United States Patent

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[54] **FLUIDIC BLOCK ASSEMBLY**
3 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **137/81.5**
[51] **Int. Cl.** **F15c 5/00**
[50] **Field of Search** 137/1, 81.5, 608

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ABSTRACT: The fluidic elements are made of profiled strips projecting between superposed base and top mounting plates. The material of the base mounting plate differs in hardness from that of the top mounting plate. A number of stacked fluidic element layers are disconnectably compressed by means of screw fasteners between a rigid support plate and a closure plate.

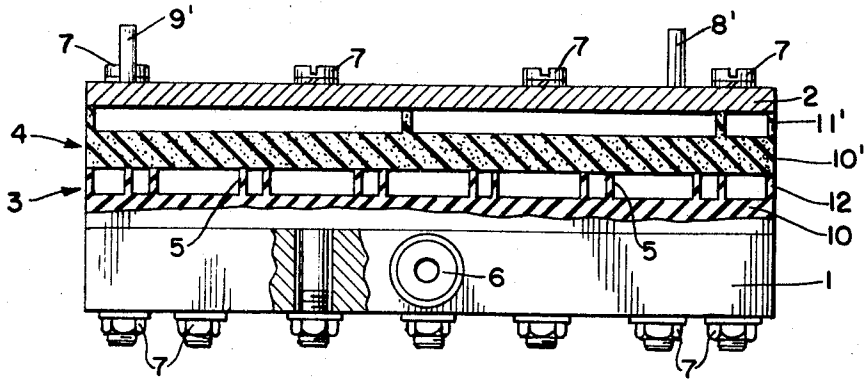


FIG. 1

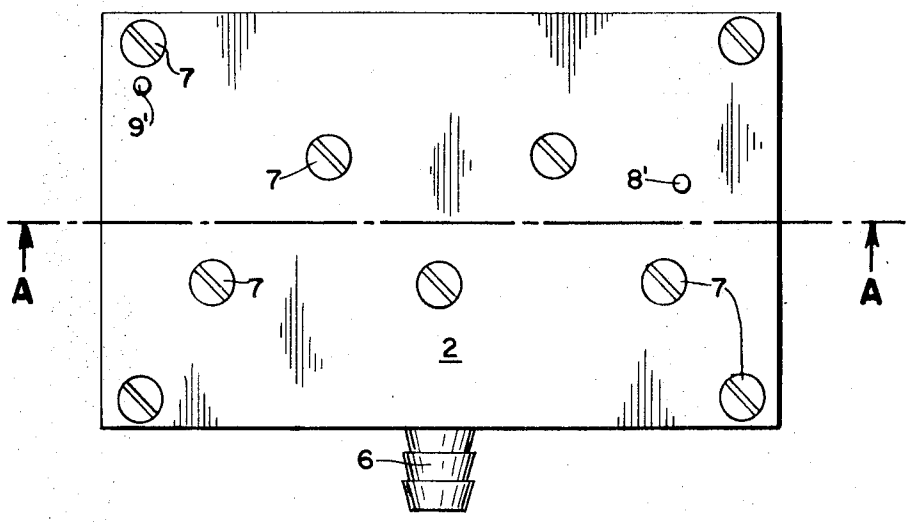


FIG. 2

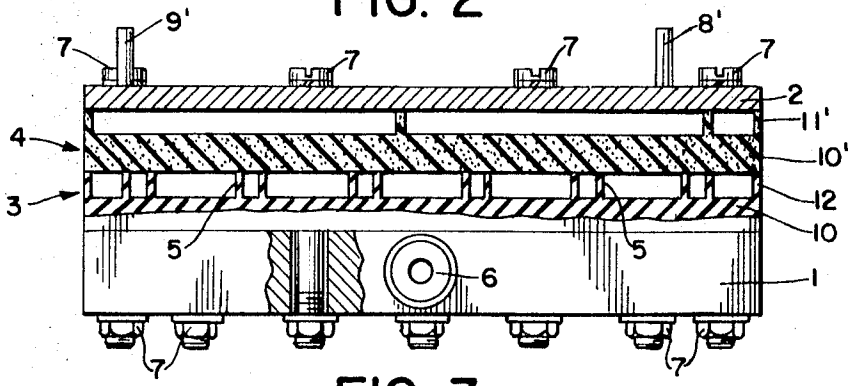
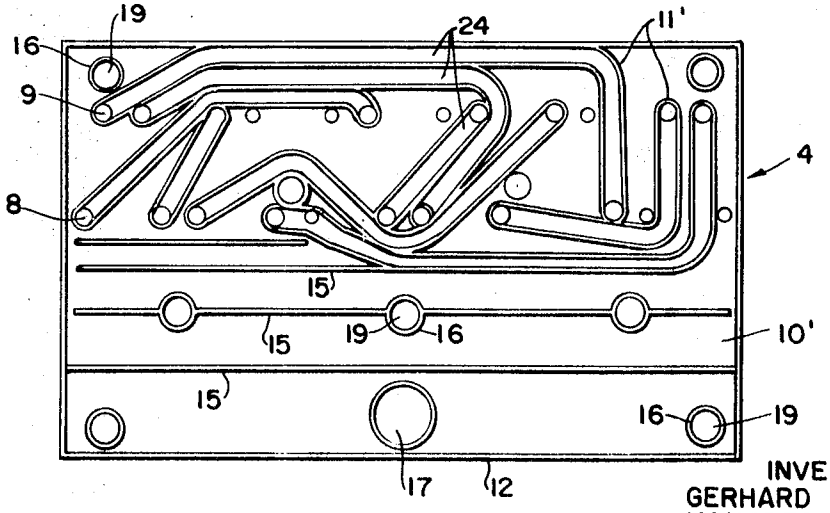


FIG. 3



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FIG. 4

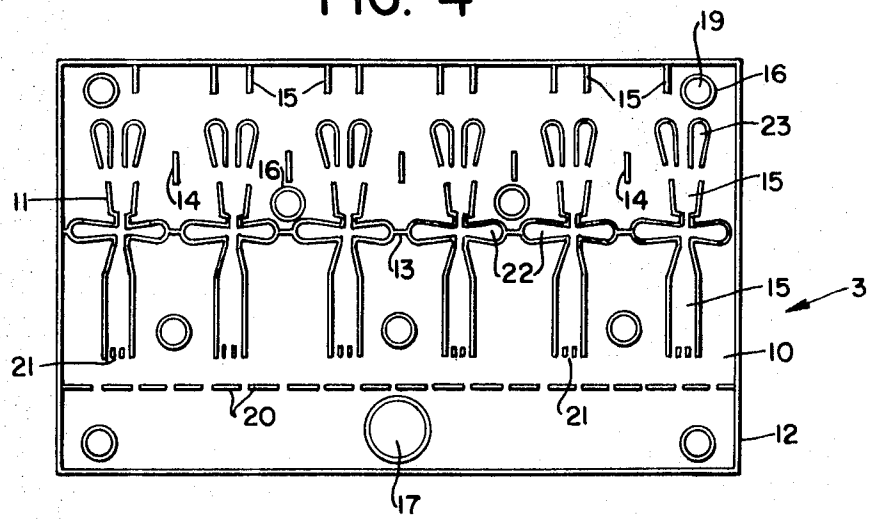
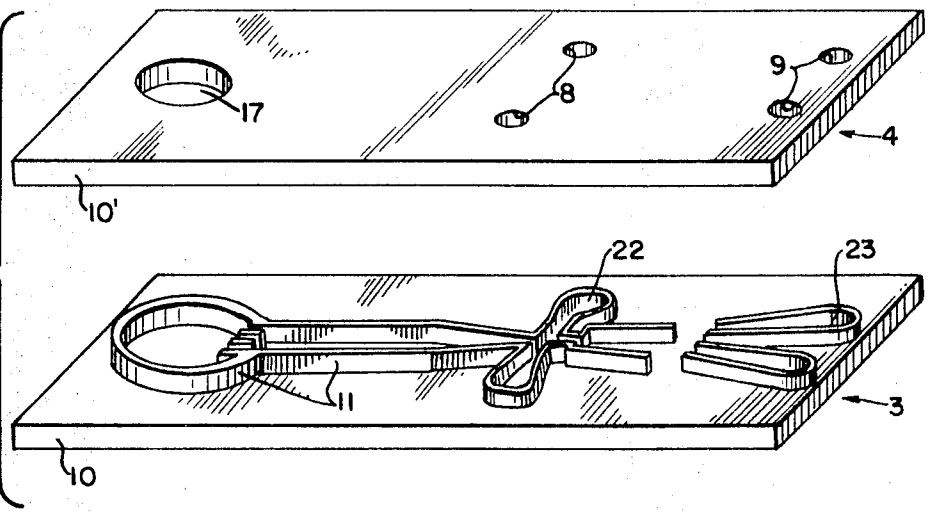


FIG. 5



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FLUIDIC BLOCK ASSEMBLY

The present invention relates to structure and production of fluidic construction elements which are arranged on a planar wafer and adapted for being packed into an interconnected functional block to control pneumatical logic operations.

The operation of fluidic construction elements is dependent on their mutual geometrical correlation and, in case of their planar arrangement, the operation is substantially defined by plan contours and by the height of each construction element.

In prior art structures of planar fluidic elements designed for planar mode of operation, each element is produced in a planar wafer recessed into the desired depth by means of a suitable machining method, such as cutting, etching, stamping, etc.

By combining a number of fluidic elements within a wafer, fluidic integrated circuits are produced. Subsequently, these preshaped wafers are hermetically covered by a top plate the tightness of which insures the operational quality of the fluidic element or circuit. The top plate is, in most cases, provided with the necessary couplings or fittings. In case of superposed fluidic element layers, the upper surface of each top plate also supports further fluidic elements whereby the essential requirement for the packed fluidic layers is the tightness between fluidic elements and the contacting top plate.

It is also known how to manufacture fluidic elements by punching or stamping a thin wafer which in the following production step is sandwiched between two cover plates.

In the aforementioned prior art manufacturing methods the tightness between the wafers and cover plates is attained either by melting the adjoining surfaces, or by means of adhesive layers.

Moreover, it is required in the manufacture of fluidic integrated circuits that the production of construction elements be inexpensive and easy to reproduce. The reproduction methods are based on various forming processes, such as die casting, pressure shaping, injection die casting etc., by means of which final products can be attained without any additional processing. However, the resulting quality of the working surfaces created according to the latter methods is not uniform. If supplemental processing is to be avoided, considerable pressing forces must be applied against relatively large surfaces which arise from these prior art manufacturing processes.

Such pressing forces, however, modify in unacceptable manner the geometrical correlation of contours of individual elements and it is necessary to apply surface equalizing and sealing adhesive layers. The application of adhesive layers has the disadvantage that the superposed fluidic element wafers and covering plates, i.e. the stacked layers of a fluidic block, are indecompressibly assembled and in the event of fouling of an element it is impossible to restore its function by cleaning. Moreover, the adhesive material frequently enters the fluidic element during the assembling of the block, and may unfavorably affect geometrical relations therein or even clog the tiny channels. As a consequence, rejects up to 70 percent result in the production methods utilizing adhesives, which fact is economically intolerable. Similar problems occur in case of joining the fluidic element wafer to the cover plate by melting, since the deformation of geometrical relations caused by the effect of forces pressing against the material plasticized by melting brings about considerably percentage of wasted final products.

Therefore, the object of the present invention is to provide a structure of fluidic elements which makes it possible to assemble, without the use of adhesives or without melting, the fluidic elements and the mounting plates into a disconnectable functional block.

Another object of the present invention is to reduce the surfaces to be sealed and thus decrease the pressing forces required for the assemblage of a fluidic block.

A further object of the present invention is to create fluidic elements which can be easily interconnected into any desired circuit configuration and disconnectably secured one to another.

According to the present invention, the above objects are attained so that the contours of fluidic elements, such as chokes, jets and the like, are made of projecting strips whereby the element base or mounting plates and the top or cover plates, respectively, are made of materials having different hardness, alternately stacked between a support plate and a closure plate, and disconnectably coupled one to each other. The element base plate is preferably made of a hard plastic and the top or cover plate of a soft plastic or elastomer. To insure uniform distribution of the pressure applied on the surface of the top plate, additional pressure distributing strips are arranged on the element base plate. The latter strips may, besides the pressure distribution, perform also fluidic functions.

The thickness of the strips which determine the contours of fluidic elements, is relatively very small; this fact enables that the sealing forces can be more effectively applied with regard to the shaped strip contours and, consequently, smaller pressure on the cover plate is sufficient for sealing the elements. The required pressing forces are so small that no deformation of the geometrical correlation in the fluidic element will occur and, at the same time, the necessary tightness between the element base plate and the cover plate is guaranteed. No adhesive layer is thereby employed.

The element base plate and the cover plate are positively connected and can be disassembled at any time. The disadvantage of prior art methods utilizing adhesive layers, such as clogging of narrow channels, can no more take place and the number of rejects is considerably diminished.

To compensate or equalize insufficient fluidic quality of operative surfaces, hard and soft plates or layers are alternately superposed. When compressed, either the soft tightening plate will encircle free edges of the strip on the element base plate and adjusts itself to the upper surface at the top portion of the strip, or the hard tightening plate will make the narrow strips so far deformed that the upper surface at the top portion of the strip becomes equalized. In both instances, the tightness is improved. The strips of fluidic elements which are sensitive to the deformation of contours are preferably made of hard material. For fluidic elements wherein a certain deformation of contours is acceptable, strips of soft material can be employed and for this reason it is not essential for the assembly of fluidic elements that the intermediate top plates be smooth and of soft material.

In order that the present invention may be readily carried into effect it will not be described with reference to the accompanying drawings, wherein:

FIG. 1 is a plan view of a fluidic element block;

FIG. 2 is a side sectional view of the block of FIG. 1 taken on line AA;

FIG. 3 is a plan view of an element top plate in the block of FIG. 1;

FIG. 4 is a plan view of an element base plate in the block of FIG. 1; and

FIG. 5 is an exploded perspective view of a fluidic element according to this invention.

FIGS. 1 and 2 show an embodiment of this invention wherein fluidic elements are packed in a compact functional block. On support plate 1 which is provided with fitting 6 for the auxiliary air supply, element base plate 3 of hard rubber, element top or cover plate 4 of soft rubber and rigid closure plate 2, are superposed on each other and compressed by means of screw fasteners 7. Strips 11 and 11' which are shaped into contours of fluidic elements, are disposed between base plate 3 and cover plate 4, as well as between cover plate 4 and closure plate 2.

Since no adhesive layer is present in the block, the entire assembly may be readily taken apart. Closure plate 2 is provided with fittings or ports for signal inlet 8' and for signal outlet 9'.

As seen in FIGS. 2 to 4, the element base plate 3 and the element top plate 4 have similar configuration and can be manufactured by identical processing steps. For the reason of simplification, these plates will be referred to in the following

description as strip mounting plates **10**. Mounted on the mounting plate **10** of the element base plate **3** (FIG. **4**) are six jet elements **5** made of profiled strips **11**, one boundary strip **12**, separating strip **13**, balancing strips **14**, protective strips **15** compression forces distributing strips **16** located around bores **19** for the screw couplings. All of the above-mentioned strips are arranged on the mounting plate **10** in such a manner that the compression forces applied on relatively narrow edges of the strips through the top plate, are evenly distributed over the entire surface areas of these edges whereby the strips are compressed to form airtight seals with the contacting mounting plates. Opening **17** which is provided in the mounting plate **10** feeds the auxiliary air from fitting **6** into air distribution chamber **18** delimitated by boundary strip **12**. The auxiliary air is evenly supplied through chokes created in distributing strip **20**, and reaches air inlets **21** of jet elements **5**.

Separating strips **13** between individual signal inputs **22** prevent the auxiliary air from chamber **18** from entering signal outputs **23**. Signal outputs **23** in fluidic elements **5** are formed of strips having hook-shaped contours and are spaced apart from strips **11** (see FIG. **5**). Respective pairs of signal outputs **23** cooperate with interposed balancing strips **14**. Borings **19** for screw fasteners **7** are encircled by strips **16** preventing the leakage of the auxiliary air as well as the introduction of false air.

Strips **11** to **16** and **20** have equal height and are symmetrically arranged on the mounting plate to uniformly counteract the compression forces resulting from the screw coupling and to evenly distribute the compression over the entire plate.

Protective strips **15** are disposed in the direction of the stream of the exit air since they must not impede its flow into the atmosphere. Element base plate **3** is made of relatively hard material preventing the contours and geometrical correlation of respective fluidic elements from deformation. Element top or cover plate **4** is made of relatively soft material and the lower surface thereof abuts the upper edges of strips **11—16** and **20** in the base plate **3** and, after the compression, hermetically tightens the fluidic element contours, thus providing an operative fluidic circuit. Element top plate **4** serves as strip mounting plate **10** for the superposed fluidic circuit which comprises channels **24** covered by closure plate **2** of hard material (FIGS. **3** and **5**). In this case, it is acceptable for the upper element to slightly deform the contours of strips **11'** for those channels without affecting the proper functioning of the strips **11'**.

In contrast to element base plate plate **3**, top plate **4** can be provided on its periphery with a closed boundary strip **12'** to insure better distribution of compression forces. Further protective strips **15'** assist the uniform distribution of the above-mentioned forces.

Bores **19** for coupling screw, similarly as in the base plate, are surrounded by annular strips **16** so that a unilateral or uneven compression of plates is prevented. Lead-through holes **8** for signal inputs and lead-through holes **9** for signal outputs are arranged in the top plate **4** to forward fluidic signals to the subsequent circuit layer of fluidic elements or to signal outlet ports **8'** and **9'** in the closure plate. For forwarding the auxiliary air to the following element base plate, top opening **17'** is disposed opposite to bottom opening **17**.

FIG. **5** shows in a simplified exploded view of two strip mounting plates **10** and **10'** the arrangement of strips **11** with regard to lead-through holes **8** and **9** in plate **10'**.

We claim:

1. A fluidic block assembly comprising a support plate and a closure plate, base and top mounting plates stacked between the support and closure plates and disconnectably secured thereto, a plurality of functionally profiled strips of relatively small thickness disposed between respective base and top mounting plates to form various fluidic elements, said base mounting plate being made of material having different hardness than that of said top mounting plate and tightly compressing the edges of said strips.

2. The fluidic block assembly according to claim **1** wherein said base mounting plate is constituted of a hard elastomer and said top mounting plate is constituted of a soft elastomer.

3. The fluidic block assembly according to claim **1** further comprising additional strips for distributing the compression forces on said base and top mounting plates.