Sept. 29, 1970 R. F. O'KEEFE 3,530,606

LARGE SCALE FLUIDIC CHARACTER DISPLAY

Filed Oct. 28, 1968

Fig. 1.

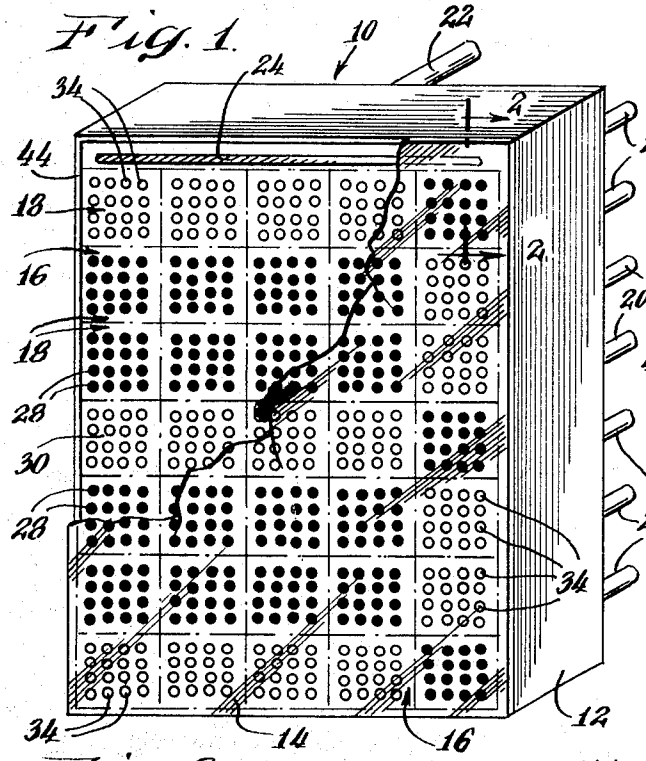


Fig. 2.

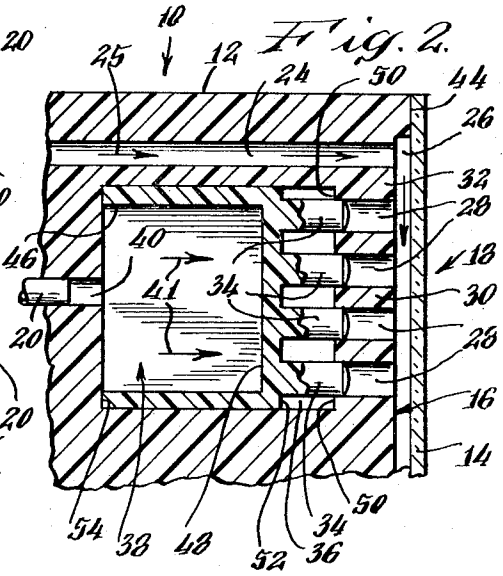


Fig. 3.

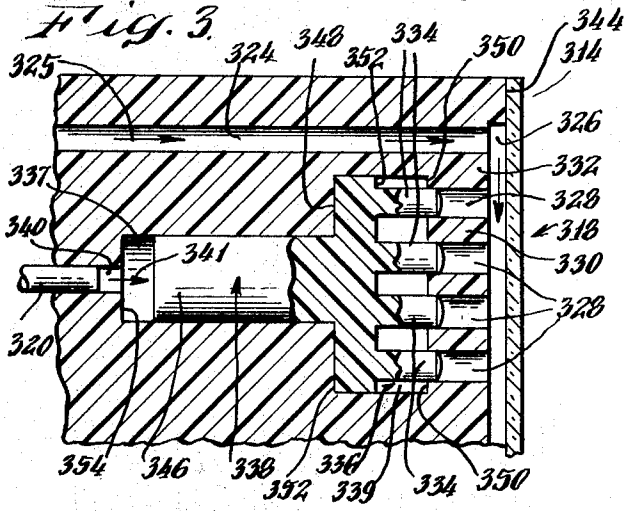
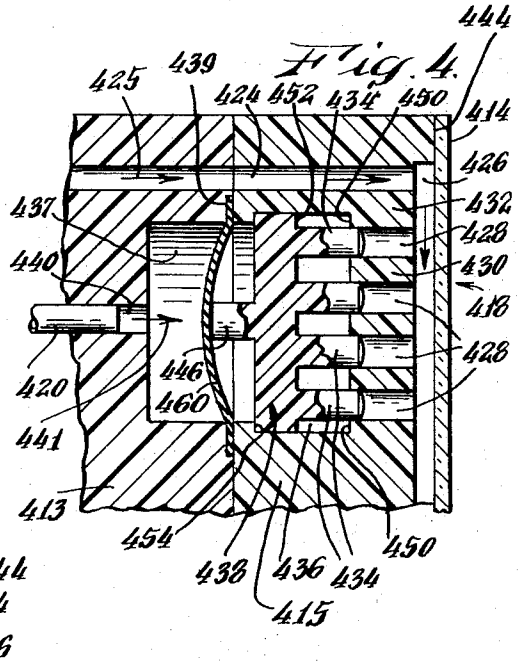


Fig. 4.



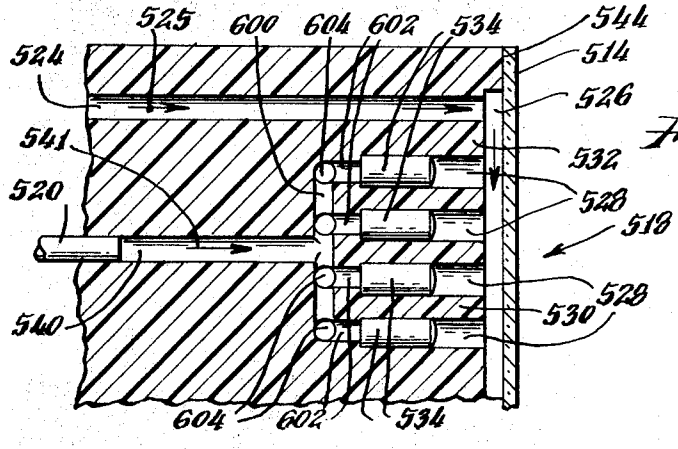


Fig. 5.

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LARGE SCALE FLUIDIC CHARACTER DISPLAY

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Int. Cl. G09f 9/30
U.S. Cl. 40—28 9 Claims

ABSTRACT OF THE DISCLOSURE

In a large scale fluidic character display of the type in which individual elements appear in different spatial patterns on a display face to form various alphanumeric characters, the elements are each divided into a plurality of sub-elements, and means are provided for insuring that all the sub-elements of an element act in unison for character display purposes. The sub-elements may be either physically or fluidically linked to achieve this result. The area of the display face which is occupied by any one of the sub-elements is but a fraction of the area occupied by the entire element. The decrease in area overcomes the response speed limitations previously encountered with large scale alphanumeric character display devices.

FIELD OF THE INVENTION

This invention relates generally to readout devices for displaying a succession of alphanumeric characters, and it is particularly concerned with a fluid driven display constructed on a large scale.

THE PRIOR ART

Data processing and control apparatus has long employed readout devices to display output information in alphanumeric form to the users of such equipment. The earliest such display devices were electrically driven, primarily because they were designed for use with electronic computing and control circuitry. More recently, the development of fluid switching and logic devices has lead to the proliferation of fluidic data handling and control equipment and a requirement for compatible character display devices.

In response to this need the type of fluid driven character display device exemplified by U.S. Pat. No. 3,400,478 was developed by the present inventor. In that device a frame resembling a honeycomb has a display face and a plurality of apertures opening therethrough. The display face has a character display area which is divided into a plurality of elemental areas, each one of which contains a single aperture of the honeycomb frame. Within each aperture is a display element in the form of a piston which reciprocates therein. Fluid pressure is used to drive some of the pistons to the front of the apertures so that they become visible at the display face, and others to the rear of the apertures so that they cannot be seen at the display face. Individual fluid lines are provided for the respective display elements, and are driven by individual fluid switching devices to obtain the appropriate spatial pattern to portray the desired alphanumeric character or other symbol.

In small scale alphanumeric readouts of the type employed, for example, in a data processing or control console, the character display need only be large enough to be visible in the immediate vicinity. In such small scale applications, this type of display has been extremely successful. In particular, its speed of response is excellent, since the characters displayed can be changed faster than the human eye can follow. In addition, in a small scale display the amount of mass included in each of the display elements is not excessive, and they can be accelerated rapidly between the visible position and the invisible position.

There are certain inherent limitations in this type of display device, however. It has been found that, in order for each individual display element to be rendered completely invisible, it must be retracted from the display face by a distance of about twice the diameter of the element. In small scale display devices, the element diameter is of the order of a minor fraction of an inch. Accordingly, the required travel of twice as much is still rather small, and the element mass is also small. It is because of this short travel and small mass that small scale display devices can be switched with sufficient speed for display purposes.

The limitations mentioned above become troublesome, however, when it is desired to produce a character display device for a large scale readout, e.g. a stock quotation or transportation arrival and departure information display, which must be large enough to be visible to a large room full of people. A display device on this scale built according to prior art concepts requires very large diameter display elements. This in turn requires a very large travel in order to preserve a ratio of 2:1 so that the display element is completely invisible in its retracted position. In addition, such large elements are massive; and the combination of massive elements moving over large distances unduly limits the response speed of the device.

SUMMARY AND OBJECTS OF THE INVENTION

It is therefore a general object of this invention to provide a high speed, large scale readout device. More specifically, this invention has as its objective the provision of a fluidic character display device of the movable element type which can be scaled up to large physical proportions without sacrificing fast response. Stated another way, the objective of this invention is to provide a fluidic character display device of this kind in which the effective element diameter is small even though the overall character proportions are greatly enlarged, so that travel distances are kept down to tolerable proportions and do not unduly limit the response speed of the device.

In carrying out the invention there is provided a large scale character display of the kind under discussion, in which each of the display elements comprises a plurality of sub-elements movable within the frame of the device from a position of visibility at the display face to a position of invisibility relative to the display face. In addition, means are provided for causing all the sub-elements of a display element to move in unison between the different visibility positions in response to fluid impulses on the individual fluid line of the display element. As a result, each such group of sub-elements acts as a single display element. Yet each individual sub-element occupies a small fraction of the element on the display face, so as to reduce the amplitude of movement necessary between the positions of visibility and invisibility. The result is a fast response time, despite the large scale proportions of the overall character display.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front perspective view of a fluidic character display device in accordance with a preferred embodiment of the present invention.

FIG. 2 is a sectional view, taken along the lines 2—2 of FIG. 1.

FIG. 3 is a sectional view similar to FIG. 2, showing an alternative embodiment of the invention.

FIG. 4 is another sectional view similar to FIGS. 2 and 3, showing another alternative embodiment of the invention.

And FIG. 5 is still another sectional view, similar to FIGS. 2–4, showing still another alternative embodiment of the invention.

The same reference characters refer to the same elements throughout the several views of the drawings; and reference characters having the same last two digits refer to corresponding elements in different embodiments of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The fluidic character display device **10** of FIGS. 1 and 2 generally comprises a large block **12** which constitutes the frame of the device, and which may be most conveniently molded from a single piece of conventional plastic material. Over the front of the frame **12** is secured a faceplate **14** of transparent material such as glass or clear plastic to permit the viewer to see an alphanumeric character displayed on the front face **16** of the frame **12**. The display face **16** comprises a plurality of elemental areas **18**, each of which contains a single display element of an alphanumeric character. In the particular example given, there are five vertical columns and seven horizontal rows of elemental areas **18**, phantom lines being provided in the drawing to separate the respective elemental areas for the purposes of illustration. Thus, the character display face **16** comprises a five by seven array of elements, and this array defines a single character position. In a typical display requiring more than one character, the display device **10** would be duplicated in horizontal rows, and possibly also in vertical columns, as many times as necessary to provide the proper number of character positions.

As in prior art devices, each individual display element **18** is "turned on" by fluid impulses (arrows **41**) which move piston means forwardly within the frame **12** to a position of visibility at the display face **16**. Individual fluid conduits **20** are provided for switching on each of the individual display elements **18** in this manner. The particular pattern of elements **18** which are "on" and "off" determines the particular alphanumeric character displayed at the moment. In the specific example of FIG. 1, the numeral **3** is displayed,

Also as in prior art devices, a common return line **22** is provided which delivers a constant fluid pressure (arrows **25**) through a return duct **24** extending through the depth and across most of the breath of the frame **12**. The pressure acts through a planar space **26** between the face plate **14** and the display face **16** to exert a continuous biasing pressure which pushes all the "off" display elements back from the display face **16** so that they are no longer visible to the viewer.

In accordance with the present invention, however, each of the elemental areas **18** of the character display face **16** contains a plurality of sub-elements, the location of which is determined by individual sub-element apertures **28**. In the specific example illustrated, there is an array of four sub-element apertures horizontally by four sub-element apertures vertically in each elemental area **18**. Each sub-element aperture **28** intersects the display face **16** at the front surface of the frame **12**, and extends rearwardly from the display face into the depth of the frame. As best seen in FIG. 2 which provides a detailed view of a representative elemental area **18**, the individual sub-element apertures **28** are separated by partitions **30** which are part of the frame **12**. Partitions **32**, which are also part of the frame block **12**, separate the elemental areas **18** from each other and from the return pressure duct **24**.

Within the sub-element apertures **28** ride small sub-elements in the form of pistons **34** which are reciprocable forwardly and rearwardly therein. Each sub-element piston **34** which is retracted to the rear of its respective sub-element aperture **28** (the position illustrated in FIG. 2) is not visible at the display face **16**. On the other hand, each sub-element piston **34** may be made visible at the display face **16** by a fluid pulse (arrows **41**) which drives it forwardly to the front of its individual sub-element aperture **28** so that the piston is visible through the transparent face plate **14**. For maximum visibility, the pistons are brightly colored, at least over their front faces **42**.

In order for each of the sub-elements within a single elemental area **18** to operate as a single display element, the frame **12** is formed with an element aperture **36** immediately behind, and in communication with, each group of sub-element apertures **28**. An element piston **38** reciprocates forwardly and rearwardly within each element aperture **36**, and is secured to all of the sub-element pistons **34** of a particular elemental area **18**. A fluid conduit **40** extending rearwardly through the frame **12** from the element aperture **36** to the rear of the frame **12** is connected to the fluid line **20** of that particular display element **18**.

Accordingly, a fluid impulse (represented by arrows **41**) arrives over a particular line **20** and drives its respective element piston **38** forwardly within its element aperture **36**, causing the associated sub-element pistons **34** to be driven forwardly within their respective sub-element apertures **28** to a position of visibilty at the display face **16**. The result is that a single fluid impulse on a single input line **20** makes visible all the sub-element pistons **34** of a given display element **18** by means of their common element piston **38**. Similarly, all other display elements **18** which are required to be "on" in the display of a particular alphanumeric character are treated in a similar manner by means of a corresponding fluid impulse on their respective input lines **20**. These fluid impulses are sustained as long as the character is displayed.

On the other hand, all those display elements **18** which are required to be "off" during the display of a particular alphanumeric character are not so driven; i.e. there is no fluid impulse on their respective input lines **20**. The continuous pressure (represented by arrows **25**) communicated from the return line **22** and duct **24** to the planar space **26**, produces a biasing force on the front surfaces **42** of the sub-element pistons **34**. This force is not great enough to overcome the impulses **41** applied to the "on" pistons, but it drives the pistons **34** and **38** of the "off" display elements rearwardly to a position of invisibility relative to the display face **16**. Then all that can be seen is the dark interior of the associated apertures **28**, which contrasts with the brightly colored surfaces **42** seen in other elemental areas. The return pressure within the planar space **26** also serves to return a previously "on" display element **18** to its "off" condition when the switching impulse **41** terminates.

The front faces **42** of the sub-element pistons **34** are somewhat convexly curved so that even when these pistons are all the way forward, at least the margins of the forward faces **42** are out of contact with the transparent face plate **14**, permitting the return fluid pressure to bias the pistons rearwardly at the appropriate time. The space **26** is created by disposing the transparent face plate **14** somewhat forwardly of the display face **16**. This is accomplished by providing the frame **12** with a border **44** to which the face plate **14** is cemented, the border **44** extending some distance beyond the partitions **30** and **32**.

In the embodiment of FIGS. 1 and 2 the element piston **38** is in the form of a hollow cylinder. The term "cylinder" is used herein in its general sense, in which the cylinder can have any desired external cross-sectional shape, for example circular, square or rectangular. The cylinder is open at the rear end **46** thereof, and has a front member **48** closing off the forward end. The group of sub-element pistons **34** within an element area **18** all extend forwardly from their associated front member **48**. The entire assembly of the element piston **38** and its associated sub-element pistons **34** may be most conveniently fabricated from a single piece of molded plastic material of a conventional kind. If desired, a shoulder **50**

may be formed in the frame **12** around the edges of the element aperture **36** in the plane where the sub-element apertures **28** open into the element aperture **36**. This shoulder **50** cooperates with a shoulder **52** formed at the margin of the front face of the element piston **38**, to limit the forward movement of the entire assembly **38, 34**. The length of the sub-element pistons **34** should then be so selected that the rounded forward faces **42** thereof at least reach the forward ends of the sub-element apertures **28**, and preferably protrude forwardly therefrom and touch or closely approach the transparent face plate **14** for maximum visibility when the display element **18** is switched "on." Alternatively, the face plate **14** itself can serve to limit forward motion of the piston assembly.

At the rear of the element aperture **36**, where it joins the fluid conduit **40**, there is an annular surface **54** cooperating with the rear end of the element piston **38** to limit the rearward motion thereof produced by the return pressure (arrows **25**). If the surface **54** is so placed that when the element piston **38** is fully retracted, the sub-element pistons **34** are not entirely retracted from the sub-element apertures **28**, as illustrated in FIG. 2, then the sub-element pistons remain keyed to the sub-element apertures to prevent unwanted rotation of the element pistons **38**, and the cross-sectional shape of the element piston **38** may be circular if desired.

On the other hand the limiting surface **54** may be set back far enough so that the sub-element pistons **34** are fully withdrawn from the sub-element apertures **28**. In that case it is desirable for the cross-sectional shape of the element pistons **38** to be non-circular to prevent rotation of the element piston in the element aperture **36**, so that on the next forward movement of the element piston, the sub-element pistons **34** will again line up perfectly with their corresponding sub-element apertures **28**. In either case the internal cross-sectional shape of the element aperture **36** must be substantially congruent with the external cross-sectional shape chosen for the element piston. Such congruence provides a close but slideable fit between the element piston **38** and the element aperture **36**, so as to provide a fluid seal therebetween, yet permit the piston to reciprocate freely within its aperture.

The visible area of the sub-element pistons **34** is the front face **42**, and it is the diameter of this visible piston face which determines the travel necessary for each sub-element piston to withdraw to a position of invisibility within its aperture **28**. Since the diameter of the front face **42** of each individual sub-element piston is far smaller than the corresponding diameter of a single large piston required to occupy an entire display element **18** by itself, the required piston travel is reduced, in the same ratio as the diameter reduction. The result is a sharp reduction in the response time of the device **10**, so that the device can be scaled up to large proportions to provide a display which is legible from a distance without undue sacrifice in speed.

To the viewer, the present character display differs from prior art devices only in that each element which forms a part of an alphanumeric character is itself broken up into dots, somewhat in the nature of a half-tone print, However, from the distances at which a large scale alphanumeric display device of this kind is intended to be viewed, these dots tend to merge into each other, so that each element in the character display will have an off-white, unitary visual effect upon the observer.

FIG. 3 shows a typical display element **318** of a somewhat different embodiment. The structure is basically similar similar to that of FIGS. 1 and 2. A transparent face plate **314** is secured to a border **344** of a frame **312**. A return duct **324** provides continuous fluid return pressure represented by arrows **325**, and introduces that return pressure into the space **326** between the face plate **314** and the display face **316** of the frame **312**. The frame is provided with sub-element apertures **328** which communicate with an element aperture **336**. The sub-element apertures **328** of a display element are separated from each other by partitions **330**, and separated from the return pressure duct **324** and adjacent display element areas by partitions **332**. Sub-element pistons **334** with brightly colored, convexly curved front faces **342** reciprocate within the individual sub-element apertures **328**, and are integral with an element piston **338** reciprocating within the element aperture **336**.

In this embodiment, however, the element piston **338** comprises a solid cylindrical body **346** of circular cross-section in this instance, which reciprocates with a corresponding shaped bore **337** at the rear of the element aperture **336**. The individual fluid line **320** of the display element **318** joins a fluid conduit **340** which is formed in the frame **312** and communicates with the rear of the bore **337** to deliver a fluid switching impulse (arrow **341**) to the body **346**. At the forward end of the cylindrical body **346**, the element piston **338** is formed with an enlarged flange **348** which rides in an enlarged cavity **339** at the front of the element aperture **336**. It is this enlarged front flange **348** which carries the integrally molded sub-element pistons **334** associated with the particular display element **318**.

Shoulder **350** is provided for a purpose similar to the shoulder **50** of the preceeding embodiment. This cooperates with shoulder **352** on the margins of the front surface of the flange **348** to limit forward movement of the element piston **338**. Limitation of rearward retraction of the element piston is provided by the abutment of the rear surface of the cylindrical body **346** against the annular rear wall **354** of the bore **337**. Once again, the rotation of the piston assembly **338, 334** can be prevented either by preventing full retraction of the sub-element pistons **34** from their respective sub-element apertures **328**, or by providing flange **348** with a non-circular external cross-sectional shape so that it is not rotatable relative to the mating internal cross-sectional shape of the aperture cavity **339**. Alternatively, the cylinder **346** can be made non-circular, along with its mating bore **337**.

FIG. 4 illustrates another embodiment in which the structure is basically similar. A frame **412** has a broder **444** to which is secured a transparent face plate **414**. Behind the face plate is a return pressure space **426** fed by a duct **424** extending through the frame **412**. The return pressure is represented by arrows **425**. The frame is provided with a group of sub-element apertures **428** comprising a display element **418**. Partitions **430** separate the sub-element apertures **428** from each other, while partitions **432** separate the display elements **418** from each other and from the return pressure duct **424**. Sub-element pistons **434** with brightly colored, convexly curved front faces **442** reciprocate within the sub-element apertures **428**, and are integrally molded with an element piston in the form of a plate **438** disposed parallel to the display face **416**. The element piston **438** reciprocates within an element aperture **436**, and is formed with a marginal shoulder **452** which engages a marginal shoulder **450** of the frame to limit forward movement of the piston. The rear margin of the piston **438** engages a marginal shoulder **454** to limit rearward motion.

In this embodiment the frame **412** is divided into a rear portion **413** and a separate front portion **415**. Front portion **413** is formed with the rear end of the return pressure duct **424**, the fluid impulse conduit **440**, and a chamber **437**. The front portion **415** is formed with the front end of the return pressure duct **424**, the sub-element apertures **428** and the element aperture **436**. An elastomeric sheet **460** in the form of a rubber diaphragm is stretched across the rear of the element aperture **436**. The edges of the sheet **460** are received within an annular recess **439** formed in the frame portion **413**, around the edges of the chamber **437**. In assembling the embodiment of FIG. 4, the diaphragm **460** is cemented within the annular recess **439** and the frame sections **413** and **415** are cemented together to anchor the diaphragm **460** in place.

The inherent resilience of the diaphragm **460** causes it to exert a continuous forward biasing force against the piston **438** by means of a plunger **446** located at the rear of the piston. This forward biasing force exerted by the diaphragm **460** assists the fluid switching impulse, represented by arrow **441**, in driving the piston assembly forward for rendering the display element **418** visible at the display face **416**. This fluid switching impulse is delivered by individual line **420** through conduit **440**, and enters the chamber **437** to exert its pressure on the diaphragm **460**, which in turn acts on plunger **446** and piston **438**.

When the "on" impulse terminates, then the return pressure (arrows) **425** in duct **424** and space **426** drives the piston assembly back into its invisible position. When this happens, the plunger **446** distends the diaphragm **460** in a rearward direction as seen in FIG. 4, the chamber **437** providing the necessary room for the diaphragm to flex rearwardly.

In the embodiments of the preceding figures the sub-element pistons were in each case mechanically connected together. However it is also possible for them to be mechanically independent of each other, yet act in unison by means of a common fluid input. In the embodiment of FIG. 5 the frame **512** once again has a border **544** to which a transparent face plate **514** is secured. A return pressure duct **524** is provided through which a steady return pressure represented by arrows **525** is applied to the space **526** between the face plate **514** and the display face **516**. The switching impulse is delivered over an individual fluid line **520**. The frame **512** is formed with individual sub-element apertures **528**, each of which has an individual sub-element piston **534** reciprocable therein. Each piston has a brightly colored convex front face **542**. Partitions **530** separate the adjacent sub-element apertures **528** of each display element **518**, while partitions **532** separate the display elements **518** from each other and from the return pressure duct **524**.

There is no mechanical connection between the sub-element pistons **534**, but the conduit **540** which receives the fluid switching impulse represented by arrow **541** has a plurality of branches which distribute the fluid impulse to all the sub-element pistons **534** of a single display element **518**, so that they are driven forwardly into their visible position in unison. Thus the conduit **540** branches into a vertical conduit **600**, which in turn branches into a plurality of forwardly directed horizontal conduits **602** to impulse the particular vertical bank of sub-element pistons **534** visible in FIG. 5, as well as sidewardly directed horizontal branch passages **604** which go to other vertical banks of sub-element pistons **534** within the same display element **518**. As a result, a single fluid switching impulse **541** turns "on" the entire display element **518** by moving all its sub-element pistons in unison.

All sub-element pistons **534** of every other display element **518** which must be turned on at the same time to portray the desired alphanumeric character are similarly switched in unison by their respective fluid impulses. On the other hand, all display elements **518** which are required to be switched off for the particular alphanumeric character are not provided with fluid impulses **541**. As a result, the return pressure represented by arrows **525** drives all the sub-element pistons **534** of those display elements **518** to their retracted or invisible positions illustrated in FIG. 5. Similarly, when a display element **518** which has been "on" must then be turned "off," the fluid impulse **541** terminates, whereupon the return pressure **525** biases all the sub-element pistons **534** back to their original invisible positions.

An additional advantage which the FIG. 5 embodiment has over the prior art resides in the fact that its response speed is further reduced, owing to the fact that the mass of each sub-element piston **534** is far less than the mass required for a single piston large enough to occupy the entire display element area **18**, and also far less than the total mass of the element piston and sub-element piston assemblies of the preceding figures. As a result, each sub-element piston **534** can be more rapidly accelerated, and thus responds more quickly when switched from one position to another.

Thus, in each of its embodiments the present invention provides a way of sub-dividing each display element into a plurality of sub-elements acting in unison, so as to achieve essentially the same character readout results with much smaller piston travel requirements. Consequently, much faster response speeds can be achieved with large scale display devices designed to be visible to a large room full of people.

Since the foregoing description and drawings are merely illustrative, the scope of protection of the invention has been more broadly stated in the following claims; and these should be liberally interpreted so as to obtain the benefit of all equivalents to which the invention is fairly entitled.

The invention claimed is:

1. In a large scale fluid-driven character display of the type having a frame, a display face on said frame including at least one character position, an array of elements at said character position, each element occupying an elemental area, said elements being individually movable within said frame from a position of visibility at said display face to a position of invisibility relative to said display face, means for connecting individual fluid lines to convey fluid impulses for moving respective display elements independently between said different visibility positions so that selected spatial patterns of display elements can be made visible to portray respective characters at said display face, and means for subsequently returning said display elements to their original positions; the improvement wherein:

each of said display elements comprises a plurality of sub-elements movable within said frame from a position of visibility at said display face to a position of invisibility relative to said display face;

said character display comprises means for causing all of the sub-elements of a display element to move in unison between said different visibility positions in response to said fluid impulses on the individual fluid line of said display element whereby to act as a group for character display purposes;

and each of said sub-elements occupies a fraction of said elemental area whereby to reduce the amplitude of movement necessary between said positions of visibility and invisibility.

2. A character display as in claim **1** wherein:

said means for causing said group of sub-elements to move in unison comprises means for connecting said individual fluid line of said display element in common to all sub-elements of said group.

3. A character display as in claim **2** wherein:

said frame is provided with a plurality of individual sub-element apertures adjacent said display face and extending transversely therefrom;

said sub-elements comprise individual sub-element pistons reciprocable within respective one of said sub-element apertures between said positions of visibility and invisibility relative to said display face;

and said common connection comprises fluid conduit means formed in said frame and branching to connect the individual fluid line of a display element to deliver said fluid impulses to all the sub-element pistons within an elemental area.

4. A character display as in claim **1** wherein:

said means for causing said sub-elements to move in unison comprises a mechanical interconnection between the sub-elements of a display element.

5. A character display as in claim **4** wherein:

said frame is provided with a plurality of individual sub-element apertures adjacent said display face and extending transversely therefrom;

said sub-elements comprise individual sub-element pistons reciprocable within respective one of said sub-element apertures between said positions of visibility and invisibility relative to said display face;

said frame is provided with respective element apertures at the ends remote from said display face of respective groups of sub-element apertures within the same elemental area;

and said mechanical interconnection comprises respective element pistons reciprocable transversely to said display face within respective element apertures in response to said fluid impulses on the respective fluid lines of respective display elements;

said element pistons being secured to each of the sub-element pistons of their respective display elements whereby the element piston and its associated sub-element pistons of each display element move as a unit in response to said fluid impulses.

6. A character display as in claim **4** wherein:

said element pistons are hollow cylinders of any desired external cross-sectional shape, said cylinders being open at a rear end thereof remote from said display face and having a front face closing off the forward end of said cylinder;

said sub-element pistons of each display element extending forwardly from said front face;

said element apertures having internal cross-sectional shapes substantially congruent with the external cross-sectional shapes of said element pistons.

7. A character display as in claim **4** wherein:

said element pistons comprise respective cylindrical bodies of any desired external cross-sectional shape, each having an enlarged flange at a forward end of said body;

said sub-element pistons of each display element extending forwardly from said flange;

said element apertures having a first internal cross-sectional shape at the rear thereof which is substantially congruent with the external cross-sectional shape of said cylindrical body, and a second internal cross-sectional shape at the front thereof which is substantially congruent with the external cross-sectional shape of said flange.

8. A character display as in claim **4** wherein:

said element pistons comprise respective connecting plates extending substantially parallel to said display face;

said sub-element pistons of each display element extending forwardly from said connecting plate toward said display face;

and said element apertures being formed with internal cross-sectional shapes substantially congruent with the external cross-sectional shape of said connecting plates.

9. A character display as in claim **8** further comprising:

an elastomeric sheet behind each connecting plate and substantially parallel thereto;

means for clamping the edges of said sheet for anchoring it in place relative to said frame;

and a plunger at the rear of said connecting plate engaging a central region of said sheet and rearwardly distending the material thereof whereby said sheets bias their respective element piston and associated sub-element pistons forwardly toward said display face;

said element apertures including space for said respective sheets to distend rearwardly therein;

said individual fluid lines being connected to introduce said fluid impulses rearwardly of the respective elastomeric sheets of each display element whereby to assist said sheet in propelling said pistons forwardly toward said display face for character display purposes.

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