United States Patent

[11] 3,628,568

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[21] Appl. No. 850,134
[22] Filed Aug. 14, 1969
[45] Patented Dec. 21, 1971
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[54] VALVE ASSEMBLY
8 Claims, 11 Drawing Figs.

[52] U.S. Cl. 137/610, 137/81.5
[51] Int. Cl. F16k 11/14, F15c 3/00
[50] Field of Search 137/610, 83, 81.5, 625.48, 625.44, 612; 251/65, 139, 141

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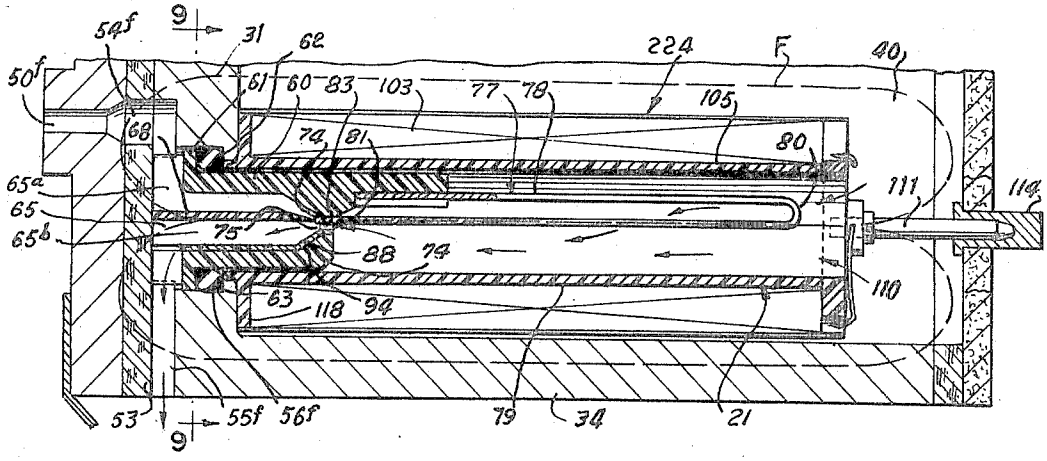
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ABSTRACT: A valve assembly for selectively directing air to either a point of use, such as a nozzle, or to a vent passage, which includes a valve body having a central passage having a restricted portion, a splitter for dividing the passage into two portions and a valve member operatively associated with the splitter and extending into the restricted portion for selectively directing air into either of the two portions of the central passages. The valve member comprises a magnetizable U-shaped resilient valve member having one leg portion fixed to tee valve body and a free leg portion extending into the restricted portion. The apparatus additionally includes an electromagnetic coil or winding disposed about the valve member and the valve body which, when energized, actuates the free leg portion to move it from its normally open nonactuated to its actuated position. The valve assembly may also include a magnetic strip also magnetizable by the current flowing in the winding which cooperates with the free leg portion to increase its speed and efficiency of operation. A combination of a plurality of the above described valve assemblies are disposed in a plenum of a housing into which air is introduced under pressure, each of the valve assemblies selectively directing air to either a vent passage or to nozzles mounted on the housing.



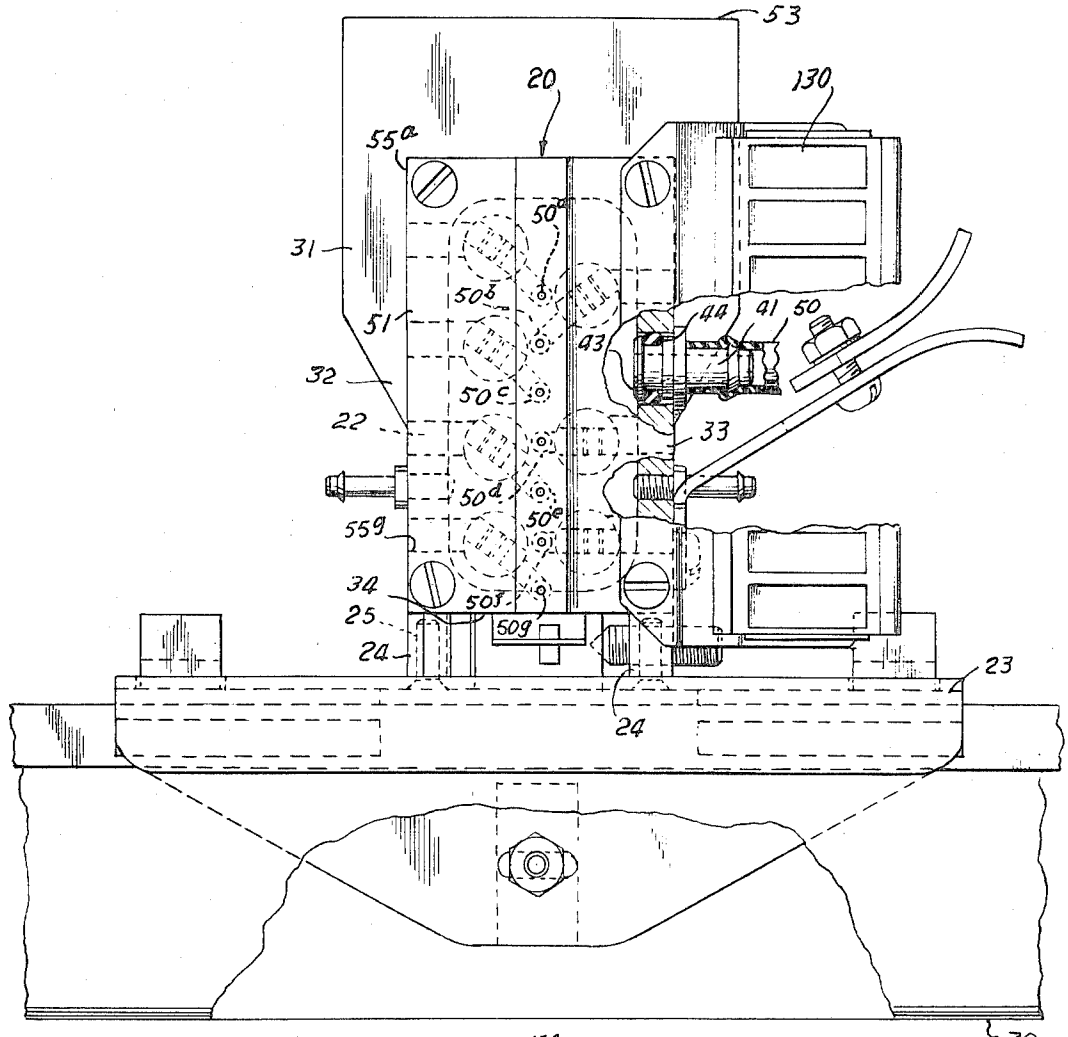


Fig.1

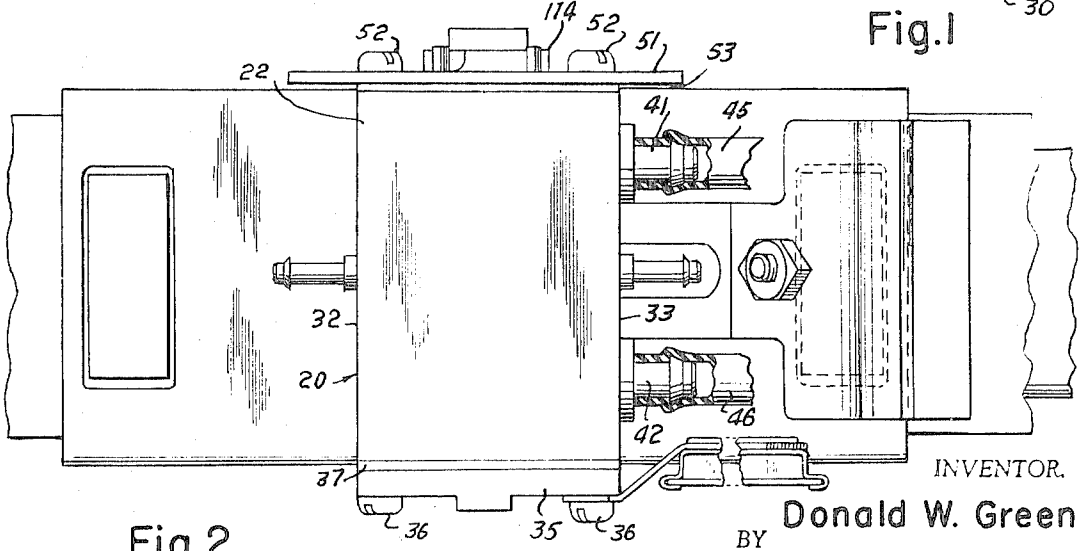


Fig.2

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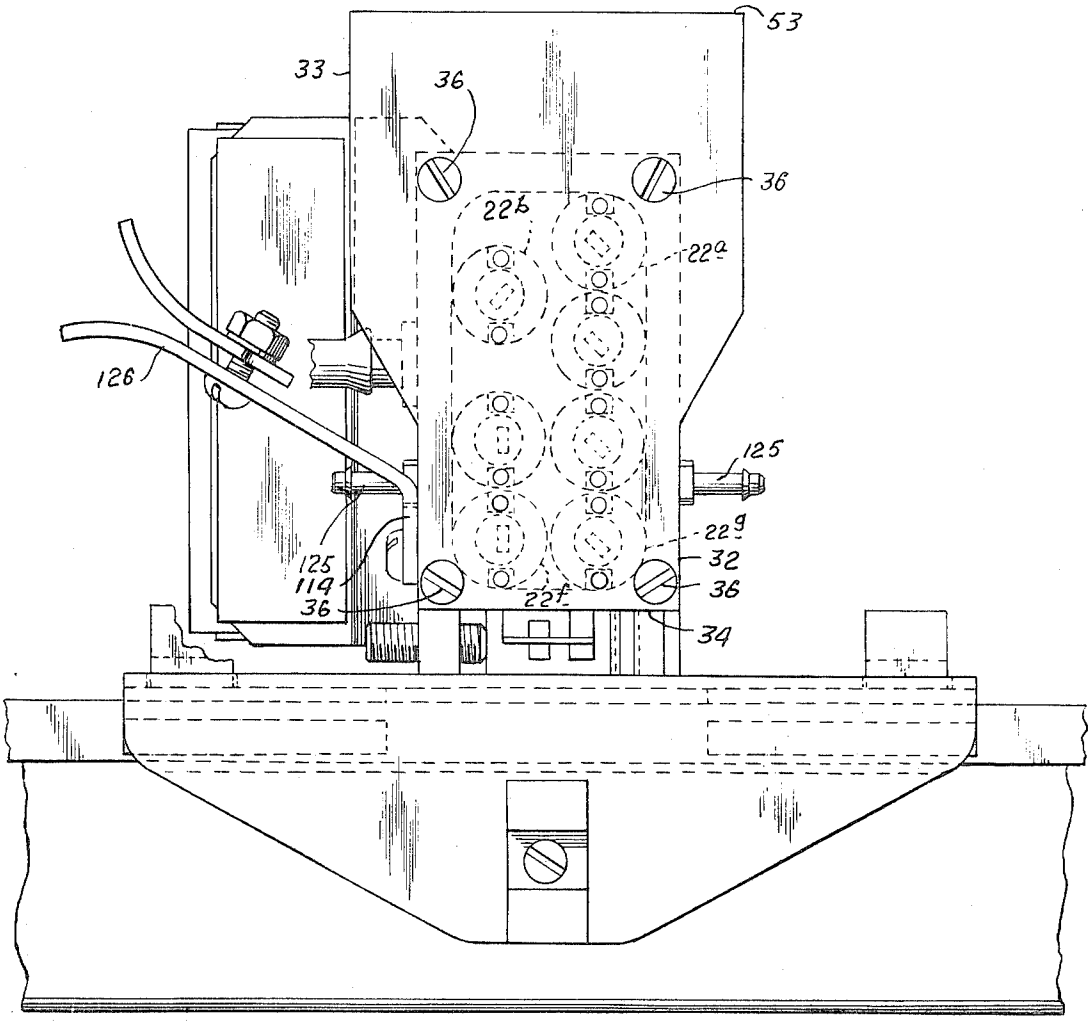


Fig. 3

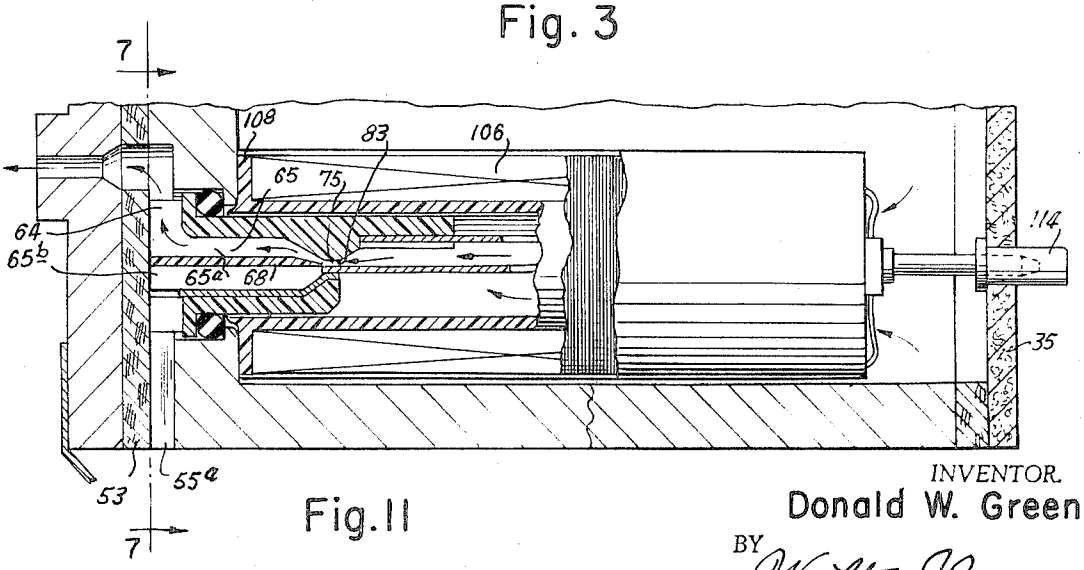
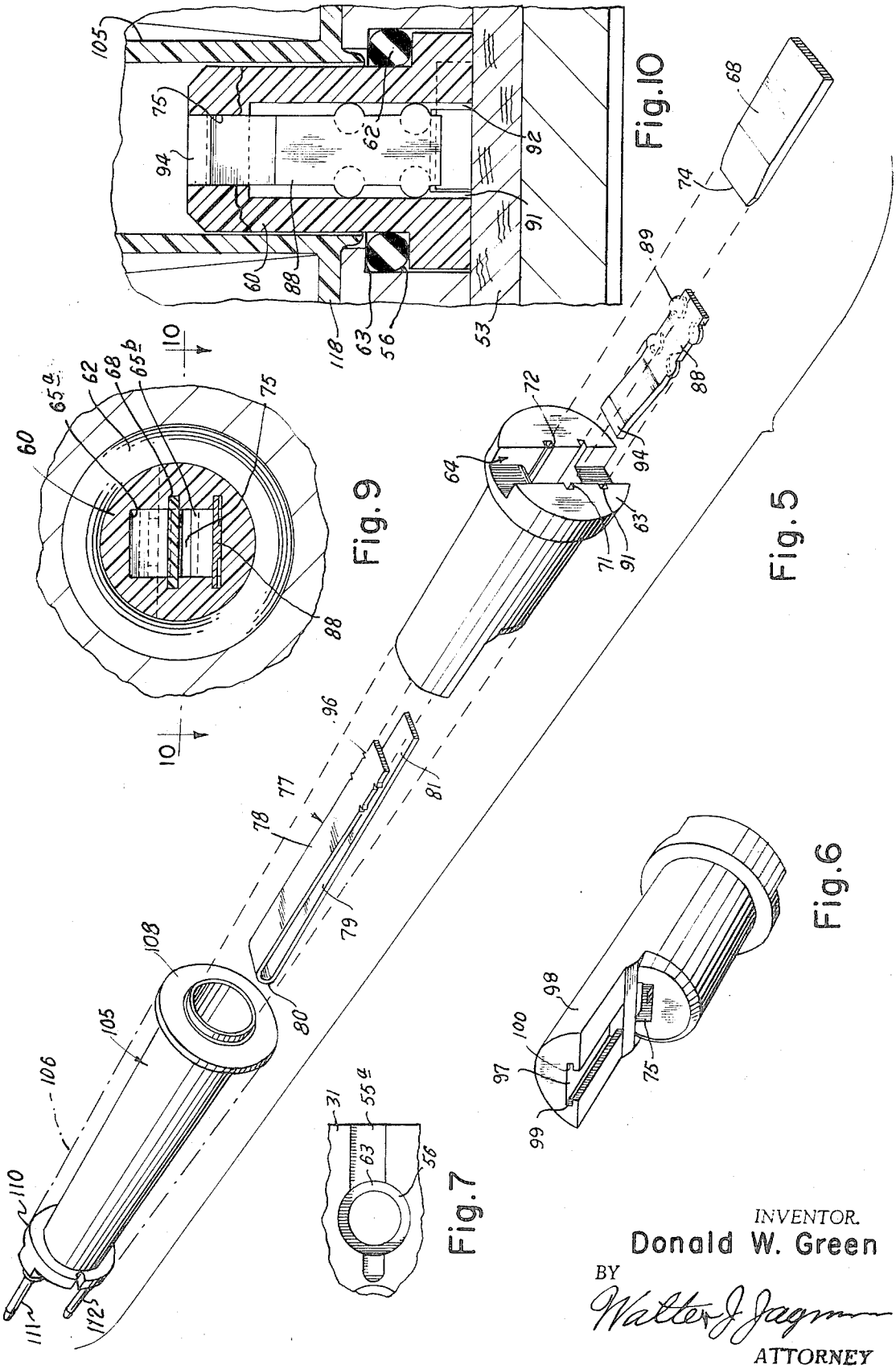


Fig. 11

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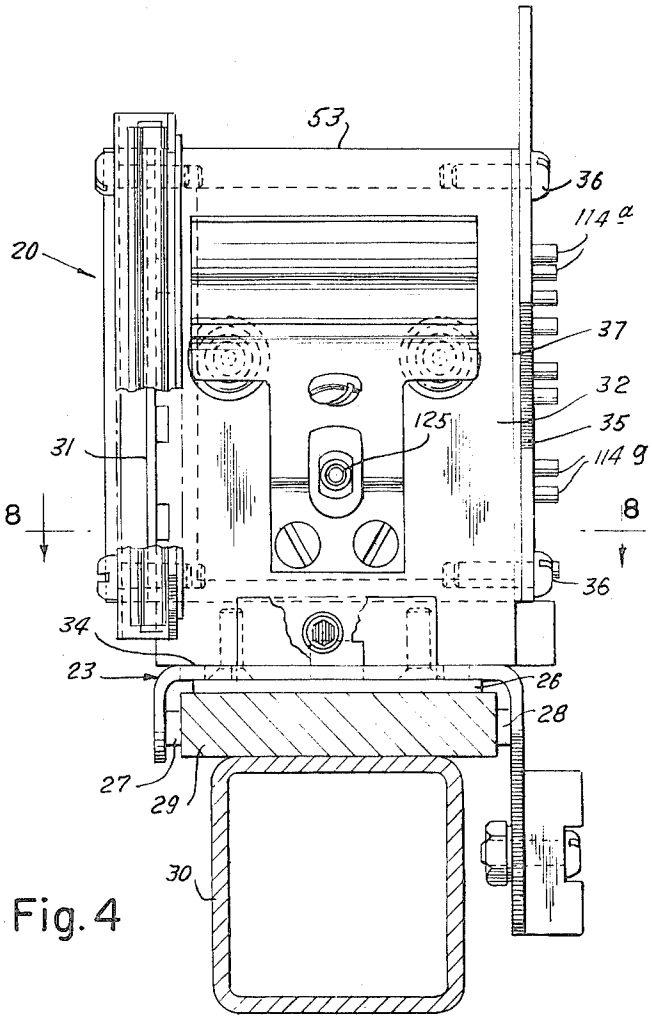


Fig. 4

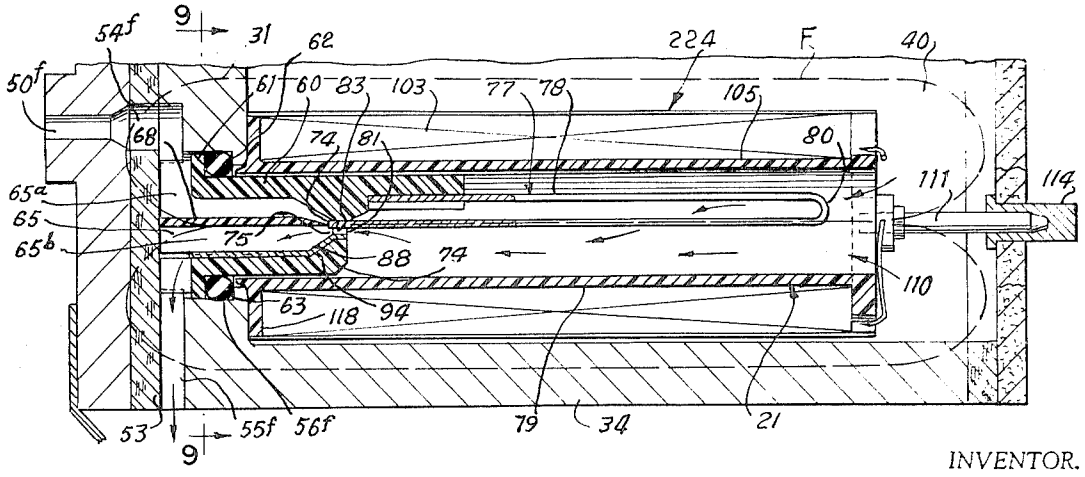


Fig. 8

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VALVE ASSEMBLY

This invention relates to valve assemblies and more particularly to electrically operable valve assemblies.

An object of this invention is to provide a new and improved valve assembly of simple structure which operates very rapidly.

Another object is to provide a valve assembly for selectively directing air either to a bypass or vent passage or to a nozzle.

Still another object is to provide a valve assembly which includes a U-shaped magnetizable valve member, one of whose leg portions is rigidly fixed to a valve body and whose other leg portion is movable in a restricted portion of the passage of the valve body to cause air to flow either to a nozzle opening or to a vent passage.

A further object is to provide a valve assembly of the type described wherein the valve member is telescoped in a coil or solenoid winding which when energized causes the free end leg portion of the U-shaped valve member to tend to move away from the fixed end leg portion thereof.

A still further object is to provide a valve assembly of the type described having a magnetic strip operatively associated with the free leg portion. When electric current flows through the winding the magnetic flux attracts the free end leg portion of the valve member to operate the valve.

Another object is to provide a housing provided with plurality of nozzles and a plurality of valve assemblies of the type described, each operatively associated with a nozzle for selectively directing air introduced under pressure into the housing either to the nozzle or to a vent or bypass passage of the housing.

Additional objects and advantages of the invention will be readily apparent from the reading of the following description of a device constructed in accordance with a preferred embodiment of the invention, and reference to the accompanying drawings thereof, wherein:

FIG. 1 is a front view, with some parts broken away, of a carriage having a plurality of the valve assemblies mounted in its housing;

FIG. 2 is a top view of the carriage illustrated in FIG. 1;

FIG. 3 is a rear view of the carriage illustrated in FIG. 1;

FIG. 4 is a side view, with some parts broken away, of the carriage illustrated in FIG. 1;

FIG. 5 is an exploded perspective view of a valve assembly embodying the invention;

FIG. 6 is a perspective view of the valve body of the valve assembly illustrated in FIG. 5;

FIG. 7 is a view taken on line 7—7 of FIG. 11 with the valve assembly removed, showing the housing aperture in which a valve body is mountable;

FIG. 8 is a fragmentary sectional view taken on line 8—8 of FIG. 4 showing the valve member in its nonactuated position;

FIG. 9 is a sectional view taken on line 9—9 of FIG. 8;

FIG. 10 is an enlarged sectional view taken on line 10—10 of FIG. 9; and,

FIG. 11 is a view similar to fIG. 8 showing the valve member in its actuated position directing air to a nozzle.

Referring now to the drawings, the carriage 20 may be used in a display apparatus of the type disclosed in the copending application of Robert L. Woolfolk, Ser. No. 645,022, filed June 9, 1967, now U.S. Pat. No. 3,487,568 granted Jan. 6,1970, and is movable past a display assembly for directing jets of air under pressure at movable display elements to move the display elements between operative and inoperative positions.

The carriage 20 has a plurality, in the illustrated embodiments, seven, of valve assemblies embodying the invention. The carriage 20 includes a housing having a U-shaped slide plate 23 secured to the housing legs 24 by means of screws 25 which extend upwardly through suitable apertures in the slide plate into threaded downwardly open blind bores in the legs. The slide plate is provided with slide strips 26, 27 and 28, (FIG. 4), formed of a low friction material, such as nylon, which are adapted to engage the top and opposite side surfaces of a track 29. The track itself is rigidly mounted on a support member 30.

The housing 22 is of substantially rectangular box shape and has a front vertical wall 31, sidewalls 32 and 33, and top and bottom walls 53 and 34, respectively. The rear side of the housing is closed by a cover plate 35 which is rigidly secured to the rear ends of the sidewalls by screws 36. A gasket 37 is interposed between the rear cover plate and the rear surfaces of the rectangular housing and seals therebetween.

It will be apparent that the housing and the cover plate 35 form an enclosed chamber of plenum into which air under pressure may be continuously introduced through a pair of tubular inlet fittings 41 and 42 having inner end portions which extend into apertures 43 in the sidewall 33 of the housing and have O-rings 44 thereon for sealing between the housing and the fittings. The fittings may be held in the apertures 43 by friction, an adhesive or any other suitable means. The fittings have flexible conduits or hoses 45 and 46 which are connected thereto. The flexible conduits are also connected to a source of air under pressure, such as a blower or the like. Air under pressure is introduced into the plenum at the two spaced locations of the inlet fittings in order to minimize pressure gradients within the plenum.

The valve assemblies 21*a*–21*g* are mounted in the housing for selectively directing air to their associated nozzles or jet openings 50*a*–50*g* provided in a front nozzle plate 51 secured to the front housing wall by screws 52. A gasket 53 is interposed between the nozzle plate and the front housing wall to seal therebetween.

The nozzles 50*a*–50*g*are aligned with and in communication with corresponding apertures 54 in the gasket 53. One of these apertures 54*f*is shown in FIG. 8 for the nozzle 50*f*. The apertures in turn communicate with respective passages, such as the passage 55*f*, in the front surface of the front housing wall. The passages are in the form of elongate grooves or recesses in the front surface of the front wall. One end of each of the passages opens to the atmosphere at an adjacent housing sidewall, and the other end of each passage opens to its associated gasket aperture 54 and nozzle 50.

The front wall of the housing is also provided with external annular apertures 56 which are intersected by the housing passages 55. The outer end portions of the tubular valve bodies 60 of the valve assemblies 21 extend inwardly into the apertures 56 and are provided with external annular flanges 61 which are received in the front enlarged portions of the apertures 56 and which compress O-rings 62 between the flanges and the internal annular surfaces 63 defining the inner ends of the enlarged portions of the apertures 56. The outer end surfaces 63 of the valve bodies press against and seal with the gasket 53.

The end flange of each valve body has a transverse slot or recess 64 (FIG. 5) which communicates with the central passage 65 of the valve body and its associated housing passage 55.

A splitter or vane 68 is press fitted into the opposed internal longitudinal slots 71 and 72 of the valve body and has a sharp or knife edge inner end 74 which is located in the restricted inner portion 75 of the central passage or bore 65 of the valve body. A resilient substantially U-shaped valve member 77 formed of a magnetizable substance, such as steel, has a short leg portion 78 and a long leg portion 79 connected by a bight portion 80. The long leg portion 79 has its extreme end portion 81 extending into the restricted portion 75 of the valve body passage. The end portion 81 is adapted to engage a valve seat surface 83 provided by the valve body and defining one side of the restricted portion 75 of the valve body passage to prevent flow of air through the passage 65*a* of the valve body at one side of the splitter 68 and to direct the air into the passage 65*b*of the valve body central bore 65 on the other side of the splitter 68 and through the slot passage or groove 55 to the atmosphere. A magnetic strip 88 extends into the central passage of the valve body and has side edge tabs or protrusions 89 which are receivable in the opposed internal slots 91 and 92 of the valve body. The inner end portion 94 of the magnetic strip overlaps the inner end portion 81 of the length 79 of the valve member 77 and extends parallel thereto. b

The valve member 77 is secured to the valve body by means of the short leg portion 78. The portion 78 is provided with protrusions 96 and is receivable in a recess 97 (FIG. 6) in the inner extension 98 of the valve body, the ribs 96 being received in the slots 99 and 100 which open to the recess 97 and being press fitted therein.

The assembly of the valve body, the valve member 77, the splitter 68 and the magnetic strip 88 is telescoped into a bobbin 105 on which the solenoid winding 106 is wound in the usual manner. The bobbin has a front external annular flange 108 which abuts the inner surface of the front housing wall to limit forward movement of the bobbin in the housing and a rear flange 110 on which are mounted a pair of terminal 111 and 112 to which the opposite ends of the coil or solenoid 106 are connected. The terminals 111 and 112 of the bobbin of each valve are received in the apertures or sockets of studs 114 (FIG. 8) mounted on the rear cover plate 35 which is preferably made of an electrically nonconductive substance, such as plastic or the like. Suitable electric conductors are of course connected to the studs 114 associated with each valve assembly 21 by means of which electric current for energizing the coil or solenoid of the valve assembly may be supplied from a source external to the housing. Rearward movement of the bobbins in the housing is limited by the engagement of their terminals with their associated studs 114.

In use, the carriage is moved past a panel of a display device having display elements movably mounted thereon, as disclosed in the said pending application of Robert L. Woolfolk. Air under relatively light pressure, for example, 2 or 3 ounces per square inch over atmospheric pressure, is continuously introduced into the plenum 40 of the housing. As long as none of the coils 106 of the valve assemblies are energized by electric current, the air flows from the plenum through each valve body to one side of the splitters 68 and to the exterior of the housing at the sidewalls thereof through the passages 55*a*–55*g* in its front wall. None of the air may now flow to the nozzles 50*a*–50 since the end portions 81 of the long legs 79 of the valve members 77 are in the closed positions illustrated in FIG. 8. In the closed positions the end portions 81 engage the seat surfaces 83 of the valve bodies, and the inner end surfaces of the end portions 81 are closely adjacent and perhaps touching the edge surface of the splitter 68.

Although there is some clearance between the side edges of the end portion of the valve member and the surfaces defining the sides of the restricted portion 75 of the bore, such clearance being exaggerated in the drawings for clarity of illustration, the amount of air which may flow between the side edges of the end portion 81 and the surfaces of the valve body defining the opposite ends of the rectangular restricted portion 75 of the valve body is very small. The resultant velocity of flow of air through the nozzles 50 when the valve member is in its nonactuated closed position is not sufficient to effect movement of the display elements which are to be moved by jets of air from the nozzles.

If a coil or winding 106 of a valve assembly, for example, the valve assembly, 21*g*illustrated in FIG. 11, is now energized, a magnetic field is immediately induced about the coil 106 which causes the inner end portions of the valve member 77 to be magnetized in such manner that the inner end portions are of the same polarity, it being well known to those skilled in the art that elongate magnetic strips positioned in a straight portion of the path of magnetic flux, induced by current in a winding, are so magnetized that one end of such strips becomes a north pole and the other a south pole. For example, the end potions of the two leg portions may be so polarized so as to be north poles, while the bight portion is polarized to be a south pole. As a result, the magnetic forces between the ends of the leg portions 78 and 79 tend to cause the end portion 81 of the long leg to move away from the leg portions 78. At the same time, the magnetic field generated by the coil 106 causes the magnetic strip 88 to be so magnetized that its inner end portion 94 is a south pole while its front end portion becomes a north pole. As a result, the magnetic attraction between the portions 94 and 81 so created also tends to cause the valve member leg portion 81 to move from its closed nonactuated position illustrated in FIG. 8 to its actuated or open positions illustrated in FIG. 11.

Due to the like polarities of the fixed and free leg portions of the valve member and the opposite polarities of the portion 94 of the auxiliary magnetic strip and the free leg portion 79, when the winding 66 is energized the valve member is moved very rapidly from its unactuated closed position to its actuated open position.

As best illustrated in FIG. 3, the carriage may be provided with connector pins 125 to which cables (not shown) or the like may be connected to enable movement of the carriage in either direction upon the track. A clamp assembly 126 is provided for clamping to the housing the electric conductors which are secured to the studs 114 and through which electric current for energizing the coils 106 of the valve assemblies is transmitted. The assembly 126 also serves to clamp the hoses 45 and 46 through which air is supplied to the plenum.

The housing may also support other auxiliary equipment such as indexing means 130 (FIG. 1) which in association with other control means permits operation of the valve assemblies only when the nozzles are in proper alignment with the display elements which are to be moved by the jets of air expelled through the nozzle. Such indexing means not being a part of this invention is not described further herein but is discussed in detail in the Woolfolk application, Ser. No. 645,022, referred to above.

It will be seen that a new and improved valve assembly has been illustrated and described which includes a valve body comprising a central bore having a restricted inner end portion 75 (FIG. 8), a splitter or divider 68 dividing the above into two passages and a U-shaped valve member 77 having one leg portion 78 fixed to the valve body and a free leg portion extending into the restricted portion of the bore 65 and cooperating with the divider and a seat surface 83 of the valve body defining one side of the restricted passage to close the passage 65*a*to flow of air when the winding 106 is not energized. The free leg portion is movable to open the first passage 65*a* and close the second passage 65*b* when the coil is energized with electric current.

It will further be seen that an auxiliary magnetic strip positioned in the bore of the valve body has an inner end portion extending into the restricted portion 75 and is magnetized to cause its inner end portion 94 and the free end portion 81 of the valve member to be of opposite polarity when the coil 106 is energized.

It will further be seen that the air may flow into the restricted inlet portion 75 of the valve body bore from the interior of the tubular bobbin which of course is open at its ends, as is illustrated in FIG. 8, and, therefore from the plenum 40.

It is to be understood that the bobbin 105 is made of a nonmagnetic substance, such as plastic. The housing 22 and the front nozzle plate 52 are also preferably formed of a nonmagnetic substance such as brass in order that the magnetic flux produced when electric current is flowing through the winding 106 not be shunted or deflected adversely to the operation of the valve member and the magnetic strip.

It will further be seen that a new and improved means for easily and simply mounting a plurality of valve assemblies in the housing has been illustrated and described which does not require the use of any fastening means for the valve bodies, such as screws or bolts, since the valve bodies are held in the apertures 56 by the engagement of their end surfaces with the gasket 53 and the bobbins similarly are held against movement by the housing front wall and the studs 114.

It will also be apparent that, if desired, a permanent magnet may be moved toward the free end 81 of the valve member to move it to its operative position. In this case, of course, the winding 106 would not be used.

The foregoing description of the invention is explanatory only, and changes in the details of the construction illustrated may be made by those skilled in the art, within the scope of the

appended claims, without departing from the spirit of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. A valve assembly including: a valve body having a main bore therethrough, said main bore having a restricted portion; divider means in said body dividing said main bore downstream of said restricted portion into a first passage and a second passage; and a resilient and substantially U-shaped valve member having first and second substantially parallel legs and a bight portion connecting said legs, said first leg having an end portion remote from said bight portion fixedly secured to said valve body and said second leg being free to move resiliently toward and away from said first leg, said second leg having a free end portion remote from said bight portion extending into said restricted portion of said main bore, said free end portion being movable between a first position and a second position and cooperating with said divider means for selectively directing fluid flowing into said restricted portion into one of said passages when said free end portion is in said first position and into the other of said passages when said free end portion is in said second position.

2. The valve assembly of claim 1, said valve member being of a magnetic substance, and a winding disposed about said valve member which when energized by electric current causes the end portions of said legs remote from said bight portion to be of like magnetic polarities whereby said free end portion is moved away from said fixed end portion of said first leg and from one of said first and second positions to the other of said first and second positions.

3. The valve assembly of claim 2, wherein said winding is of substantially cylindrical configuration and substantially surrounds said valve member.

4. The valve assembly of claim 2, and an auxiliary magnetic strip having an end portion in said restricted portion.

5. The valve assembly of claim 4, wherein said end portion of said magnetic strip extends substantially parallel to and in alignment with said free end portion, said magnetic strip extending from said restricted portion away from said bight portion whereby said end portion of said magnetic strip in said restricted portion is magnetized to be of the opposite magnetic polarity than said free end portion when said winding is energized.

6. The valve assembly of claim 5, wherein said winding is of substantially cylindrical configuration and substantially surrounds said valve member.

7. The valve assembly of claim 1, wherein said valve member is of magnetic substance, and means for magnetically polarizing said fixed and free end portions of said first and second legs to cause said free end portion to be moved away from said fixed end portion and from one of said first and second position to the other when said end portion of said legs are magnetically polarized.

8. The valve assembly of claim 7 and an auxiliary magnetic strip having an end portion in said restricted portion extending substantially parallel to and in alignment with the free end portion, said magnetic strip extending from said restricted portion away from said bight portion whereby said end portion of said magnetic strip in said restricted portion is magnetized to be of the opposite magnetic polarity than said free end portion when said winding is energized.

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