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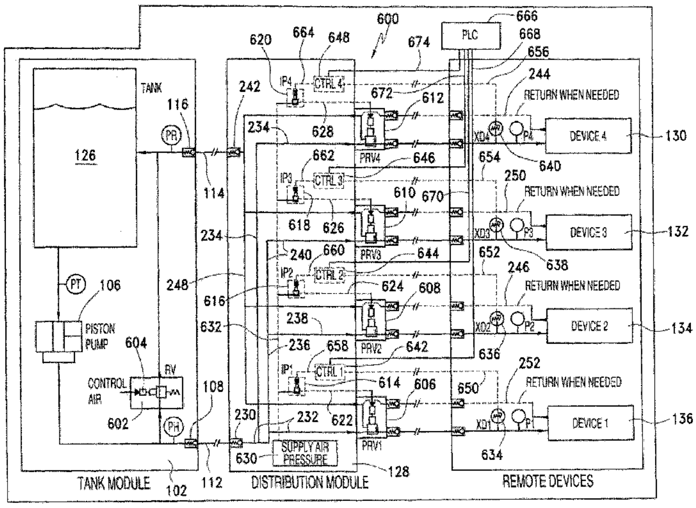

(57) Abstract: A modular system (100), for delivering hot melt adhesive materials, comprises a modular metering assembly (104), having metering stations disposed therein, that is able to be attachably and detachably mounted upon a modular tank assembly (102). Alternatively, one or more of the metering stations may be disposed externally of the modular metering assembly, and alternatively still further, one or more additional modular metering assemblies may be attachably and detachably connected to the first modular metering assembly. Also disclosed is a closed-loop fluid pressure control system, for independently controlling the pressure of the hot melt adhesive material being conveyed to the metering devices, whereby the working pressures of the hot melt adhesive materials being conveyed to the metering devices can have different working pressures.

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MODULAR SYSTEM FOR DELIVERING HOT MELT ADHESIVE OR OTHER THERMOPLASTIC MATERIALS, AND PRESSURE CONTROL SYSTEM THEREFOR

CROSS-REFERENCE TO RELATED PATENT APPLICATION

This patent application is a Continuation-in-Part of United States Patent Application entitled **MODULAR SYSTEM FOR THE DELIVERY OF HOT MELT ADHESIVE OR OTHER THERMOPLASTIC MATERIALS**, which was filed on February 12, 2007 and which has been assigned Serial Number 11/705,060.

FIELD OF THE INVENTION

The present invention relates generally to hot melt adhesive or other thermoplastic material dispensing systems, and more particularly to a new and improved modular system for the delivery of hot melt adhesive or other thermoplastic materials wherein, for example, a modular metering assembly, having a plurality of hot melt adhesive or other thermoplastic material metering stations contained internally therewith-in, is able to be attachably and detachably mounted upon, and operatively and fluidically connected to, a modular hot melt adhesive or other thermoplastic material tank or supply assembly. Alternatively, one or more of the plurality of hot melt adhesive or other thermoplastic material metering stations may be disposed externally of, and yet operatively and fluidically connected in an attachable and detachable manner, to and from the modular metering assembly, and alternatively still further, one or more additional modular metering assemblies may be operatively and fluidically connected, in an attachable and detachable manner, to and from the original modular metering assembly. In this manner, the entire modular system exhibits enhanced versatility and flexibility in order to effectively accommodate, or permit implementation of, various or different hot melt adhesive or other thermoplastic materiial deposition or application procedures that may be required by means of a particular end-user or customer. Also disclosed is a closed-loop fluid pressure control system, for controlling the pressure of the hot melt adhesive or other thermoplastic material being conveyed to the metering devices, whereby the working pressure of the hot melt adhesive or other thermoplastic material being conveyed to each one of the metering devices can have a different working pressure.

BACKGROUND OF THE INVENTION

In connection with the delivery of hot melt adhesive or other thermoplastic materials for use in implementing various or different hot melt adhesive or other thermoplastic material deposition or application procedures, conventional practices have dictated that depending upon, or as a function of, particular predetermined application requirements or parameters, a particularly or specifically structured system be designed, manufactured, and installed. As can therefore be readily appreciated, when considered from a somewhat opposite or reverse point of view or perspective, and as is well known in the industry, different deposition or application procedures require different structural systems to be designed, manufactured, purchased, and installed. For example, different deposition or application procedures may require differently sized hot melt adhesive or other thermoplastic material supply units or tanks. Alternatively, different deposition or application procedures, comprising, for example, different output material volume parameters or requirements, may dictate or require the use or employment of different hot melt adhesive or other thermoplastic material metering pump assemblies. Alternatively, still further, different deposition or application procedures, comprising, for example, the minimalization of pressure losses, or the optimalization of pressure values, occurring within the various fluid flow lines or conduits comprising the entire hot melt adhesive or other thermoplastic delivery system, may dictate or require that the hot melt adhesive or other thermoplastic material metering pump assemblies and their applicators be disposed or located relatively close to the hot melt adhesive or other thermo-plastic material supply units or tanks. Along these lines, depending, for example, upon the different locations of the metering devices or applicators, different working pressures operatively associated with each metering device or applicator may be required.

Still yet further, spatial or logistic parameters characteristic of a particular plant or manufacturing facility, that is, for example, the particular product manufacturing or production lines, may dictate or require that the hot melt adhesive or other thermoplastic material metering pump assemblies and their applicators be disposed or located remotely from the hot melt adhesive or other thermoplastic material supply units or tanks. Accordingly, it can be readily appreciated that if various hot melt adhesive or other thermoplastic material delivery systems are to be erected or installed within particular manufacturing facilities in connection with various production lines for implementing various or different hot melt adhesive or other thermoplastic material deposition or application procedures, it is prohibitively expensive to in fact incorporate such a variety of delivery systems within any one manufacturing plant or facility, or considered from an alternative point of view or perspective, different manufacturing plants or facilities would have to be erected in order to in fact accommodate such a variety of delivery systems. Alternatively, still further, while a particular delivery system could effectively be converted from one type of delivery system to another type of delivery system, again, the costs involved in connection with such conversion procedures would effectively prevent the same from being economically viable.

A need therefore exists in the art for a new and improved system for the delivery of hot melt adhesive or other thermoplastic materials, wherein the delivery system would be flexible and versatile as a result, for example, of the interchange or exchange of various components within the system, or as a result of the operative extension of the delivery system, whereby various different deposition or application procedures, having or characterized by means of various different operational parameters or requirements, can be readily achieved without the necessity of constructing or erecting a multitude of various different fixed or permanent delivery systems. In addition, there is also a need for a fluid control system whereby the separate fluids being supplied to the various metering devices or applicator heads may be independently controlled so as to be characterized by different pressure parameters or values as required.

SUMMARY OF THE INVENTION

The foregoing and other objectives are achieved in accordance with the teachings and principles of the present invention through the provision of a new and improved modular system for the delivery of hot melt adhesive or other thermoplastic materials wherein, for example, a modular metering assembly, having a plurality of hot melt adhesive or other thermoplastic material metering stations contained internally therewithin, is able to be attachably and detachably mounted upon, and operatively and fluidically connected to, a modular hot melt adhesive or other thermoplastic material tank or supply assembly. Alternatively, one or more of the plurality of hot melt adhesive or other thermoplastic material metering stations may be disposed externally of, and yet operatively and fluidically connected in an attachable and detachable manner, to and from the modular metering assembly, and alternatively still further, one or more additional modular metering assemblies may be operatively and fluidically connected, in an attachable and detachable manner, to and from the first or original modular metering assembly. In this manner, the entire modular system exhibits enhanced versatility and flexibility in order to effectively accommodate, or permit implementation of, various or different hot melt adhesive or other thermoplastic material deposition or application procedures that may be required by means of a particular end-user or customer. Also disclosed is a closed-loop fluid pressure control system, for controlling the pressure of the hot melt adhesive or other thermoplastic material being conveyed to the metering devices, whereby the working pressures of the hot melt adhesive or other thermoplastic materials being conveyed to each one of the metering devices can have different working pressure values as may be required.

BRIEF DESCRIPTION OF THE DRAWINGS

Various other features and attendant advantages of the present invention will be more fully appreciated from the following detailed description when considered in connection with the accompanying drawings in which like reference characters designate like or corresponding parts throughout the several views, and wherein:

FIGURE 1 is a perspective view of a first embodiment of a new and improved modular system, for the delivery of hot melt adhesive or other thermoplastic materials, as constructed in accordance with the principles and teachings of the present invention, and showing the cooperative parts thereof, wherein the modular metering assembly is independent of, and located remotely from, the modular tank assembly;

FIGURE 2 is a perspective view, similar to that of **FIGURE 1**, showing, however, a second embodiment of a new and improved modular system, for the delivery of hot melt adhesive or other thermoplastic materials, and also constructed in accordance with the principles and teachings of the present invention, wherein the modular metering assembly is fixedly attached to, and effectively forms an integral assembly with, the modular tank assembly;

FIGURE 3 is a perspective view, similar to, and corresponding to that of **FIGURE 1**, showing, however, the internal components of the modular tank assembly and the internal components of the modular metering assembly with some of the internal components of the modular metering assembly illustrated in an exploded format for clarity purposes;

FIGURE 4 is a side elevational view of the distribution manifold of the modular metering assembly, schematically showing the mounting of some of the metering station metering interfaces upon the upper and front wall members of the distribution manifold as well as some of the fluid conduits defined internally within the distribution manifold for supplying the hot melt adhesive or other thermoplastic material into and out from the distribution manifold;

FIGURE 4a is a cross-sectional view of the distribution manifold as illustrated within **FIGURE 4** and as taken along lines **4a-4a** of **FIGURE 4**;

FIGURE 4b is a cross-sectional view of the distribution manifold as illustrated within **FIGURE 4a** and as taken along lines **4b-4b** of **FIGURE 4a**;

FIGURE 4c is a cross-sectional view of the distribution manifold as illustrated within **FIGURE 4a** and as taken along lines **4c-4c** of **FIGURE 4a**;

FIGURE 5 is a cross-sectional view of the integral modular tank assembly-modular metering assembly entity as illustrated within **FIGURE 2** and as taken along the lines **5-5** of **FIGURE 2**;

FIGURE 6 is a partial perspective view of the hot melt adhesive or other thermoplastic material collector housing, the distribution manifold, and a rotary clamping fastener assembly mounted upon the hot melt adhesive or other thermoplastic material collector and the distribution manifold for attachably and detachably mounting the distribution manifold upon the hot melt adhesive or other thermoplastic material collector housing, wherein the rotary clamping fastener assemblies are illustrated as being disposed at their unlocked positions such that distribution manifold can be detached from the hot melt adhesive or other thermoplastic material collector housing;

FIGURE 7 is a partial perspective view, similar to that of **FIGURE 6**, showing, however, one of the rotary clamping fastener assemblies disposed at its locked position such that the distribution manifold is able to be fixedly attached to the hot melt adhesive or other thermoplastic material collector housing;

FIGURE 8 is a cross-sectional view, similar to that of **FIGURE 5**, showing, however, a third embodiment of a new and improved modular system, for the delivery of hot melt adhesive or other thermoplastic materials, and also constructed in accordance with the principles and teachings of the present invention, wherein the modular metering assembly is fixedly attached to, and effectively forms an integral assembly with a modular pump assembly, the modular tank assembly being separate, and located at a remote location, from the modular pump assembly;

FIGURE 9 is a perspective view, similar to that of **FIGURE 3**, showing, however, a fourth embodiment of a new and improved modular system, for the delivery of hot melt adhesive or other thermoplastic materials, and also constructed in accordance with the principles and teachings of the present invention, wherein one, or more, or all of the plurality, of metering stations is or are in fact located externally of, and remote from, the modular metering assembly and the distribution manifold disposed therein;

FIGURE 10 is a perspective view, similar to those of **FIGURES 1** and **9**, showing, however, a fifth embodiment of a new and improved modular system, for the delivery of hot melt adhesive or other thermoplastic material, and also constructed in accordance with the principles and teachings of the present invention, wherein one or more additional modular metering assemblies can be located remote from and serially connected to the original or first modular metering assembly and the distribution manifold disposed therein;

FIGURE 11 is a schematic diagram illustrating the fluid control circuit operatively associated with the various system components which may be similar to those illustrated, for example, within **FIGURE 3** but which may be located at various locations;

FIGURE 12 is an enlarged, cross-sectional view of one of the pressure-reducing valves operatively incorporated within the fluid control circuit disclosed within **FIGURE 11,** wherein the spool member of the pressure-reducing valve is disclosed at its downward position so as to permit fluid flow therethrough from the tank module to one of the remote devices; and

FIGURE 13 is an enlarged, cross-sectional view, similar to that of **FIGURE 12,** of one of the pressure-reducing valves operatively incorporated within the fluid control circuit disclosed within **FIGURE 11,** wherein, however, the spool member of the pressure-reducing valve is disclosed at its upward position so as to permit return fluid flow therethrough from one of the remote devices back the material supply tank of the tank module.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

Referring now to the drawings, and more particularly to **FIGURE 1** thereof, a first embodiment of a new and improved modular system, for the delivery of hot melt adhesive or other thermoplastic materials, is disclosed and is generally indicated by the reference character 100. More particularly, it is seen that the new and improved modular delivery system 100 comprises a modular tank assembly 102 within which a supply of hot melt adhesive or other thermoplastic material is melted and stored, and a modular metering assembly 104 within which a plurality of metering stations, each comprising a plurality of metering gear pumps as will be disclosed more fully hereinafter, are disposed for outputting predetermined or precisely metered amounts of the hot melt adhesive or other thermoplastic materials. In accordance with additional structural features characteristic of the new and improved modular system 100 for delivering hot melt adhesive or other thermoplastic materials, it is further seen that the modular tank assembly 102 comprises a primary pump 106 which pressurizes the hot melt adhesive or other thermoplastic material, contained within the modular tank assembly 102, to a predetermined constant pressure value, and that the pressurized hot melt adhesive or other thermoplastic material is then supplied, at variable volume rates to the modular metering assembly 104 depending upon or as a function of the demand of the plurality of metering gear pumps disposed within the modular metering assembly 104, by means of a fluid supply outlet port 108, defined within a front wall member 110 of the modular tank assembly 102, and a fluid supply conduit 112 which may comprise a suitable heated hose.

Unused hot melt adhesive or thermoplastic material is returned to the modular tank assembly 102, from the modular metering assembly 104, by means of a fluid return conduit 114 and a fluid return inlet port 116 also defined within the front wall member 110 of the modular tank assembly 102. It can therefore be appreciated that, in accordance with the principles and teachings of this first embodiment of the present invention, the modular metering assembly 104 is independent of, and can be remotely located at various distances from, the modular tank assembly 102 as defined, for example, by means of various, predetermined length dimensions of the fluid supply and fluid return conduits 112,114. In addition, it is seen that the front wall member 118 of the modular metering assembly 104 is provided, for example, with sixteen fluid supply outlet ports 120, wherein the sixteen fluid supply outlet ports 120 are arranged in four sets or arrays, with each set or array of the fluid supply outlet ports 120 comprising four individual fluid supply outlet ports 120. As will become more apparent hereinafter, the outputs of the plurality of metering gear pumps, comprising the plurality of metering stations disposed within the modular metering assembly 104, are fluidically connected to the plurality of fluid supply outlet ports 120, and a plurality of applicator hoses, schematically shown at 122, may be respectively fluidically connected to the plurality of fluid supply outlet ports 120 so as to in fact supply the predetermined or precisely metered amounts of the hot melt adhesive or other thermoplastic materials to hot melt adhesive or thermoplastic material applicator heads.

With reference now being made to **FIGURE 2**, a second embodiment of a new and improved modular system, for delivering hot melt adhesive or other thermoplastic materials, is disclosed and is generally indicated by the reference character 200. It is to be appreciated that this second embodiment modular system 200 is substantially similar to the first embodiment modular system 100 as disclosed within **FIGURE 1**, except as will be discussed hereinafter, and therefore a detailed discussion of the second embodiment modular system 200 will be omitted for brevity purposes, the disclosure and description of the same being confined substantially to the differences between the first and second embodiment modular systems 100,200. In addition, it is also noted that in view of the similarity between the first and second embodiment modular systems 100,200, component parts of the second embodiment modular system 200 which correspond to component parts of the first embodiment modular system 100 will be designated by corresponding reference characters except for the fact that they will be within the 200 series.

More particularly, one of the differences between the first and second embodiment modular systems 100,200 resides in the fact that, in accordance with the principles and teachings of the second embodiment modular system 200, the modular metering assembly 204 has been fixedly attached to the modular tank assembly 202 in order to effectively form a single integral unit. Cooperative fastener means, which will be disclosed hereinafter, are mounted upon the front wall member 210 of the modular tank assembly 202 and upon the rear wall member 224 of the modular metering assembly 204 so as to in fact attachably and detachably secure the modular metering assembly 204 to the modular tank assembly 202. In addition, as a result of such attachment of the modular metering assembly 204 to the modular tank assembly 202, and the formation of the aforenoted integral entity, the fluid supply and fluid return conduits 112,114, characteristic of the first embodiment modular system 100 and utilized to fluidically inter-connect the modular tank assembly 102 to the modular metering assembly 104, are able to be eliminated.

With reference now being made to **FIGURE 3**, and effectively reverting back to, or considered in conjunction with, **FIGURE 1** disclosing the first embodiment modular system 100, the internal structural details of the modular tank assembly 102 and of the modular metering assembly 104 will now be discussed. More particularly, it is seen that the modular tank assembly 102 has disposed therein a hot melt adhesive or other thermoplastic material reservoir or hopper 126 within which a supply of the hot melt adhesive or other thermoplastic material is melted and maintained at a predeterminedly desired temperature level and viscosity. The primary pump 106 receives the hot melt adhesive or other thermo-plastic material from the hot melt adhesive or other thermo-plastic material reservoir or hopper 126, pressurizes the material to a predetermined pressure value, and conveys the same toward the modular metering assembly 104 through means of the fluid supply conduit 112. As can also be readily appreciated from **FIGURE 3**, the modular metering assembly 104 has a distribution manifold 128 disposed internally thereof, and the distribution manifold 128 has a plurality of metering stations, such as, for example, four metering stations 130, 132,134,136, fixedly mounted thereon and operatively or fluidically connected thereto. While the four metering stations 130,132,134,136 are illustrated as being disposed externally of the modular metering assembly 104, it is to be understood and appreciated that the four metering stations 130,132,134, 136 are, in effect, being simply illustrated in an exploded format with respect to the modular metering assembly 104 for illustrative purposes only and that the four metering stations 130,132,134,136, for delivering the hot melt adhesive or other thermoplastic materials to downstream applicator heads, are, in accordance with the principles and teachings of this first embodiment of the new and improved modular system, in fact adapted to be disposed internally within the modular metering assembly 104.

Accordingly, it is further seen that a plurality of mounting brackets 138,140,142,144 are fixedly secured internally within the modular metering assembly 104, and that the plurality of metering stations 130,132,134,136 are adapted to be respectfully mounted and fixedly secured thereon. Continuing still further, it is also seen that each one of the plurality of metering stations 130,132,134,136 is seen to respectively comprise a set of metering gear pumps 146,148,150, 152, a drive motor 154,156,158,160 for respectively rotatably driving each set of metering gear pumps 146,148,150,152 through means of a gearbox assembly 162,164,166,168, and a metering interface 170,172,174,176 for respectively providing a fluidic interface between the distribution manifold 128 and each set of metering gear pumps 146,148,150,152. In addition, it can also be appreciated that hot melt adhesive or other thermoplastic material fluid supply paths 178,180,182,184, and hot melt adhesive or other thermoplastic material fluid return paths 186,188,190,192, are respectively defined between the distribution manifold 128 and each one of the metering interfaces 170,172,174,176 respectively associated with each set of metering gear pumps 146,148,150,152. Still yet further, it is seen that each one of the four sets of metering gear pumps 146,148,150,152 comprises, for example, four serially arranged metering gear pumps, and therefore, the total number of metering gear pumps operatively associated with and fluidically connected to the distribution manifold 128 disposed within the modular metering assembly 104 comprises sixteen metering gear pumps, the fluidic outputs of which are adapted to be fluidically connected to the fluid supply outlet ports 120 defined within the front wall member 118 of the modular metering assembly 104 as disclosed within **FIGURE 1**.

It can therefore be appreciated that, in connection with the supply and return of the hot melt adhesive or other thermoplastic material, the hot melt adhesive or other thermoplastic material, disposed within the hot melt adhesive or other thermoplastic material reservoir or hopper 126, will be conveyed to the fluid supply outlet port 108, defined within the front wall member 110 of the modular tank assembly 102, by means of the primary pump 106, and the hot melt adhesive or other thermoplastic material will, in turn, be conveyed along the fluid supply conduit 112 to the distribution manifold 128 which, in turn, will convey the hot melt adhesive or other thermoplastic material to each set of metering gear pumps 146,148,150,152 by means of the hot melt adhesive or other thermoplastic material fluid supply paths 178,180,182, 184 and the metering interfaces 170,172,174,176. Conversely, hot melt adhesive or other thermoplastic material that is to be returned to the hot melt adhesive or other thermoplastic material reservoir or hopper 126 will be conveyed from each set of metering gear pumps 146,148,150,152 through means of its respective metering interface 170,172,174,176, the hot melt adhesive or other thermoplastic material fluid return paths 186,188,190,192, the distribution manifold 128, and the fluid return conduit 114.

With reference still being made to **FIGURE 3**, and with additional reference being made to **FIGURES 4-4c**, it is seen that the metering interfaces 170,172, operatively and fluidically associated with the metering stations 130,132, are adapted to be mounted upon the upper or top wall member 194 of the distribution manifold 128, and that the metering interfaces 174,176, operatively and fluidically associated with the metering stations 134,136, are adapted to be mounted upon the front wall member 196 of the distribution manifold 128. In addition, as can best be appreciated and understood from **FIGURES 4-4c**, the different hot melt adhesive or other thermoplastic material fluid supply and fluid return passageways, defined internally within the distribution manifold 128 and leading toward and away from the metering interfaces 170, 172,174,176, and the sets of metering gear pumps 146,148,150, 152 operatively and fluidically connected thereto, will now be disclosed and described. More particularly, as can be appreciated from **FIGURES 4,4a,** and **4c,** as well as **FIGURE 3**, the fluid supply conduit 112 fluidically connected to, and extending outwardly from, the front wall member 110 of the modular tank assembly 102, is operatively and fluidically connected to a lower portion of the rear wall member 198 of the distribution manifold 128 by means of an inlet port 230. A first horizontal, longitudinally oriented fluid supply passageway 232 leads internally into the distribution manifold 128 from the inlet port 230, in the direction of the fluid supply conduit 112, so as to fluidically connect to a first one of the metering interfaces 174,176 disposed upon the front wall member 196 of the distribution manifold 128, while a first vertically oriented fluid supply passageway 234, fluidically connected to or intersecting the first horizontal fluid supply passageway 232, fluidically connects to a first one of the metering interfaces 170,172 disposed upon the upper or top wall member of the distribution manifold 128.

In addition, a second horizontal, transversely oriented fluid supply passageway 236, as seen in **FIGURE 4**, fluidically interconnects the first horizontal fluid supply passageway 232 to a third horizontal fluid supply passageway 238, which extends substantially parallel to the first horizontal fluid supply passageway 232 and is seen in **FIGURE 4a**, so as to provide hot melt adhesive or other thermoplastic material to a second one of the metering interfaces 174,176 disposed upon the front wall member 196 of the distribution manifold 128, while a second vertically oriented fluid supply passageway 240, disposed substantially parallel to the first vertically oriented fluid passageway 234, is fluidically connected to or intersects the third horizontal fluid supply passageway 238 so as to provide hot melt adhesive or other thermoplastic material to the second one of the metering interfaces 170,172 disposed upon the upper or top wall member 194 of the distribution manifold 128. After being conducted along the first and second vertically oriented fluid supply passageways 234,240, the hot melt adhesive or other thermoplastic material will effectively be conducted along the fluid supply paths 178,180, which are also schematically illustrated within **FIGURE 3**, so as to respectively enter into the metering interfaces 170,172 from which the hot melt adhesive or other thermoplastic material will then be supplied to the metering gear pumps 146,148 of the metering stations 130,132. Similar fluid flow paths are of course provided in connection with the supply of the hot melt adhesive or other thermoplastic material to the metering interfaces 174,176 and the metering gear pumps 150,152 of the metering stations 134,136.

In connection with the return of the hot melt adhesive or other thermoplastic material from the metering stations 130,132,134,136 back to the hot melt adhesive or other thermoplastic reservoir or storage tank 126 of the modular tank assembly 102, through means of the distribution manifold 128, reference to **FIGURES 4,4a,** and **4b,** as well as to **FIGURE 3,** illustrates that, in a similar manner to the supply of the hot melt adhesive or other thermoplastic material to the distribution manifold 128, the distribution manifold 128 is provided with various internal fluid passageways so as to fluidically interconnect the metering interfaces 170,172,174,176 of the metering stations 130,132,134,136 to the fluid return conduit 114. More particularly, it is seen that the fluid return conduit 114 is fluidically connected to, and extends outwardly from, the rear wall member 198 of the distribution manifold 128, through means of a fluid outlet port 242, so as to fluidically mate with the fluid return inlet port 116 of the modular tank assembly 102. A first vertically oriented fluid return passageway 244 extends downwardly within the distribution manifold 128 from a first one of the metering interfaces 170,172 disposed upon the upper or top wall member 194 of the distribution manifold 128, and a first horizontal, longitudinally oriented fluid return passageway 246 extends inwardly within the distribution manifold 128 from a first one of the metering interfaces 174,176 disposed upon the front wall member 196 of the distribution manifold. The first vertically oriented fluid return passageway 244 and the first horizontal, longitudinally oriented fluid return passageway 246 fluidically intersect or merge into a second horizontally oriented fluid return passageway 248 which is fluidically connected to the fluid outlet port 242, and as can best be seen from **FIGURE 4a**, a second vertically oriented fluid return passageway 250, operatively and fluidically connected to a second one of the metering interfaces 170,172, is also provided internally within the distribution manifold 128 so as to extend substantially parallel to the first vertically oriented fluid return passageway 244 and to be fluidically connected to the second horizontally oriented fluid return passageway 248 leading to the fluid outlet port 242. In addition, a third horizontally oriented fluid return passageway 252 is provided for fluidically connecting the second one of the metering interfaces 174,176 to the second horizontally oriented fluid return passageway 248 and the fluid outlet port 242, and in this manner, return hot melt adhesive or other thermo-plastic material is able to be returned to the hot melt adhesive or other thermoplastic material reservoir or hopper, from the metering stations 130,132,134,136, along the fluid return paths 186,188,190,192, the distribution manifold 128, and the fluid return conduit 114.

It is to be noted further that in connection with the plurality of supply and return fluidic interfaces defined, for example, between the plurality of metering interfaces 170,172,174,176 and the distribution manifold 128, as well as the fluidic interface defined, for example, between the fluid supply conduit 112 and the distribution manifold 128, and the fluidic interface defined, for example, between the fluid return conduit 114 and the distribution manifold 128, a pair of oppositely disposed check valves are respectively incorporated within the distribution manifold 128 and the plurality of metering interfaces 170,172,174,176, at the junctions of such components, as illustrated at 254,256 in **FIGURE 4b**, and in a similar manner, a pair of oppositely disposed check valves are respectively incorporated within the distribution manifold 128 and the fluid supply and fluid return conduits 112, 114, at the junctions of such components, as illustrated at 258,260 in **FIGURES 4c** and **4b**, although it is noted that only the check valves incorporated within the distribution manifold 128 are illustrated. As a result of the presence of such oppositely disposed check valves 254,256,258,260, the various structural components are able to be separated from each other without any inadvertent discharge or leakage of the hot melt adhesive or other thermoplastic material across the noted interfaces. It is also noted that in connection with, for example, the fluid supply and return conduits 112,114, such conduits 112,114 may be readily and easily attachably and detachably connected to the distribution manifold 128 and the modular tank assembly 102 by means of suitable threaded fittings or the like.

With reference now being made to **FIGURE 5**, and effectively reverting back to, or considered in conjunction with, **FIGURE 2** disclosing the second embodiment modular system 200, additional internal structural details of the modular tank assembly 202, and its operative and fluidic connection to the modular metering assembly 204, will now be discussed. More particularly, it is seen that the modular tank assembly 202 has the primary pump 206 and a hot melt adhesive or other thermoplastic material reservoir or hopper 226, similar to the hot melt adhesive or other thermoplastic material reservoir or hopper 126, disposed therein, and that the modular metering assembly 204 has a distribution manifold 228, similar to the distribution manifold 128, disposed therein. The hot melt adhesive or other thermoplastic material reservoir or hopper 226 contains a supply of hot melt adhesive or other thermoplastic material 262 therewithin, and the lower end or bottom portion of the hot melt adhesive or other thermoplastic material reservoir or hopper 226 is effectively apertured, as at 264, so as to permit the melted hot melt adhesive or other thermoplastic material 262 to discharge into a horizontally oriented collection passageway 266 which is fluidically connected to a pump supply passageway 268 which leads to the inlet end of the primary pump 206. The primary pump 206 then outputs the hot melt adhesive or other thermo-plastic material 262 to its pump outlet passageway 270 whereby the hot melt adhesive or other thermoplastic material 262 then passes through a strainer-filter member 272 so as to remove unwanted or undesirable particles or impurities therefrom.

After passing through the strainer-filter member 272, the hot melt adhesive or other thermoplastic material 262 then enters a first horizontally oriented output passageway 274, which is formed within the lower region of the primary pump housing 276, and a second horizontally oriented output passageway 278 which is formed within the base region or lower collector housing portion 279 of the reservoir or hopper 226 and which is fluidically connected to the distribution manifold 228 through means of a pair of oppositely disposed check valves 280 which may be similar to the aforenoted check valves 258. The hot melt adhesive or other thermoplastic material 262 is then conducted through a vertically oriented supply passageway 282, which may be similar to either one of the vertically oriented supply passageways 234, 240, so as to be conducted along a fluid supply path 284, which may be similar to either one of the fluid supply paths 178,180, leading to metering interfaces similar to the metering interfaces 170,172. In a similar manner, hot melt adhesive or other thermoplastic material 262 can be returned, from the metering interfaces, to the collection passageway 226 along a fluid return path 286, which may be similar to either one of the fluid return paths 186,188, a vertically oriented return passageway 288 which may be similar to either one of the vertically oriented passageways 244, 250, and a pair of oppositely disposed check valves 290 which may be similar to the aforenoted check valves 260.

Continuing further, in order to fixedly secure together the distribution manifold 228 and the lower collector housing portion 279 of the reservoir or hopper 226, in an attachable and detachable manner, suitable fastener assemblies, such as, for example, a pair of rotary clamping fastener assemblies may be utilized. More particularly, as can best be seen in **FIGURE 6**, each one of the pair of rotary clamping fastener assemblies comprises a pair of mounting blocks 292, 292, which are fixedly mounted upon opposite sides of the lower collector housing portion 279 of the reservoir or hopper 226, and a pair of clamping brackets, only one of which is visible as at 294, mounted upon opposite sides of the distribution manifold 228. Each one of the clamping brackets 294 has a substantially C-shaped cross-sectional configuration, and each one of the mounting blocks 292,292 is internally threaded so as to respectively receive an externally threaded adjustment or tightening screw 296,296.

A rotary or pivotal clamping member 298 is freely rotatably mounted upon each one of the adjustment or tightening screws 296, and accordingly, when the distribution manifold 228 is to be fixedly mounted upon and connected to the lower collector housing portion 279 of the reservoir or hopper 226, the clamping members 298,298 are initially disposed at their unlocked position as illustrated within **FIGURE 6**. The lower collector housing portion 279 of the reservoir or hopper 226, with the mounting blocks 292,292 and the clamping members 298,298 mounted thereon, is then, in effect, moved in a direction parallel to the longitudinal axes of the adjustment or tightening screws 296,296 such that the enlarged portions of the clamping members 298, 298 pass through the C-shaped clamping brackets 294. After effectively clearing the C-shaped clamping brackets 294, the clamping members 298,298 are then rotated or pivoted around the adjustment or tightening screws 296,296 through means of an angular extent of 180°, and subsequently, the adjustment or tightening screws 296,296 are tightened so as to cause the projecting lug portions of the clamping members 298,298 to respectively tightly engage the clamping brackets 294 thereby causing the lower collector housing portion 279 of the reservoir or hopper 226 and the distribution manifold 228 to be tightly engaged with each other.

With reference now being made to **FIGURE 8**, a third embodiment of a new and improved modular system for the delivery of hot melt adhesive or other thermoplastic materials, constructed in accordance with the principles and teachings of the present invention, and similar to the second embodiment modular system 200 as disclosed within **FIGURES 2** and **5**, except as will be noted hereinafter, is disclosed and is generally indicated by the reference character 300. It is to be appreciated that in view of the fact that this third embodiment modular system 300 is similar to the second embodiment modular system 200 as disclosed within **FIGURES 2** and **5**, a detailed discussion of the third embodiment modular system 300 will be omitted for brevity purposes, the disclosure and description of the same being confined substantially to the differences between the second and third embodiment modular systems 200,300. In addition, it is also noted that in view of the similarity between the second and third embodiment modular systems 200,300, component parts of the third embodiment modular system 300 which correspond to component parts of the second embodiment modular system 200 will be designated by corresponding reference characters except that they will be within the 300 series. More particularly, one of the differences between the second and third embodiment modular systems 200,300 resides in the fact that, in accordance with the principles and teachings of the third embodiment modular system 300, the hot melt adhesive or other thermoplastic reservoir tank or hopper, and its operatively associated collector housing portion, as respectively disclosed at 226 and 279 within **FIGURE 5**, have effectively been eliminated, and therefore, in lieu of the modular tank assembly 202, characteristic of the second embodiment modular system 200, the third embodiment modular system 300 comprises a modular pump or supply assembly 303 within which the primary pump 306, and its strainer-filter member 372, are located. Still further, it is also to be appreciated that in accordance with the principles and teachings of the third embodiment modular system 300, the modular metering assembly 304 is fixedly attached directly to, and effectively forms an integral assembly with the modular pump assembly 303, and that the modular tank assembly, not shown, now comprises a separate modular entity which may be located at a location remote from the modular pump assembly. Accordingly, the modularity concepts, inter-changeability of component parts depending upon, or as a function of, the various needs or requirements of the end-user or customer, are therefore enhanced still further.

With reference now being made to **FIGURE 9**, a fourth embodiment of a new and improved modular system for the delivery of hot melt adhesive or other thermoplastic materials, constructed in accordance with the principles and teachings of the present invention, and similar to the first embodiment modular system 100 as disclosed within **FIGURES 1** and **3**, except as will be noted hereinafter, is disclosed and is generally indicated by the reference character 400. It is to be appreciated that in view of the fact that this fourth embodiment modular system 400 is similar to the first embodiment modular system 100 as disclosed within **FIGURES 1** and **3**, a detailed discussion of the fourth embodiment modular system 400 will be omitted for brevity purposes, the disclosure and description of the same being confined substantially to the differences between the fourth and first embodiment modular systems 400,100. In addition, it is also noted that in view of the similarity between the fourth and first embodiment modular systems 400,100, component parts of the fourth embodiment modular system 400 which correspond to component parts of the first embodiment modular system 100 will be designated by corresponding reference characters except that they will be within the 400 series.

More particularly, one of the differences between the fourth and first embodiment modular systems 400,100 resides in the fact that, in accordance with the principles and teachings of the fourth embodiment modular system 400, one or more, or all, of the plurality of metering stations, such as, for example, the metering station 434, which may be similar to the metering station 134 of the first embodiment modular system 100 as disclosed within **FIGURE 3**, can in fact be located externally of, and remote from, the modular metering assembly 404. In connection with the external disposition of the metering station 434 with respect to the modular metering assembly 404, and the distribution manifold disposed internally thereof but not illustrated within **FIGURE 9**, the plurality of metering gear pumps of the other metering stations, disposed internally within the modular metering assembly 404 but also not illustrated within **FIGURE 9**, will function in a manner similar to the metering stations 130,132,136 of the modular metering assembly 104 as illustrated within **FIGURE 3** wherein such internally disposed metering stations of the modular metering assembly 404 will have their fluid outputs respectively fluidically conducted to the fluid supply outlet ports 420 defined within the front wall member 418 of the modular metering assembly 404. In this manner, a plurality of applicator hoses 422 can be respectively fluidically connected to the plurality of fluid supply outlet ports 420 for conducting the hot melt adhesive or other thermoplastic material to applicator heads or the like.

However, since, for example, the metering station 434 is disposed externally of, and remote from, the modular metering assembly 404, the fluid supply outlet ports, which would normally be defined within the front wall member 418 of the modular metering assembly 404 as a result of being respectfully fluidically connected to and associated with the metering gear pump outputs of the metering station 434, are not in fact defined or provided within the front wall member 418 of the modular metering assembly 404, but, to the contrary, the hot melt adhesive or other thermoplastic material will be routed internally within the distribution manifold disposed within the modular metering assembly 404 and outputted to the externally and remotely located metering station 434 from an outlet supply port 421 defined within the front wall member 418 of the modular metering assembly 404 and conducted along a hot melt adhesive or other thermoplastic material fluid supply path 482 which is similar to the hot melt adhesive or other thermoplastic material fluid supply path 182 as disclosed within **FIGURE 3** and which also may be similar in structure to the fluid supply conduit 412. In a similar manner, hot melt adhesive or other thermoplastic material, being conducted from the external, remote metering station 434 back to the modular metering assembly 404 and the distribution manifold disposed therewithin, will be conducted along a hot melt adhesive or other thermoplastic material fluid return path 490 which is similar to the hot melt adhesive or other thermoplastic material fluid return path 190 as disclosed within **FIGURE 3**, for entry into an inlet return port 423 defined within the front wall member 418 of the modular metering assembly 404 so as to be conducted back to the distribution manifold disposed within the modular metering assembly 404, and which may be similar in structure to the fluid return conduit 414.

With reference now being made to **FIGURE 10**, a fifth embodiment of a new and improved modular system for the delivery of hot melt adhesive or other thermoplastic materials, constructed in accordance with the principles and teachings of the present invention, and similar to the first and fourth embodiment modular systems 100,400 as disclosed within **FIGURES 1** and **3**, and **9**, except as will be noted hereinafter, is disclosed and is generally indicated by the reference character 500. It is to be appreciated that in view of the fact that this fifth embodiment modular system

500 is similar to the first and fourth embodiment modular systems 100,400 as disclosed within **FIGURES 1** and **3**, and **9**, a detailed discussion of the fifth embodiment modular system 500 will be omitted for brevity purposes, the disclosure and description of the same being confined substantially to the differences between the fifth and first or fourth embodiment modular systems 500,100,400. In addition, it is also noted that in view of the similarity between the fifth and first or fourth embodiment modular systems 500,100,400, component parts of the fifth embodiment modular system 500 which correspond to component parts of the first or fourth embodiment modular system 100,400 will be designated by corresponding reference characters except that they will be within the 500 series.

More particularly, one of the differences between the fifth and first or fourth embodiment modular systems 500, 100,400 resides in the fact that, in lieu of all of the metering stations 130,132,134,136 being located internally within the modular metering assembly 104 as disclosed within the first embodiment modular system 100 illustrated within **FIGURES 1** and **3**, and in lieu of one or more of the metering stations being located externally of the modular metering assembly 404 as has been disclosed within the fourth embodiment modular system 400 illustrated at 434 in **FIGURE 9**, in accordance with the principles and teachings of the fifth embodiment modular system 500, one or more, but not all, of the metering stations, similar to the metering stations 130,132,136 located internally within the modular metering assembly 104 of the first embodiment modular system 100 disclosed within **FIGURES 1** and **3**, may, for example, be similarly located internally within the modular metering assembly 504, while concomitantly, for example, one or more of the metering stations, similar to the metering station 434 operatively and fluidically connected to the modular metering assembly 404 of the fourth embodiment modular system 400 disclosed within **FIGURE 9**, may effectively be removed from the modular metering assembly 504 and replaced by, for example, a second modular metering assembly 505, which internally houses a second set or array of metering stations, not shown but similar to the first set or array of metering stations 130,132,134,136 disposed internally within the first modular metering assembly 504, such that the first and second modular metering assemblies 504,505 are fluidically connected together in a serial manner.

More specifically, in view of the fact that, for example, the metering station, normally disposed internally within the modular metering assembly 504 and similar to, for example, the metering station 134 or 434, has effectively been replaced by means of the second modular metering assembly 505 which is located externally of, and remote from, the first modular metering assembly 504, the fluid supply outlet ports, which would normally be defined within the front wall member 518 of the first modular metering assembly 504 as a result of being respectfully fluidically connected to and associated with the metering gear pump outputs of the metering station 134 or 434, are not in fact defined or provided within the front wall member 518 of the first modular metering assembly 504, but, to the contrary, the hot melt adhesive or other thermoplastic material will be routed internally within the distribution manifold disposed within the first modular metering assembly 504 and outputted to the externally and remotely located second modular metering assembly 505 from a fluid supply outlet port 509, similar to fluid supply outlet port 508, defined within the front wall member 518 of the first modular metering assembly 504 and conducted along a fluid supply conduit 513 similar to the fluid supply conduit 512. In a similar manner, hot melt adhesive or other thermo-plastic material, being conducted from the second modular metering assembly 505 back to the first modular metering assembly 504 and the distribution manifold disposed therewithin, will be conducted along a fluid return conduit 515, similar to the fluid return conduit 514, for entry into a fluid return inlet port 517, similar to fluid return inlet port 516, also defined within the front wall member 518 of the first modular metering assembly 504 so as to be conducted back to the distribution manifold disposed within the first modular metering assembly 504. Still yet further, it is also to be appreciated that a plurality of fluid supply outlet ports 521, similar to the fluid supply outlet ports 120,420, are defined within the front wall member 519 of the second modular metering assembly 505, and that a plurality of applicator hoses 523, similar to the applicator hoses 122,422, are adapted to be respectively fluidically connected to the plurality of fluid supply outlet ports 521. In this manner, in accordance with the principles and teachings of the fifth embodiment modular system 500 of the present invention, it can be appreciated that a plurality of modular metering assemblies can be serially connected together, disposed at different, remote locations with respect to each other, and in turn, also permit different sets or arrays of metering stations, and their operatively associated applicators or the like, to likewise be located at different, remote locations.

With reference lastly being made to **FIGURES 11-13**, it has been noted hereinbefore that in view of the fact, for example, that the various metering devices or applicator head components may be located at different locations and distances from the relatively high pressure fluid source, then it is to be appreciated that the individual relatively low pressure fluid flows, being conducted toward such remote metering devices or applicator heads, will necessarily require different fluid pressure parameters or values, and furthermore, that such fluid pressure parameters or values will necessarily need to be independently controlled. In accordance then with further principles and teachings of the present invention, a new and improved closed-loop fluid pressure control system, which has been developed for effectively monitoring such relatively low pressure fluid flows and for independently adjusting and controlling the pressure parameters or values thereof so as to in fact maintain the desired fluid pressure levels as may be required, is disclosed within **FIGURE 11** and is generally indicated by the reference character 600. It is to be noted that such closed-loop fluid pressure control system 600 is to be used in conjunction with a modular system, such as, for example, the modular system 100 as disclosed within **FIGURES 1,3**, and **4-4c**, and accordingly, some of the structural components of the closed-loop fluid pressure control system 600, which correspond to the structural components of the modular system 100 have been designated by corresponding reference characters.

More particularly, as illustrated within **FIGURE 11**, the primary pump 106, disposed within the tank module 102, comprises, for example, a piston pump which is adapted to draw fluid from the supply tank or reservoir 126 and to pressurize the same such that the fluid pressure of the drawn fluid, which is to be supplied to the distribution module or manifold 128 by means of the fluid supply conduit 112, is effectively converted from a tank pressure value PT to a relatively high line pressure value PH. In addition, an air-controlled pressure relief valve RV-602 fluidically interconnects the fluid supply conduit 112 and the fluid return conduit 114 so as to effectively relieve pressure within the fluid supply conduit 112, to the fluid return conduit 114, under overpressure conditions, the pressure relief level at which the pressure relief valve RV-602 will open and fluidically connect the fluid supply conduit 112 to the fluid return conduit 114 being controlled or set by means compressed control air fluidically conncted to the pressure relief valve RV-602 by means of a control air inlet port 604. Still further, as has been noted hereinbefore, the distribution module 128 receives high pressure fluid PH from the tank module 102 and is adapted to distribute the same to one or more of the metering devices or applicator heads 130,132,134,136 through means of the fluid supply lines, conduits, or passageways 234,240,236/238,232. However, the high line pressure fluid PH being conducted into the distribution module 128 from the tank module 102 must be independently reduced and controlled to variously different working pressure levels or values P1-P4 for each one the metering devices or applicator heads 130,132,134,136.

Therefore, in accordance with the principles and teachings of the present invention, a plurality of pressure reducing valves PRV1-606,PRV2-608,PRV3-610,PRV4-612 are disposed within the distribution module 128 so as to be respectively fluidically connected to the fluid supply lines, conduits, or passageways 232,234,238,240 and the fluid return conduitsm, lines, or passageways 252,246,250,244. It is specifically emphasized that each one of the plurality of pressure reducing valves PRV1-606,PRV2-608,PRV3-610,PRV4-612 is adapted to be independently operated and adjustably controlled so that the hot melt adhesive or other thermoplastic fluid materials being conducted to each one of the metering devices or applicator heads 136,134,132,130 can have different working pressure values. The pressure reducing valves PRV1-606, PRV2-608,PRV3-610,PRV4-612 are adapted to be controlled by air pressure, and therefore, the fluid pressure settings or working pressure values are directly proportional to the air pressure applied to each one of the pressure reducing valves PRV1-606,PRV2-608,PRV3-610,PRV4-612. Accordingly, it is seen that each one of the plurality of pressure reducing valves PRV1-606,PRV2-608,PRV3-610,PRV4-612 respectively has a variable air pressure transducer IP1-614,IP2-616,IP3-618,IP4-620 operatively associated therewith and fluidically connected thereto by means of control air inlet lines 622,624,626,628, and that the variable air pressure transducers IP1-614, IP2-616,IP3-618,IP4-620 are respectively fluidically connected to a supply air pressure source 630 by means of a fluid line 632 so as to be provided with control air.

Still yet further, each one of the fluid supply or inlet lines, conduits, or passageways 232,238,240,234, respectively leading to the metering devices or applicator heads 136,134,132,130, has a pressure transducer XD1-634,XD2-636,XD3-638,XD4-640 operatively and fluidically connected thereto so as to respectively sense or detect the prevailing working pressure values P1,P2,P3,P4 within the fluid supply or inlet lines, conduits, or passageways 232,238,240,234. In addition, it is seen that the plurality of pressure transducers XD1-634,XD2-636,XD3-638, XD4-640 are respectively operatively connected to a plurality of electronic controllers CTRL1-642,CTRL2-644,CTRL3-646,CTRL4-648 by means of signal lines 650,652,654,656 so as to respectively convey the detected or sensed working pressure values P1,P2,P3,P4 to the electronic controllers CTRL1-642,CTRL2-644,CTRL3-646, CTRL4-648, and in turn, the plurality of electronic controllers CTRL1-642,CTRL2-644,CTRL3-646,CTRL4-648 are adapted to be respectively connected to the plurality of variable air pressure transducers IP1-614,IP2-616,IP3-618,IP4-620 by means of suitable signal lines 658,660,662,664. Yet still further, the plurality of electronic controllers CTRL1-642,CTRL2-644,CTRL3-646,CTRL4-648 are also adapted to be respectively connected to a system controller, comprising, for example, a programmable logic controller PLC-666, by means of signal lines 668,670,672,674.

In this manner, the plurality of pressure transducers XD1-634,XD2-636,XD3-638,XD4-640 will respectively sense or detect the prevailing working pressure values P1,P2,P3,P4 within the fluid supply or inlet lines, conduits, or passageways 232,238,240,234, and signals, corresponding to such working pressure values P1,P2,P3,P4, will be respectively transmitted to the electronic controllers CTRL1-642, CTRL2-644,CTRL3-646,CTRL4-648 by means of the signal lines 650,652,654,656. In turn, the electronic controllers CTRL1-642,CTRL2-644,CTRL3-646,CTRL4-648 will communicate with the programmable logic controller PLC-666, by means of the signal lines 668,670,672,674, which has, for example, the desired or predetermined working pressure values P1,P2,P3,P4 stored therein, and accordingly, suitable signals will be respectively transmitted back from the programmable logic controller PLC-666 to the individual electronic controllers CTRL1-642,CTRL2-644,CTRL3-646,CTRL4-648, by means of the signal lines 668,670,672,674, so that the plurality of electronic controllers CTRL1-642,CTRL2-644,CTRL3-646,CTRL4-

648 can respectively and independently control the plurality of variable air pressure transducers IP1-614,IP2-616,IP3-618,IP4-620 for respectively, individually, and independently controlling the plurality of pressure reducing valves PRV1-606,PRV2-608, PRV3-610,PRV4-612, through means of the plurality of control air inlet lines 622,624,626,628, in order to, in turn, adjust or maintain the working pressure values P1,P2,P3,P4 to or at the desired levels as may be required. Accordingly, by means of the aforenoted closed-loop monitoring system, the various different working pressure values or parameters P1,P2,P3,P4 respectively associated with the metering devices or applicator heads 136,134,132,130 can be independently adjusted and controlled as necessary.

Continuing further, and with reference being made to **FIGURES 12** and **13**, the specific structure characteristic of each one of the plurality of pressure reducing valves PRV1-606,PRV2-608,PRV3-610,PRV4-612 will now be discussed, with pressure reducing valve PRV1-606 being exemplary. More particularly, it is seen that the pressure reducing valve PRV1-606 comprises a cylinder housing 676, and a pressure control piston 678 is adapted to be reciprocally movable within a control air chamber 680 defined within the upper region of the cylinder housing 676. A cylinder cap 682 is fixedly secured within the upper end portion of the cylinder housing 676 by means of a plurality of bolt fasteners 684 in order to close off or define the internal control air chamber 680, and the cylinder cap 682 is provided with an annular O-ring seal member 686 so as to provide fluidic sealing between the cylinder housing 676 and the cylinder cap 682. It is also seen that the cylinder cap 682 is provided with a centrally located control air inlet port 688 so as to admit control air into the control air chamber 680 from the control air inlet Line 622, and it is seen that a piston return spring 690 is interposed between an annular shoulder portion 692 of the cylinder housing 676 and an undersurface portion of the pressure control piston 678 so as to normally bias the pressure control piston 678 in the upward direction against the downwardly oriented biasing force of the control air being conducted into the control air chamber 680 from the control air inlet port 688. The upper end portion of the pressure control piston 678 is provided with an annular seal member 694 so as to provide fluidic sealing between the external annular surface portion of the pressure control piston 678 and the internal peripheral wall surface of the control air chamber 680 defined within the cylinder housing 676, while the lower end portion of the pressure control piston 678 is integrally provided with an axially oriented piston rod or stem 696 which is adapted to be reciprocally guided within a piston bushing member 698 that is fixedly mounted within the cylinder housing 676.

A spool valve body 700 is fixedly mounted within the lower end portion of the cylinder housing 676, and a spool valve 702 is adapted to be reciprocally movable within the spool valve body 700. A spool valve bushing 704 is fixedly mounted within the spool valve body 700 at a substantially axially central portion thereof, and an annular O-ring seal member 706 is disposed within the outer peripheral surface portion of the spool valve bushing 704 so as to fluidically seal the interface defined between the spool valve bushing 704 and the spool valve body 700, while an annular spool seal member 708 is provided upon a lower internal peripheral surface portion of the spool valve bushing 704 so as to fluidically seal the interface defined between the spool valve bushing 704 and the spool valve 702. The lower end portion of the piston rod or stem 696 has a wear button 710 fixedly mounted therewithin so as to provide an operative interface between the piston rod or stem 696 and the upper end portion of the spool valve 702, whereby the piston rod or stem 696, which is fabricated from a relatively softer metal material than that from which the spool valve 702 is fabricated, can effectively be protected, and it is also seen that the spool valve 702 has an annular stop ring 712 mounted upon an upper region thereof. An annular retainer member 714 is fixedly mounted within an upper end portion of the spool valve body 700, and it is seen that the annular retainer member 714 is provided with an internal annular shoulder portion 716.

Accordingly, it can be readily appreciated, when comparing **FIGURES 12** and **13**, that when the spool valve 702 is moved axially downwardly, as a result of control air being conducted into the control air chamber 680, acting upon pressure control piston 678, and thereby forcing spool valve 702 to be disposed at its lowermost axial position as illustrated within **FIGURE 12**, the annular stop ring 712 will engage or be seated upon the upper annular end portion of the spool valve bushing 704, whereas when the spool valve 702 is moved axially upwardly, as a result of a rise in the working pressure P1 disposed within the fluid line fluidically connected to the metering device or applicator head 136, and thereby forcing spool valve 702 to be disposed at its uppermost axial position, as illustrated within **FIGURE 13**, the annular stop ring 712 will engage the internal annular shoulder portion 716 of the annular retainer member 714. It is noted further, in connection with the afore-noted axial lowermost and uppermost positions of the spool valve 702, that the spool valve body 700 is provided with axially spaced lower and upper annular inlet and outlet ports 718,720, and that the lower tubular or hollow portion of the spool valve 702 is similarly provided with axially spaced lower and upper through-ports 722,724 which fluidically communicate with an axially oriented passageway 726 which is defined within the lower tubular or hollow portion of the spool valve 702 and which fluidically communicates with an outlet port 728.

Accordingly, when the spool valve 702 is disposed at its lowermost axial position as illustrated within **FIGURE 12**, upper through-ports 724 will be blocked off, however, lower through-ports 722 will fluidically register or communicate with the lower annular inlet ports 718 of the spool valve body 700 so as to permit incoming hot melt adhesive or other thermoplastic material from fluid supply passageway 232 to enter axially oriented passageway 726 and be conducted to outlet port 728 and on to the metering device or applicator head 236. It can therefore be additionally appreciated that depending upon whether or not the lower through-ports 722 of the spool valve 702 are in full registry, or completely open communication, with the lower annular inlet ports 718 defined within the spool valve body 700, or are only disposed in partial registry or communication with the lower annular inlet ports 718 of the spool valve body 700, which is a function of the axial disposition of the spool valve 702 with respect to the spool valve body 700 as determined by means of the amount of air conducted to the air inlet port 688 from the variable air pressure transducer IP1-614, the pressure of the hot melt adhesive or other thermoplastic material being conducted through the pressure reducing valve PRV1-606, and therefore determining the working pressure of the fluid being conducted toward the metering device or applicator head 136, may be accordingly throttled and varied as may be desired. In a similar manner, when the spool valve 702 is disposed at its uppermost axial position as illustrated within **FIGURE 13**, lower through-ports 722 of the spool valve 702 will effectively be blocked off, however, upper through-ports 724 of the spool valve 702 will fluidically register or communicate with the upper annular inlet ports 720 of the spool valve body 700 so as to permit incoming hot melt adhesive or other thermoplastic material, being returned from the metering device or applicator head 236, to be conducted into the axially oriented passageway 726, through means of the outlet port 728, and to be subsequently conducted to the fluid return passageway 252 for return to the supply tank or reservoir 126.

Thus, it may be seen that in accordance with the principles and teachings of the present invention, a new and improved modular system for the delivery of hot melt adhesive or other thermoplastic materials has been disclosed wherein, for example, a modular metering assembly, having a plurality of hot melt adhesive or other thermoplastic material metering stations contained internally therewithin, is able to be attachably and detachably mounted upon, and operatively and fluidically connected to, a modular hot melt adhesive or other thermoplastic material tank or supply assembly. Alternatively, one or more of the plurality of hot melt adhesive or other thermoplastic material metering stations may be disposed externally of, and yet operatively and fluidically connected in an attachable and detachable manner, to and from the modular metering assembly, and alternatively still further, one or more additional modular metering assemblies may be operatively and fluidically connected, in an attachable and detachable manner, to and from the first or original modular metering assembly. In this manner, the entire modular system exhibits enhanced versatility and flexibility in order to effectively accommodate, or permit implementation of, various or different hot melt adhesive or other thermoplastic material deposition or application procedures that may be required by means of a particular end-user or customer. In addition, there has also been disclosed a closed-loop fluid pressure control system, for independently controlling the pressure of the hot melt adhesive or other thermoplastic material being conveyed to the metering devices, whereby the working pressures of the hot melt adhesive or other thermo-plastic materials being conveyed to each one of the metering devices can have different working pressure values as may be required.

Obviously, many variations and modifications of the present invention are possible in light of the above teachings. More particularly, various structural permutations and combinations of the various system components, as have been disclosed and illustrated within the aforenoted drawing figures, are also possible. For example, while all of the metering stations 130,132,134,136 of the modular metering assembly 104 have been disclosed as being located internally within its modular metering assembly 104 in accordance with the principles and teachings of the first embodiment modular system 100 as illustrated within **FIGURES 1** and **3**, while one or more of the metering stations, such as, for example, the metering station 434 of the modular metering assembly 404, have been disclosed as being located externally of its modular metering assembly 404 in accordance with the principles and teachings of the fourth embodiment modular system 400 as illustrated within **FIGURE 9**, and while one or more of the metering stations located internally within the modular metering assembly 504 have, in effect, been removed from the modular metering assembly 504 and have, in effect, been replaced by means of the second modular metering assembly 505, it can be further appreciated or envisioned that one or more of the metering stations of a particular modular metering assembly can be located externally of such particular modular metering assembly while in addition, one or more of the other metering stations of such particular modular metering assembly can be removed from the particular modular metering assembly and be replaced by means of another serially connected modular metering assembly. It is therefore to be understood that within the scope of the appended claims, the present invention may be practiced otherwise than as specifically described herein.

WHAT IS CLAIMED IS:

1. A pressure control system for a fluid flow system, comprising:

a fluid supply source for housing a supply of fluid to be conducted to a plurality of devices;

a plurality of devices for receiving said fluid from said fluid supply source;

first means for outputting said fluid from said fluid supply source toward said plurality of devices at a predetermined high line pressure value; and

second means fluidically interposed between said first means and said plurality of devices for respectively and independently adjusting the pressure level of said fluid from said fluid supply source, characterized by said predetermined high line pressure value, to predetermined lower working pressure values such that said fluid conducted to each one of said plurality of devices may have a different lower working pressure value as may be required.

2. The fluid pressure control system as set forth in Claim 1, wherein:

said first means for outputting said fluid from said fluid supply source comprises a piston pump; and

said second means fluidically interposed between said piston pump and said plurality of devices comprises a plurality of pressure reducing valves.

3. The fluid pressure control system as set forth in Claim 2, wherein:

each one of said pressure reducing valves comprises a spool valve member for controlling the flow of said fluid from said fluid supply source to a respective one of said plurality of devices so as to effectively throttle the flow of said fluid from said fluid supply source to said respective one of said plurality of devices and thereby variably adjust said predetermined high line pressure value to said predetermined lower working pressure values.

4. The fluid pressure control system as set forth in Claim 3, further comprising:

a cylinder defined within each one of said pressure reducing valves;

a piston disposed within each cylinder of each one of said pressure reducing valves and respectively operatively connected to said spool valve member of each one of said pressure reducing valves;

a control air chamber defined within each one of said cylinders of each one of said pressure reducing valves; and

control air supply means fluidically connected to said control air chamber of each one of said pressure reducing valves for supplying control air into each one of said control air chambers in order to control the disposition of each one of said pistons within each one of said cylinders and, in turn, the disposition of each one of said spool valve members within each one of said pressure reducing valves so as to adjustably control said predetermined high line pressure value to said predetermined lower working pressure values being fluidically conducted to each one of said plurality of devices.

5. The fluid pressure control system as set forth in Claim 4, further comprising:

a plurality of air pressure transducers respectively interposed between said control air supply means and individual ones of said pressure reducing valves so as to respectively control the input of said control air into each one of said control air chambers of said cylinders of said pressure reducing valves.

6. The fluid pressure control system as set forth in Claim 5, further comprising:

a plurality of pressure transducers respectively connected to fluid flow lines, respectively fluidically interconnecting said plurality of pressure reducing valves to said plurality of devices, for detecting said working pressure values characteristic of said fluids respectively conducted through said fluid flow lines respectively fluidically interconnecting said plurality of pressure reducing valves to said plurality of devices.

7. The fluid pressure control system as set forth in Claim 6, further comprising:

a plurality of electronic controllers respectively interposed between said plurality of air pressure transducers and said pressure transducers for controlling said air pressure transducers so as to, in turn, control said pressure reducing valves, in response to said working pressure values, characteristic of said fluids respectively conducted through said fluid flow lines respectively fluidically interconnecting said plurality of pressure reducing valves to said plurality of devices, detected by said plurality of pressure transducers.

8. The fluid pressure control system as set forth in Claim 7, further comprising:

a programmable logic controller (PLC) for receiving first signals from said plurality of electronic controllers, indicative of said working pressure values, respectively characteristic of said fluids respectively conducted through said fluid flow lines respectively fluidically interconnecting said plurality of pressure reducing valves to said plurality of devices, as detected by said plurality of pressure transducers, and for sending second signals back to said plurality of electronic controllers so that said plurality of electronic controllers can respectively control said plurality of air pressure transducers in order to control the input of said control air into each one of said control air chambers of said cylinders of said pressure reducing valves so as to maintain said working pressure values, respectively characteristic of said fluids respectively conducted through said fluid flow lines respectively fluidically interconnecting said plurality of pressure reducing valves to said plurality of devices, at predeterminedly desired values.

9. The fluid pressure control system as set forth in Claim 7, wherein:

said plurality of pressure reducing valves, said plurality of pressure transducers, said plurality of air pressure transducers, said plurality of electronic controllers, and said programmable logic controller (PLC) together comprise a closed-loop pressure control system.

10. The fluid pressure control system as set forth in Claim 1, wherein:

said plurality of devices comprises a plurality of fluid metering stations.

11. The fluid pressure control system as set forth in Claim 1, wherein:

said plurality of devices comprises a plurality of applicator heads.

12. The fluid pressure control system as set forth in Claim 1, wherein:

said fluid pressure control system comprises a system for controlling the flow of hot melt adhesive toward said plurality of devices.

13. A method for independently controlling the working pressures within fluid lines interconnecting a supply of fluid to be conducted to a plurality of devices, comprising the steps of:

providing a fluid supply source for housing a supply of fluid to be conducted to a plurality of devices;

providing a plurality of devices for receiving said fluid from said fluid supply source;

outputting said fluid from said fluid supply source toward said plurality of devices at a predetermined high line pressure value; and

respectively interposing pressure reducing devices between said fluid supply source and said plurality of devices for respectively and independently adjusting the pressure level of said fluid from said fluid supply source, characterized by said predetermined high line pressure value, to pre-determined lower working pressure values such that said fluid conducted to each one of said plurality of devices may have a different lower working pressure value as may be required.

14. The method as set forth in Claim 13, further comprising the steps of:

utilizing a piston pump as said fluid supply source; and

utilizing a plurality of pressure reducing valves for respectively and independently adjusting the pressure level of said fluid from said fluid supply source, characterized by said predetermined high line pressure value, to said predetermined lower working pressure values such that said fluid conducted to each one of said plurality of devices may have a different lower working pressure value as may be required.

15. The method as set forth in Claim 14, further comprising the step of:

providing a spool member within each one of said pressure reducing valves for controlling the flow of said fluid from said fluid supply source to a respective one of said plurality of devices so as to effectively throttle the flow of said fluid from said fluid supply source to said respective one of said plurality of devices and thereby variably adjust said predetermined high line pressure value to said predetermined lower working pressure values.

16. The method as set forth in Claim 15, further comprising the steps of:

providing a cylinder within each one of said pressure reducing valves;

movably disposing a piston within each cylinder of each one of said pressure reducing valves such that each one of said pistons is respectively operatively connected to one of said spool valve members disposed within each one of said pressure reducing valves;

defining a control air chamber within each one of said cylinders of each one of said pressure reducing valves; and

fluidically connecting a control air supply to said control air chamber of each one of said pressure reducing valves for supplying control air into each one of said control air chambers in order to control the disposition of each one of said pistons within each one of said cylinders and, in turn, the disposition of each one of said spool valve members within each one of said pressure reducing valves so as to adjustably control said predetermined high line pressure value to said predetermined lower working pressure values being fluidically conducted to each one of said plurality of devices.

17. The method as set forth in Claim 16, further comprising the step of:

respectively interposing a plurality of air pressure transducers between said control air supply and individual ones of said pressure reducing valves so as to respectively control the input of said control air into each one of said control air chambers of said cylinders of said pressure reducing valves.

18. The method as set forth in Claim 17, further comprising the step of:

respectively connecting a plurality of pressure transducers to fluid flow lines, respectively fluidically interconnecting said plurality of pressure reducing valves to said plurality of devices, for detecting said working pressure values characteristic of said fluids respectively conducted through said fluid flow lines respectively fluidically interconnecting said plurality of pressure reducing valves to said plurality of devices.

19. The method as set forth in Claim 18, further comprising the step of:

respectively interposing a plurality of electronic controllers between said plurality of air pressure transducers and said pressure transducers for controlling said air pressure transducers so as to, in turn, control said pressure reducing valves, in response to said working pressure values, characteristic of said fluids respectively conducted through said fluid flow lines respectively fluidically interconnecting said plurality of pressure reducing valves to said plurality of devices, detected by said plurality of pressure transducers.

20. The method as set forth in Claim 19, further comprising the steps of:

utilizing a programmable logic controller (PLC) for receiving first signals from said plurality of electronic controllers, indicative of said working pressure values, respectively characteristic of said fluids respectively conducted through said fluid flow lines respectively fluidically interconnecting said plurality of pressure reducing valves to said plurality of devices, as detected by said plurality of pressure transducers; and utilizing said programmable logic controller (PLC)for sending second signals back to said plurality of electronic controllers so that said plurality of electronic controllers can respectively control said plurality of air pressure transducers in order to control the input of said control air into each one of said control air chambers of said cylinders of said pressure reducing valves so as to maintain said working pressure values, respectively characteristic of said fluids respectively conducted through said fluid flow lines respectively fluidically interconnecting said plurality of pressure reducing valves to said plurality of devices, at predeterminedly desired values.

21. The method as set forth in Claim 20, further comprising the step of:

operatively interconnecting said plurality of pressure reducing valves, said plurality of pressure transducers, said plurality of air pressure transducers, said plurality of electronic controllers, and said programmable logic controller (PLC) together so as to comprise a closed-loop pressure control system.

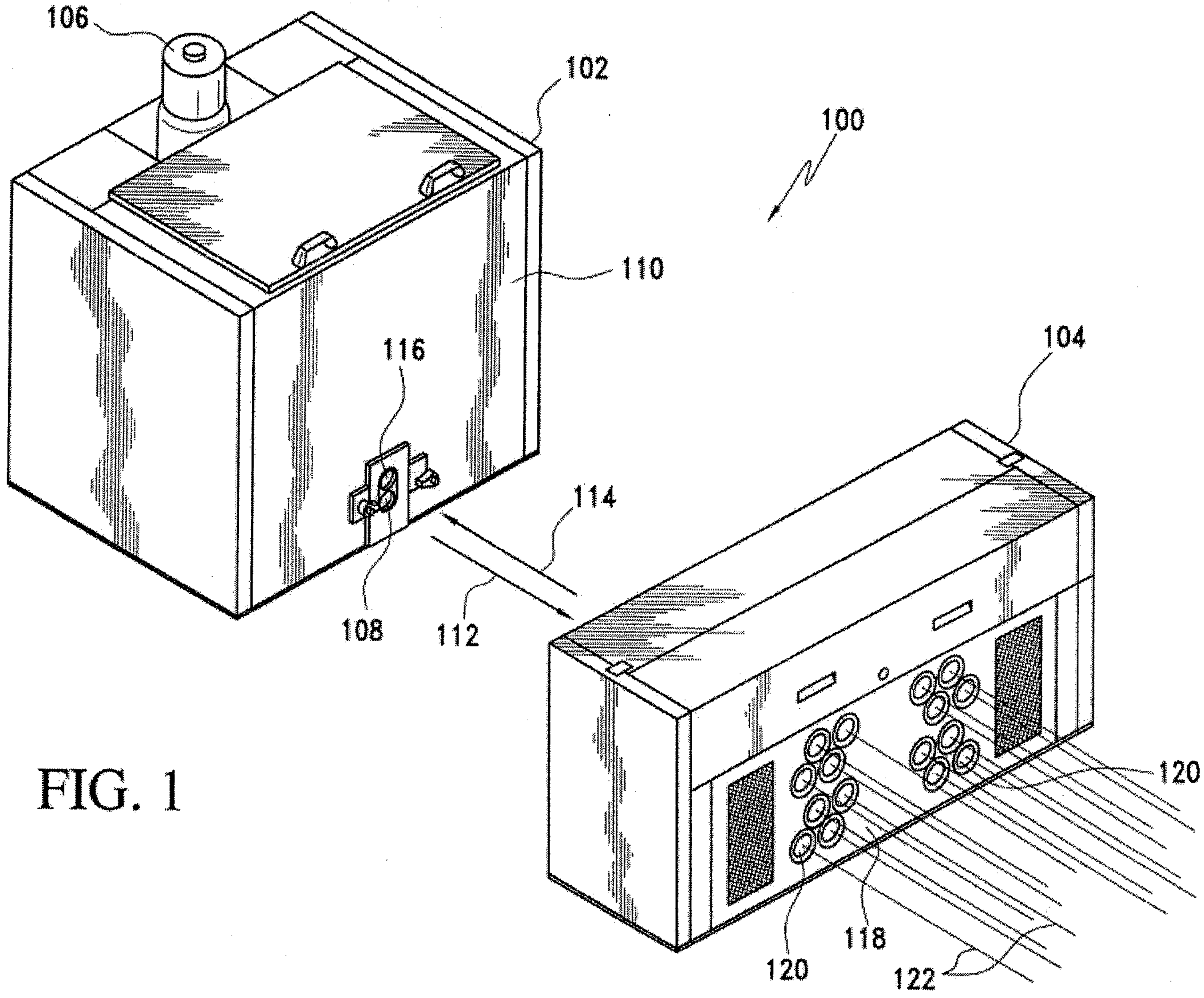

FIG. 1

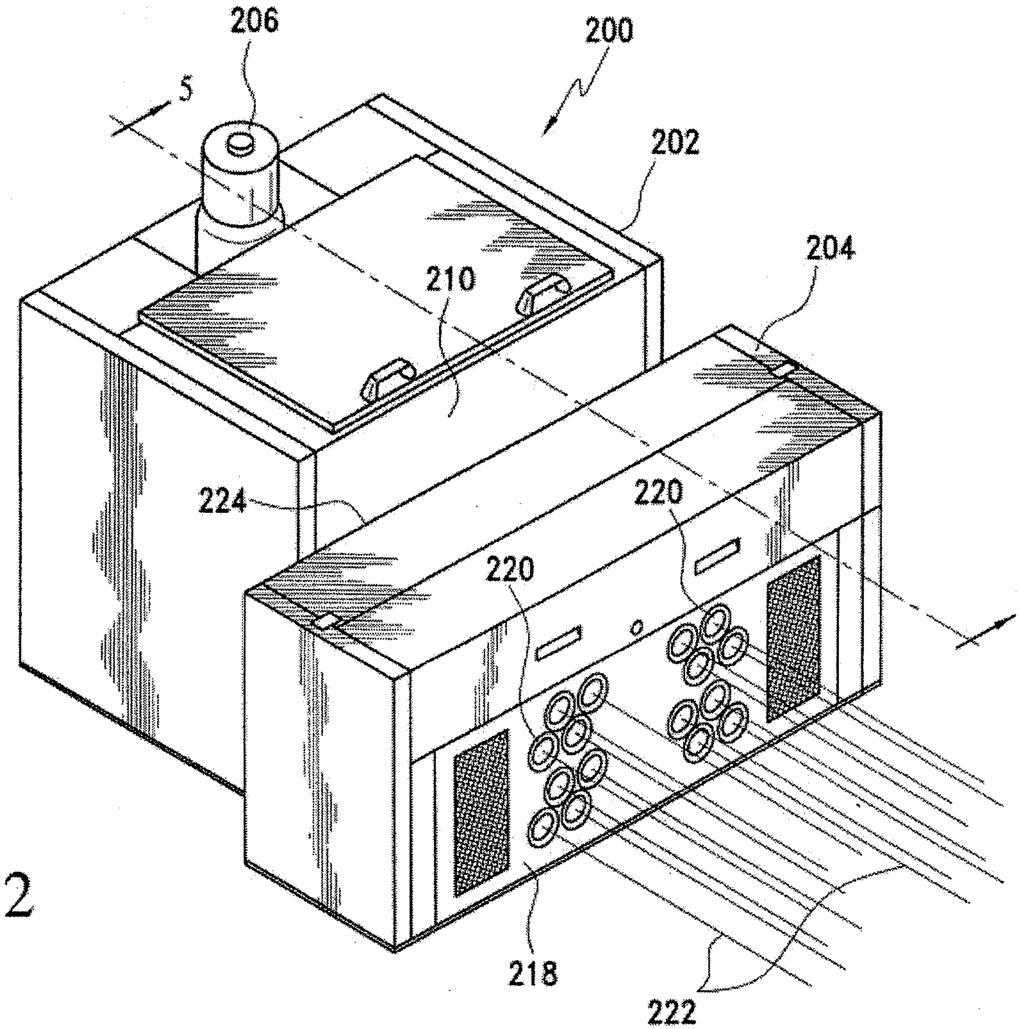

FIG. 2

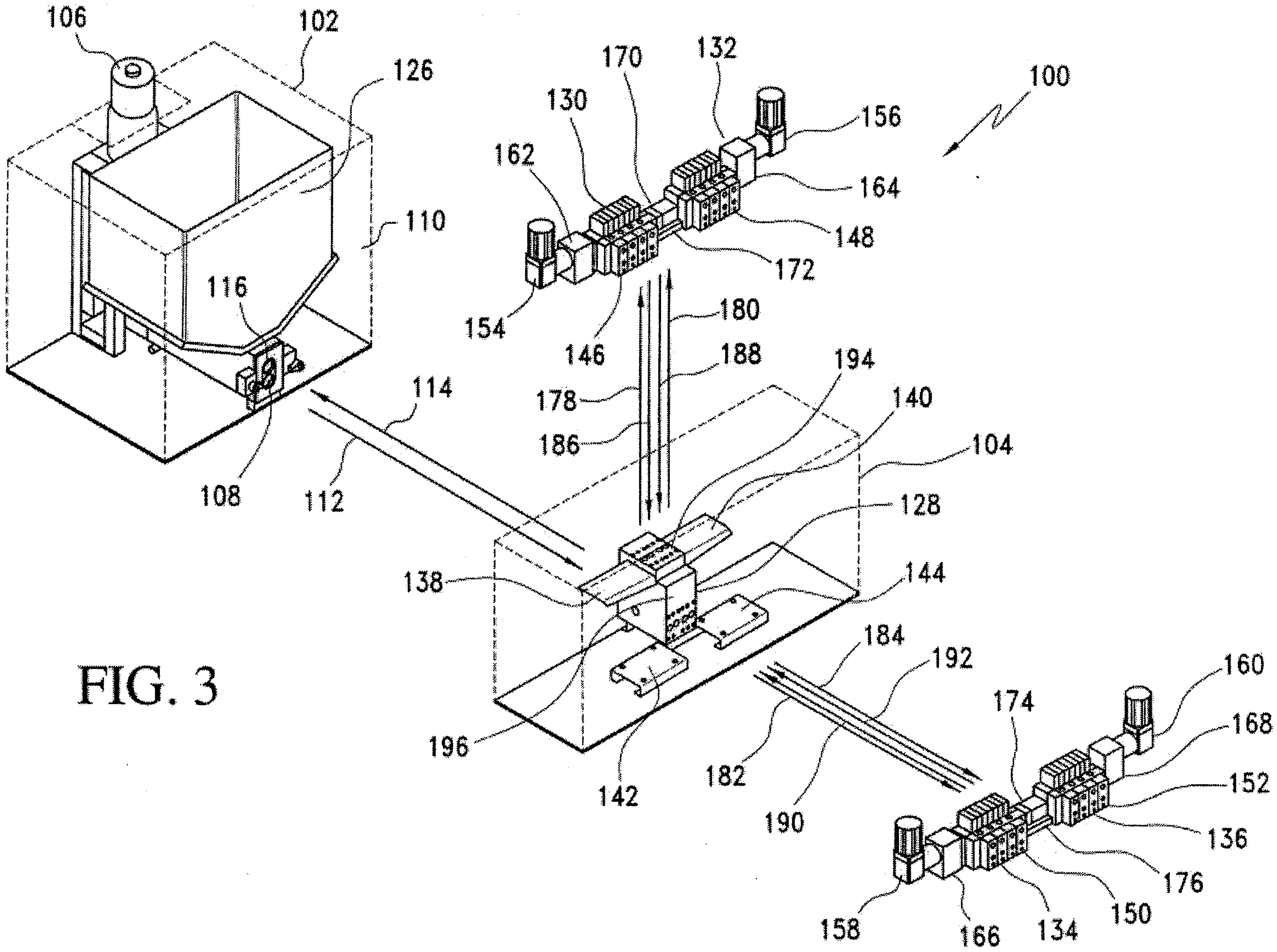
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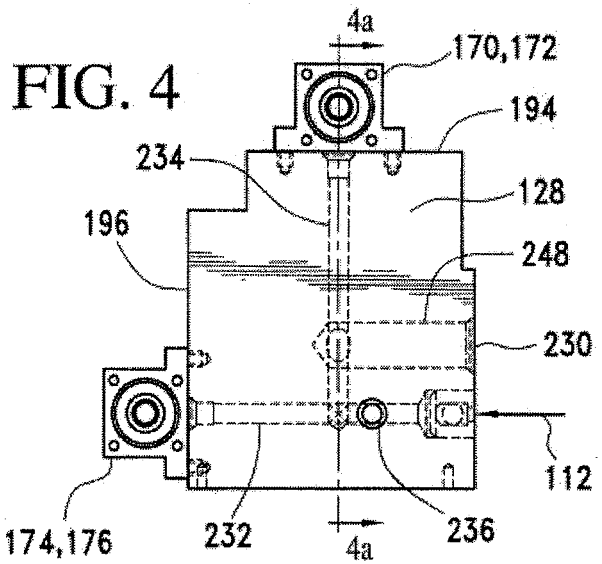
FIG. 3

FIG. 4



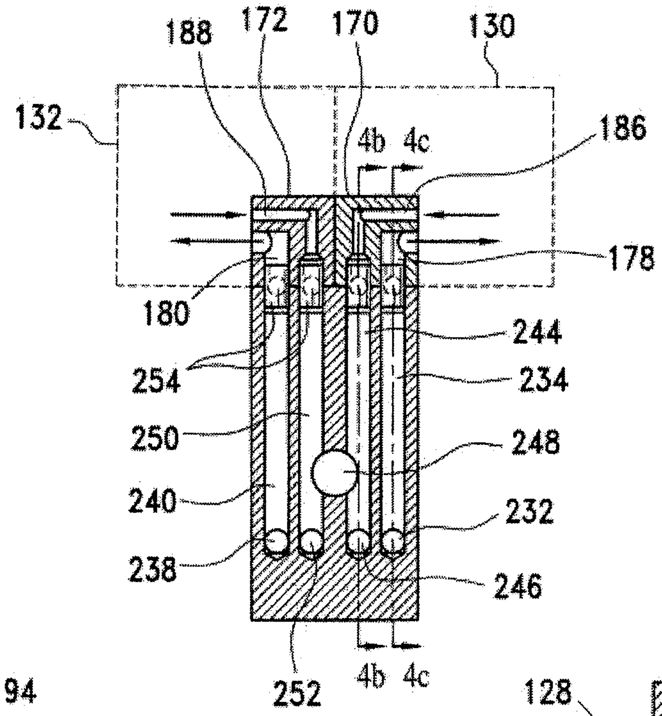


FIG. 4a

FIG. 4b

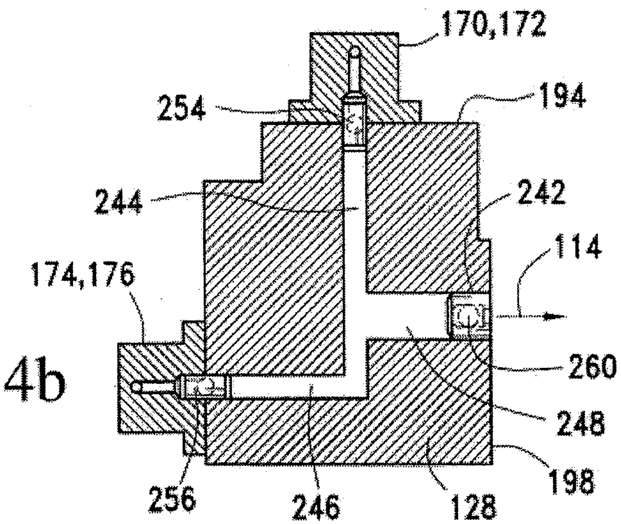


FIG. 4c

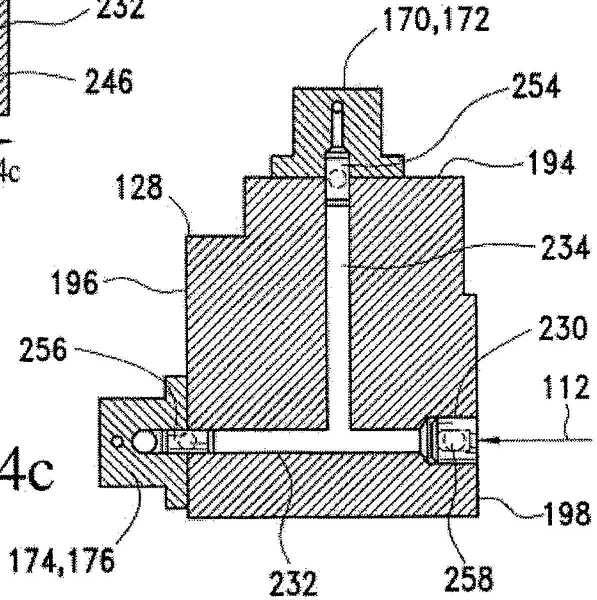


FIG. 5

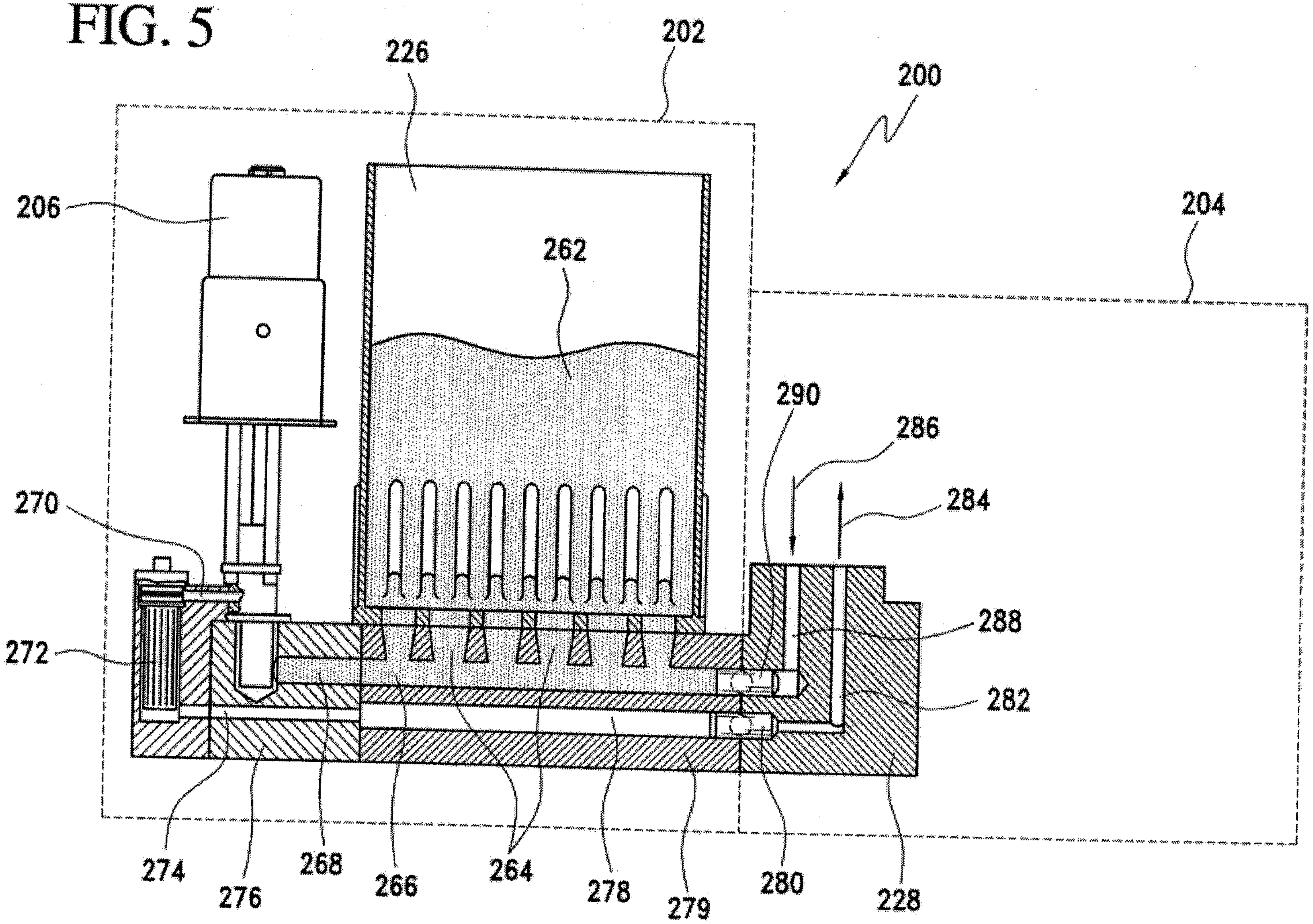

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FIG. 6

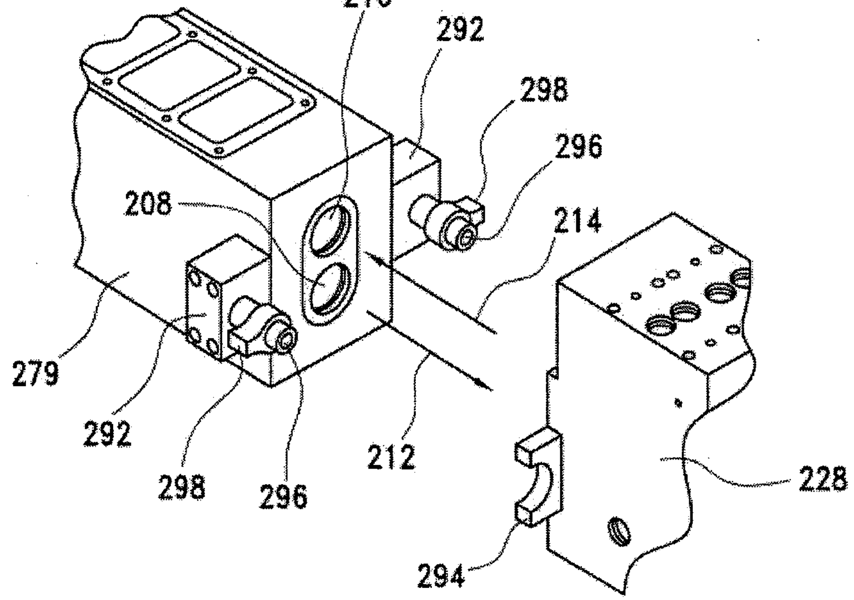
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FIG. 7

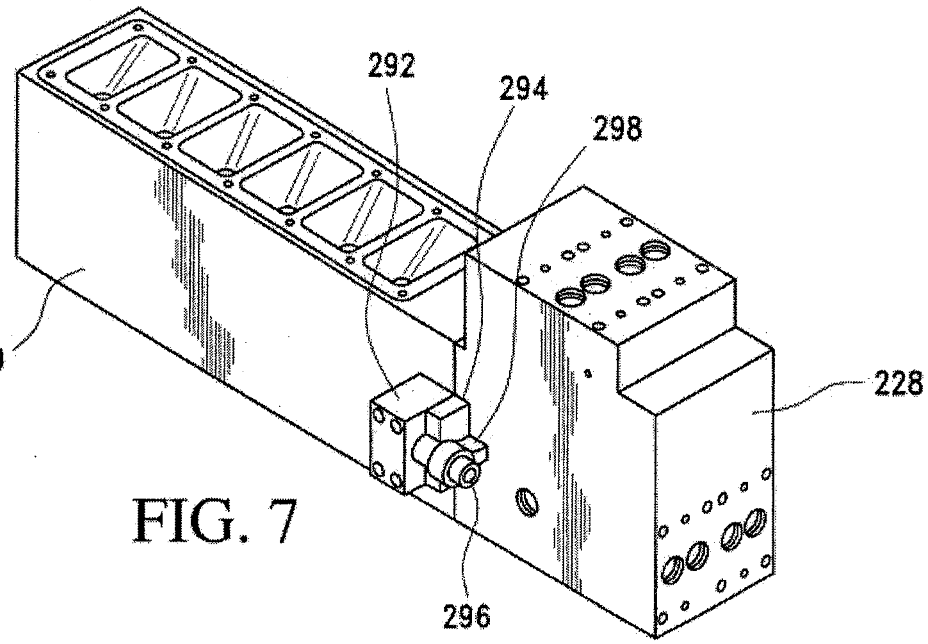
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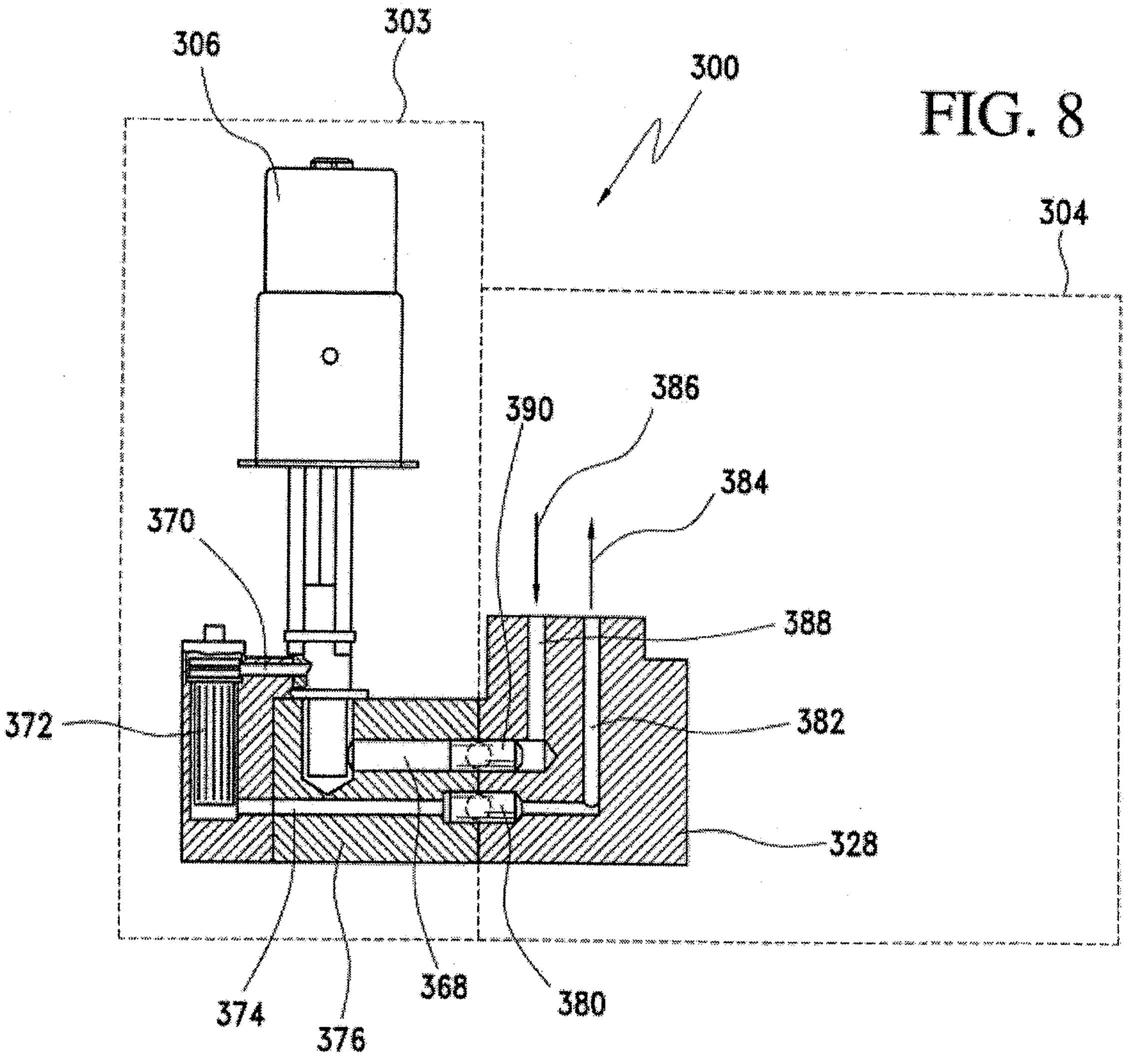
FIG. 8



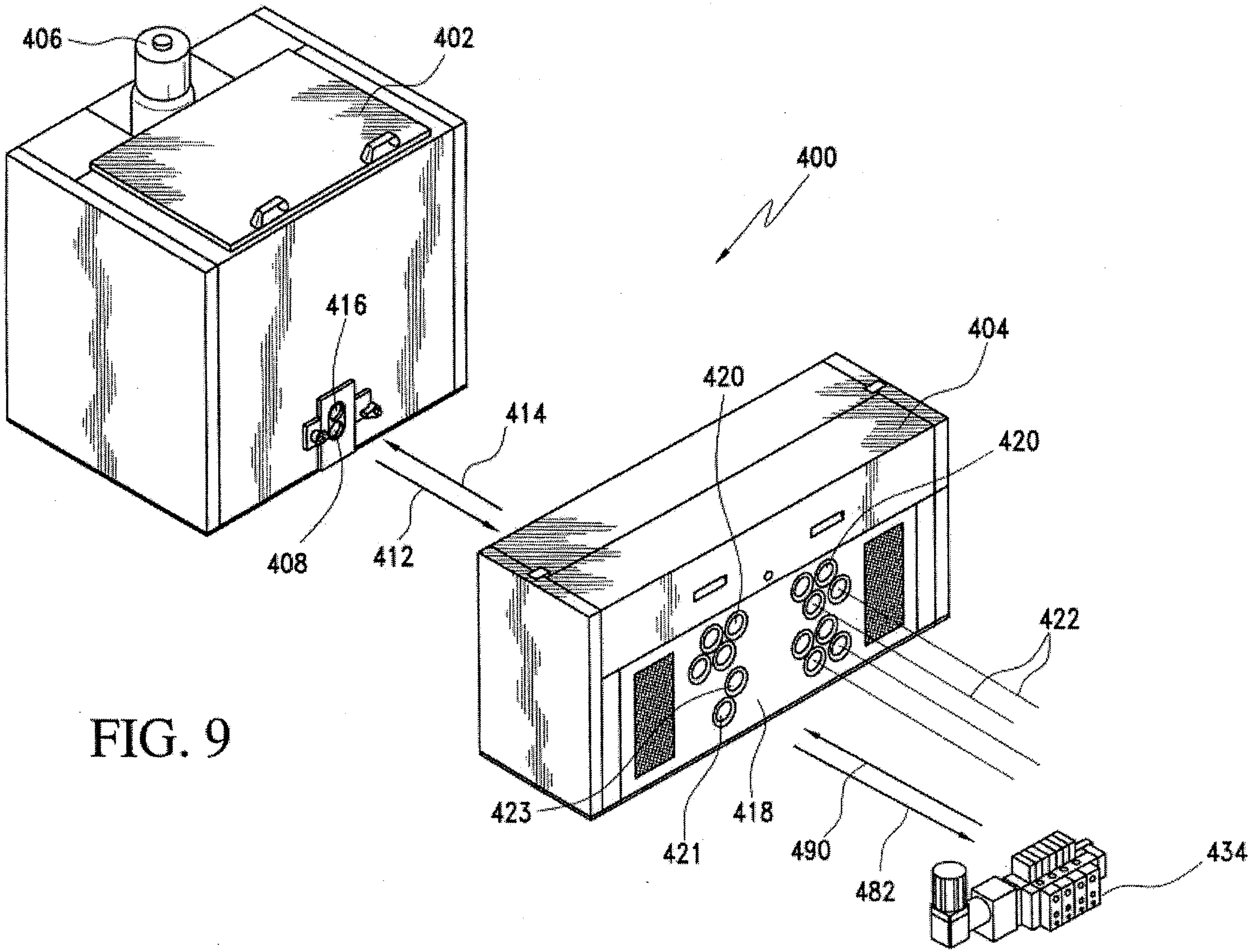

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FIG. 9

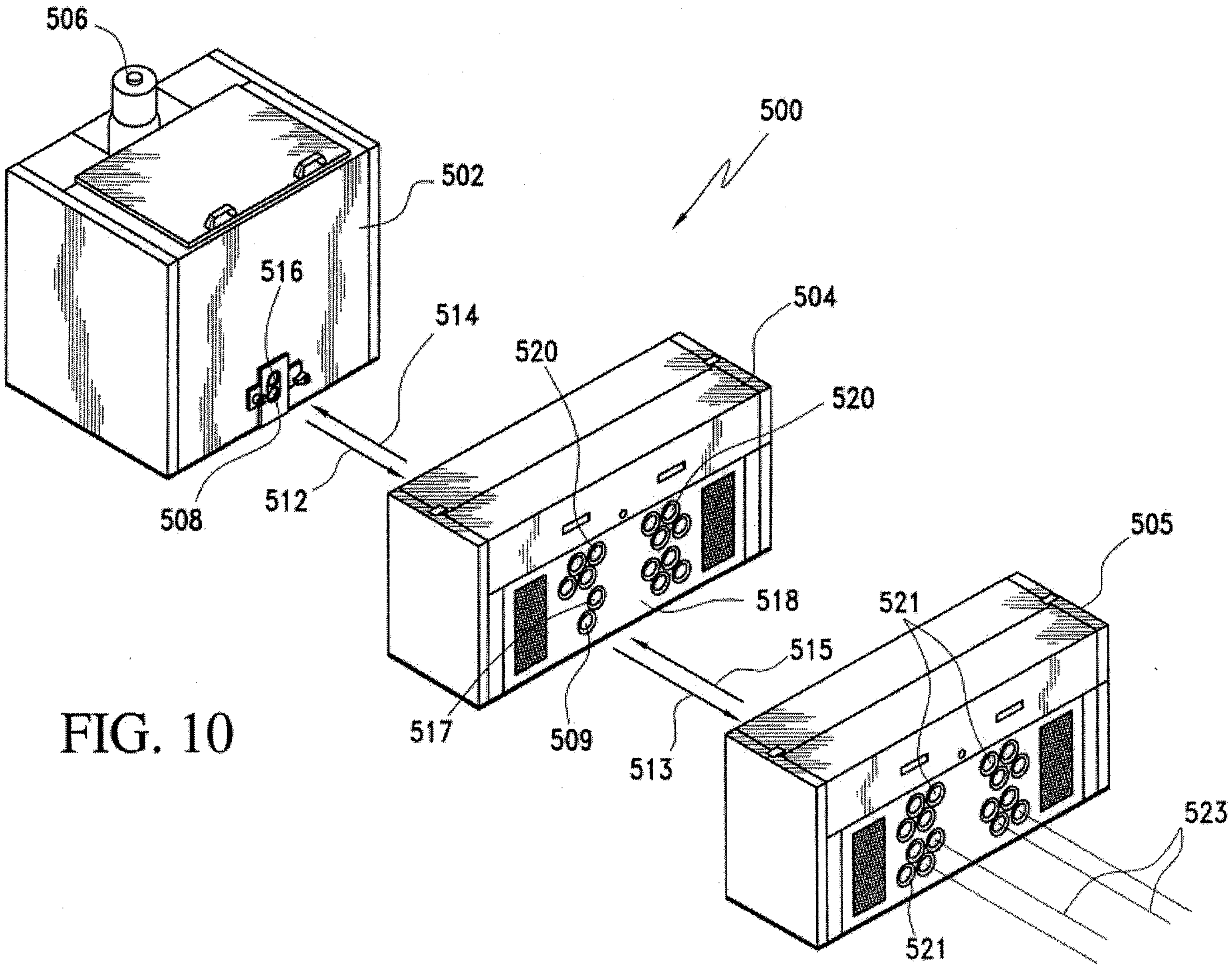
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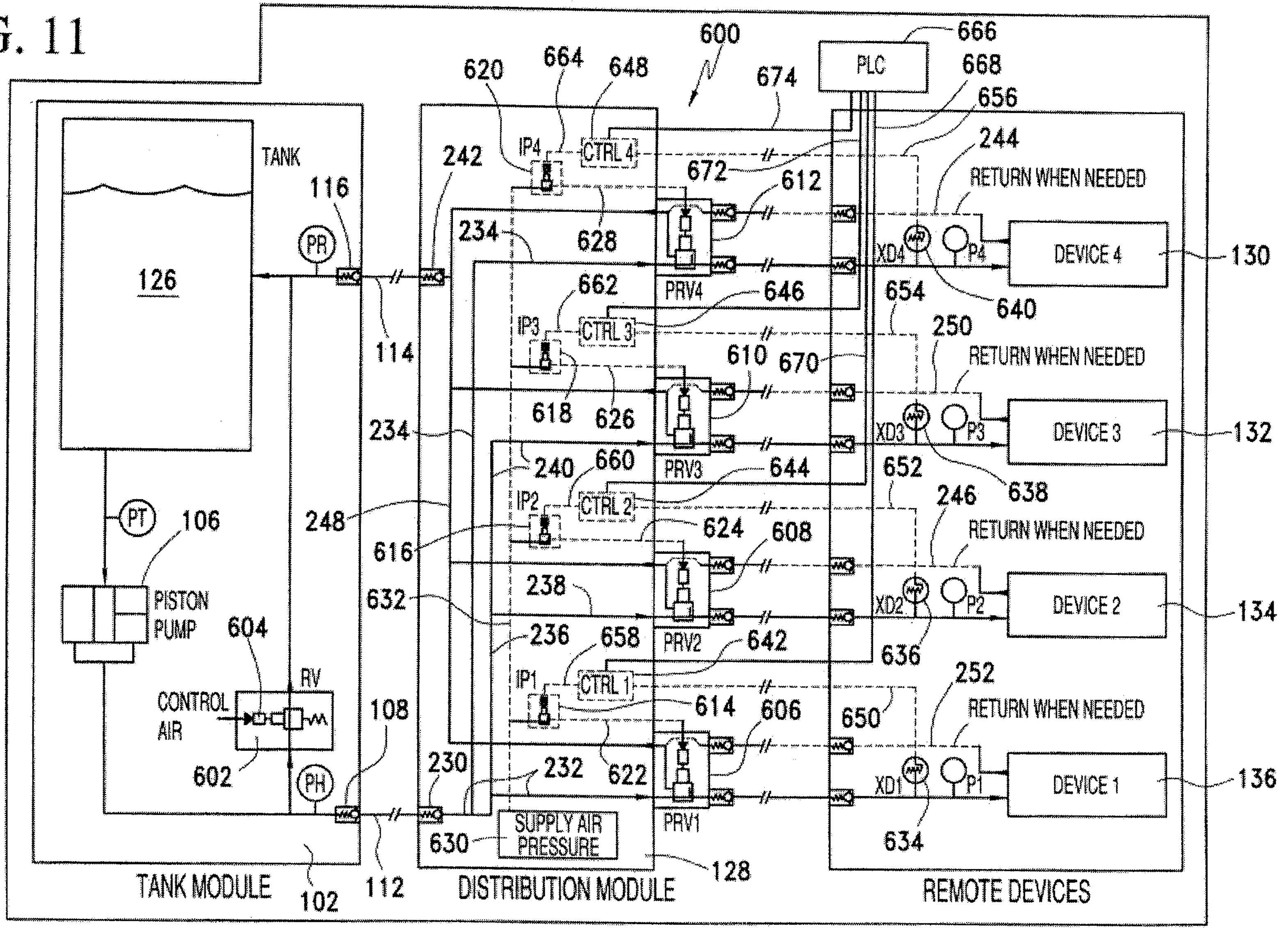
FIG. 10

FIG. 11



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REMOTE DEVICES

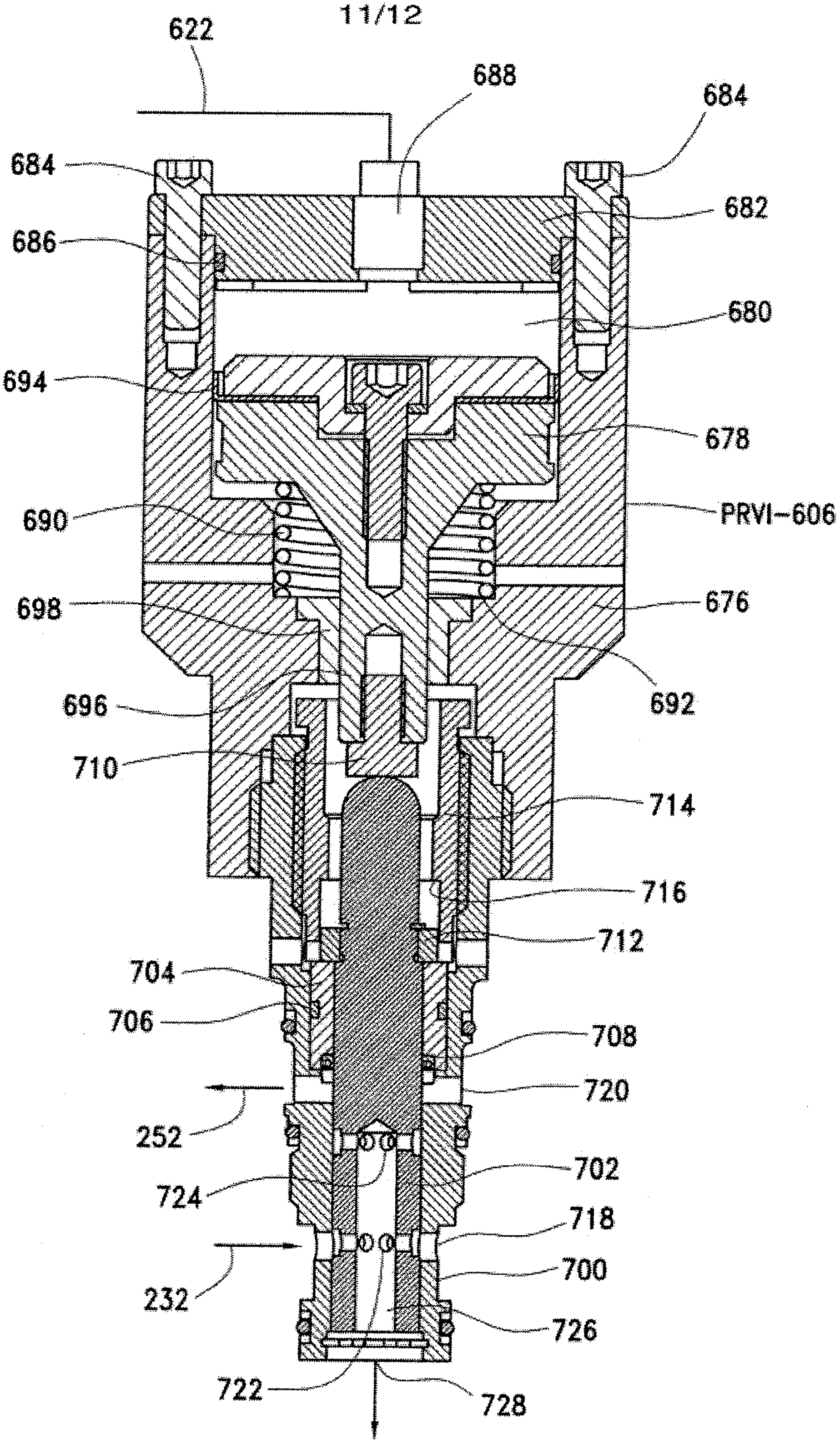

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FIG. 12

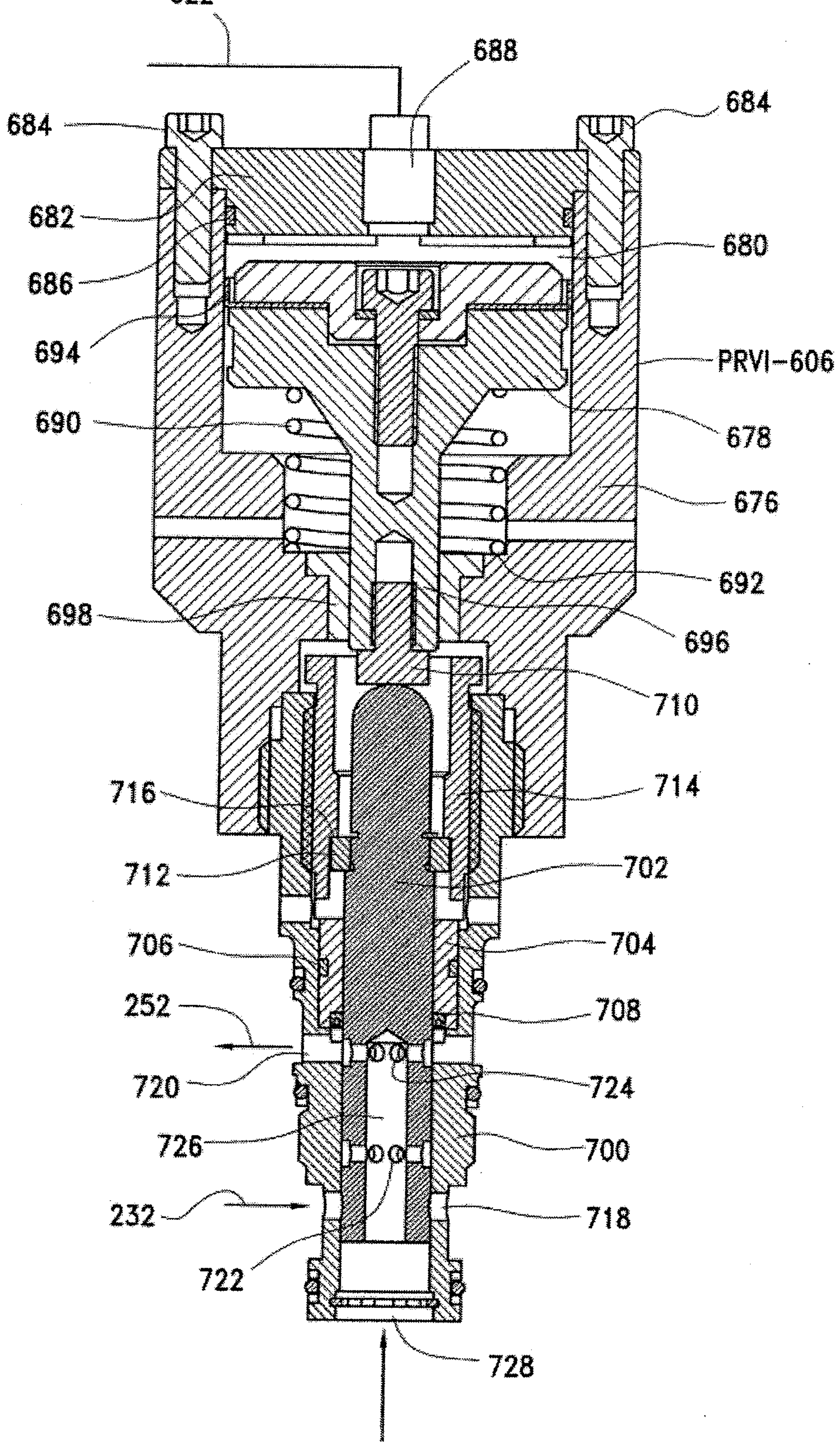
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FIG. 13

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2008/052921

A. CLASSIFICATION OF SUBJECT MATTER
INV. B65B51/02 B05C11/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B65B B05C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 437 303 A (FOCKE & CO [DE]) 14 July 2004 (2004-07-14) the whole document -----	1,13

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 June 2008	02/07/2008

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Eberwein, Michael

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2008/052921

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EP 1437303 A	14-07-2004	BR 0400103 A	28-12-2004
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