United States Patent [19]

Yoshida

[11] **3,768,418**

[45] **Oct. 30, 1973**

[54] **PNEUMATIC TRANSPORTER**

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May 4, 1971 Japan 46/29617

[52] **U.S. Cl.** **104/161,** 104/88
[51] **Int. Cl.** **B61b 13/10**
[58] **Field of Search** 104/155–161, 88; 243/29, 33, 32

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Assistant Examiner—George H. Libman
Attorney—George B. Oujevolk

[57] **ABSTRACT**

A pneumatic transporter for conveying articles by driving a runner received in an air pipe by compressed air conducted therethrough, wherein the air pipe is bored with a slit linearly extending along its full length; there are tightly attached to both edges of said slit two elastic members extending similarly lengthwise of the entire air pipe so as to define therebetween a linear airtight contact section; the runner has an arm fixed thereto at one end and projected at the other end to the outside of the air pipe through said airtight contact section; and the article is conveyed by a carriage engaged with said projected end of the runner arm.

7 Claims, 15 Drawing Figures

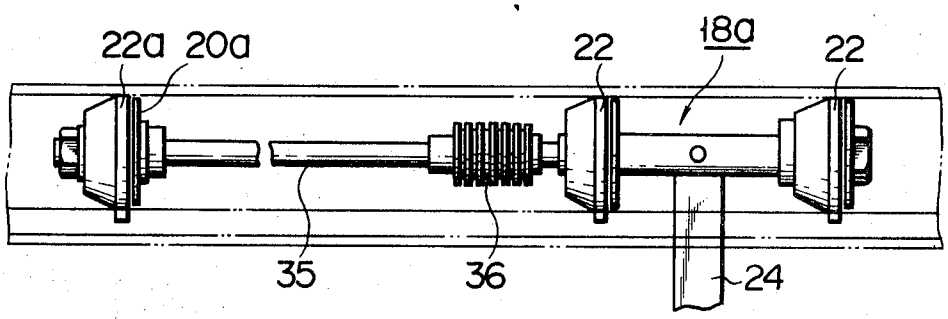


FIG. 1

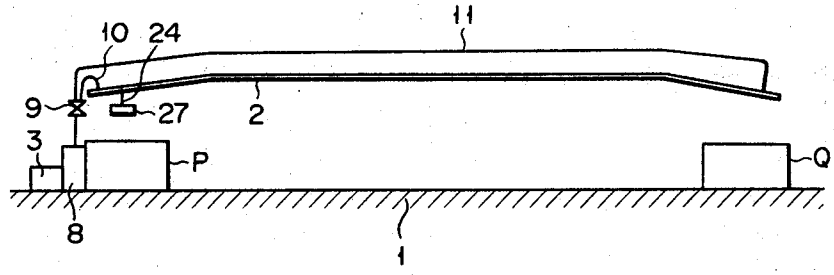
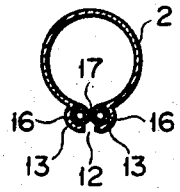


FIG. 3

FIG. 2



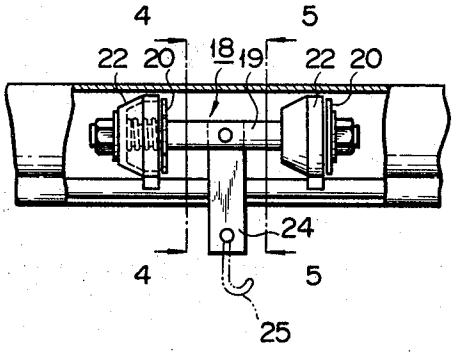


FIG. 4

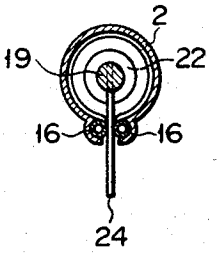


FIG. 5

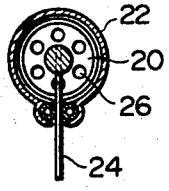


FIG. 6

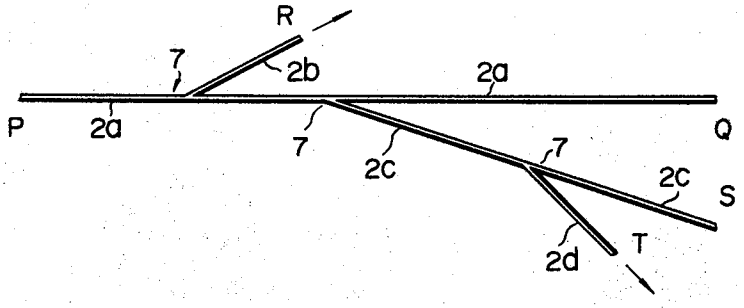


FIG. 7

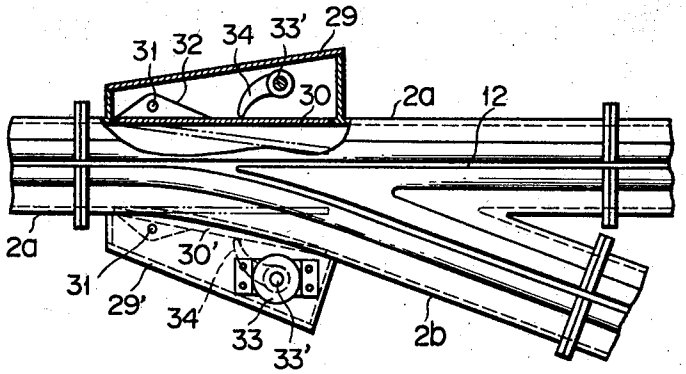


FIG. 8

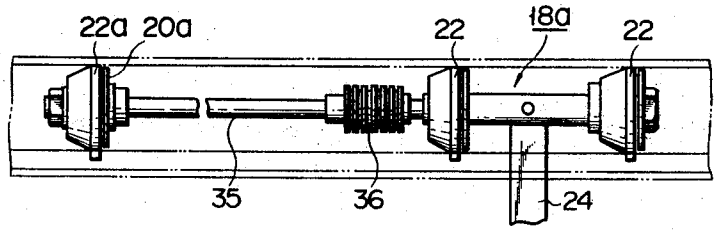


FIG. 9

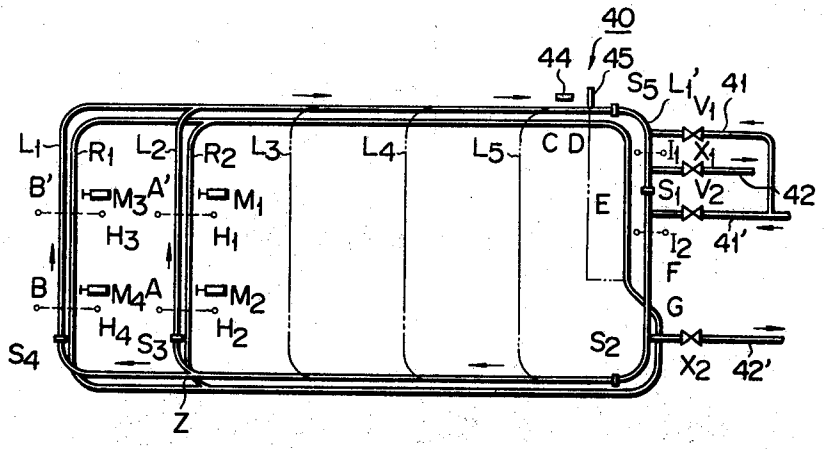


FIG. 10

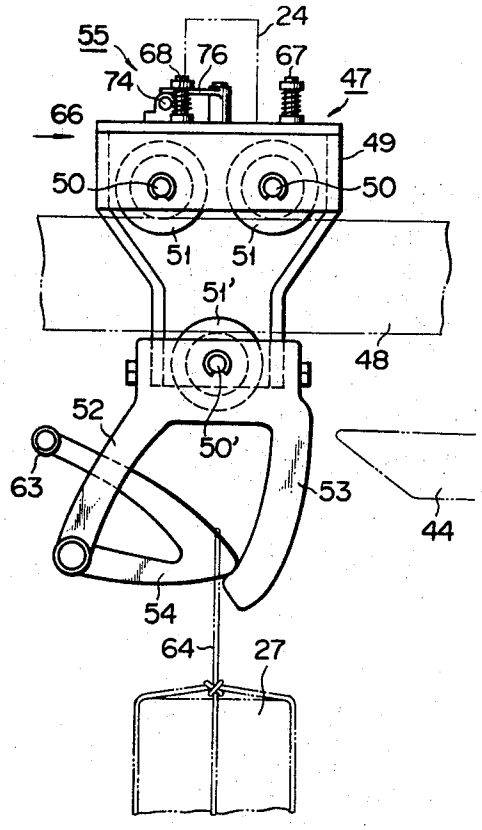


FIG. 11

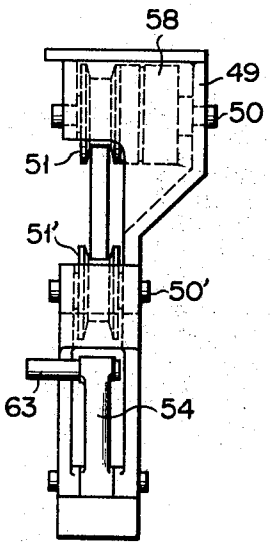


FIG. 12

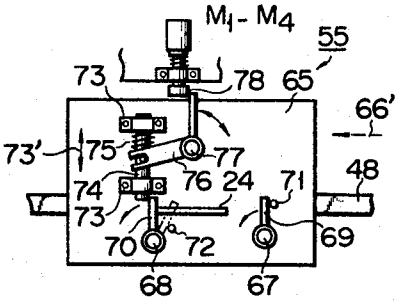


FIG. 13

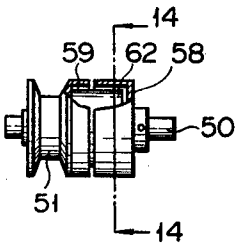


FIG. 14

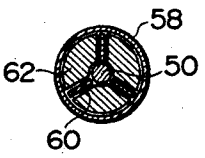
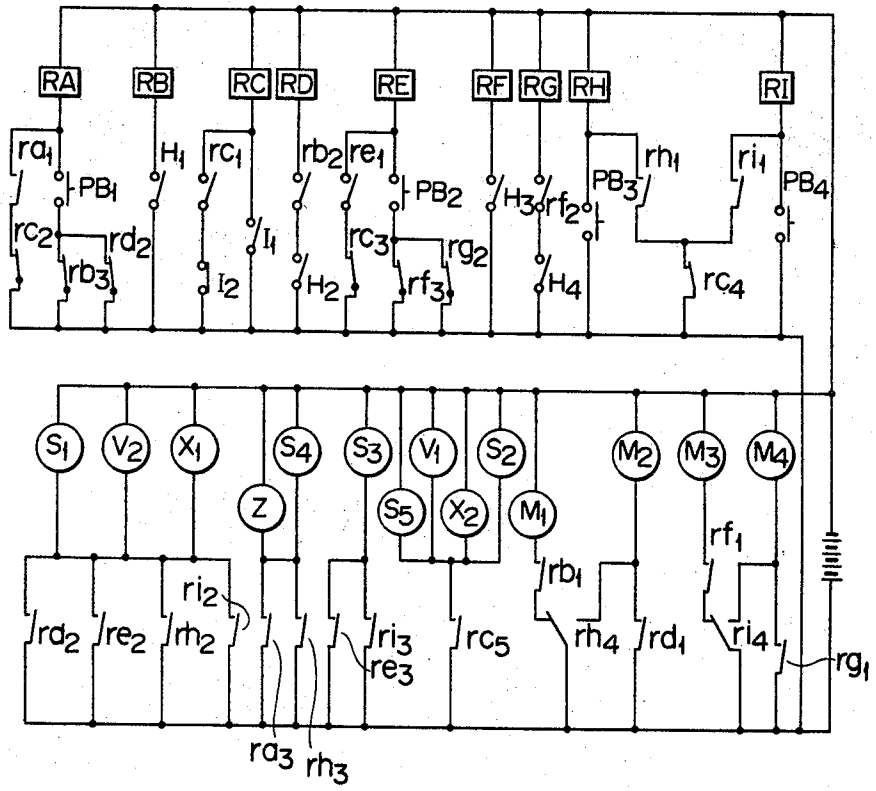


FIG. 15



PNEUMATIC TRANSPORTER

BACKGROUND OF THE INVENTION

This invention relates to a pneumatic transporter for conveying articles to any desired place by means of compressed air and more particularly to a pneumatic transporter of simple construction capable of carrying large articles quickly.

There is already known a pneumatic transporter which consists in conveying articles through an air pipe extending from one place to another by driving a runner received in said pipe by compressed air conducted therethrough. With this type of transporter, however, articles being conveyed therethrough are limited in size by the inner diameter of the air pipe used. Therefore, such apparatus is not adapted for general application. Where it is desired to transport articles of any shape and size, there has heretofore been employed the process of driving a looped chain to convey such articles. However, this apparatus is of complicated arrangement and fails to carry articles quickly.

SUMMARY OF THE INVENTION

It is accordingly an object of this invention to provide a pneumatic transporter which consists in driving a runner received in an air pipe by compressed air conducted therethrough and transporting articles along a passageway outside of the air pipe by moving a carriage engaged with said runner.

Another object of the invention is to provide a pneumatic transporter comprising main and branched air pipes which enables articles to be conveyed over a larger horizontal area by controlling a gating means disposed at the junction of said branched air pipes.

Still another object of the invention is to provide a pneumatic transporter comprising numerous air pipes constituting a plurality of closed loops and means for selecting the destination of articles being conveyed, thereby further broadening the range of transport.

A pneumatic transporter according to this invention comprises an air pipe perforated with a linear slit extending along its full length with two edge portions facing said slit projected outward so as to conduct compressed air therethrough; two elastic members tightly contacting the inner walls of said two edge portions of the air pipe to define therebetween a linear contact section running along the central line of the slit similarly lengthwise of the entire air pipe, thereby keeping the interior of the air pipe substantially airtight from the outside; a runner received in the air pipe to be freely driven by compressed air conducted therethrough; an arm fixed to the runner at one end and projected at the other end to the outside of the air pipe through said airtight contact section and travelling along said airtight contact section jointly with the runner with the interior of the air pipe kept substantially airtight from the outside; and means detachably fitted to said projected end of the arm for transport of articles. Therefore, this invention can convey articles larger than the inner diameter of the pipe quickly to any desired place by simple arrangement.

According to the invention, the air pipe may include at least one branched section. In such case, there is provided a mechanically operable gating means controlled by electric signals. Thus articles may be conveyed selectively along either said branched section or the main air pipe, thereby enlarging the floor space of transport.

Further, according to the invention, the air pipe assembly may comprise a main closed loop of air pipes disposed in a plane provided with a control section connected to supply and discharge ducts of compressed air and also provided with at least one supplementary closed loop consisting of air pipes branched off from the main loop with said control section used in common. In this case, there is used a suspended carriage provided with means engageable with the arm of the runner, thus enabling articles to be conveyed over a far more broadened floor space.

According to a further embodiment of the invention, there are laid rails below the air pipes along their extension. This enables most of the horizontal driving force of the runner to be utilized in the transport of articles without subjecting the air pipes and runner to their vertical load.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevation showing the relationship of an air pipe connecting the start and end points of articles being conveyed according to the method of this invention and other supplementary devices;

FIG. 2 is a cross sectional view of the air pipe of FIG. 1;

FIG. 3 is a side view of a runner received in the air pipe of FIG. 1 with part thereof cut away;

FIG. 4 is a sectional view on line 4—4 of FIG. 3;

FIG. 5 is a cross sectional view of the runner on line 5—5 of FIG. 3;

FIG. 6 is a plan view of an air pipe assembly according to the invention including branched sections;

FIG. 7 is a plan view of the junction of the first branched section of the air pipe assembly as taken from below with part of said junction cut away in the axial direction of the air pipe;

FIG. 8 is an elevation of a modified runner received in the air pipe assembly including branched sections;

FIG. 9 is a plan view of an air pipe assembly constituting a plurality of loops indicated in connection with the position of the associated rails, control section and component members thereof;

FIG. 10 is an elevation of a suspended carriage travelling on the rails of FIG. 9;

FIG. 11 is a side view of FIG. 10 eliminating a mechanism effecting engagement between the carriage and runner;

FIG. 12 is a top view of FIG. 10 showing the mechanism effecting said engagement;

FIG. 13 is a fractional cross sectional view of the carriage wheel of FIG. 11;

FIG. 14 is a cross sectional view on line 14—14 of FIG. 13; and

FIG. 15 presents a circuit for controlling the transport of articles along the air pipe assembly of FIG. 9.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, there are disposed on the floor 1 stands P and Q for handling articles being conveyed. There is suspended by means (not shown) an air pipe extending from the stand P to the stand Q. On that side of the air pipe 2 which faces the stand P is provided an air compressor 8 driven by a motor 3. Compressed air is introduced into the air pipe 2 through an electromagnetic valve 9 and supply duct 10 or 11 at that end of the air pipe 2 which faces the stand P or Q.

The air pipe 2 is perforated, as seen from its cross sectional view of FIG. 2, with a linear slit 12 extending along its full length. The two edge portions 13, 13 of the air pipe 2 facing said slit 12 project outward. The inner wall of each of said projecting edge portions 13, 13 is formed into a semicircular cavity. There are inserted two tubular members 16, 16 into said projecting edge portions 13, 13 in such a manner that the semicircular peripheral walls of those sides of said tubular members 16, 16 which are disposed remote from their junction closely fit into said semicircular cavities and the semicircular peripheral walls of the mutually facing sides of said tubular members 16, 16 abut against each other, thereby defining a contact section 17 extending along the central line of the slit 12 lengthwise of the entire air pipe 2. The tubular members 16, 16 are made of elastic material, foe example, wear-resistant polyvinyl chloride resin. Accordingly, the contact section 17 of said tubular members 16, 16 plays the part of packing to keep the interior of the air pipe substantially airtight from the outside.

There is received in the air pipe 2 a runner 18 illustrated in FIG. 3. The runner according to the embodiment of FIG. 3 consists of a shaft 19 disposed parallel with the axis of the air pipe 2 and pressure receivers 22, 22 fitted to both ends of the shaft 19 through screws (not shown) and cap plates 20, 20. The pressure receiver 22 as a whole has a blind conical form and its inner pressure receiving surface is made of wear-resistant elastic material, for example, Neoprene. When there is applied pressure by compressed air, the expansible base edge of said conical section tightly abuts against the inner wall of the air pipe 2 to provide an airtight condition therein. To the center of the shaft 19 is fixed one end of an arm 24, the other end of which projects to the outside of the air pipe 2 through the aforesaid airtight contact section 17.

The arm 24 travels through the air pipe 2 jointly with the runner 18 with the interior of the air pipe 2 kept substantially airtight from the outside. Said projecting end of the arm 24 is fitted, where necessary, with a hook 25 for suspending articles being conveyed. The cap plate 20 is properly disposed to face the opening of the pressure receiver 22 in order to prevent the undue deformation of said opening when subjected to the pressure of compressed air. The pressure receiver 22 is perforated, as shown in FIG. 5, with apertures 26 to permit the easy introduction of compressed air thereinto. FIG. 4 illustrates how the interior of the air pipe 2 can be kept substantially airtight even though the arm 24 extends outside thereof.

Referring to FIG. 1, an article 27 is suspended from the arm 24 above the stand P to be conveyed to the stand Q by operation of an electromagnetic valve 9. Return of the runner 18 from the stand Q to the stand P may be effected by conducting compressed air from the stand Q by operation of the electromagnetic valve 9, or through a separate air pipe (not shown).

The air pipe 2 may include, as shown in FIG. 6, branched sections 2*b*, 2*c* and 2*d* in addition to the main body 2*a*, thereby enabling an article to be conveyed from the stand P to any of the stands Q, R, S and T. For transport of the article through a selected branch pipe, its junction 7 with the main air pipe body may be constructed as illustrated in FIG. 7, which shows, partly in section, the underside of the junction of the branch pipe 2*b* of FIG. 6. On both sides of the junction 7 are provided projections 29 and 29' open to the air passageway to keep the junction 7 substantially airtight. In the openings of the projections 29 and 29' are disposed guide plates 30 and 30' extending parallel with the inner walls of the junction 7 and rotatable about the respective shafts 31, 31. Since both guide plates 30 and 30' are of the same arrangement and function, there is only described the guide plates 30. A coil spring 32 wound about the shaft 31 biases the guide plate 30 counterclockwise. The guide plate 30 is normally held by an actuating arm 34 fixed to the rotary shaft 33' of a rotary solenoid 33 to take a position indicated in solid lines. When the rotary solenoid 33 is energized by a control signal, then the guide plate 30 is urged to the position indicated in broken lines by the counterclockwise rotation of the arm 34. While the other guide plate 30' is operated by exactly the same drive mechanism as the first mentioned guide plate 30, said other guide plate 30' tightly abuts on the inner wall of the branch pipe 2*b*. Accordingly, an article is conducted along the branch air pipe 2*b* whithout moving along the main air pipe body 2*a*.

A runner 18*a* used in the above-mentioned air pipe assembly including branched sections is preferred to be constructed as illustrated in FIG. 8. The shaft of the runner 18*a* has a flexible shaft (herein defined to mean a rigid shaft partly consisting of a flexible section) attached to the extension of the left side of the shaft 18 indicated in FIG. 3. Said flexible shaft is connected at one end to the pressure receiver 22 and at the other end to the cap plate 20*a* of the other pressure receiver 22*a*. According to the embodiment of FIG. 8, said flexible shaft is formed of a rigid shaft 35 and bellows 36. The runner 18*a* of the above-mentioned construction is so designed that when the forward pressure receiver 22*a* enters the branch air pipe 2*b*, the rear pressure receivers 22, 22 still remain in the main air pipe body 2*a* to prevent leakage of compressed air, and moreover that the runner 18*a* as a whole can be easily diverted to the branch air pipe 2*b* due to the action of the aforementioned flexible shaft. The rotary solenoid 33 provided at the junction of each branch air pipe is reliably operated according to a predetermined schedule by an electric signal generated by means of, for example, a memory device. In this case, additionally provided rails, though not shown in FIG. 6, can take upon themselves the vertical load of an article while it is travelling.

Alternatively, as shown in FIG. 9, there may be assembled numerous air pipes to constitute a plurality of air pipe loops with a control section 40 provided in common thereto, thereby enabling articles to be conveyed over a larger floor space in a well-arranged order. A pneumatic transport of such type is effective for transport of articles when they have to be rearranged in a warehouse or on a spacious outdoor ground. The control section of said transporter can control introduction of compressed air into a predetermined air pipe loop or its discharge therefrom, selection of places desired for loading and unloading of articles and their engagement with and disengagement from the runner 18*a*. To this end, the prescribed locations in the loops are provided with necessary electromagnets and shutters and the control section is fitted with a proper electric circuit.

In FIG. 9, there are provided a plurality of closed loops L_1 to L_5 of air pipes with the control section 40

used in common thereto. The loops L_2 to L_5 include part of the loop L_1 used in common, that is, are all branched therefrom. To the air pipe L_1' of the control section 40 are connected compressed air supply ducts 41 and 41' through valves V_1 and V_2 respectively, and also compressed air discharge ducts 42 and 42' through the valves X_1 and X_2 respectively. The valves V_1, V_2, X_1 and X_2 are normally closed and, where required, a selected valve is opened to introduce compressed air, thereby forwarding the runner 18*a* through the desired one of said air pipe loops, or to expel compressed air through the corresponding discharge duct. Below the air pipe loops are laid similarly looped rails R_1 to R_5 to take upon themselves the vertical load of articles in transit (indication of rails R_3 to R_5 is omitted). The air pipe loops L_1 to L_5 are provided with shutters S_1 to S_5 respectively, each of which has a shield rotated by a signal from the electric circuit of the control section 40 so as to supply compressed air to the specified air pipe loop or draw it off therefrom.

Electromagnets M_1 to M_4 disposed close to said rails (generally indicated by numeral 48) control engagement between the later described suspended carriage 47 and the arm 24 of the runner 18*a*. Notations H_1 to H_4 represent position detectors, such as photoelectric detectors or limit switches for detecting the location of the carriage 47. Numerals 1_1 and 1_2 denote limit switches for detecting the passage of the runner 18*a*, 44 a fixed cam for disengaging an article from the carriage 47, and 45 a movable cam or member for controlling engagement between the carriage 47 and the runner arm 24, the last mentioned cam being operated in the same manner as a cam member 78 shown in FIG. 12. Character Z is a relay provided for the junction of a branch air pipe similar to that of FIG. 7 so as to control the operation of the rotary solenoid 33.

The aforementioned carriage 47 comprises, as illustrated in FIGS. 10 to 14, a frame 49; a shaft 50 fixed thereto; wheels 51, 51 rotating about the shaft 50 to travel on the rail 48 with the frame 49 mounted on said wheels 51, 51; another wheel 51' rotating about a shaft 50' fixed to the frame 49 to run on the rail 48 in such a manner as to clamp it from above and below conjunction with the aforementioned wheels 51, 51; holding members 52, 53 and 54 for jointly suspending an article 27; and a mechanism 55 for effecting engagement between the arm 24 of the runner 18*a* and the carriage 47.

The wheel 51 rotates about the stationary shaft 50 in abutment against a cylindrical member 58 fixed to said stationary shaft 50. The wheel 51 has a cavity 59 (FIG. 13) formed on that side which faces the cylindrical member 58. In the cavity 59 there are provided three partition walls 60 at an equal peripheral distance so as to project from the interior of the cavity 59 to the right side of FIG. 13. Between the adjacent partition walls 60 is received a movable weight which also projects outward from the interior of the cavity 59 (FIG. 14). As the carriage 47 is driven more quickly by the runner 18, the wheel 51 rotates more rapidly to cause the weight 62 to be centrifugally pressed against the inner walls of the cylindrical member 58. Accordingly, the weight 62 acts as a sort of governor for limiting the travelling speed of the carriage 47 to a prescribed range.

One holding member 53 of the article suspending device is fixed at one end to the frame 49 and curved at the other end near to the extension of the gravitational center of the carriage 47. Another holding member 52 of said suspending device is similarly fixed at one end to the frame 49 and at the other end pivotally connected to one rotatable end of still another holding member 54 bent in the V-shape. The other end of said V-shaped holding member 54 is fitted with a cylindrical roller 63 (FIG. 11) rotatable about a shaft pin (not shown) extending at right angles to said member 54. Where an article 27 is going to be transported, one end 64 of the cord fastening it is made into a loop, and the V-shaped member 54 is rotated counterclockwise so as to cause the first mentioned member 53 to pass through the looped cord end 64 for contact with the former member 54. Where the carriage 47 is driven by the runner 18*a* in the direction of 66, then a pointed stationary cam 44 (FIGS. 9 and 10) provided at the prescribed location of the air pipe loop contacts the roller 63 to urge the V-shaped member 54 counterclockwise so as to release the article 27 from the first mentioned member 53, thereby placing it at the required point.

There will now be described by reference to FIG. 12 a mechanism 55 for engaging the carriage 47 with the arm 24 of the runner 18*a*. To the upper part of the frame 49 is fitted a base plate 65 on which there are mounted various parts of said engagement mechanism 55. Now let it be assumed that the arm 24 of the runner 18*a* travels in the direction of the indicated arrow 66'.

There are provided rotatable members 69 and 70 normally biased counterclockwise relative to the stationary shafts 67 and 68. Numerals 71 and 72 are stoppers for said rotatable members 69 and 70. There is provided a movable shaft 74 supported by supports 73, 73 so as to reciprocate in the direction of the indicated arrows 73'. The shaft 74 is engageable at one end with the free end of the rotatable member 70 and normally urged, as shown in FIG. 12, by a spring 75 so as to prevent the counterclockwise rotation of the rotatable member 70. There is provided a bent arm 76 rotatable about a stationary shaft 77 disposed at the center. The bent arm 76 is so linked with the reciprocable shaft 74 that any slight clockwise rotation of the arm 76 pushes the reciprocable shaft 74 upward to disengage it from the rotatable member 70. Notations M_1 to M_4 to denote stationary electromagnets previously described by reference to FIG. 9, which are selectively energized to urge a movable cam 78 toward the bent arm 76, thereby rotating it clockwise. When, therefore, running in the direction of the arrow 66', the arm 24 of the runner 18*a* first rotates the rotatable member 69 counterclockwise and then strikes the other rotatable member 70. Since the latter rotatable member 70 remains locked by the reciprocable shaft 74 unless actuated by the selectively energized one of the aforesaid electromagnets M_1 to M_4, the carriage 47 is driven by the runner arm 24 in the direction of the arrow 66'. Where it is desired to disengage the carriage 47 from the runner 18*a*, any of the electromagnets M_1 to M_4 is selectively energized to disengage the rotatable member 70 from the runner arm 24, thereby allowing the runner 18*a* alone to continue its course up to the prescribed place with the carriage 47 carrying an article left at the aforesaid desired point of disengagement. The rotatable member 69 is intended to prevent the backward run of the carriage 47 which might occur while it is in such rest position.

Referring again to FIG. 9, where it is desired to halt carriages 47 together with articles 27 at the points B'

and B in turn, there are provided electromagnets M_3 and M_4 at said points B' and B respectively. Similarly where carriages **47** are required to rest together with articles **27** at the point A' and A in turn, there are provided electromagnets M_1 and M_2 at said points A' and A respectively. It will be noted that articles **27** brought to the above-mentioned points B', B, A' and A together with the carriages **47** still remain suspended therefrom. Further where one of the carriages **47** rested at the points bearing an article **27** is brought by the runner **18***a*, for example, from the point A' to the point C, the article **27** is automatically removed from the carriage **47** by the pointed cam **44** (FIG. **10**) disposed there. It will be apparent that this pointed cam **44** may be provided at the aforementioned points B', B, A' and A if it is desired to take off articles **27** from the carriages **47**. After releasing the article **27**, for example, at C the carriage **47** is brought back to its waiting station E by the runner **18***a* driven through the loop. Character D represents the location where the carriage **47** brought to the aforesaid point C through the prescribed loop and reeved of an article is disengaged from the arm **24** of the runner **18***a* by a stationary cam **45** having the same function as the cam **78** (FIG. **12**). Character F denotes the waiting station of runners **18***a*, and the character G shows the section where the runners **18***a* and carriages **47** are engaged with each other for a new cycle of transporting an article **27**.

More detailed transporting manner of articles will be explained as follows.

One of the carriages **47** received in the waiting station E is drawn out mechanically or manually to the section G to be engaged with one of the runners **18***a* taken out of the waiting station F by conducting compressed air into the supply ducts **41** and **41'** of the control section **40**. The carriage **47** engaged with the runner **18***a* at G is sent to any of the aforesaid points of destination A', A, B' and B to convey an article **27** there by opening the shutter S, controlling the movement of the guide plates **30** or **30'** (FIG. **7**) to select a predetermined loop by, for example, a junction control relay Z (FIG. **9**) and selecting a required resting point of the carriage by energizing any of the electromagnets M_1 to M_4. Thus, the carriages each bearing an article may be rested at A', A, B' and B. The carriages **47** each bearing an article **27** which were transported to the aforesaid destinations may be engaged with the arm **24** of a separate runner **18***a* subsequently conducted through the desired loop, thereby bringing the carriage to the point C to take off its article.

FIG. **15** illustrates a control electric circuit used in connection with the air pipe loops of FIG. **9**. The rotations RA to RI represent relay coils, ra to ri the contacts thereof and PB_1 to PB_4 push buttons provided at the waiting section F of the runners **18***a*. The rotations S_1 to S_5, M_1 to M_4, H_1 to H_4, V_1 and V_2 and X_1 and X_2 have already been described by reference to FIG. **9**. Character Z shows a relay coil for actuating the rotary solenoid disposed at the loop junction.

Now let it be assumed that there are received runners **18***a* in the waiting station F (FIG. **9**) and there is going to be conveyed an article **27** to point A' using one of said runners **18***a*. Then one of the carriages **47** gathered in the waiting station eE is drawn out and an article **27** is suspended thereto. Depresion of a push button PB_1 actuates a relay RA, so that even when the push button PB_1 is turned off by the closing of the contact ra_1, the relay RA holds itself. The shutters S_1 and S_4 are closed by actuation of the contacts ra_2 and ra_3 to energize the relay Z. Accordingly, the runner **18***a* is brought into the air pipe loop L_2 by the action of the guide plates **30** or **30'**. At this time the valves V_2 and X_1 are opened to conduct compressed air through a route of V_2-F-G-S_2-Z-S_3-A-C-D-S_5 and finally to discharge it through the valve X_1. The runner **18***a* drawn out of the waiting station F is engaged with the carriage **47** already brought to the section G to transport the carriage **47** along the loop L_2. When the travelling carriage **47** reaches the point A', a detection switch H_1 disposed there detects its arrival. Then the electromagnet M_1 is energized through the actuation of the relay RB and the closing of its contact rb_1, causing the free end of the reciprocable shaft **74** to engage the movable cam **78** (FIG. **12**) of the electromagnet M_1, with the resultant disengagement of the reciprocable shaft **74** from the rotatable member **70**. Therefore, the carriage **47** is halted at this point A', though the runner **18***a* still continues its course. When a detection limit switch 1_1 detects the passage of the runner **18***a* through the shutter S_5 (namely, is turned on), then there is actuated a relay RC which holds itself by the closing of its contact rc_1. At the same time contact rc_2 is opened to release relay RA from its self-holding condition. As the result, the contacts ra_2 and ra_3 and shutter S_1 are opened, the valve X_1 is closed, the guide plates of the loop junction are brought back to the original position and the shutter S_4 is opened. On the other hand, the shutters S_5 and S_2 are closed and the valves V_1 and X_2 are opened by the closing of the contact rc_5. Since compressed air flows through a route of V_1-1_1-S_1-1_2-F-G-X_2, the runner **18***a* passes through the shutter S_1, and the detection switch 1_2 is turned off, releasing the relay RC from its self-holding condition. Finally, the air pipe loop L_1 is fully brought back to its original position and the runner **18***a* is received again in the waiting station F. Since, however, the carriage **47** still remains at the point A' of the air pipe loop L_2, the relay RB continues to be energized, rendering the cam **78** (FIG. **12**) operable, that is, making the rotatable member **70** ready to be urged.

Next when another carriage **47** bearing an article **27** is transported to the point A by depressing the push button PB_1 once more, a separate runner **18***a* is driven through exactly the same passageway as in the previous case. Since, however, the contact rb_2 is already closed, the passage of said carriage **47** through the position of a detection switch H_2 actuates a relay Rd disposed there, its contact rd_1 being closed to energize an electromagnet M_2. As the result, the carriage **47** is disengaged from the runner **18***a* to rest at A. The runner **18***a* is brought back to the waiting station F as in the previous case. Under the above-mentioned condition, the detection switches H_1 and H_2 are still actuated, and consequently the relays RB and RD continue to be energized, with the respective contacts rb_3 and rd_2 left open. Accordingly, even when the push button PB_1 is depressed a third time, the relay RA does not work, nor is driven the runner **18***a*.

There will now be described the transportation of an article **27** to the point B' in turn. Depression of a push button PB_2 closes a contact re_2, thereby closing the shutter **1**, and opening the valves V_2 and X_1. In this case, the guide plates **30** or **30'** of the loop junction are in a condition to guide the runner **18***a* into the loop L_1. The shutter S_4 is opened, the contact re_3 is closed and

consequently the shutter S_3 is closed. Thus compressed air passes through a route of V_2-F-G-S_2-Z-S_4-B-C-D-S_5-X_1.

The carriage 47 bearing the article 27 is disengaged from the runner 18*a* by the action of a detection switch H_3, and the runner 18*a* alone continues its course. When the limit switch H_1 is closed upon detection of the passage of the runner 18*a*, the relay RC is energized to switch over the operation of the valves and shutters as in the preceding case. The runner 18*a* is brought back to the waiting station F by the action of the detection switch 1_2. When there is depressed a push button PB_2 to convey an article 27 to the point B, then a relay RG performs the same operation as the aforementioned relay RD, causing a separate carriage 47 bearing an article 27 to be brought to a limit switch H_4.

Where the carriage 47 already reaching the point A' is desired to be further sent to the point C to unload the article 27 carried thereby, there is depressed a push button PB_3. Then there is actuated a relay RH which holds itself by the closing of its contact rh_1. Its contacts rh_2 and rh_3 are also closed to energize the relay Z of the loop junction with the resultant actuation of the guide plates 30 or 30'. Accordingly, a separate runner 18*a* is driven to the point A' so as to convey the carriage 47 further to the point C. On pushing PB_3, the contact rh_4 of the aforesaid relay RH is so operated as to energize the electromagnet M_2 in place of M_1. As the result, the reciprocable shaft 74 (FIG. 12) is urged for engagement with the rotatable member 70. Upon arrival of the runner arm 24, therefore, the carriage 47 rested at A' is engaged therewith to be transported to the point C. When the carriage 47 leaves the position of the limit switch H_1, the relay RB is deenergized. Even when there is halted a separate carriage 47 at the position of the limit switch H_2, the relay RD is brought back to its original state with the resultant opening of its contact rd_1. However, unless the contact rh_4 of the relay RH is turned off, the electromagnet M_2 remains inoperative. When the carriage 47 at A' reaches the point C, the article 27 carried thereby is unloaded by the action of the pointed cam 44 (FIG. 10). When the carriage 47 thus relieved of the article 27 is brought to the point D, it is disengaged from the runner 18*a* by the stationary cam 45 (which has the same function as the electromagnet M_1 of FIG. 12). When the runner 18*a* reaches the position of a switch 1_1, the relay RC is energized to change over the operation of the valves and shutters, thereby diverting the flow of compressed air. At this time, the contact rc_4 of the relay RC is turned off to release the self-holding condition of the relay RH with the result that its contact rh_4 is brought back to the position indicated in FIG. 15 to deenergize the electromagnet M_2. The carriage 47 which was halted at the position of the limit switch H_2 up to this point gravitationally moves to the limit switch H_1 upon the deenergization of the electromagnet M_2, utilizing the inclination of a rail R_2 (it will be noted that where required, the rail is locally inclined to a horizontal plane). When the carriage 47 is thus brought to the location of said limit switch H_1, then the relay RB is turned on to energize the electromagnet M_1 again, thereby halting the carriage 47 at this point. On the other hand, the runner 18*a* continues its case to return to the waiting station F by the action of a switch 1_2.

The carriage 47 each bearing an article 27 which were previously conveyed to the points B' and B are transported to the point c to have the articles 27 unloaded by exactly the same process as described above. In this case, there is depressed a push button PB_4 to operate the relays R_1 and Z and shutter S_3.

What is claimed is:

1. A pneumatic transporter comprising an air pipe with a slit extending lineraly along its full length and having two edge portions facing said slit projecting outward so as to conduct compressed air therethrough; two elongate elastic hollow tube members of polyvinyl chloride tightly abutting on the inner walls of said two projecting edge portions so as to define therebetween a linear contact section extending longitudinally along the central line of said slit of the full length of the air pipe, thereby keeping the interior of the air pipe substantially airtight from the outside; a runner in the air pipe disposed so as to be driven therethrough by compressed air introduced thereinto; and arm connected at one end to the runner and projecting at the other end outside of the air pipe through said substantially airtight contact section so as to travel therethrough jointly with the runner with the interior of the air pipe kept substantially airtight from the outside; and means engageable with said other end of the arm so as to convey an article as the result of the movement of the runner.

2. The pneumatic transporter according to claim 1 wherein the runner comprises a shaft disposed parallel with the axis of the air pipe and two pressure receivers formed of elastic material and fitted to both ends of said shaft, and said one end of the arm is fixed to the substantially central part of the shaft.

3. The pneumatic transporter according to claim 1 wherein the runner comprises a main shaft disposed parallel with the axis of the air pipe; first and second pressure receivers formed of elastic material and fitted to both ends of said main shaft; a supplementary shaft partly consisting of a flexible portion and extending opposite to the first pressure receiver through the second one; a third pressure receiver fitted to the free end of said supplementary shaft, said one end of the arm being fixed to the substantially central part of said main shaft.

4. The pneumatic transporter according to claim 1 wherein the air pipe assembly comprises a main air pipe, at least one branch air pipe and means for selecting that unit through which the runner should be driven, said selecting means including first and second projections open to the interior of the air pipe and disposed on both outer horizontal sides of the main air pipe and branch air pipe; two guide plates disposed in the opening of said projections so rotatable as to conduct the runner into either of the main and branch air pipes; and means for controlling the operation of said guide plates.

5. The pneumatic transport according to claim 4 wherein the means for controlling the operation of said guide plates comprises stationary shafts disposed on that side of the junction where the runner enters the projections and used as pivots about which said guide plates rotate; elastic members for biasing said guide plates toward the interior of said projections; and a rotary solenoid for normally holding the guide plates substantially parallel with the walls of the air pipe against the biasing action of said elastic member and upon recipt of an electric signal, urging said guide plates toward the interior of the prescribed air pipe, thereby preventing the runner from being diverted into an unnecessary air pipe.

6. In a pneumatic transporter which includes an air pipe arrangement with a slit extending lineraly along the full length thereof and having two edge portions with inner walls facing said projecting outward so as to conduct compressed air therethrough; two elongate elastic members tightly abutting on said inner walls so as to define therebetween a linear contact section extending longitudinally along the central line of said slit the full length of the air pipe, thereby keeping the interior of the air pipe substantially airtight from the outside; a runner in the air pipe disposed so as to be driven therethrough by compressed air introduced thereinto; an arm connected at one end to the runner and projecting at the other end outside of the air pipe through said substantially airtight contact section so as to travel therethrough jointly with the runner with the interior of the air pipe kept substantially airtight from the outside; and means engageable with said other end of the arm so as to convey an article as the result of the movement of the runner, the improvement therein wherein said air pipe arrangement comprises a main closed pipe loop provided with a control section connected to supply ducts and discharge ducts of compressed air; at least one supplementary closed loop branched from said main closed loop with said control section used in common; a rail built below each loop in parallel relationship therewith; a carriage provided with wheels permitting its travel on the rail, holding members constituting a first mechanism for detachably hanging an article and a second mechanism for effecting automatic engagement and disengagement between said carriage and the arm of the runner; magnetic means disposed at the prescribed points of the loops so as to effect the engagement and disengagement of said second mechanism with said runner arm; detecting means for detecting the position of said runner; loop selecting means for selecting the loop for conveying said carriage including valves, shutters and guide plates provided in the loop; and electrical control means for conveying an article to and from the prescribed position by controlling said magnetic means and said loop selecting means.

7. A pneumatic transporter comprising:

a. closed compressed air pipe loops including a main loop provided with a control section connected to compressed air supply ducts and discharge ducts of said compressed air and at least one supplementary loop branched from said main loop with said control section used in common, said air pipe having a slit extending linearly along the full length thereof and having two edge portions facing said slit projecting outward so as to conduct compressed air therethrough and two elongate elastic hollow tubes made of synthetic resin tightly abutting on the inner walls of said two projecting edge portions so as to define therebetween a linear contact section extending longitudinally along the central line of said slit for the full length of the air pipe, thereby keeping the interior of the air pipe substantially airtight from the outside;

b. a runner received in the air pipe so as to be driven therethrough by said compressed air introduced thereinto;

c. an arm connected at one end to the runner and projecting at the other end outside of the air pipe through said substantially airtight contact section so as to travel therethrough jointly with the runner with the interior of the air pipe kept substantially sealed shut from the outside;

d. a rail built below each loop in parallel relationship therewith;

e. a carrier provided with wheels permitting travel on the rail, holding members constituting a first mechanism for detachable handing an article and a second mechanism for effecting automatic engagement and disengagement between said carriage and the arm of the runner;

f. magnetic means disposed at the prescribed points of the loop so as to effect the engagement and disengagement of the loop so as to effect the engagement and disengagement of said second mechanism with said runner arm;

g. detecting means for detecting the position of the runner;

h. loop selecting means for selecting the loop of conveying said carriage including valves, shutters and guide plates provided in the loop; and,

i. electrical control means for conveying an article to and from the prescribed position by controlling said magnetic means and said loop selecting means.

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