier destination stations each connected to said main conveying tube by a destination branch tube; diverter means disposed at the junction of each of said destination branch tubes and said main conveying tube for diverting a carrier to an associated branch tube when said diverter means is actuated; a supply line connected to a source of pneumatic fluid at supply pressure; a manually-operated pressure selector switch associated with said dispatch station and connected to said supply line for providing a selected one of a plurality of output pressures respectively indicative of the addresses of said destination stations; pressure responsive means associated with each of said destination stations for actuating the diverter means associated with said destination station only upon receipt of pneumatic fluid at a pressure indicative of the address of said destination station; and means connecting each of said pressure responsive means in common to said pressure selector switch whereby when a carrier is dispatched from said dispatch station it travels to the particular destination station the address of which corresponds to the selected pressure provided by said pressure selector switch.

2. The pneumatic tube system defined in claim **1** further comprising means at each dispatch station and at each destination station for pneumatically isolating its associated station from said main carrier conveying tube when the door of said associated station is open.

3. A pneumatic tube system comprising: a source of pneumatic fluid under supply pressure; a main carrier conveying tube provided with circulating pneumatic fluid; a plurality of carrier dispatch stations each connected to said main conveying tube by an associated dispatch branch tube; a plurality of carrier receiving stations each connected to said main carrier conveying tube by an associated receiving branch tube; diverter means disposed at the junction of each receiving branch tube and said main carrier conveying tube for diverting a carrier to the associated receiving branch tube when said diverter means is actuated; a manually-operated pressure selector switch associated with each dispatch station and connected to said source of supply pressure for providing a selected one of a plurality of output pressures respectively indicative of the addresses of said receiving stations; pressure responsive means associated with each of said receiving stations for actuating the diverter means associated with said receiving station upon receipt of pneumatic fluid at a pressure indicative of the address of said receiving station; means connecting each of said pressure responsive means in common to each of said pressure selector switches such that, when a pressure selector switch associated with a particular dispatch station is caused to provide a selected pressure indicative of the address of a particular receiving station, a carrier dispatched from said dispatch station is directed to said particular receiving station; door lock signaling means connected to said source of supply pressure at each dispatch station for responding to the loading of said dispatch station to provide a door lock pressure signal; door locking means associated with each dispatch station for locking said dispatch station door closed upon receipt of a door lock pressure signal; and means connecting in common each of said door lock signaling means with each of said door locking means such that the door lock signal transmitted by any door lock signaling means when its associated dispatch station is loaded causes the doors at all other dispatch stations to be locked.

4. The pneumatic tube system defined in claim **3** further comprising: door unlock signaling means associated with each receiving station and connected to said source of supply pressure for emitting a door unlock pressure signal upon sensing the receipt of a carrier by said receiving station; and means connecting in common each of said door unlock signaling means with each of said door locking means, each of said door locking means being responsive to said door unlock signal to unlock the door of its associated dispatch station.

5. A pneumatic tube system comprising: a source of pneumatic fluid under supply pressure; a main carrier conveying tube provided with circulating pneumatic fluid; a plurality of carrier dispatch stations each connected to said main carrier conveying tube by an associated dispatch

branch tube; a plurality of carrier receiving stations each connected to said main carrier conveying tube by an associated receiving branch tube; diverter means at the junction of each receiving branch tube and said main carrier conveying tube for diverting a carrier to the associated receiving branch tube when said diverter means is actuated; a manually-operated pressure selector switch associated with each dispatch station and connected to said source of supply pressure for providing a selected one of a plurality of output pressures respectively indicative of the addresses of said receiving stations; pressure responsive means associated with each said receiving station for actuating the diverter means associated with said receiving station upon receipt of pneumatic fluid at a pressure indicative of the address of said receiving station; first conduit means connecting each of said pressure responsive means in common to each of said pressure selector switches in common such that, when a pressure selector switch associated with a particular dispatch station is caused to provide a selected pressure indicative of the address of a particular receiving station, a carrier dispatched from said dispatch station is directed to said particular receiving station; carrier received signaling means associated with each receiving station and connected to said source of supply pressure for emitting a carrier received pressure signal upon sensing the receipt of a carrier by said receiving station; pressure selector switch reset means associated with each of said pressure selector switches for resetting its associated pressure selector switch to stand-by position upon receipt of a carrier received pressure signal; and second conduit means connecting in common each of said selector switch reset means to each of said carrier received signaling means such that upon receipt of a carrier by one of said receiving stations, the particular pressure selector switch in dial position is reset to stand-by position removing the address pressure signal from said first conduit means.

6. The pneumatic tube system defined in claim 5 further comprising: pressure selector switch lock means associated with each pressure selector switch and connected to said first conduit means for locking all other pressure selector switches against manual use in response to the provision of a pressure signal in said first conduit means from one of said selector switches, each of said pressure selector switch lock means being responsive to said removal of the address pressure signal from said first conduit means to unlock its associated pressure selector switch.

7. A pneumatic tube system comprising: a source of pneumatic fluid under supply pressure; a main carrier conveying tube provided with circulating pneumatic fluid; a plurality of carier dispatch stations each connected to said main conveying tube by an associated dispatch branch tube; a plurality of carrier receiving stations each connected to said main carrier conveying tube by an associated receiving branch tube; diverter means disposed at the junction of each receiving branch tube and said main carrier conveying tube for diverting a carrier to the associated receiving branch tube when said diverter means is actuated; a manually-operated pressure selector switch associated with each dispatch station and connected to said source of supply pressure for providing a selected one of a plurality of output pressures respectively indicative of the addresses of said receiving stations; pressure responsive means associated with each of said receiving stations for actuating the diverter means associated with said receiving station upon receipt of pneumatic fluid at a pressure indicative of the address of said receiving station; first conduit means connecting each of said pressure responsive means in common to each of said pressure selector switches such that, when a pressure selector switch associated with a particular dispatch station is caused to provide a selected pressure indicative of the address of a particular receiving station, a carrier dispatched from said dispatch station is directed to said particular receiving station; pressure selector switch lock means associated with each pressure selector switch and connected to said first conduit means for locking all other pressure selector switches against manual use in response to the provision of a pressure signal in said first conduit means from one of said selector switches; door lock signaling means connected to said supply line at each dispatch station for responding to the loading of said dispatch station to provide a door lock pressure signal; door locking means associated with each dispatch station for locking said dispatch station door closed upon receipt of a door lock pressure signal; second conduit means connecting in common each of said door locking means such that the door lock signal transmitted by any door lock signaling means when its associated dispatch station is loaded causes the doors at all other dispatch stations to be locked; carrier received signaling means associated with each receiving station and connected to said source of supply pressure for emitting a carrier received pressure signal upon sensing the receipt of a carrier by said receiving station; pressure selector switch reset means associated with each of said pressure selector switches for resetting its associated pressure selector switch to stand-by position upon receipt of a carrier received pressure signal; and third conduit means connecting in common each of said carrier received signaling means with each of said selector switch reset means and with each of said door locking means such that upon receipt of a carrier by one of said receiving stations the particular pressure selector switch in dial position is reset to stand-by position, removing the address pressure signal from said first conduit means, each of said pressure selector switch lock means being responsive to said removal of the address pressure signal from said first conduit means to unlock its associated pressure selector switch, and each of said door locking means being responsive to said carrier received signal to unlock the door of its associated dispatch station.

8. A multi-loop pneumatic tube system comprising: a source of pneumatic fluid under supply pressure; a plurality of loop carrier conveying tubes provided with circulating pneumatic fluid; loop transfer means associated with each said loop carrier conveying tube for transferring carriers to said loop carrier conveying tube from other loop carrier conveying tubes when said loop transfer means is actuated; each of said loop carrier conveying tubes having a plurality of carrier dispatch stations each connected to said loop carrier conveying tube by an associated dispatch branch tube; each of said loop carrier conveying tubes having a plurality of carrier receiving stations each connected to said loop carrier conveying tube by an associated receiving branch tube; each of said loop carrier conveying tubes having a loop pressure conduit, each of said dispatch stations having a manually-operated loop selector switch having an inlet connected to said source of supply pressure and a plurality of outlets each connected to a different one of said loop pressure conduits such that only the loop pressure conduit in the selected loop is pressurized, each of said loop transfer means being connected to its associated loop pressure conduit and the pressurizing of said loop pressure conduit serving to actuate said loop transfer means whereby a carrier dispatched from any dispatch station will be directed to the loop carrier conveying tube which has its associated pressure conduit pressurized; diverter means at the junction of each receiving branch tube and loop carrier conveying tube for diverting a carrier to said receiving branch tube when said diverter means is actuated; a manually-operated pressure selector switch associated at each dispatch station for each loop carrier conveying tube and connected to its associated loop pressure conduit for providing a selected one of a plurality of output pressures respectively indicative of the addresses of the receiving stations in relation to their associated loop carrier conveying tube; pressure responsive means associated with each receiving station for actuating the diverter means associated with said receiving

station upon receipt of pneumatic fluid at a pressure indicative of the address of said receiving station; means connecting each of said pressure responsive means associated with the receiving stations on a given one of said loop carrier conveying tubes in common to each of said pressure selector switches associated with the same loop carrier conveying tube such that when the loop pressure conduit for a particular loop carrier conveying tube is pressurized and the pressure selector switches at a particular dispatch station connected to said pressurized loop pressure conduit is caused to provide a selected pressure indicative of the address of a particular receiving station associated with said particular loop carrier conveying tube,

a carrier dispatched from said dispatch station is directed to said particular receiving station.

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EDWARD A. SROKA, *Primary Examiner.*

H. C. HORNSBY, *Assistant Examiner.*

U.S. DEPARTMENT OF COMMERCE

PATENT OFFICE

Washington, D.C. 20231

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,406,928 October 22, 1968

David H. Thorburn

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, lines 7 and 8, cancel "into retracted position by a compression spring 372 bearing"; line 45, "untilization" should read -- utilization --; line 52, cancel "it", second occurrence. Column 8, line 68, "54" should read -- 53 --; line 72, "popet" should read -- poppet --. Column 9, line 5, "dose" should read -- does --. Column 13, line 52, "carier" should read -- carrier --.

Signed and sealed this 10th day of March 1970.

(SEAL)

Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents