July 9, 1968 R. F. O'KEEFE 3,391,480

DISPLAY DEVICE

Filed Feb. 1, 1966

Fig. 1

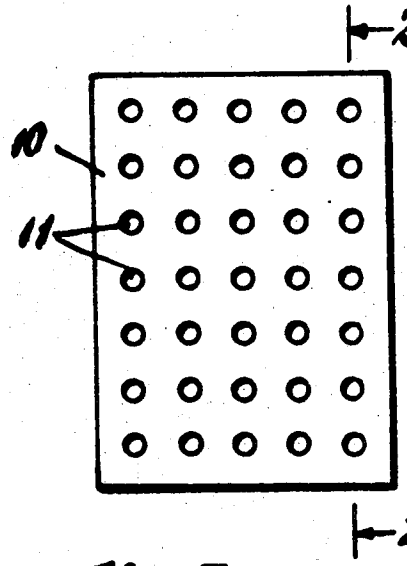


Fig. 2

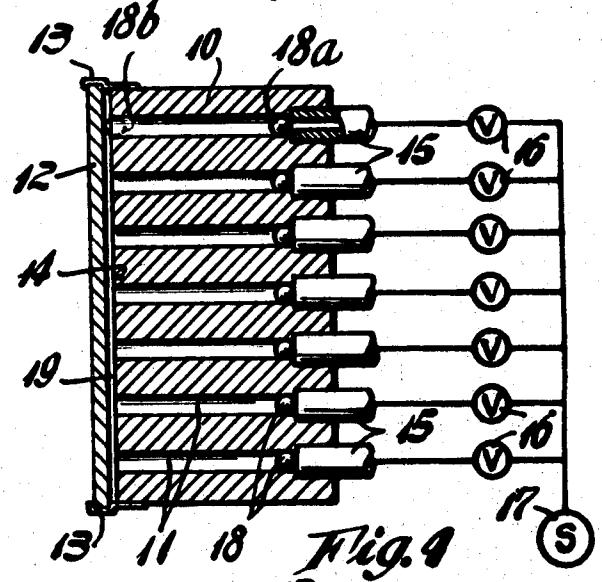


Fig. 3

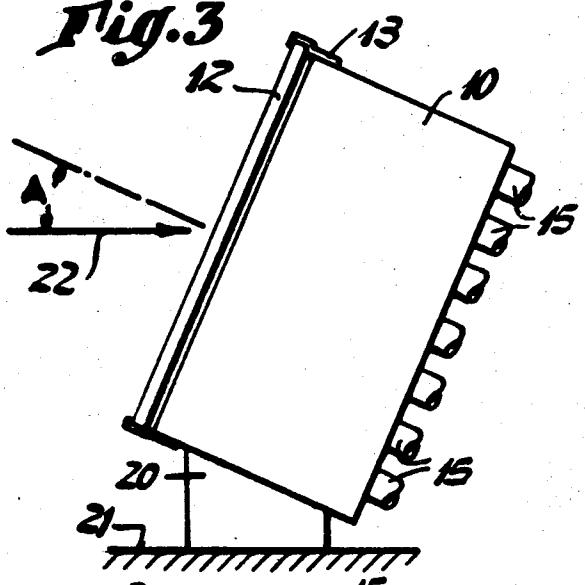


Fig. 4

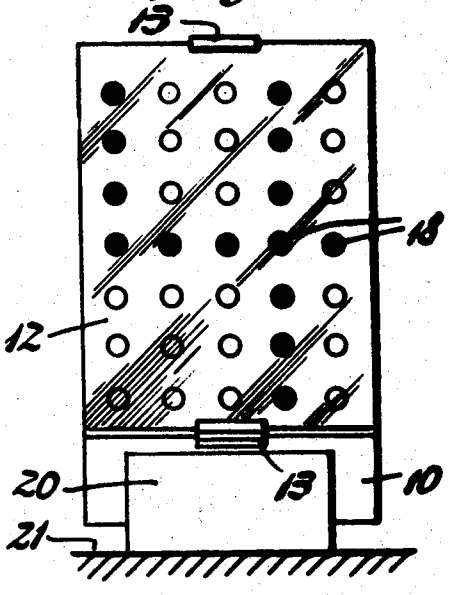
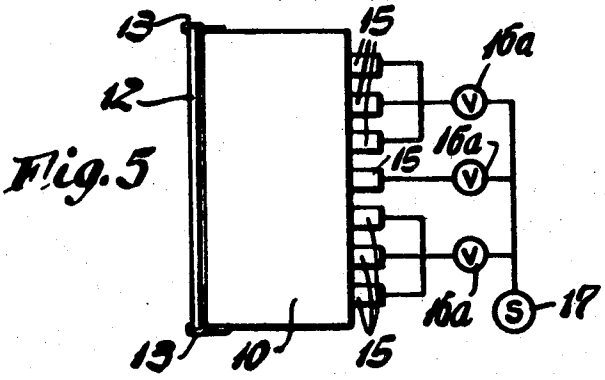


Fig. 5



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DISPLAY DEVICE

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ABSTRACT OF THE DISCLOSURE

A display device having a matrix array of passages each containing a ball or the like which is adapted to be fluid actuated from a nonvisible position to a visible position. Control valves are provided for said passages whereby successive selected groups of said valves may be operated so as to displace successive groups of said balls to visible positions wherein they collectively define successive characters.

This invention relates to an improved matrix type display device. More particularly the invention relates to a novel matrix type display device having power actuated indicator elements that are movable between visible and nonvisible positions.

With the advent of new fluid control means, such as fluid amplifiers and the like, a need has arisen for a simple low cost reliable display means for visibly "reading out" information from control or logic circuits. Many proposals have been made here, however most such proposals have not afforded all of the functional characteristics needed and/or desired.

The primary object of the invention is to provide a very simple, low cost display device which will operate reliably for long periods of time.

Another object of the invention is to provide a novel fluid actuated display device which may be rapidly operated at relatively low fluid pressure levels.

Another object of the invention is to provide a novel matrix type display device wherein a plurality of free piston-like members may be selectively bodily moved to display positions by selectively operating a plurality of individual control means that are respectively associated with said free piston-like members.

Further objects and advantages of the invention will become apparent as the description proceeds.

In the drawings:

FIG. 1 is a front elevational view of the main body member of the instant apparatus.

FIG. 2 is a side elevational view in partial section taken along a section line corresponding to section line 2—2 of FIG. 1.

FIG. 3 is a diagrammatic side elevational view illustrating an inclined orientation for the instant display device.

FIG. 4 is a front elevational view of the instant device showing a predetermined group of indicator members that have been displaced to their forward display positions so as to collectively define the character 4.

FIG. 5 is a diagrammatic view illustrating an alternate type of connection for the fluid control means.

Referring to FIGS. 1 and 2 there is shown a main body member **10** having a plurality or a matrix of substantially parallel elongated cylindrical passages **11** formed therethrough. A transparent plate **12** is secured to the front portion of body member **10** by any suitable means such as brackets **13**, the plate **12** thus being disposed substantially parallel to and closely spaced from the adjacent display surface or plane **14** of said main body member **10**. Respectively sealingly coupled to the rearward ends of said passages **11** are a plurality of suitable fluid conduit lines **15** which are in turn respectively coupled through individually operable fluid control valves **16** to a common fluid pressure source **17**. Each of the control valves **16** may for example comprise a fluidic device such as a wall attachment type fluid amplifier or a turbulence amplifier. In each of said passages **11** there is positioned an indicator ball or member **18** which is bodily movable therein between a substantially non-visible rearward position and a visible forward position, such positions being respectively illustrated by the reference numerals **18***a* and **18***b* of FIG. 2. The rearward limit of movement of each ball **18** is determined by its engagement with the end of the associated conduit line **15** while the forward limit of movement thereof is determined by its engagement with the inner surface of the transparent plate **12**. Here the width of the gap **19** between the inner surface of plate **12** and the display surface **14** is made less than the radius of said balls **18** so that there will be no tendency for any ball to become wedged or otherwise unnecessarily restrained in its forward display position.

As will be apparent the balls **18** are displaced forwardly along the respective lengths of said passages **11** by the application of fluid under pressure to the rearward ends of said passages. The effective diameters of the balls **18** are made slightly less than the diameters of the respectively associated passages to an extent sufficient to allow a small amount of air to pass between each ball and the surrounding walls of its associated passage **11** when the ball is in its forward display position. In this way the ball may be retained in a forward display position by the impact fluid pressure generated by the fluid flow through the associated line **15** and passage **11**, the expended air escaping through said gap **19**. The said forward surface **14** of the main body which defines the effective display plane of the device may be light colored, e.g., yellow, while the balls **18** may be dark colored, e.g., black, so as to contrast sharply with said light colored display surface **14**.

In operation the instant device is mounted by any suitable means, such as **20**, at an angle A on and with respect to a horizontal base **21** as illustrated in FIG. 3. Conversely the main body member could of course be vertically oriented with the passages **11** formed at an angle A with respect to the display surface **14**. In either case all the valves **16** are normally retained in their "off" conditions and all the balls **18** are thus gravitationally biased to their normal rearward positions, the relative dimensions and arrangement of the parts being such that when said balls are in said rearward positions they will be substantially non-visible with respect to a viewing line such as is illustrated at **22** in FIG. 3. When it is desired to display a character, say the character 4, a predetermined set of valves **16** will be operated, i.e., placed in their respective "on" conditions so that fluid under pressure flows into the associated passages **11** so as to fluid actuate the corresponding selected set of balls **18** whereby the latter move to their respective forward visible positions. Under these conditions the various selected and displaced dark colored balls **18** which are now located in or adjacent to the light colored display surface **14** will collectively define a visible character 4 as illustrated in FIG. 4. Upon returning the operated valves **16** to their respective normal "off" conditions the displaced balls **18** will be free to roll by gravity back to their rearward nonvisible positions. As will be apparent successive groups of valves **16** can be serially operated (by group) so as to successively display a predetermined sequence of letters or numbers, and also by the use of several laterally adjacent display units of the above de-

scribed type several characters defining a word may be simultaneously displayed.

In FIG. 5 there is shown an alternate type of connection for the fluid control lines. Here each valve **16***a* controls the flow of fluid, such as air, to more than one passage **11**. Under these conditions each of seven valves such **16***a* may control one bar of a seven-bar numeric display matrix, the seven-bar type of display matrix having a basic **8** configuration being well known in the art.

The instant matrix type display device has been tested and found to be very reliable at relatively high speeds. It will be noted that the selected control valves effectively defining a second character may be actuated without waiting for all the balls that effectively define a first character to return to their normal positions. It will also be noted that the balls **18** may be displaced in a rearward direction as well as a forward direction by the use of suitable additional fluid pressure differentials and related control means including, e.g., bistable fluid amplifiers so that the slower gravity action illustrated in FIG. 3 need not be relied on to restore the balls to their normal positions.

Since many changes could be made in the embodiments of the invention as particularly described and shown herein without departing from the scope of the invention, it is intended that these embodiments be considered as exemplary and that the invention not be limited except as warranted by the following claims.

What is claimed is:

1. A display device comprising:

body means defining a plurality of passages, said body means having associated therewith an effective display plane located adjacent the forward ends of said passages;

an indicator member freely mounted in each of said passages for bodily movement between a forward visible position and a rearward substantially nonvisible position;

said passages each being cylindrical and each of said indicator members having an effective cross-sectional area less than that of the passages respectively associated therewith so that the resultant small annular gap around each of said indicator members will allow fluid to flow from the rearward ends of said passages past said respective indicator members and out through said forward ends of said passages;

a plurality of selectively operable means operable to direct fluid under pressure to the rearward ends of selected ones of said passages so as to cause displacement of selected ones of said indicator members between said rearward and said forward positions; and

means for retaining said indicator members in said passages and for venting the said forward ends of said passages to the surrounding atmosphere.

2. Apparatus as defined by claim **1** wherein at least one of said selectively operable means controls the admission of fluid pressure to the rearward ends of more than one of said passages.

3. A display device comprising:

body means defining a plurality of passages, said body means having associated therewith an effective display plane located adjacent the forward ends of said passages;

an indicator member mounted in each of said passages for free bodily movement between the forward visible position and a rearward substantially nonvisible position;

a plurality of selectively operable means operable to cause displacement of selected ones of said indicator members between said forward and rearward positions;

said body means including a transparent retaining plate mounted in spaced relation to said display plane for retaining said indicator members in said passages; and the forward ends of said passages being spaced from said retaining plate thereby being vented.

4. A display device comprising:

a main body member, said body member defining a plurality of passages which effectively terminate adjacent a display surface associated with said main body member;

an indicator element freely mounted in each of said passages, each such element being movable between an effective rearward substantially nonvisible position and a forward visible position adjacent said display surface, each indicator element being colored so as to contrast with the effective color of said display surface;

retaining means for respectively retaining said indicator elements in said passages;

fluid operating means for selectively displacing said indicator elements between their respective forward and rearward position;

said indicator elements comprising balls, said passages being substantially cylindrical so as to allow for the bodily free movement of said balls between said rearward and forward positions, and said passages being vented at their forward ends; and

said retaining means including a transparent plate which is fixed with respect to said main body member and which limits the forward movement of the indicator balls.

5. A fluid operated display device comprising:

a main body, said main body having a plurality of passages formed therein, the forward ends of said passages terminating at an effective display plane so as to thereby define an effective character matrix at said plane;

an indicator element freely mounted for predetermined free sliding movement in each of said passages;

a transparent retaining plate mounted on said main body in spaced relation to said display plane for preventing said indicator elements from moving out of the forward ends of said passages, the said forward ends of said passages being vented;

a source of fluid pressure;

fluid conduit lines operatively coupled between the respective rearward ends of said passages and said source; and

a fluid control valve operatively connected in each of said conduit lines whereby said indicator elements may be selectively fluid actuated to their forward display positions by the selective operation of said control valves.

6. Apparatus as defined by claim **5** wherein each of said passages is cylindrical and each of said indicator elements has an effective cross-sectional area less than that of the associated passage whereby the resultant small annular gap between each element and the walls defining the associated passage allows pressure fluid to flow from the rearward end to the forward end of the associated passage to thereby relieve the fluid pressure in the rearward end of said associated passage.

7. A fluid operated display device comprising:

a main body, said main body having a plurality of passages formed therein, the forward ends of said passages terminating at an effective display plane so as to thereby define an effective character matrix at said plane;

an indicator element freely mounted for predetermined sliding movement in each of said passages;

a transparent retaining plate for preventing said indicator elements from moving out of the forward ends of said passages, the said forward ends of said passages being vented;

a source of fluid pressure;

fluid conduit lines operatively coupled between the respective rearward ends of said passages and said source; and

a fluid control valve operatively connected in each of said conduit lines whereby said indicator elements may be selectively fluid actuated to their forward display positions by the selective operation of said control valves;

said indicator elements being balls, said transparent retaining plate being secured in spaced relation with respect to the forward ends of said passages, and at least one of said control valves comprising a fluid amplifier.

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