MOVABLE DISPLAY MEMBER CONTROLLED BY IMPEDANCE ELEMENTS MOUNTED ON SAID MEMBER

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This invention relates generally to display devices, and particularly to devices which are capable of statically displayed graphically recorded intelligence, and which are also capable of providing coded electrical signals corresponding to the displayed intelligence.

There has been a long felt need in the graphic-display arts for a display device of simple, reliable, and rugged construction for statically displaying graphically recorded intelligence while simultaneously transmitting and corresponding electrical signals representative of said intelligence, the latter signals being useful for remote control of the graphic display. The difficulty with prior display apparatus in this general category has been that the code representations of the graphic display records from which the electrical code representations are derived tend to obscure or otherwise interfere with the display of the graphic intelligence, and the electrical sensing apparatus has been unreliable. One particular prior-art arrangement requires physical brush-type contact between the unit which transmits the electrical representations and the record-bearing member. In order to avoid such physical contact, resort has been had in other prior-art arrangements to the use of photoconductive elements and the like which are actuated by associated light sources through apertures or the equivalent in the record medium. In this instance, the code apertures obscure or occupy valuable graphic record space, and, in addition, the operational life of the display device is shortened by the use of relatively short-lived components; e.g., photocells and light bulbs. Other disadvantages are that photocells and light bulbs occupy a considerable volume within the display apparatus, and, upon failure of any code-digits signalling unit, the malfunctioning component—e.g., light source or photocell—is not readily ascertainable.

In still other arrangements, magnetic-code representations have been tried which require movement of a magnetically coded graphic record member relative to a magnetic sensing head at a predetermined speed for generating the required electrical output signals. In this instance, while the magnetic representations need not obscure the graphic records, the requirement of movement poses a severe design problem.

Accordingly, it is an object of this invention to provide a display device of simple, reliable, and rugged construction which is capable, while in a static condition, of displaying graphically recorded intelligence and of simultaneously transmitting electrical code signals which accurately represent said displayed intelligence.

Another object is to provide a display arrangement having the foregoing attributes, which is more sensitive than hitherto available devices.

A feature of my invention resides in the provision of a housing in which is located a signalling unit including a plurality of electrical-signal-translating networks each having a reactive load therein. The said reactive loads are all of similar composition and construction, and they are arranged to correspond with respective code-digit regions, of variably determined composition, in a graphic record member, so as to present different impedances to applied electrical signals which are thus variably translated through the associated networks. As a result, the output signals appearing at the said reactive loads differ from the applied electrical input signal in accordance with code representations on the graphic record member, this being accomplished without contact between the signalling unit and the record member, and without the necessity for relative movement therebetween. The resulting arrangement is highly reliable, durable, compact, and rugged in construction.

Another feature of my invention involves the use of a graphic record member, such as an endless belt, which includes a closed surface of a given length, along which the graphic items of intelligence are distributed at equal intervals covering the entire length of the surface, and wherein the code representations assigned to graphic items which are spaced apart by one half of the total length of the said surface, are binary complements of each other. The code signalling unit is arranged to sense simultaneously the code representations at points one half of the said surface length apart, so that the differences between binary "one" and "zero" output signals which are derived through the reactive loads in the signal-translating networks in the above-mentioned signalling unit are twice as great as the differences which would otherwise be obtained.

These and other objects and features of my invention may be more fully understood and appreciated when considered in connection with the following detailed description to be read in association with the accompanying drawings wherein:

FIG. 1 is a view in perspective of a display device in accordance with the present invention, with a portion thereof broken away to reveal the internal arrangement of parts therein.

FIG. 2 is a diagrammatic view in elevation of a portion of the inner surface of the graphic display record member employed in the apparatus of FIG. 1.

FIG. 3 is a schematic block diagram illustrating the general arrangement of a signalling unit, in accordance with my invention.

FIG. 4 is a schematic drawing illustrating the circuit details of a typical one of the signal-translating network channels indicated in FIG. 3.

FIG. 5 is a diagrammatic view of a preferred arrangement for varying both of the reactive elements shown in the bridge circuit of FIG. 4 in complementary fashion so as to provide a greater difference in amplitude between binary "one" and "zero" signals translated through said circuit.

Referring now particularly to FIG. 1, a display according to my invention comprises a housing 1 having a protective transparent cover plate 2 fastened thereto. Plate 2 covers a row of display apertures 3 through which graphically recorded intelligence may be viewed. In the preferred arrangement, symbols and/or characters, which are to be displayed in the apertures 3, are disposed on the outer closed surfaces of endless belt members, such as the member 4 which is shown in the broken-away view through the housing. Although endless belt members are shown, those skilled in the art will immediately appreciate that, in many instances, the corresponding display function could also be provided by disc-type members and the like.

The images which are to be displayed are located at given intervals along the outer surface of each belt. In the preferred arrangement, the given intervals are all equal, and they cover the entire length of the said outer surface. I find it advantageous to allot one of these intervals to a blank, or empty, display region, so that any one of the belts may be conveniently omitted from the combined row display. I further find it convenient to position the belts so that they convey the recorded graphic images across the associated apertures in a direction parallel to the row of apertures, so that a slight irregularity in the positioning of any individual image in the row only affects the lateral spacing between that image and the ad-
jacent ones, without vertical misalignment of the said images, the latter having a more noticeable and disagreeable visual effect.

In the exemplary arrangement of FIG. 1, seven apertures are provided, which, viewed from left to right in the particular illustration, are displaying the combination of symbols NWK-39, the darkened areas representing the above-mentioned blank display intervals. This arrangement may thus be used to represent, for example, an airline announcement of the departure of flight 39 from Newark Airport.

Each of the graphic display record members 4 is driven by a corresponding shaft 5 over corresponding rollers, not shown, in the vicinity of the associated aperture 3. The belts are coupled to the shaft 5 and are driven thereby, by means of sprocket holes 6 which are engaged by suitable sprocket projections on the shafts 5. Each shaft 5 is discretely positioned by means of a stepping servo motor which is located either to the rear of the shafts or within the enclosures defined by the record members 4, but which is not shown in FIG. 1 in order to avoid complication of the drawing with unessential details. Each stepping servo motor is coupled to the shaft 5 by means of a coupling belt or gear which, again for the sake of simplicity, is not shown in the drawing, as such arrangements are well known to those skilled in the art. Suitable miniature stepping servo motors for this purpose and associated driving arrangements are referred to and illustrated, for example, in an article entitled *Stepper Motors May Someday Replace A.C. and D.C. Servo Motors,* in the September 1960 issue of Electro-mechanical Design, pages 39–40, and also in Bulletin (brochure) 4–12 of American Electronics Inc., entitled *Logic Stepper Controls.*

A signalling unit 10 is positioned preferably within the belt enclosure to coat with special material on the surface of the record member 4, so as to provide electrical code output signals representative of the intelligence being visually displayed in the associated aperture 3, for each discrete display position of the record member in the novel manner described below.

Referring to FIG. 2, each of the graphic record members 4 preferably contains overlaying graphic and coded representations located respectively on the outer and inner surfaces of the belt 4, as indicated in the region 19. A graphic record indicated in dotted outline at 20 is the letter U while the coded representation in the present instance is a binary-code representation which is used to represent the letter N. This is done to indicate that the graphic symbol being displayed is the letter N, although the graphic symbol adjacent the signalling unit 10 is the character U. The binary-code representation includes, in this particular instance, three binary-digit areas as indicated at 21 in which the surface material is the same as in the adjacent areas of the member 4, and three other binary-code-digit areas indicated at 22 in which the composition of the surface material is altered by means of a coating of different composition, or the like, as further explained below. These code-digit areas affect the impedances of corresponding reactive elements in the sensing unit 10 to provide thereby dynamically varying electrical code signals in a manner discussed below. The combination of the areas 21 and 22 taken in sequence from left to right, top row first and then bottom row, represents the combination of binary digits 010101, which combination as indicated in the figure is assigned to the letter N.

Referring now to FIG. 3, a signalling unit 10 which cooperates with the coded representations on the belt member 4 is shown. Such a unit generally comprises an input terminal 30 and six output terminals 31–36 between which are respectively connected signal-translating networks 41–46. In operation, a fluctuating electrical signal, either in the form of a pulsed or alternating current is applied through terminal 30 to the individual nets-works 41–46. Thus, at the outputs, 31–36, the resultant signals are altered in accordance with the respective binary-digit impedance coupling between the said networks and the belt member 4 as described below.

Each of the networks 41–46 preferably comprises a bridge circuit including parallel circuit paths connected between a pair of terminals 30 to which the aforementioned fluctuating signal is applied. Each of these parallel circuit paths in the present instance preferably consists of a series reactance and resistance, and the circuit output is taken across the junctions of the series reactances and resistances. More particularly, referring to FIG. 4, the network 41, shown by way of example, includes the series combination of a reactance X1 and resistance R1 connected in parallel with the series combination of a reactance X2 and resistance R2 across the input terminals 30. The output terminals 31 of network 41 are connected between the respective junctions of the aforesaid reactances and resistances, one of the output terminals being grounded for convenience as indicated at 50.

In operation, a pulse signal applied to terminal 30 is transferred to all six networks 41–46, while either one or both of the bridge reactances, which are located adjacent the surface of the member 4, are varied in accordance with the composition of the surface material in corresponding digit regions of the member 4, as indicated in FIG. 2, in a manner to be discussed in detail below. Referring to the previously described network, X1 and X2 may either be inductive or capacitive type reactances, and the different material in the regions 22 of the member 4 will accordingly differ in magnetic permeability or dielectric constant, respectively, from the surrounding composition of the member 4.

In the preferred arrangement as seen from FIG. 5, the reactances X1 and X2 are taken to be inductive reactances, and both are used in the determination of the bridge output as follows. Referring to FIG. 5, as indicated schematically, the digit-sensing reactive elements X1 and X2 in the preferred arrangement communicate with the interior surfaces of the belt 4 at points spaced apart one half of the total length (L) of the belt 4. The elements X1 and X2 respectively comprise inductors, 61 and 62, which are respectively wound on partial magnetic core members, 63 and 64, which are generally C-shaped and having their open portions adjacent corresponding digit areas of the belt 4 at a distance 1/4L apart. Six such pairs of sensing elements are arranged so that, in any discrete character-displaying position of the belt, each pair of members, e.g. 63 and 64, are facing corresponding digit regions of complementary code representations. Specifically, considering, for example, the representation 010101 shown in FIG. 2, for the letter N, the complementary representation is the representation 101010 (which may, for example, constitute the representation of a graphic image displaced 1/2L from the image "N"), and if, for example, the element X1 were positioned opposite the first digit of the representation for N, namely, 0, then the elements X2 would be positioned adjacent the first digit of the complementary representation, namely, 1. Thus, in general, if the code digit to be electrically transmitted to the output terminal 31 is to be a representation of binary 1, then the normally magnetically impermeable tape 4 would be coated with a magnetically permeable material in the region facing the member 63, while in the region facing the member 64 no magnetically permeable coating would be provided, so that the resultant effect on the bridge circuit network 41 will be a variation in the impedance of the elements 61 and 62, causing an output from the network 41.
fore the bridge circuit leg containing the element X2 would be varied while that containing the element X1 would remain unaltered. As a result, the difference between a binary 1 and a binary 0 output signal is twice as great, since if the applied input signal is, for example, a positive-going pulse at the upper terminal 30 in relation to the lower terminal 30, then for a binary 1 condition on the load 4, the self-inductance of X1 is greater than the self-inductance of X2, and the potential drop across inductive reactance X1 is therefore greater than that across inductive reactance X2 during the pulse, so that the potential at the ungrounded terminal 31 is relatively negative-going with respect to the grounded terminal. For the same reasons, under binary 0 conditions an input pulse will be translated as a relatively positive-going pulse at the ungrounded terminal 31 relative to ground. The difference between the positive- and negative-going output pulses respectively associated with binary 1 and 0 values is thus twice that which would be obtained if only one of the inductive reactances X1 and X2 were varied. However, in similar instances where space is of the essence, it may be desirable to employ a signalling unit in which only a single one of the reactances is varied, and therefore, it should be noted that the foregoing arrangement shown in FIG. 5 is only the preferred one of a plurality of possibilities. It should also be understood that the arrangement of FIG. 5 requires six pairs of reactive reactive elements such as the pair, X1 and X2, which consist of six corresponding pairs of complementary binary-code-digit regions on the inner surface of the tape 4 to produce six electrical output signals indicative of the value of the magnetic-code representation on the tape. It is further emphasized that the electrical representation produced by the signalling unit is preferably associated with the graphic item of intelligence which is being displayed in the aperture 3, which item is not necessarily the same as that observing the magnetic-code representation adjacent the signalling unit.

It should further be noted that an analogous reactive arrangement could also be used in which, for the elements X1 and X2, conductive plates are used, and in which the material on tape 4 is a dielectric which is backed by a conductive plate connected to one of the terminals 31 of FIG. 4, so that the combination then represents a capacitor, and the binary 1 areas may then be embossed areas of dielectric volume which provide corresponding increases in the capacitance between the aforementioned plates, whereby the output signals obtained therefrom are correspondingly varied in accordance with the value of a binary-code digit.

While the principles of my invention have been described above in connection with a particular embodiment, and particular variants thereof, it is to be understood that this description is made only by way of example and not as a limitation on the scope of the invention as set forth in the objects thereof and in the following claims.

I claim:

1. A display device comprising:
(a) a housing having a display region therein;
(b) a signalling unit mounted within said housing including first and second sets of electrical signal translating networks having reactive loads therein of the same composition and construction, the reactances of which loads vary in a predetermined manner when the said loads are positioned near material of a given composition; and

(c) a graphic-display record member mounted within said housing for movement in relation to said display region and said signalling unit, said member having corresponding graphic and code representations recorded thereon, which are respectively movable adjacent said display region and said unit, to determine simultaneously a static graphic display and a corresponding set of dynamic electrical output signals, the said member including a closed surface along which the said graphic representations are uniformly distributed at equal intervals, and further along which the said code representations are distributed at the same equal intervals,
(d) each said recorded code representations comprising a set of elemental binary code digit regions in which the different binary code digit values are represented respectively by the presence or absence of said material of a given composition, said representations having first and second regions spaced apart by one-half the total length of said closed surface and being binary complements of each other, said representations being operative statically to vary the reactances of corresponding ones of said reactive loads in said first and second sets of electrical signal translating networks of the signalling unit when the corresponding graphic representations are adjacent said display region, whereby electrical signals transferred through said reactive loads may be altered in accordance with the code representations of said displayed graphic representations.

2. A device according to claim 1 in which
(a) one of said intervals is allotted to a blank graphic display representation.

3. A device including a plurality of members according to claim 1 in which
(a) the said graphic representations on said members in said display region are aligned in a row, and
(b) the said members are constrained to move parallel to said row in said display region to prevent vertical mis-alignment of said displayed graphic representations.

4. A device according to claim 1 in which
(a) the said member is an endless belt.

5. A device according to claim 1 in which
(a) the said movement of said member is limited to discrete incremental displacements corresponding to the spacings between successive ones of said graphic representations.

References Cited by the Examiners

UNITED STATES PATENTS
2,073,066 3/1937 Wheeler et al. 340—324
2,784,392 3/1957 Chaimowicz 340—174.1
2,897,267 7/1959 Prince 340—174.1 X
3,197,765 7/1965 Simpkin 340—174.1

OTHER REFERENCES

NEIL C. READ, Primary Examiner.

H. I. PITTS, Assistant Examiner.