Aug. 8, 1967 P. O. W. HOPKINSON, JR 3,334,401

METHOD OF FORMING FLUID PASSAGES

Filed March 4, 1965

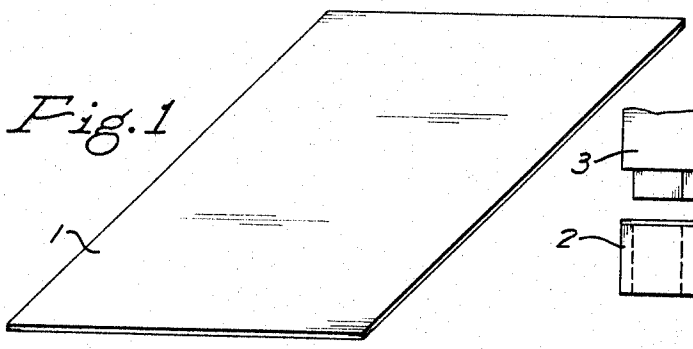

Fig. 1

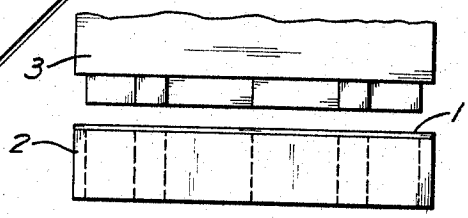

Fig. 2

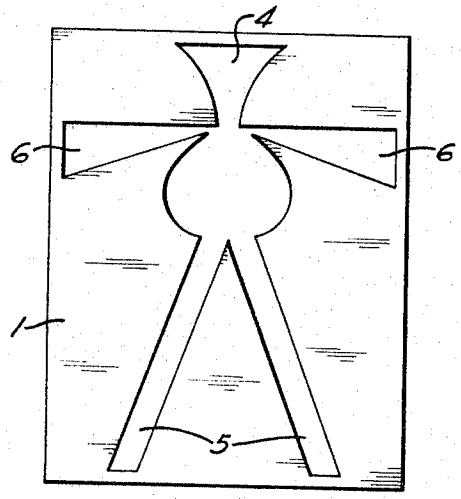

Fig. 3

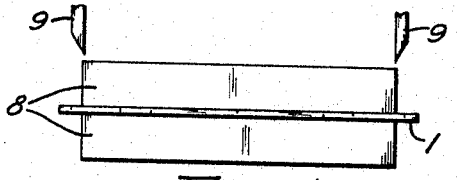

Fig. 5

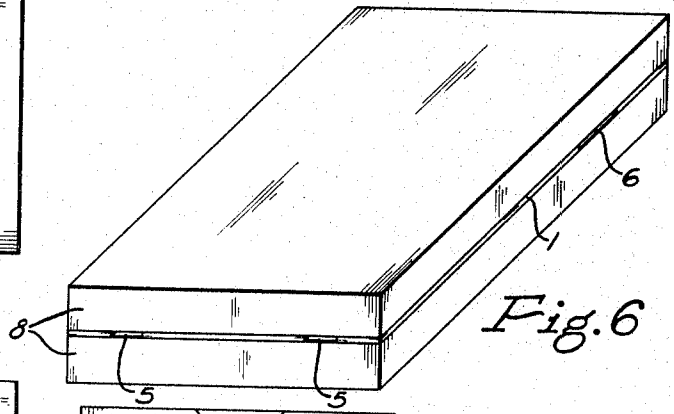

Fig. 6

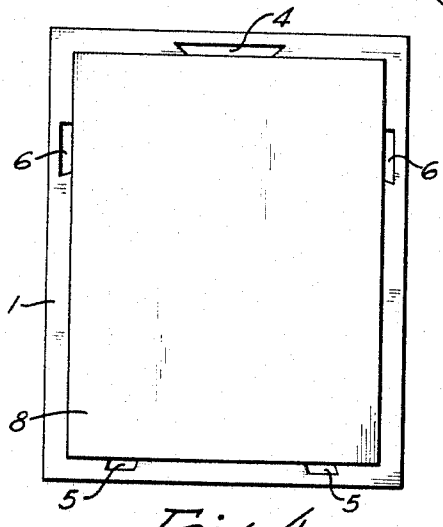

Fig. 4

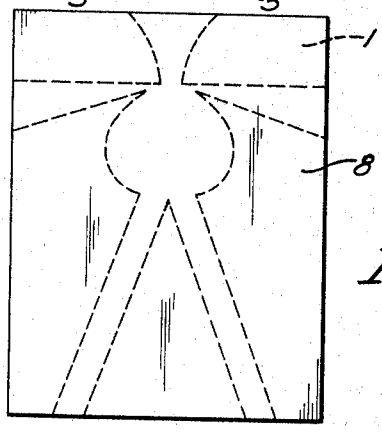

Fig. 7

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METHOD OF FORMING FLUID PASSAGES

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This invention relates to the formation of short fluid passages, and more particularly complex passages such as used in fluid amplifiers.

In fluid amplifiers a stream of fluid is delivered to the outer end of the stem of a Y-shape passage, the outer ends of the branches of which form outlets. To direct the fluid into the desired branch, there are a pair of lateral passages that open into the stem of the Y. A control fluid under pressure directed into the outer end of either of these branch passages will divert the main fluid stream into one or the other of the branches of the Y-shape passage. A common way of forming such passages heretofore has been to etch channels having their shape in one side of a plate and then bond thereto another plate in order to cover the channels. The inlets and outlets of the passages thus formed therefore are located at the edges of the plates.

It is among the objects of this invention to provide a method of forming a fluid passage, which is simpler and less expensive than etching, which can produce passages very rapidly, and which can form them in any desired shape.

In accordance with this invention, a flat sheet is cut to remove a section from it that forms in the sheet a slot having closed ends. The slotted sheet then is sealed between a pair of backing members that cover all of the slot except its ends, so that the ends of the sheet will project from between the two backing members. The projecting ends of the sheet then are removed in order to open the ends of the slot and thereby form a through passage between the backing members. Preferably, the sheet that is slotted is made from a gasket material and the slot is formed by a punching operation.

The invention is illustrated in the accompanying drawings, in which:

FIG. 1 is an oblique view of a sheet that is to be punched;

FIG. 2 is an end view of the sheet between dies that will punch a section out of it;

FIG. 3 is a plan view of the sheet after it has been stamped, showing the opening that has been formed;

FIG. 4 is a plan view of the sheet between two backing members;

FIG. 5 is an end view of the assembly, showing the projecting portion of the sheet about to be trimmed off;

FIG. 6 is an oblique view of the assembly with the marginal area of the sheet removed to expose the ends of the passages; and

FIG. 7 is a plan view of the finished device, with the passages shown in dotted lines.

Referring to the drawings, a sheet **1** of suitable material that is larger than the desired passage is selected. The sheet should be the same thickness as the desired passage. Different materials may be used for the sheet, such as subber, plastic and even metal, but a very suitable material is that from which cylinder gaskets are made for automobiles. Suitable means for cutting an opening of the desired shape in the sheet is provided. Most suitably, this means consists of a pair of dies for punching out a section of the sheet in order to leave the desired opening. Such dies are indicated in FIG. 2, where the sheet is shown resting on the lower die **2** and about to be punched by the upper die **3**. After the sheet has been punched it may look like the one shown in FIG. 3, although a single straight slot or an opening of some other shape could be formed just as well, depending upon the use. The opening shown is intended to be formed into passages for a fluid amplifier. It will be seen that it is generally Y-shaped with a stem **4** and two diverging branches **5**. Also, behind the point where the branches join the stem, there is a pair of laterally projecting arms **6** communicating with the stem. It should be noted that at no place has the sheet been cut through to its edge. In other words, the outer ends of the extremeties of the opening or slot are all closed and spaced from the edges of the sheet. This permits the sheet to be handled as a unit instead of several separate pieces that would have to be assembled and arranged.

The next step, as shown in FIG. 4, is to place the slotted sheet between a pair of backing members **8** that preferably are rigid. These may be either thin or thick plates of any suitable material. The plates are smaller than the punched sheet so that they leave the marginal portions of the sheet projecting from between them in all directions just far enough to expose the ends of the slots. The plates are bonded to the sheet in any suitable manner to seal them together. Then the projecting marginal portions of the sheet are removed, such as by trimming them off by knives **9** as shown in FIG. 5. The resulting product shown in FIGS. 6 and 7 is a sandwich in which the three parts all have the same length and width. By removing the projecting portions of the sheet, the ends of its opening are opened and exposed for connection in any suitable manner to fluid conduits. The opening in the sheet between the two plates now has become connected through-passages, two opposite walls of which are formed by the plates.

It will be seen that passages of any desired shape can be formed in this manner very quickly and inexpensively in great numbers after dies of the proper configuration have been made.

According to the provisions of the patent statutes, I have explained the principle of my invention and have illustrated and described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. The method of forming a fluid passage, comprising cutting a flat sheet to remove a section therefrom that forms in the sheet a slot having closed ends, sealing the slotted sheet between a pair of backing members that cover all of said slot except its ends so that the ends of the sheet project from between said members, and then removing said projecting ends of the sheet to open the ends of the slot and thereby form a through-passage between said backing members.

2. The method of forming a fluid passage, comprising punching out of a flat sheet a section thereof to form in the sheet an opening having ends that are closed, sealing the punched sheet between a pair of backing members that cover all of said opening except its ends so that the marginal portions of the sheet containing said closed ends project from between said members, and then trimming off said marginal portions of the sheet to open the ends of said opening and thereby form a through-passage between said backing members.

3. The method of making fluid amplifier fluid passages, comprising punching out of a flat sheet a section that is Y-shape with laterally projecting arms connected to the stem of the Y, said section being small enough for the opening left by it in the sheet to have the outer ends of its stem and branches and arms closed, placing the punched sheet between a pair of rigid backing members that cover all of said opening except said outer ends so

that the marginal portions of the sheet project from beneath said members, and then trimming off said marginal portions of the sheet to open the outer ends of said opening and thereby form through-passages between said backing members.

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