United States Patent

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[54] **FLUIDICS PLUG-IN MODULE DEVICE**
1 Claim, 7 Drawing Figs.

[52] **U.S. Cl.** **137/269,** 137/608, 137/81.5, 285/137, 285/304, 285/325, 340/365
[51] **Int. Cl.** **F16k 11/06,** F16l 39/04
[50] **Field of Search** 285/1, 25–29, 131, 137, 304, 305, 325; 137/269, 271, 608; 340/365

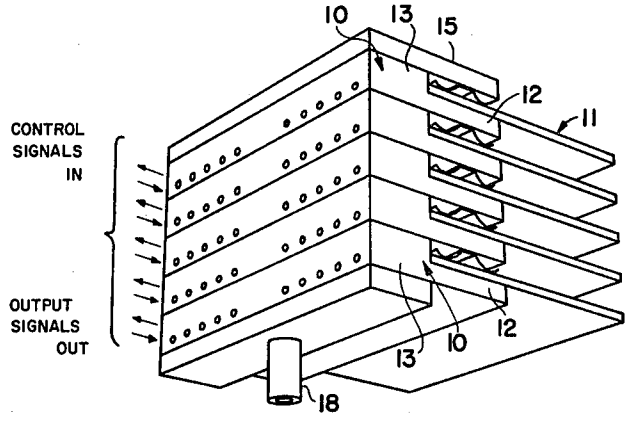
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ABSTRACT: Fluidics coupling means in the form of module manifold means for plug-in assembly with fluid circuit board(s). The coupling means also provides fluid supply plug-in, and lends itself to dense fluidic packaging with plug-in means for integrated fluidic circuits.



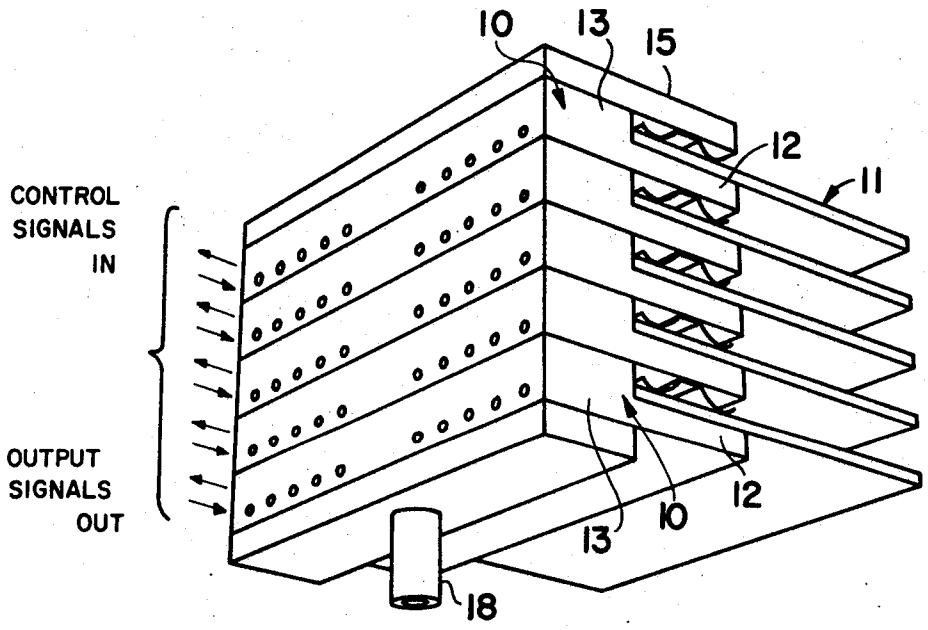


FIG. 1

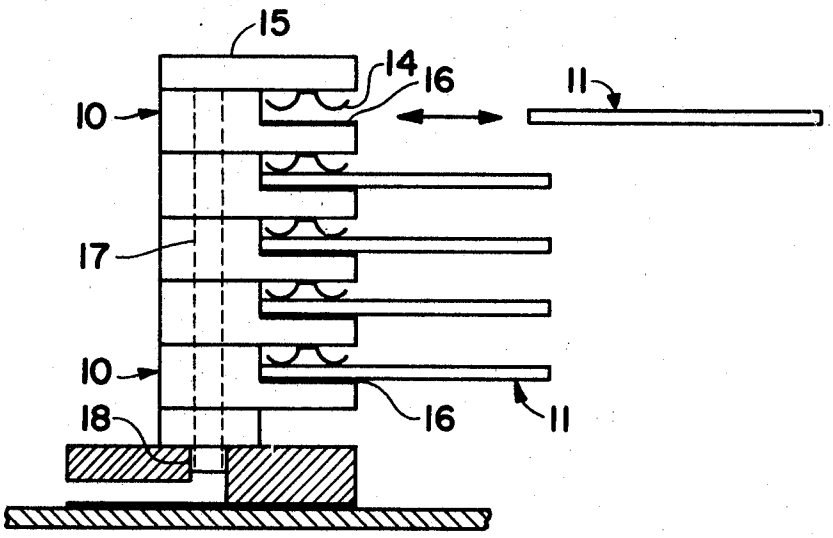


FIG. 2

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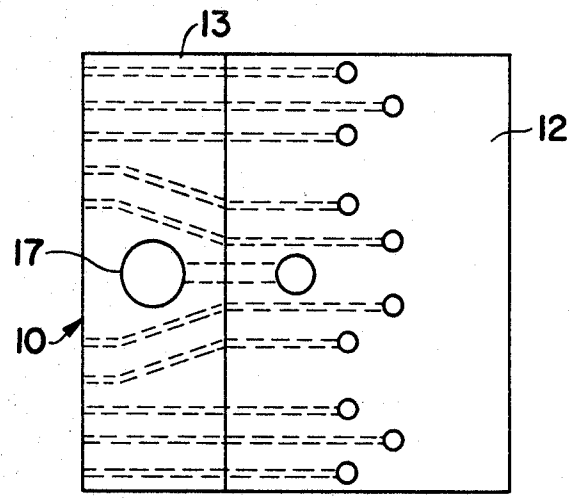


FIG. 3

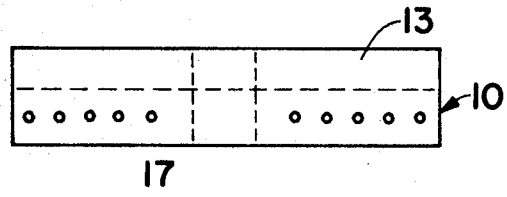


FIG. 4

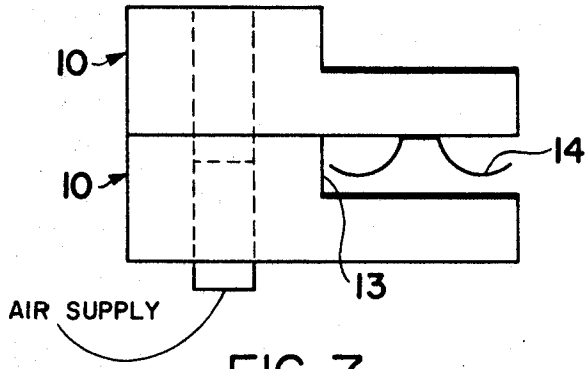


FIG. 7

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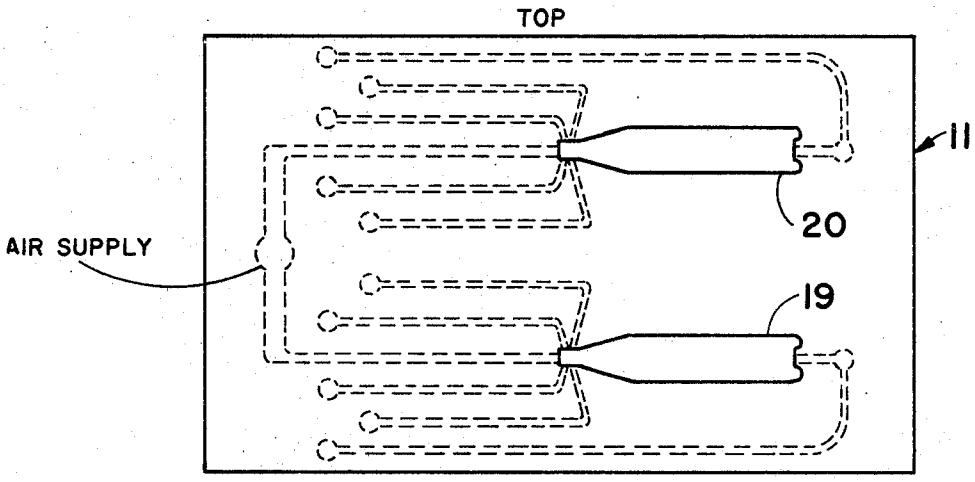


FIG. 5

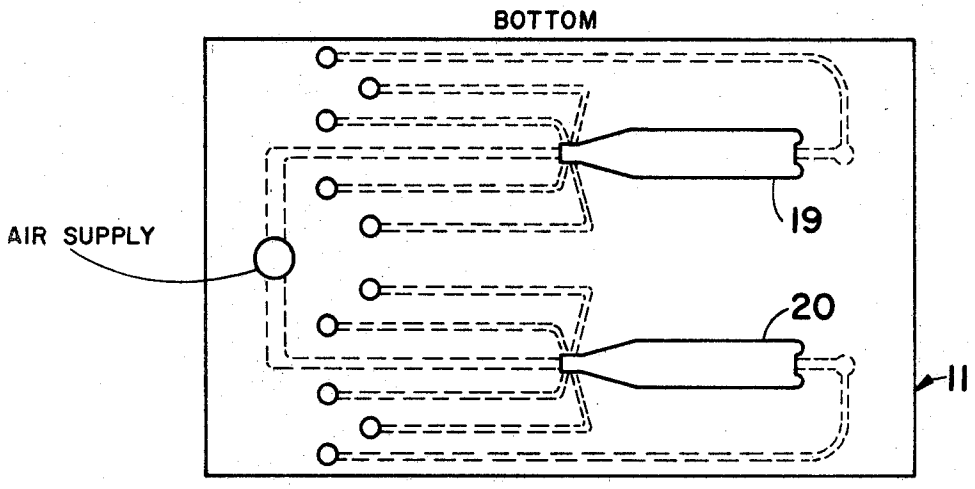


FIG. 6

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FLUIDICS PLUG-IN MODULE DEVICE

This invention relates to fluidics systems, and has particular reference to means for mounting and connecting units or subsystems into layer units or systems.

Fluidics systems involve the use of fluid streams or pressures, in interaction with each other, for purposes such as operation and control. They may be powered (fluid) systems, or passive systems, or combinations of these. They may be entirely fluid, without moving parts, or may be in combination with moving part devices such as mechanical or electrical devices.

In any case, fluidics systems are of substantial importance in industry today. With the increasing complexity of industrial situations and processes, fluidics systems are necessarily increasingly complex, varied in application and often bulky. It is therefore important to provide ways, and means of providing flexibility of design and construction in setting up systems in the great varieties that are needed. It becomes necessary, further, to provide systems which lend themselves to dense fluidic packaging for fluidic systems which by their small-sized unitary combinations may be considered as integrated fluidic circuits.

This invention provides means for meeting these needs in the form of fluidic system module assemblies. As an example, fluidic manifolds are stacked into a single module assembly, and fluid circuit boards are individually plug-in mounted on respective ones of the manifolds. Thus, fluid circuits can be interchanged by simple plug-in technique, and module assemblies can comprise varied numbers of manifold units in stack formation, with the entire stack, when desired, in plug-in relation with a single fluid power supply.

The manifold may be supported in the stack by a mounting support plug-in arrangement of each manifold with its next adjacent manifold. Further, a single fluid power supply may be used with a common passage to all manifolds.

Such module stack assemblies may be used in groups of stacks, connected according to the particular application. Any form of analog or digital system, unit, or combination may be established, according to the desired control or operation function.

Although not specifically shown herein, module stack assemblies may be connected in abutting, passage direct connecting relation where desired, and suitable plug-in mounting and support connections may be provided between such module stack assemblies.

This invention therefore lends itself to dense fluidic packaging of integrated fluidic circuits, with ready and simple plug-in means for interchange of parts or units, and simple structure of varied or complicated fluidic system designs.

FIGURE 1 is a perspective showing of a fluidics module assembly according to this invention;

FIGURE 2 is a side elevation presentation of the structure of **FIGURE** 1, illustrating fluid supply therefor, and showing a circuit board ready for plug-in;

FIGURE 3 is a plan view of a manifold taken from the structure of **FIGURES** 1 and 2;

FIGURE 4 is a left-end view of the manifold of **FIGURE** 3;

FIGURE 5 is a plan view of one example of a plug-in fluidic circuit board such as those in **FIGURES** 1 and 2;

FIGURE 6 is a bottom view of the circuit board of **FIGURE** 5; and

FIGURE 7 is an illustration of one form of assembly means between the manifold of **FIGURES** 1 and 2, and of the plug-in of the module as a whole into a fluid supply.

The illustrative embodiment of this invention set forth in the drawing is shown in assembly in **FIGURES** 1 and 2. This assembly is called a module, and comprises a stack of subassemblies, each made up of a manifold unit **10** and a fluidic system circuit board **11**, these in plug-in assembly relation with each other.

Each manifold, see also **FIGURES** 3 and 4, comprises a step portion **12** with a step riser body **13** across one end thereof. Thus, in the stack assembly the step riser bodies are placed one on the other, leaving a substantial vertical spacing between the step portions of vertically abutting manifolds. In these spacings, fluid circuit boards are inserted, abutting against the step risers of each manifold unit.

As shown in **FIGURE** 2, spring fingers **14** are mounted on the under side of each of the manifold steps, and the under side of the top plate **15**, for engagement with the tops of the circuit boards to press them against the top faces of the next lower adjacent manifold step portions **12**. Each of the top faces of the manifold step portions **12** may be provided with a seal **16** in the form of a layer of rubber with fluorocarbon coating to seal off around fluid passages between the manifolds **10** and the circuit boards **11**. The rubber provides resilience and the coating prevents sticking of the circuit boards to the manifold.

Thus, the circuit boards **11** are mounted in plug-in relation with the manifolds **10**. Later drawings herein indicate the fluid passages which are thus matched up to form continuous passages from one to the other of the manifold and circuit board of any one sub-module of this stacked module.

The stacked module is provided with a common fluid power supply passage **17**, which extends vertically through all the manifold units and is blocked off at the top by the top plate **15**. A lead-in to the supply passage **17**, at the bottom of the module, and in the form of a depending pipe **18**, is used as a plug-in member for mounting the whole module on a fluid power supply plate, both as a fluid power connection and as a mounting support for the whole module.

The plug-in concept may also be applied to the manifold units with respect to each other, as shown in **FIGURE** 7. This may be a sleeve within a pipe, or particularly when the device is made of plastic, snap-in fingers or expandable sleeves may be used where desired, not shown, simple vertical bolt assembly of the module sub-units may be used. Also small vertical pins may be used where needed for lateral alignment of the circuit boards on the manifolds. The top plate **15** may be similarly mounted on the stack of manifolds.

Thus the whole module is a plug-in device as a unit, each manifold is an individual plug-in device, with as many manifolds piled on vertically as desired for a particular function capacity requirement. The circuit boards **11** are also plug-in devices and may be mounted or dismounted at will by simple push insertion or pull removal.

Whatever degree of sealing means or pressure is needed for a particular application may be supplied by conventional means. This device, however, lends itself to modern needs for fluidic systems, where the pressures involved may be of the order of **2** to **10** inches of water, and simple face-to-face assembly of adjacent units is often sufficient to seal off around the various passages, especially if the members are made of plastic. In the case of plastic members, the springs **14** may be integral moulded parts of the manifold which is next above the circuit plate it binds, or may be integral with the manifold to which the circuit is joined.

FIGURES 3 and 4 illustrate the form of one of the manifold units of **FIGURES** 1 and 2. The fluid passages indicated in **FIGURES** 3 and 4 are specific to one simple form of fluid circuit board, that shown in **FIGURES** 5 and 6. All the inner passage openings are upward, in the top face of the manifold step portion. The outer ends of these passages, except the fluid power passage, lead to the vertical end wall of the manifold as in **FIGURE** 4. Some of these are input signal control passages, and some are output signal exit passages. Thus, another module unit may be connected to this vertical end wall to continue these passages, or they may be from and/or to controller operation units, as desired.

In the case of the **FIGURE** 3 passage openings, they are matched by openings to and from the circuit board fluid system as shown in **FIGURES** 5 and 6. This circuit system is a set of NOR gate diffusion amplifiers.

In the circuit board of **FIGURES** 5 and 6, the diffusion waste exits are through the openings **19** and **20**, which extend through the entire thickness of the circuit board. When used in the structure of **FIGURES** 1 and 2, these openings are

located open to atmosphere, outward beyond the contact faces with the manifolds.

Further, in the circuit board of **FIGURES** 5 and 6, the waste exits are open top and bottom, but the fluid passages are open only on the bottom, to match the manifold openings of **FIGURE** 3.

The manifold opening pattern, **FIGURE** 3, may be standardized to match passage openings from a variety of circuit board systems. They may be circuits for a counter, a buffer, a clock, or whatever is needed. The circuits may be complex and small. Etching techniques in the forming of passages in metal plates which are sandwiched to form such circuit boards are useful in providing dense fluidic packaging with integrated circuits. Thus the particular circuits and fluid passage patterns shown herein are by way of illustrative example only.

This invention therefore provides a new and improved fluidic system means, based on a fluidic coupling device in the form of a manifold with plug-in functions.

This manifold can be three-fold in purpose. It carries input control signals, output operating signals, and fluid power supply input.

We claim:

1. A fluidics manifold assembly for receiving a group of fluidic circuit boards in dense fluidic packaging,

said assembly comprising a base, a manifold supply inlet to said base, a base supply passage from said inlet up through the top of said base, a group of separable manifold units mounted in a stack on said base with a stack supply passage up from said base supply passage to the top of said stack, a top member for said stack as a closure for the top of said stack supply passage,

each of said separable manifold units having a step cut-out form, and resilient means secured to the bottom of each of said manifold units in overlying relation to the step cut-out form of the next below manifold unit,

a fluidic circuit board mounted on each of selected ones of said step cut-out forms and held thereagainst by said resilient means depending from the next above manifold unit,

and operative fluidic connections from said stack supply passage through each of said manifold units and up through the top surfaces of the respective step cut-out forms for fluidic connection with circuits in said circuit boards,

each of said separable manifold units having a pipe boss extending down into the manifold stack supply passage of the next below adjacent manifold unit, including said top member and said base, whereby said assembly is, overall, a plug-in device, and whereby said manifold units are plug-in units with respect to each other, whereby said entire assembly of a plurality of circuit boards is a system plug-in device,

each of said separable manifold units, further, having, in addition to said manifold supply passage connection to the respective circuit boards, a plurality of control signal input passages and output signal passages, transversely through and individual to each of said manifold units, terminating upwards through the top of each of said step cut-out forms, into operative connection with related fluid passages in the circuit board individual to the particular manifold units.