

[54] **FLUIDIC PULSE AND FLOW DIVIDER**

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[51] Int. Cl. **E03b**

[58] Field of Search 137/561 R, 561 A, 836, 838, 137/839; 138/39

[56] **References Cited**

UNITED STATES PATENTS

3,405,725 10/1968 Fox 137/839
3,037,629 6/1962 Fontein et al. 137/561 R

FOREIGN PATENTS OR APPLICATIONS

18,745 10/1895 Great Britain 137/561 A

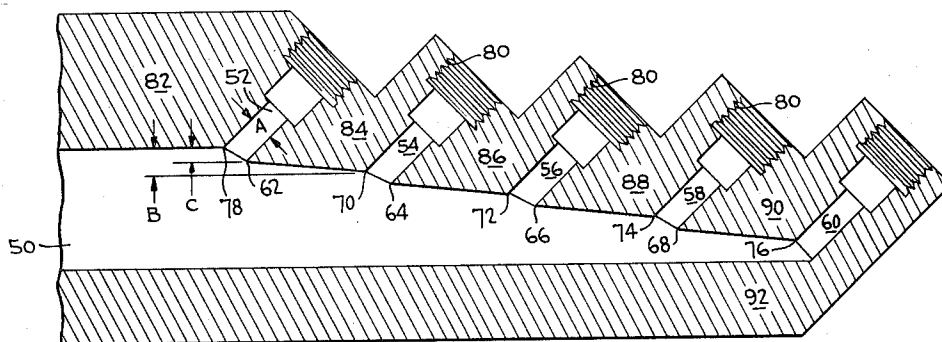
Primary Examiner—William R. Cline

Attorney, Agent, or Firm—Edward J. Kelly; Herbert Berl

[57] **ABSTRACT**

A fluidic pulse and flow divider which has a single input and a plurality of outlet channels which communicate with the input and are disposed at an acute angle with respect to the fluid flow in the entrance section to provide a plurality of fan-outs exiting toward one side of the device. The combined area of the outlets is equal to the area of the entrance flow straightening section to eliminate reflection of waves. The area of the entrance section itself is smoothly reduced before each successive outlet channel by an amount equal to the area of the preceding output channel.

8 Claims, 2 Drawing Figures



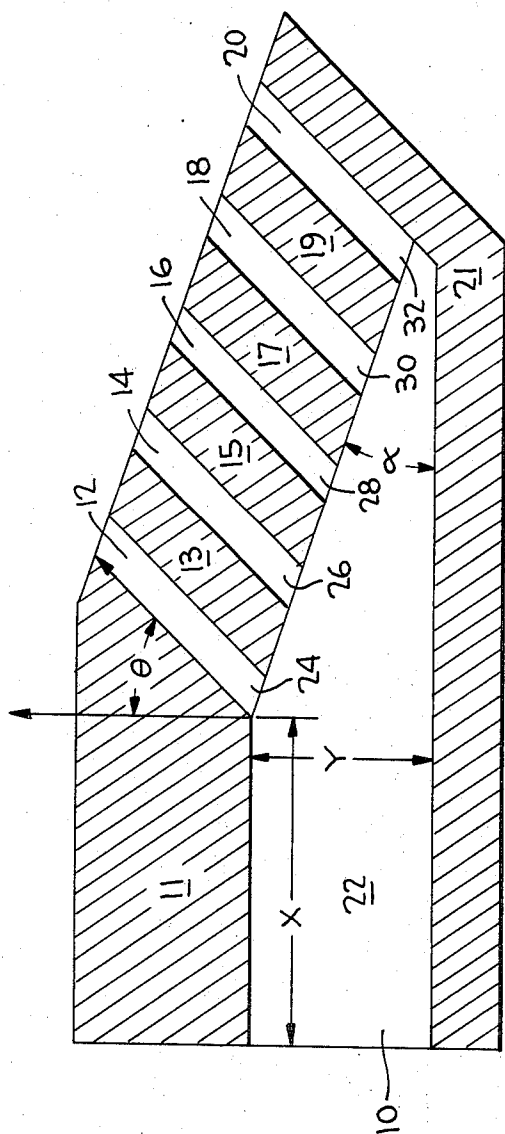
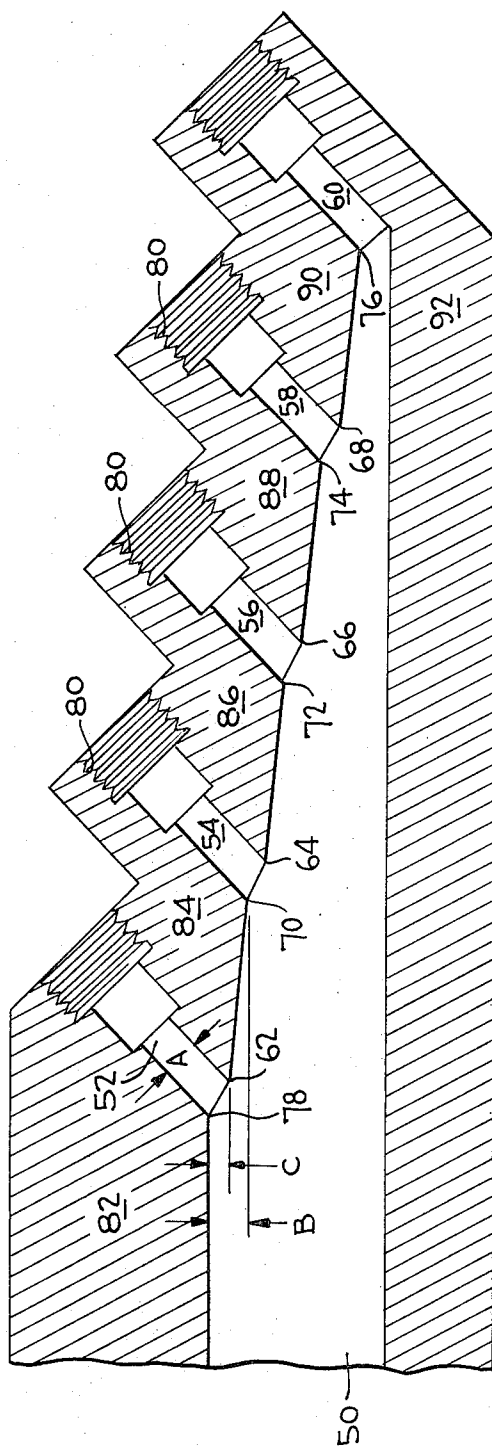


FIG. 1

FIG. 2



FLUIDIC PULSE AND FLOW DIVIDER

RIGHTS OF GOVERNMENT

The invention described herein may be manufactured, used, and licensed by or for the United States Government for governmental purposes without the payment to me of any royalty thereon.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to fluidic devices and, more particularly, to a fluidic device that divides a fluid signal into equal pulses.

2. Description of the Prior Art

In synchronous fluidic circuits, it is often necessary to have a fluid signal at many stages of the circuit at essentially the same time. An example of this would be the clock pulse required in a fluidic shift register. Even flow division and transmission of a fluidic signal is accomplished by means of devices known as fluidic pulse and flow dividers.

The first flow dividers were constructed in the form of a Y. A typical Y splitter is shown in FIG. 2 of United States Pat. No. 3,340,884. The bottom leg of the Y is generally designed to be long enough to serve as a flow straightening section to obtain a uniform flow profile. This ensures that the splitter divides the wave and flows equally between the two upper legs. To prevent the reflection of waves, the combined area of the upper two legs of the Y was made equal to the area of the single lower leg of the Y. Therefore, reflection of the fluid waves was prevented inasmuch as a constant area was presented to the wavefronts as they progressed through the device. Additional fan-out was achievable simply by attaching additional Y sections. However, each flow divider had to straighten the flow into a uniform profile prior to dividing it. Another example of the prior art with respect to stacking Y sections is suggested in United States Pat. No. 3,282,297. Others have suggested the possibility of constructing an axis-symmetric device to provide equal wave and flow division of four times and eight times with only one straightening section. However, such a three-dimensional device does not lend itself to adaptation to essentially one-dimensional fluidic circuits in common usage.

It is therefore one object of the present invention to provide a fluidic pulse and flow divider in which equal multiflow division in essentially one plane is provided for use in fluidic circuits.

A further object of the present invention is to provide a fluidic pulse and flow divider for use in synchronous fluidic circuits in which a plurality of outlet pulses can be provided to many stages of a fluidic circuit at essentially the same time by utilizing a single inlet section flow divider.

A further object is to provide a pulse and flow divider which requires only a single straightening entrance flow section for a plurality of output channels in an essentially planar fluidic configuration.

SUMMARY OF THE INVENTION

Briefly, in accordance with the invention, a fluidic pulse and flow divider is provided which comprises a constant depth input channel for receiving a steady fluid flow and a plurality of constant depth output channels located downstream of the receiving portion of the input channel. While the devices of the present

invention may be considered to be essentially planar, the constant depth of the devices is of a finite dimension and the term "area" is therefore used in conjunction with the description thereof. The area of the input channel as that term is used in the specification and the claims, is the area of a section normal to the longitudinal axis of the input channel and the area of an output channel is the area of a section normal to the longitudinal axis of an output channel. Each of the output channels is located at the same acute angle with respect to the axis defining the flow path of the incoming fluid flow. Also, the area of the input channel is essentially equal to the combined total area of the output channels. The width of the flow straightening input channel is smoothly reduced before each successive outlet channel by an amount equal to the width of the preceding output channel.

BRIEF DESCRIPTION OF THE DRAWINGS

The specific nature of the invention as well as other objects, aspects, uses, and advantages thereof will clearly appear from the following description from the accompanying drawing, in which:

FIG. 1 is a sectional schematic view of a device constructed according to the principles of the present invention; and

FIG. 2 is another schematic of a preferred embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In order to obtain an equal multiflow division in essentially one plane for use in fluidic circuits, the devices in FIGS. 1 and 2 were constructed according to the following principles:

1. The area of the entrance section/input channel was made essentially equal to the total area of the combined outlet channels;
2. The entrance section/input channel was made of sufficient length to provide a uniform flow profile for the incoming fluid waves;
3. The outlet channels are disposed at an acute angle with respect to the flow in the entrance section/input channel;
4. The downstream edge of each outlet channel projects into the entrance section/input channel one half the width of the output channel; and
5. For constant depth channels, the width (area) of the entrance section/input channel is smoothly reduced by an amount equal to the width (area) of the preceding outlet channel prior to the next outlet.

FIG. 1 illustrates one embodiment of the device of the present invention. Input channel 10 is comprised of a constant area receiving portion 22 to the left of channel 24 and a tapered output portion to the right of channel 24. The receiving portion which is an initial straightening section, is constructed to provide a uniform flow and pressure profile. Five outlets 12, 14, 16, 18 and 20 are disposed at an angle θ to the incoming fluid flow. The outlet openings 24, 26, 28, 30 and 32 are tapered at an angle α with respect to the horizontal axis. The taper angle α is chosen to provide the desired projection of the downstream sides 13, 15, 17, and 19 of each outlet and simultaneously to reduce the entrance area smoothly by an amount equal to the area of the preceding outlet channel before the next outlet.

This input channel/entrance area is similarly reduced for each successive outlet.

In operation, when a fluid wave enters the straightening section 22 in the input channel 10 of the device, the wavefront becomes uniform across the channel width. A small portion of the wave extends and is removed at the first outlet channel 12, which lowers the pressure in the remaining wavefront. Since the outlet channels are disposed at an acute angle to the fluid flow and define a decreasing width tapering section, the section of the taper 13 will reconstitute the wave to its previous condition, and another small portion of the wave will be removed at the next outlet channel 14. This process repeats itself with the end result being each outlet channel having an equal pressure and flow wave exiting therefrom. In a device constructed according to the principle enunciated hereinabove the dimensions shown in FIG. 1 were chosen as follows:

$x = 1.5$ inches; $y = 0.25$ inches; the projected width of each outlet was 0.05 inches; the width of each taper-forming section was 0.1 inches; $\theta = 45^\circ$; and $\alpha = 18^\circ$. The depth of the inlet and outlet channels was a constant 0.040 inches.

Depicted in FIG. 2 is another device built according to the above enumerated specifications. Five outlet channels 52, 54, 56, 58 and 60 were provided at an acute angle of 45° to the direction of the fluid flow. Provided at the output of each outlet channel were hose fittings 80 to facilitate connections to the remainder of the fluidic circuitry. In the device of FIG. 2, the design criteria involving the downstream edge of each outlet being projected into the entrance section one half the width of the outlet channel becomes more clear. For example, the width A of outlet channel 52 was constructed to be 0.1 inches and the width C, which constitutes the portion of the inlet wave that will be diverted through outlet channel 52, was constructed to be equal to 0.05 inches, whereas the width B was designed to be 0.1 inches. From the foregoing, it is more easily seen that each downstream edge 62, 64, 66, and 68 projects into the entrance section one half the width of each outlet channel. Moreover, it is more easily understood that the width (area) of the entrance section is smoothly reduced by an amount equal to the width (area) of each preceding outlet channel prior to the next outlet channel. The foregoing specifications ensure that the wave will be reconstituted to its previous condition, thereby eliminating reflections and providing equal pressure and flow outlets from each output channel.

It will be appreciated that unequal pulse and flow divisions proportional to the area of the outlets can be made using the same principles, and therefore I do not desire to be limited to the exact details of construction shown and described, for obvious modifications will

occur to a person skilled in the art.

I claim as my invention:

1. A fluidic pulse and flow divider, which comprises:

- a. a constant depth input channel having a receiving portion which has a constant area along its length for receiving a steady fluid flow and an output portion;
- b. a plurality of constant depth output channels located at said output portion of said input channel;
- c. each of said output channels juxtaposed at the same acute angle with respect to the axis defining the flow path of said steady fluid flow; and
- d. said constant area of said receiving portion of said input channel being essentially equal to the combined total area of said plurality of output channels.

2. The fluidic pulse and flow divider of claim 1 wherein the area of said output portion of said input channel is smoothly reduced before each successive outlet channel by an amount equal to the area of the preceding output channel.

3. The fluidic pulse and flow divider of claim 2 wherein the portion of each output channel that defines the downstream edge thereof projects into said output portion of said input channel a distance equal to one-half the width of said output channel.

4. The fluidic pulse and flow divider of claim 2 wherein the shape of the areas of said input and output channels is rectangular.

5. The fluidic pulse and flow divider of claim 4 wherein one wall boundary of said output portion of said input channel is co-linear and a continuation of one wall boundary of said receiving portion of said input channel while the other wall boundary of said output portion comprises a plurality of sections separated by said output channels, said other wall boundary of said output portion being at an oblique angle to the other wall boundary of said receiving portion.

6. The fluidic pulse and flow divider of claim 5 wherein said output channels are also juxtaposed at said oblique angle with respect to said other wall boundary of said receiving portion.

7. The fluidic pulse and flow divider of claim 5 wherein said output channels are juxtaposed at a different oblique angle than said oblique angle with respect to said other wall portion of said receiving portion.

8. The fluidic pulse and flow divider of claim 7 wherein said different oblique angle is such that the downstream edge of each output channel projects into said output portion of said input channel a distance equal to one-half the width of said output channel.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,794,056 Dated February 26, 1974

Inventor(s) Raymond W. Warren

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Add:

[73] Assignee: The United States of America as
represented by the Secretary of the
Army,

Signed and sealed this 2nd day of July 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents