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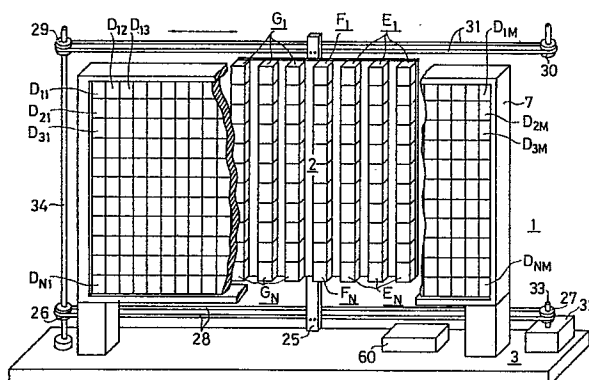
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54 **Display panel and display elements therefor.**

57 A display panel which is provided with a display surface structure having a large number of display elements rotatably arranged in a vertical plane. The display elements are each formed by a block member having a plurality of display surfaces of different colors and a plurality of magnetic pieces. One of the magnetic pieces is shorter than the others in a vertical direction. By successive movement of head assemblies, each comprised of a first erasing head, a second erasing head and a writing head, one or more of the display elements are turned to bring a predetermined one of their display surfaces to the front of the display surface to erase a display of a character, graph, pattern or the like provided thereon, thereafter bringing a selected one of the display surfaces of a selected display element or elements to the front of the display surface to provide thereon a display of a character, graph, pattern or the like.



DISPLAY PANEL AND DISPLAY ELEMENTS THEREFORBACKGROUND OF THE INVENTIONField of the Invention

This invention relates to a display panel which has a large number of display elements arranged in the same vertical plane to provide a display of a character, graph, pattern or the like, and display elements for use in the display panel.

Description of the Prior Art

Display panels of this type are employed for providing a display of a traffic sign, a directional sign, an advertisement, time, date or like information. Display elements used in the past are usually formed by electrophoto conversion elements, and hence are of large power consumption. Further, the conventional display elements are readily broken by an external force and short-lived. Also there have been proposed display panels of the type employing display elements, each formed by a block member having a plurality of display surfaces of different colors, but these panels are defective in that the contents of displays cannot easily be changed.

SUMMARY OF THE INVENTION

Accordingly, this invention is to provide a novel display panel free from the abovesaid defects of the prior art and display elements for use in the display panel.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view, partly cut away, schematically showing an embodiment of the display panel of this invention;

5 Fig. 2 is a front view of an example of a display surface structure of the display panel depicted in Fig. 1;

Fig. 3 is a sectional view taken on the line III-III in Fig. 2;

10 Fig. 4 is a front view of an example of a display element of this invention;

Fig. 5 is a bottom view of the display element shown in Fig. 4;

Fig. 6 is a sectional view taken on the line VI-VI in Fig. 4;

15 Fig. 7 is a sectional view taken on the line VII-VII in Fig. 4;

Fig. 8 is an enlarged front view, partly in section, schematically illustrating in detail a portion of the display surface structure depicted in Fig. 2;

20 Fig. 9 is a sectional view taken on the line IX-IX in Fig. 8;

Fig. 10 illustrates how Figs. 10A and 10B are interconnected;

25 Fig. 10A and 10B show in elevation an example of a display switching unit and an example of the circuit

-3-

construction of a drive unit for use in the display panel of this invention;

Fig. 11 is a perspective view schematically showing, by way of example, one of electromagnets forming each of first erasing heads and writing heads;

Fig. 12 is a perspective view schematically showing, by way of example, an electro magnet forming each of second erasing heads;

Fig. 13 is a sectional view taken on the line XIII-XIII in Fig. 10A;

Figs. 14 and 15 are tables showing a sequence of change of the front display surface of each display element during erasing and writing, respectively;

Fig. 16 is a front view schematically illustrating another embodiment of the display panel of the present invention;

Fig. 17 is a plan view of the display panel shown in Fig. 16; and

Figs. 18 and 19 are an enlarged front view schematically illustrating in detail a portion of the display surface structure of the display panel shown in Figs. 16 and 17 and its side view.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 illustrates an embodiment of a display panel of this invention, which is composed of a display surface

-4-

structure 1, a display switching unit 2 and a drive unit 3.

In the example of the display surface structure 1 such as shown in Figs. 2 and 3, letting N horizontal lines of arrangement spaced a predetermined distance L_A from adjacent ones of them in a vertical direction be represented by a_1 , a_2 , a_N , respectively, M display elements D_{i1} , D_{i2} , ... D_{iM} are disposed on the horizontal line a_i ($i=1, 2, \dots N$) at predetermined intervals L_B in a horizontal direction.

In this instance, the display element D_{ij} ($j=1, 2, \dots M$) has a construction such, for example, as shown in Figs. 4, 5, 6 and 7 in which a four-sided right prismatic member 4 formed as of a synthetic resin material has a height H a little smaller than the distance L_A and a width W a little smaller than the interval L_B , has two pairs of opposed display surfaces d_1 and d_3 and d_2 and d_4 of different color displays, for instance, in red, blue, white and green, and has a square cross section.

The display element D_{ij} has embedded therein magnetic pieces m_1 , m_2 , m_3 and m_0 at the parallel edges between the display surfaces d_1 and d_4 , between d_1 and d_2 , between d_2 and d_3 and between d_3 and d_4 , respectively. Each of the magnetic pieces m_1 , m_2 and m_3 extends vertically and its length l_1 has a value close to the height H of the member 4. The magnetic piece m_0 also extends vertically but its

-5-

length ℓ_2 is smaller than the length ℓ_1 . The magnetic piece m_0 is disposed centrally of the member 4 in the direction of its height, and consequently it lies opposite only the central portions of the magnetic pieces m_1 , m_2 and m_3 .

The display element D_{ij} has a bore 5 extending through the member 4 in the vertical direction. Further, the display element D_{ij} has grooves 6a and 6b substantially triangular in section which are cut in the bottom 4a of the member 4 to extend across the bore 5 so that they intersect at right angles. In this case, the groove 6a extends, as viewed on the bottom 4a, in the same direction as the direction of extension of the display surfaces of d_1 and d_3 , and the groove 6b extends in the same direction as the direction of extension of the display surfaces d_2 and d_4 .

The display surface structure 1 has a frame 7 for arranging the display elements D_{11} to D_{1M} , D_{21} to D_{2M} , D_{N1} to D_{NM} on the horizontal lines a_1 , a_2 , a_N , respectively. Between opposing upper and bottom panels 7a and 7b of the frame 7 are provided fixed shafts B_1 , B_2 , B_N at regular intervals L_B which extend vertically. Between opposing left-hand and right-hand panels 7c and 7d of the frame 7 are provided laterally extending fixed support plates C_1 , C_2 , C_N at regular intervals L_A . In this case, the support plates C_1 to C_N extend through the fixed shafts

- 6 -

B_1 to B_N , respectively. On the support plate C_i are formed projections 9 which extend from the side of the fixed shaft B_j in the direction of extension of the support plate C_i in such a manner that they hold therebetween the fixed shaft B_j . The projections 9 each have a width which permits selective reception of the grooves 6a and 6b of the display element D_{ij} . The display element D_{ij} is disposed on the support plate C_i with the bore 5 receiving the fixed shaft B_j through a sleeve 8 fixed thereto. The display element D_{ij} assumes its normal position where it lies on the support plate C_i with either one of the groove 6a and 6b received by the projections 9 on the support plate C_i . However, the display element D_{ij} thus disposed on the support plate C_i is rotatable about the sleeve 8 fixed to the shaft B_j .

When the display element D_{ij} lies in such a rotational position where its groove 6a is received by the projections 9 of the support plate C_i , the display surfaces d_1 or d_3 faces forwardly. When the display element D_{ij} is turned in this state, the groove 6a disengages from the projections 9 and then the groove 6b engages with the projections 9. In this state, the display surface d_2 or d_4 of the display element D_{ij} faces to the front.

An example of the display switching unit 2 has first erasing heads $E_1 \sim E_N$, second erasing heads $F_1 \sim F_N$ and writing heads $G_1 \sim G_N$, as shown in Figs. 1 and 10A.

-7-

The first erasing head E_i has three electromagnets 101, 102 and 103 arranged laterally in this order at intervals $2 \times L_B$, where L_B is referred to previously in respect of Fig. 2. Each of the electromagnets 101, 102 and 103, as shown in Fig. 11, comprises a magnetic core 12 circular in cross section and having wound thereon a coil 11 and magnetic plates 13U and 13L respectively attached to both ends of the magnetic core 12 so that they coextend in a direction substantially perpendicular to the lengthwise direction of the magnetic core 12. The magnetic core 12 and the magnetic plates 13U and 13L make up each of the electromagnets 101, 102 and 103. In the illustrated case, the magnetic plates 13U and 13L are spaced apart a distance substantially equal to the length ℓ_1 of the magnetic pieces m_1 , m_2 and m_3 of the aforesaid member 4 of the display element D_{ij} in the vertical direction.

The second erasing head F_i has one electromagnet 104 as shown in Fig. 12. The electromagnet 104 comprises a magnetic core 22 circular in cross section and having wound thereon a coil 21 and magnetic plates 23U and 23L respectively attached to both ends of the magnetic core 22 so that they coextend in a direction substantially perpendicular to the lengthwise direction of the magnetic core 22. The magnetic core 22 and the magnetic plates 23U and 23L make up the electromagnet 104. In the illustrated case,

the magnetic plates 23U and 23L are spaced apart a distance substantially equal to the length ℓ_2 of the magnetic piece m_0 of the aforesaid block member 4 of the display element D_{ij} in the vertical direction.

5 The writing head G_i has three electromagnets 105, 106 and 107 arranged laterally in this order at this intervals of $2 \times L_B$. The electromagnets 105, 106 and 107 are each identical in construction with the abovesaid electromagnets 103 to 105 as shown in Fig. 11; therefore, no detail description will be repeated.

10 A vertical rod 25 is provided behind the display surface structure 1 in a manner to be movable to right and left in parallel therewith. The first and second erasing heads E_i and F_i and the writing head G_i are mounted on the
15 vertical rod 25 at a position opposite the aforementioned horizontal line a_i in such a manner that the front end faces of the magnetic plates 13U and 13L of the electromagnets 101 to 103 and 105 to 107 of the first erasing head E_i and the writing head G_i and the magnetic plates 23U
20 and 23L of the electromagnet 104 of the second erasing head F_i may lie adjacent the display surfaces d_1 to d_4 of the display element D_{ij} .

 An example of the drive unit 3 has, as shown in Figs. 1, 10A and 13, a belt, chain or like strap member 28 installed between a pair of pulleys 26 and 27 disposed in the
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- 9 -

horizontal direction, for instance, on the lower side of the display surface structure 1 and spaced a predetermined distance apart and a similar strap member 31 installed between a pair of pulleys 29 and 30 likewise disposed in the horizontal direction on the upper side of the display surface structure 1 and spaced a predetermined distance apart. The vertical rod 25 of the abovesaid display switching unit 2 is secured at both ends to the strap members 28 and 31. A rotary shaft 33 of a motor 32 is coupled, for instance, to the pulley 27 and a shaft 34 is bridged between the pulleys 26 and 29 so that the strap members 28 and 31 may be driven by the rotation of the motor 32 to right or left in synchronism with each other. Accordingly, the vertical rod 25 is moved to right and left while being held vertical.

The drive unit 3 has, as shown in Figs. 10A and 13, a detecting mechanism 41 for detecting the position of the vertical rod 25. An example of the detecting mechanism 41 has, as shown in Figs. 10A and 13, a position detecting plate 42 which is disposed on the lower side of the display elements $D_{N1}, D_{N2}, \dots, D_{NM}$ to extend in the horizontal direction and whose front marginal edge has rectangular recesses R_1 to R_M . The recess R_j extends leftwards from the position corresponding to the center of the display element D_{Nj} in the horizontal direction to a position

spaced a distance equal to $1/2$ of the interval L_B from the abovesaid position, and a light emitting element 43 and a photo detector 44 which are disposed in opposing relationship to each other with the position detecting plate 42
5 interposed therebetween. The light emitting element 43 and the photo detector 44 are mounted on the supporting members 16 and 17 respectively planted on the vertical rod 25. The photo detector 44 provides a detected output "1" or "0" in the binary representation depending on whether
10 the recess R_j exists or not between the photo detector 44 and the light emitting element 43. In practice, the position detecting plate 42 has at least the aforesaid recesses R_1 to R_M and similar recesses $R_{S1} \sim R_{S12}$. The recesses $R_{S8}, R_{S7}, \dots, R_{S1}$ are formed in this order at the intervals
15 L_B leftwards of the position spaced the distance L_B from the leftmost recess R_1 and the recess $R_{S9}, R_{S10}, \dots, R_{S12}$ are disposed in this order rightwards of the rightmost recess R_M at a position spaced therefrom the distance L_B .

Further, the drive unit 3 has detecting switches 51
20 and 52 for detecting the leftmost and rightmost positions of the vertical rod 25, respectively. The detecting switch 51 is adapted to provide an output "1" in the binary representation upon engagement with an engaging piece 53 of the vertical rod 25 when the magnetic plates 13U and 13L of the
25 rightmost electromagnet 101 of the first erasing head E_1

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mounted on the vertical rod 25 are moved out of the opposing relation with the display element D_{i1} . The detecting switch 52 is similarly adapted to provide an output "1" in the binary representation upon engagement with an engaging
 5 piece 53 of the vertical rod 25 when the magnetic plates 13U and 13L of the leftmost electromagnet 107 of the writing head G_i are moved out of the opposing relation with the display element D_{iM} .

Moreover, the drive unit 3 has a drive circuit 60 for
 10 driving the first and second erasing heads E_i and F_i and the writing head G_i of the display switching unit 2.

The drive circuit 60 comprises, for instance, memory circuits H and H', address selector circuits I and I', output circuits J and J', a data processing circuit K and
 15 shift registers Q1, Q2 and Q3.

The memory circuits H and H' are designed to store information "0" and "0", "0" and "1", "1" and "0" or "1" and "1", for selecting the display surfaces d_1 , d_2 , d_3 and d_4 of the display elements D_{11} to D_{N1} , D_{12} to D_{N2} ,
 20 D_{1M} to D_{NM} of the display surface structure 1. That is, in each of the memory circuits H and H', N information of the display elements D_{11} to D_{N1} are stored as first parallel information at a first address, N information of the display elements D_{12} to D_{N2} are stored as second parallel information
 25 at a second address, and N information of the display

elements D_{1M} to D_{NM} are stored as Mth parallel information at an Mth address. The N information making up the jth parallel information stored at the jth address selected by each of the address selector circuits I and I' are read
5 out one by one upon each occurrence of a read control pulse from the data processing circuit K. Each of the address selector circuits I and I' is adapted to sequentially select the first, second, Mth addresses of each of the memory circuits H and H' for sequentially reading out the M para-
10 lled information stored in each of the memory circuits H and H'. The output circuits J and J' receive and output the N jth parallel information read out of the memory circuits H and H', respectively.

The data processing circuit K has two information
15 input terminals x1 and x2 and three information output terminals y1, y2 and y3 and is adapted so that the information from the output circuits J and J' may be supplied to the information input terminals x1 and x2, respectively. Moreover, three shift registers Q1, Q2 and Q3 are provided
20 and information from the information output terminals y1, y2 and y3 of the data processing circuit K are applied to information input terminals of the shift registers Q1, Q2 and Q3, respectively.

The data processing circuit K receives the sequential
25 information from the output circuits J and J' to generate

pulses upon each reception of the information, which pulses are applied as a read control pulse and a shift pulse to the memory circuits H and H' and the shift registers Q1, Q2 and Q3, respectively. The data processing circuit K is
5 also adapted to provide a reset pulse RP for resetting the shift registers Q1, Q2 and Q3. Each of the shift registers Q1, Q2 and Q3 has first to Nth digits and is designed so that the N information sequentially applied from the data processing circuit K are stored at the N digits, respective-
10 ly, and are simultaneously read out thereof.

Further, the drive circuit 60 has input terminals T1 and T2 supplied with the detected outputs from the aforesaid detecting switches 51 and 52, respectively, an input terminal T3 supplied with the detected output from the photo
15 detector 44, output terminals O1 and O2 connected to forward and backward revolution input sides of the motor 32, respectively, output terminals OG_{11} to OG_{1N} , OG_{21} to OG_{2N} and OG_{31} to OG_{3N} , an output terminal O3 and a power source switch S.

20 The output terminal OG_{1i} is connected to the coil 11 of the electromagnet 105 of the writing head G_i , the output terminal OG_{2i} to the coil 11 of the electromagnet 106 and the output terminal OG_{3i} to the coil 11 of the electromagnet 107. The output terminal O3 is connected to the coils 11
25 of the electromagnets 101 to 103 of the first erasing heads

E_1 to E_N and to the coils 21 of the electromagnets 104 of the second erasing heads F_1 to F_N .

When the vertical rod 25 of the display switching unit 2 lies at its leftmost position to maintain the detecting switch 51 in its ON state, if the power source switch S is turned ON for a very short period of time, output signals are derived from the output terminals 01 and 03. While the output signals are obtained from the output terminals 01 and 03, if the detected output "0" in the binary representation is supplied from the photo detector 44 to the input terminal T3 after counting eight detected outputs "1", then the output "0" in the binary representation is supplied to the input terminal T3 from the photo detector 44 in the state that the address selector circuits I and I', the memory circuits H and H', the data processing circuit K and the shift registers Q1, Q2 and Q3 are controlled so that information stored in the memory circuits H and H' are supplied via the output circuits J and J' to the data processing circuit K. At this time, N pulses CP are sequentially provided from the data processing circuit K and the shift registers Q1, Q2 and Q3 are sequentially shifted upon occurrence of each of the N pulses CP. The data processing circuit K provides at its output terminals y1, y2 and y3 information "0", "0" and "0", respectively, in the case of the information from the memory circuits H and H' being "0"

and "0", and information "1", "0" and "0" in the case of the latter information being "0" and "1". When the information from the memory circuits H and H' are "1" and "0", the data processing circuit K provides information "1", "0" and "0" at its output terminals y1, y2 and y3, respectively, and then if an output "0" in the binary representation is provided twice from the photo detector 44 in the above state, the information "1", "0" and "0" at the output terminals y1, y2 and y3 change to "0", "1" and "0", respectively. In the case of the information from the memory circuits H and H' being "1" and "1", the data processing circuit K provides information "1", "0" and "0" and then, if the output "0" is obtained twice from the photo detector 44 in the above state, the information at the output terminals y1, y2 and y3 change to "0", "1" and "0", respectively, and thereafter, if the output "0" is derived twice from the photo detector 44 in this state, the information at the abovesaid three output terminals change to "0", "0" and "1", respectively. The information thus obtained are successively stored in the shift register Q1, Q2 and Q3. Then, when the output from the photo detector 44 to be supplied to the input terminal T3 becomes "1", the information stored in the shift registers Q1, Q2 and Q3 are derived at the output terminals OG₁₁ to OG_{1N}, OG₂₁ to OG_{2N} and OG₃₁ to OG_{3N}, respectively. And then, when the output from the

photo detector 44 is altered to "0", no outputs are provided at the output terminals OG_{11} to OG_{1N} , OG_{21} to OG_{2N} and OG_{31} to OG_{3N} . At the same time, the shift registers Q1, Q2 and Q3 are reset and, as described above, the address selector
5 circuits I and I', the memory circuits H and H', the data processing circuit K and the shift registers Q1, Q2 and Q3 are respectively controlled so that information stored at the next address is successively read out of the memory circuits H and H', and, as is the case with the above, the
10 data processing circuit K is actuated and the information therefrom are stored in the shift registers Q1, Q2 and Q3, respectively. Then, when the output from the photo detector 44 is altered again to "1", the information stored in the shift registers Q1, Q2 and Q3 are derived at the output
15 terminals OG_{11} to OG_{1N} , OG_{21} to OG_{2N} and OG_{31} to OG_{3N} , respectively, in the same manner as mentioned above and thereafter such operations are repeated. Further, when the detected output "1" in the binary representation is supplied from the detecting switch 52 to the input terminal T2, no
20 output is obtained from the output terminals O1 and O3.

The above is the construction of an example of the display panel employing the display elements of the embodiment of this invention. With such a construction, by turning on the power source switch S of the drive circuit 60 of the
25 drive unit 3 for a very short period of time with the vertical

rod 25 of the display switching unit 2 being located at its leftmost position to hold the detecting switch 51 in its ON state, the vertical rod 25 is moved to right. While the vertical rod 25 is moved rightwards, the output "1" is

5 yielded at the output terminal O3 of the drive circuit 60, so that the erasing heads E_1 to E_N and F_1 to F_N are energized. By the rightward movement of the vertical rod 25, the electromagnets 101, 102 and 103 of the erasing head E_i are brought to right into opposing relation to the display

10 element D_{ij} one after another and then the electromagnet 104 of the erasing head F_i is brought to right into opposing relation to the display element D_{ij} . As a result of this, such operations as described below are selectively carried out depending on which one of the display surfaces d_1 to d_4

15 of the display element D_{ij} lies on the front side of the display panel before the electromagnets 101, 102, 103 and 104 are brought to right into opposing relation to the display element D_{ij} one after another, that is, "Before Erasing"; ultimately, the display surface d_2 of the display element

20 D_{ij} is brought to the front side of the display panel.

(A) In the case where the display surface d_1 of the display element D_{ij} lies on the front side of the display panel "before erasing":

The magnetic piece m_0 of the small length l_2 lies near

25 the rear left edge of the display element D_{ij} . By the way,

the electromagnets 101 to 103 each have the pair of magnetic plates 13U and 13L spaced apart the distance corresponding to the length ℓ_1 larger than the length ℓ_2 of the magnetic piece m_0 , as described previously in respect of Fig. 11.

- 5 On the other hand, the electromagnet 104 has the pair of magnetic plates 23U and 23L spaced apart the distance corresponding to the length ℓ_2 of the magnetic piece m_0 and described previously in respect of Fig. 12.

Accordingly, when the electromagnets 101, 102 and 103
10 move rightwards along the back of the display element D_{ij} in succession, the display element D_{ij} is not turned, whereas when the electromagnet 104 is brought to right across the display element D_{ij} , the latter is turned through 90° in the clockwise direction in Fig. 13, bringing its display
15 surface d_2 to the front side.

(B) In the case where the display surface d_2 of the display element D_{ij} lies on the front side of the display panel "before erasing":

- The magnetic piece m_1 of the length ℓ_1 lies near the
20 rear left edge of the display element D_{ij} . By successive confrontation of the electromagnets 101, 102 and 103 with the display element D_{ij} , the latter is turned through 90° upon each confrontation with the former, bringing the display surface d_1 of the display element D_{ij} to the front
25 side, with the magnetic piece m_0 lying near the rear left

edge of the display element D_{ij} . Accordingly, by the confrontation of the electromagnet 104 with the display element D_{ij} , the latter is turned through 90° , resulting in its display surface d_2 lying on the front side.

5 (C) In the case where the display surface d_3 of the display element D_{ij} lies on the front side of the display panel "before erasing":

The magnetic piece m_2 lies near the rear left edge of the display element D_{ij} . By successive confrontation of
10 the electromagnets 101 and 102 with the display element D_{ij} , the latter is turned through 90° upon each confrontation, bringing the display surface d_1 of the display element D_{ij} to the front side, with the magnetic piece m_0 lying near the rear left edge of the display elements D_{ij} . Accordingly,
15 when the electromagnet 103 is moved rightwards across the display element D_{ij} , the latter is not turned. But when the electromagnet 104 is brought into confrontation with the display element D_{ij} , the latter is turned through 90° , resulting in its display surface d_2 lying on the front side.

20 (D) In the case where the display surface d_4 of the display element D_{ij} lies on the front side of the display panel "before erasing":

The magnetic piece m_3 lies near the rear left edge of the display element D_{ij} . By the confrontation of the
25 electromagnet 101 with the display element D_{ij} , the latter

-20-

is turned through 90° to bring its display surface d_1 to the front side, with the magnetic piece m_0 lying near the rear left edge of the display element D_{ij} . Accordingly, the display element D_{ij} is turned by successive confrontation therewith of the electromagnets 102 and 103. When the electromagnet 104 is brought to right to the display element D_{ij} , the latter is turned through 90° to bring its display surface d_2 to the front side.

The above-described operations are tabulated in Fig. 14.

By successive confrontation of the photo detector 44 with the recesses $R_{S1}, R_{S2}, \dots, R_{S8}, R_1, R_2, \dots, R_M, R_{S9}, R_{S8}, \dots, R_{S12}$ after the vertical rod 25 starts its rightward movement, the photo detector 44 yields the outputs "0" in succession, which are provided to the input terminal T3 of the drive circuit 60. As described previously, upon each occurrence of the output "0" after the application of eight outputs "0" to the input terminal T3, the address selector circuits I and I', the memory circuits H and H', the data processing circuit K and the shift registers Q1, Q2 and Q3 of the drive circuit 60 are controlled to selectively energize the electromagnets 105, 106 and 107 of a selected one or ones of the writing heads G_1 to G_N of the display switching unit 2 in accordance with the memory contents of the memory circuits H and H'. The electromagnets

-2/-

105, 106 and 107 of the writing head G_i are brought to the position opposite the display element D_{ij} one after another in synchronism with successive generation of the abovesaid output "0" after the electromagnets 101 to 103 and 104 of the erasing heads E_i and F_i are moved across the display element D_{ij} . In other words, the successive confrontation with the display element D_{ij} starts with the state in which the display surface d_1 of the display element D_{ij} lies on the front side and consequently the magnetic piece m_1 stays near the rear left edge of the display element D_{ij} . Accordingly, the display element D_{ij} performs such operations as described below in accordance with the contents of the memory circuits H and H', whereby a selected one of the display surfaces d_1 to d_4 of the display element D_{ij} is brought to the front side according to the contents of the memory circuits H and H'.

(E) In the case where the contents of the memory circuits H and H' are both "0":

When the electromagnets 105, 106 and 107 confront the display element D_{ij} one after another, these electromagnets are respectively supplied with outputs "0", and hence they are not energized. Accordingly, the display element D_{ij} is not turned, in consequence of which its display surface d_2 remains on the front side.

(F) In the case where the contents of the memory

circuits H and H' are "0" and "1", respectively:

When the electromagnets 105, 106 and 107 sequentially confront the display element D_{ij} , these electromagnets are supplied with outputs "1", "0" and "0", respectively, and
5 hence only the electromagnet 105 is energized. As a result of this, the display element D_{ij} is turned through 90° , bringing its display surface d_3 to the front side.

(G) In the case where the contents of the memory circuits H and H' are "1" and "0", respectively:

10 When the electromagnets 105, 106 and 107 confront the display element D_{ij} in a sequential order, these electromagnets are supplied with outputs "1", "1" and "0", respectively, and hence the electromagnets 105 and 106 are energized. Consequently, the display element D_{ij} is turned
15 through 180° to bring its display surface d_4 to the front side.

(H) In the case where the contents of the memory circuits H and H' are both "1":

When the electromagnets 105, 106 and 107 confront the
20 display elements D_{ij} in succession, these electromagnets are all supplied with the outputs "1", and hence they are all energized. In consequence, the display element D_{ij} is turned through 270° to bring its display surface d_1 to the front side.

25 The above-described operations are tabulated in Fig. 15.

When the vertical rod 25 is brought right to its rightmost position to turn on the detecting switch 52 to derive therefrom a detected output "1", the output is no more produced from the output terminal 02, stopping the motor
5 32 from rotating.

In accordance with the display panel using the display elements according to the above embodiment of this invention, the display surfaces d_2 of all the display elements D_{11} to D_{N1} , D_{12} to D_{N2} , D_{1M} to D_{NM} can be made to face
10 forwardly and a desired one of the display surfaces d_1 , d_3 and d_4 of a desired one or ones of the display elements can be made to face forwardly. Accordingly, if the display surfaces d_2 , d_1 , d_3 and d_4 of the display element D_{ij} are previously colored, for example, in white, red, green and
15 blue, respectively, a character, symbol, graph or pattern can be displayed in colors as desired. Such a display can be produced with a simple construction as a whole.

Further, since the display element D_{ij} has such a simple construction as shown in Figs. 4, 5, 6 and 7, the
20 distance between adjacent ones of the display elements can be made small; therefore, the overall apparatus can be simplified in construction and reduced in size correspondingly.

Moreover, as the display element is free from power dissipation, the display panel does not consume much power
25 and, in addition, as the display element is not readily

broken by an external force, the display panel can be used without trouble for a long time.

As will be appreciated from the above, the display element according to the foregoing embodiment of this invention can be applied to construct a display panel which includes a number of such display elements arranged in the same vertical plane and which is capable of providing a character, graph, pattern or like display without much power consumption and with a long life.

Further, the present invention exhibits the advantages that the content of a display of a character, symbol, graph, pattern or the like can be changed by a single movement of the display switching unit 2 in one direction and that such a change does not take much time.

In the foregoing embodiment of the present invention it is preferred that the writing heads G_1 to G_N of the display switching unit 2 be constructed so that those magnetic plates 13U or 13L of the electromagnets 105, 106 and 107 of the writing heads G_{i-1} and G_{i+1} lying on the side of the writing head G_i may be of the same polarity. The advantage by this construction will be briefly described in connection with the electromagnets of the writing heads G_{i-1} , G_i and G_{i+1} . Namely, in the case where the electromagnet 105 of the writing head G_i is not energized but the electromagnets 105 of the writing heads G_{i-1} and G_{i+1} are energized, the

electromagnet 105 of the writing head G_i is not exposed to a magnetic field by the electromagnet 105 of the writing head G_{i-1} and/or G_{i+1} . This eliminates the possibility of erroneous activation of the display elements D_{i1} to D_{iN} .

5 Next, a description will be given with reference to Figs. 16 to 19, of another embodiment of the display panel of the present invention.

10 In Figs. 16 to 19, the parts corresponding to those in Figs. 1 to 15 are identified by the same reference numerals and characters and no detailed description will be repeated. This embodiment is identical in construction with the embodiment described previously in respect of Figs. 1 to 15 except that the display surface structure 1 has such a construction as described below.

15 As shown in Figs. 16 and 17, a pair of rotary shafts 74L and 74R are rotatably provided at a predetermined distance on a substrate 72 to extend vertically. On the rotary shafts 74L and 74R are mounted pulleys 73L and 73R, respectively. A carrier member 71, such as an endless belt, is
20 placed on the pulleys 73L and 73R. On the outer surface of the carrier member 71 are arranged the display elements D_{11} to D_{1M} , D_{21} to D_{2M} , D_{N1} to D_{NM} in the same manner as described previously with regard to Figs. 1 to 3. In this case, as will be more apparent from Figs. 18 and 19, the
25 display element D_{ij} is mounted on the carrier member 71

-26-

through a support plate C_{ij} corresponding to that C_i described previously with respect to Fig. 2. The support plate C_{ij} has the projections 9 selectively engageable with the grooves 6a and 6b of the display element D_{ij} .

5 On the other hand, the rotary shaft 74L is adapted to be rotatable by a drive mechanism 75 as desired and, consequently, the carrier member 71 is adapted to be endlessly movable laterally as required. Accordingly, the display surface structure 1 can be endlessly moved lateral-
10 ly.

Furthermore, this embodiment is identical in construction with the embodiment of Figs. 1 to 15 except that the first erasing head E_i , the second erasing head F_i and the writing head G_i , which constitute the display switching unit
15 2, are fixedly arranged in the order described previously in respect of Fig. 10A, as shown in Fig. 17.

Moreover, the drive unit 3 is designed so that, upon moving the display surface structure 1 by the driving mechanism 75 in a lateral direction, the electromagnets 101 to
20 103 of the first erasing heads E_1 to E_N and the electromagnets 105 to 107 of the second erasing heads F_1 to F_N and the writing heads G_1 to G_N are energized in synchronism with the movement of the display surface structure 1, though neither illustrated nor described in detail. In con-
25 sequence, the display surfaces d_1 to d_4 of the display

elements D_{11} to D_{1M} , D_{21} to D_{2M} , D_{N1} to D_{NM} are selected as desired and face forwardly.

In accordance with the embodiment described above with reference to Figs. 16 to 19, it is also possible to obtain
5 the same advantages as those of the embodiment of Figs. 1 to 15. That is to say, the display surfaces d_2 of all the display elements D_{11} to D_{N1} , D_{12} to D_{N2} , D_{1M} to D_{NM} can be made to face forwardly and a desired one of the display surfaces d_1 , d_3 and d_4 of a desired one or ones of
10 the display elements can be made to face forwardly. Accordingly, a character, symbol, graph or pattern can be displayed in colors as desired. Such a display can be produced with a simple construction as a whole.

Further, since the display element D_{ij} has such a
15 simple construction as described previously, the distance between adjacent ones of the display elements can be made small; therefore, the overall apparatus can be simplified in construction and reduced in size correspondingly.

Moreover, as the display element is free from power
20 dissipation, the display panel does not consume much power and, in addition, as the display element is not readily broken by an external force, the display panel can be used without trouble for a long time.

The foregoing description should be construed as
25 merely illustrative of the present invention and should not

be construed in limiting sense. For example, the display element D_{ij} need not be limited specifically to the four-sided right prismatic block member 4 with the four display surfaces d_1 to d_4 but may be a multi-sided prismatic block member with plural (P) display surfaces of different colors. In this case, the magnetic pieces responsive to the first erasing head and the writing head are disposed in the block member near its (P-1) edges and a magnetic piece responsive to the second erasing head is disposed near the remaining one edge and (P-1) electromagnets are disposed in the first erasing head and the writing head correspondingly.

Moreover, the length l_2 of the magnetic piece m_0 of the display element D_{ij} need not always be selected smaller than the lengths l_1 of the other magnetic pieces m_1 to m_3 .

Besides, the structures of the heads E_i , F_i and G_i and the magnetic pieces m_0 and m_1 to m_3 of the display element D_{ij} can be modified from those employed in the foregoing embodiment if the first erasing head E_i and the writing head G_i have such construction that acts on only the magnetic pieces m_1 to m_3 of the display element D_{ij} . Also it is possible to substitute the first and second erasing heads with permanent magnetic heads.

It will be apparent that many modifications and variations may be effected without departing from the scope of the novel concepts of this invention.

WHAT IS CLAIMED IS:

1. A display panel comprising:
 - a display surface structure;
 - a display switching unit; and
 - 5 a drive unit;

in which, letting N horizontal lines of arrangement spaced a predetermined distance from adjacent ones of them in a vertical direction be represented by $a_1, a_2, \dots, a_N$, respectively, the display surface structure has M display
10 elements $D_{i1}, D_{i2}, \dots, D_{iM}$ disposed on the horizontal line a_i ($i=1, 2, \dots, N$) at predetermined intervals in a horizontal direction;

in which the display element D_{ij} ($j=1, 2, \dots, M$) is formed with a block member with uniform cross section having
15 an outer periphery forming a plurality of display surfaces of different colors to form a plurality of edges parallel to and around the axis extending in the vertical direction, a first magnetic piece disposed near each of the edges except one of them and second magnetic piece disposed near
20 the remaining edge, the display element D_{ij} being supported by supporting means in a manner to be rotatable about the axis and to permit a selected one of the display surfaces to lie in a vertical plane;

in which the display switching unit has a first erasing
25 head E_i , a second erasing head F_i and a writing head G_i

disposed to be movable along the horizontal line a_i in the horizontal direction, the first erasing head E_i having electro- or permanent-magnets less than the edges of the block member by one, the second erasing head F_i having an electro- or permanent-magnet, the writing head G_i having electromagnets of the same number as the electro- or permanent-magnets of the first erasing head; and

in which the drive unit has means for simultaneously moving laterally the first erasing heads E_1 to E_N , the second erasing heads F_1 to F_N and the writing heads G_1 to G_N and the display surface structure relative to each other, and means for energizing the electromagnets of the writing heads G_1 to G_N in synchronism with the movement of the writing control heads G_1 to G_N .

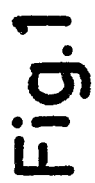
2. A display panel according to claim 1 wherein the block member forming the display element D_{ij} is a four-sided right prismatic member, and hence four parallel edges and four display surfaces and has three first magnetic pieces, wherein the writing head G_i has three electromagnets, and wherein the first erasing head E_i has three electro- or permanent-magnets.

3. A display panel according to claim 1 wherein the first magnetic pieces of the block member forming the display element D_{ij} differ in length from the second magnetic piece.

4. A display element for a display panel, which is formed with a block member with uniform cross section having an outer periphery forming a plurality of display surfaces of different colors to form a plurality of edges parallel to and around the axis extending in the vertical direction, a first magnetic piece disposed in each of the edges except one of them and a second magnetic piece disposed near the remaining edge.

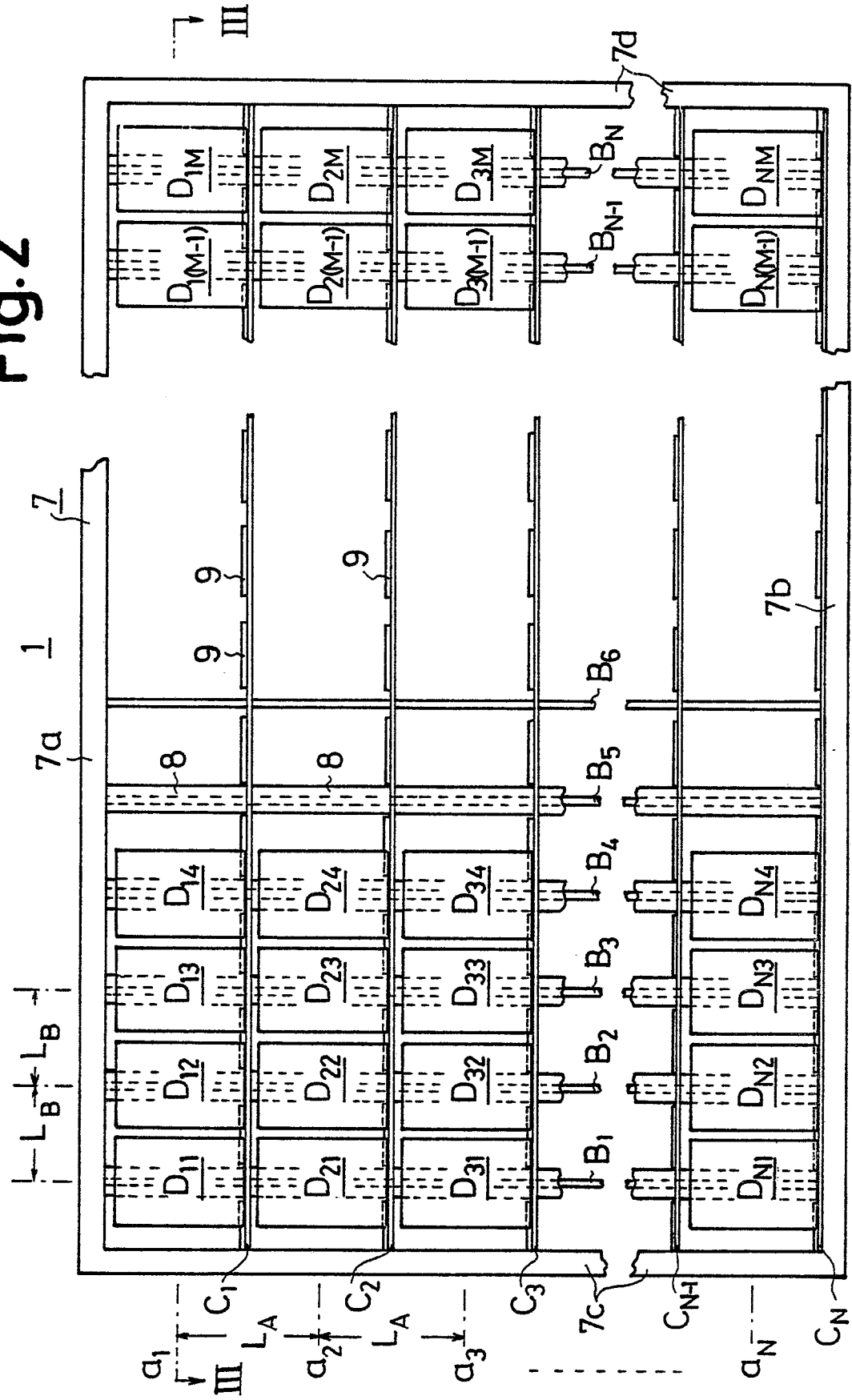
5. A display element according to claim 4 wherein the block member is four-sided right prismatic member, and hence has four-parallel edges and four display surfaces and has three first magnetic pieces.

6. A display element according to claim 4 wherein the first magnetic pieces differ in length from the second magnetic piece.



2/12

Fig. 2



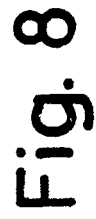
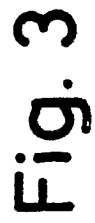


Fig. 4 4/12

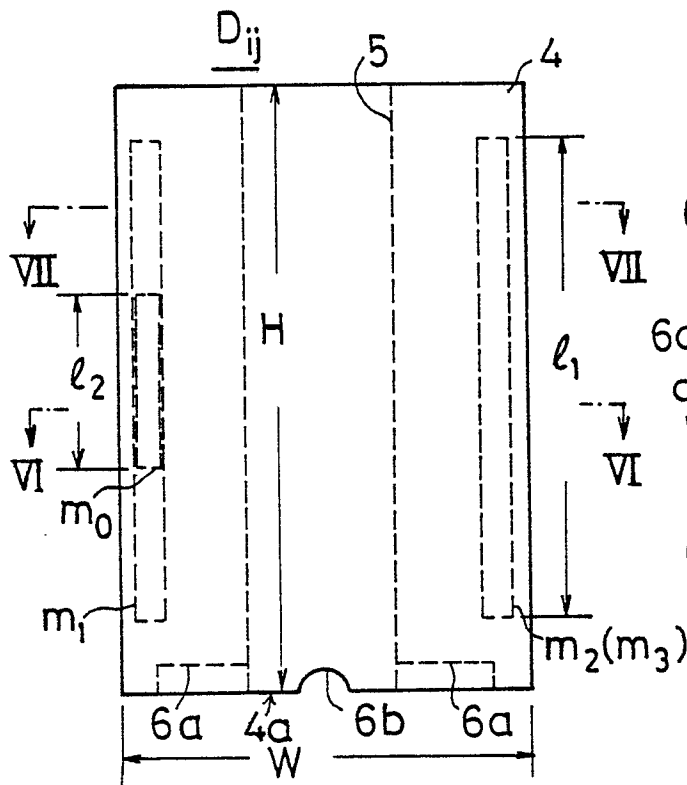


Fig. 6

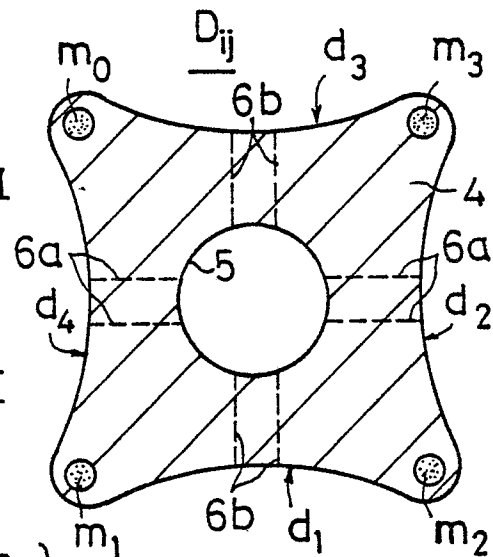


Fig. 5

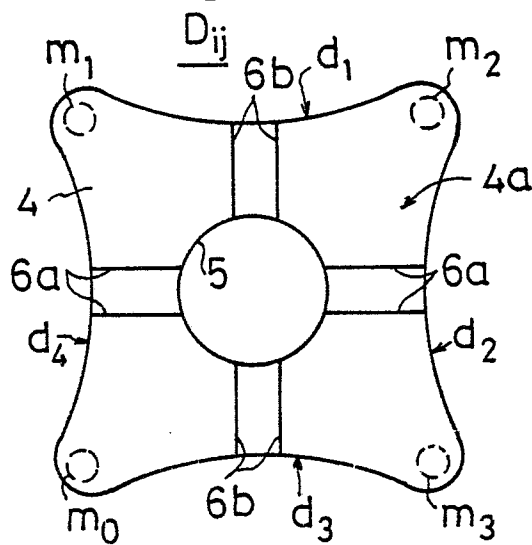
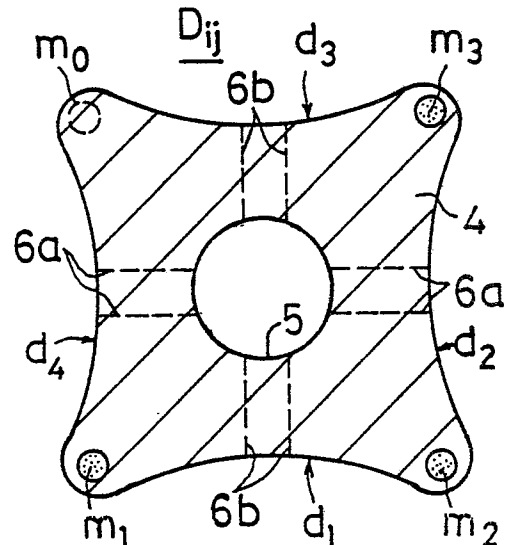


Fig. 7



5/12

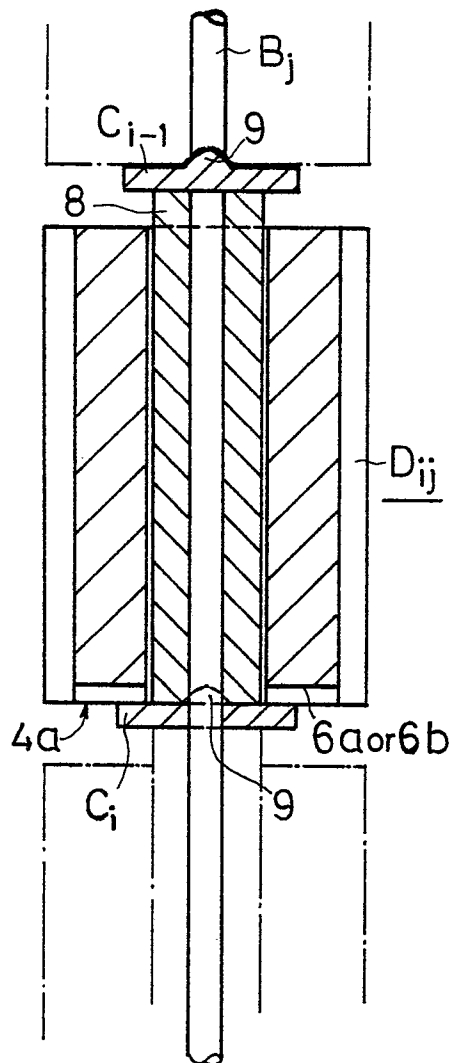
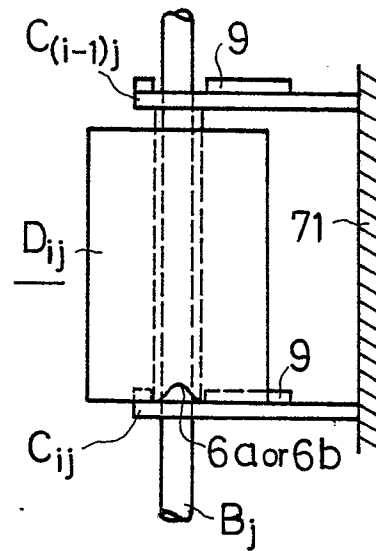
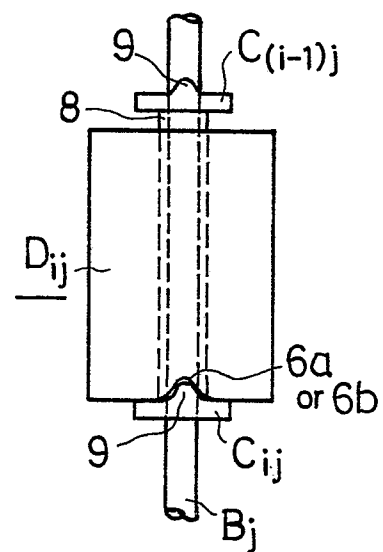
Fig. 9**Fig. 19****Fig. 18**

Fig.10A

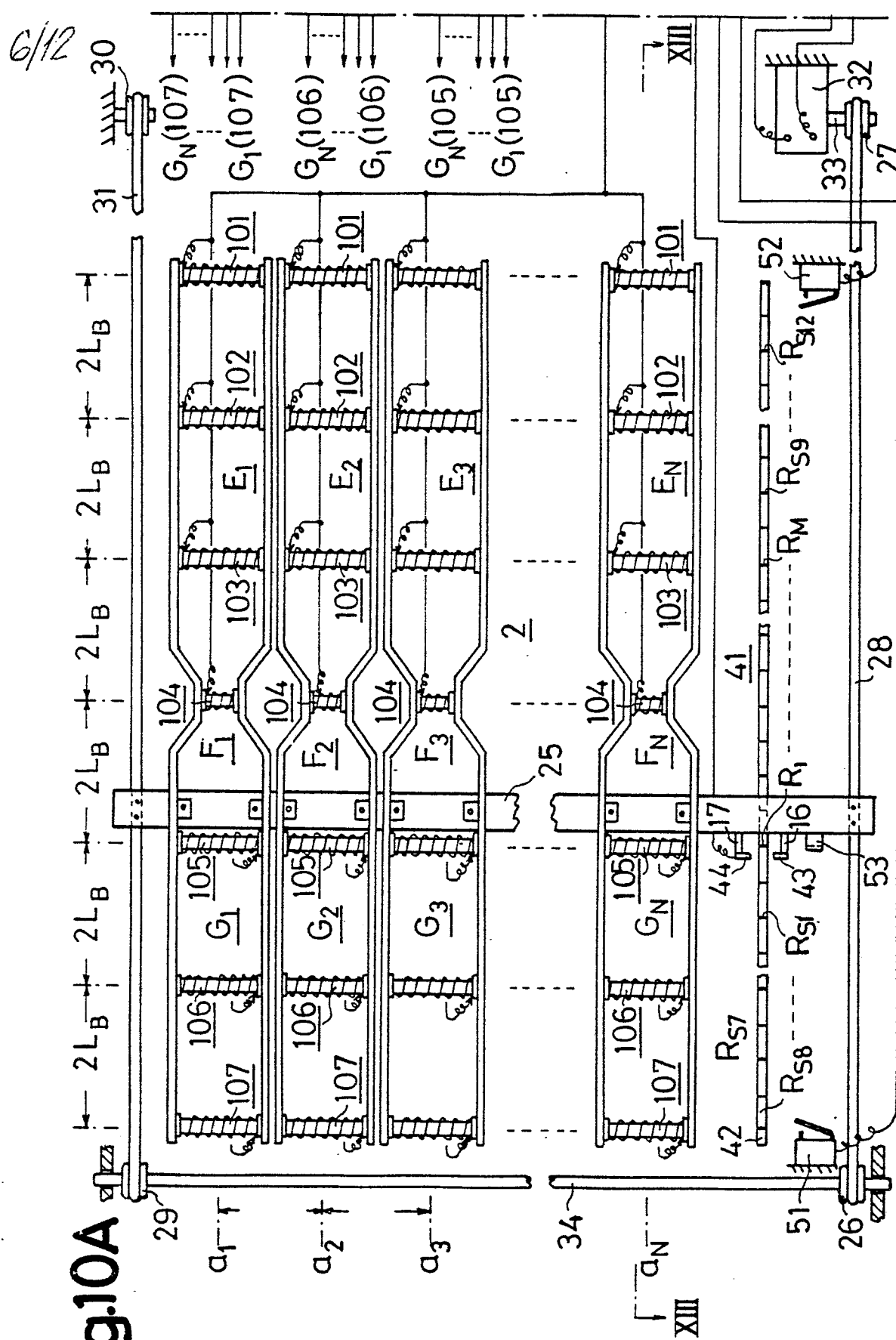


Fig. 10B

7/12

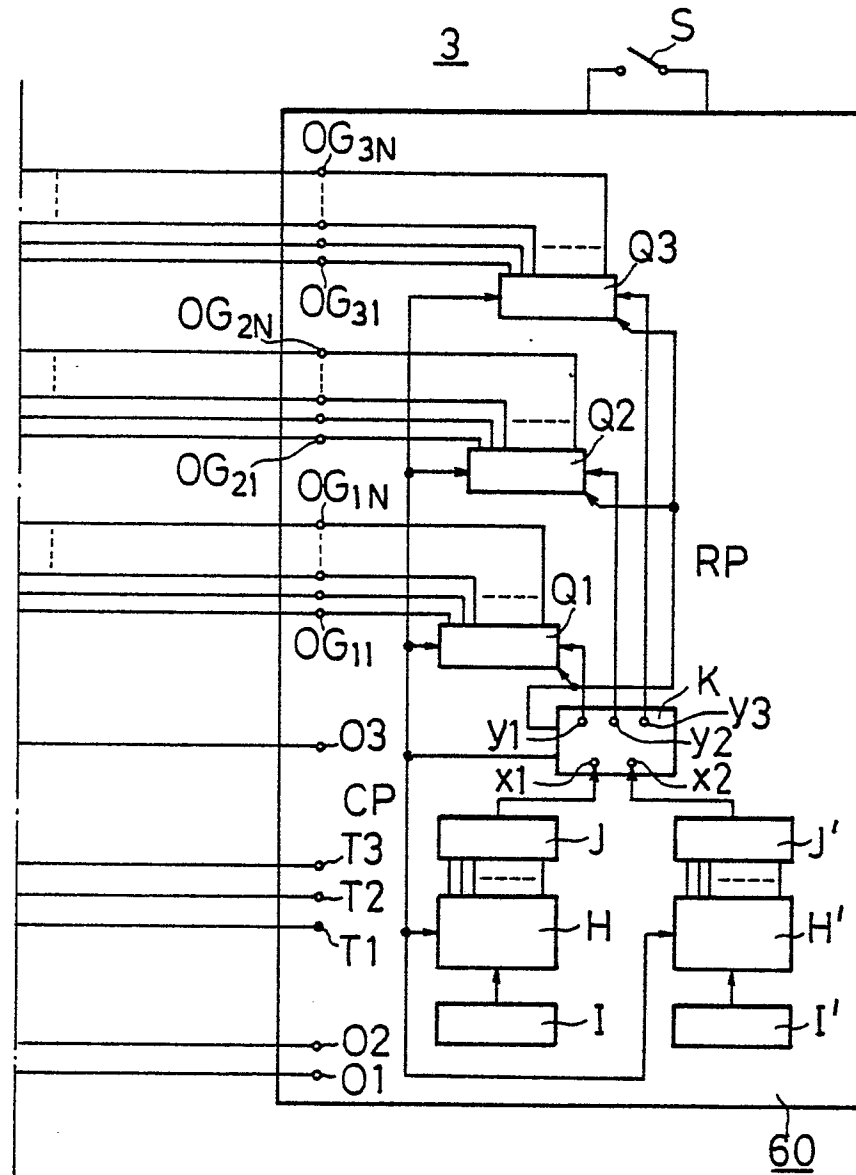


Fig. 10

Fig. 10A	Fig. 10B
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8/12

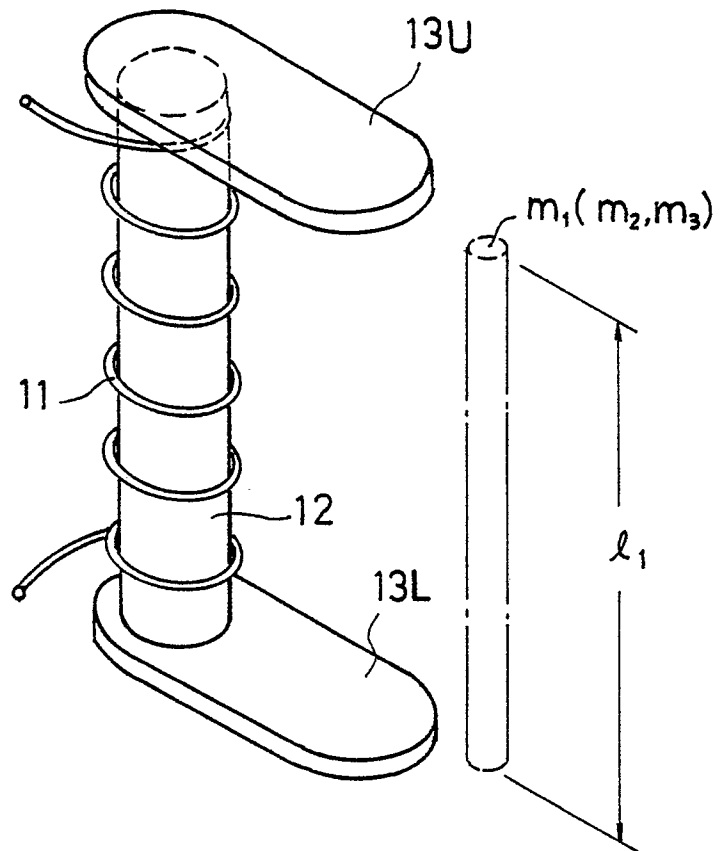
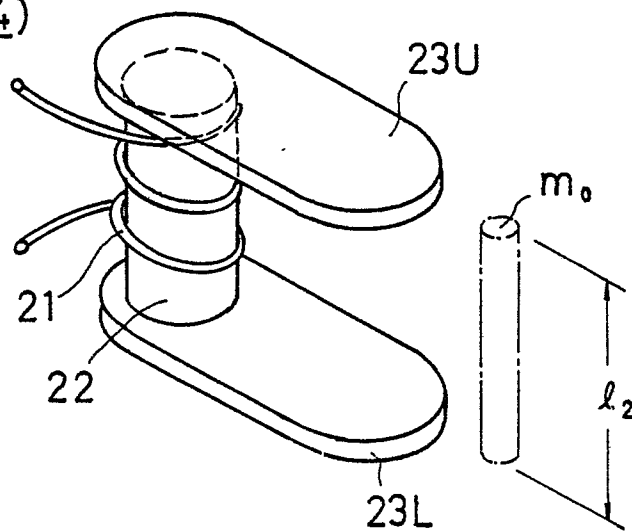
Fig. 11 $E_i (101 \sim 103)$ $G_i (105 \sim 107)$ **Fig. 12** $F_i (104)$ 

Fig. 14 *10/12*

Before Erasing		d_1	d_2	d_3	d_4
Heads	Magnets				
E_i	101	d_1	d_3	d_4	d_1
	102	d_1	d_4	d_1	d_1
	103	d_1	d_1	d_1	d_1
F_i	104	d_2	d_2	d_2	d_2
After Erasing		d_2	d_2	d_2	d_2

Fig. 15

Information		(0,0)	(0,1)	(1,0)	(1,1)
Before Writing		d_2	d_2	d_2	d_2
Head	Magnets				
G_i	105	d_2	d_3	d_3	d_3
	106	d_2	d_3	d_4	d_4
	107	d_2	d_3	d_4	d_1
After Writing		d_2	d_3	d_4	d_1

Fig. 16

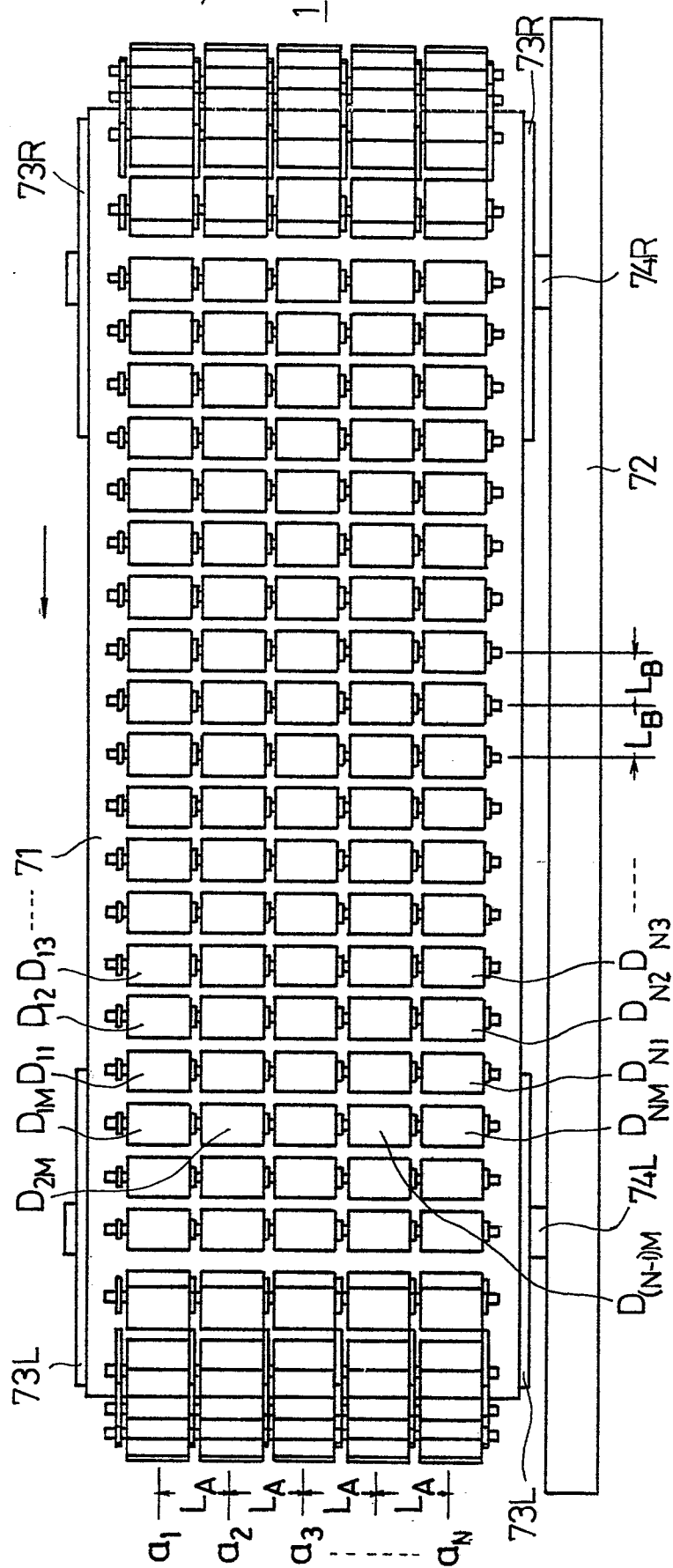


FIG. 17

The diagram illustrates a magnetic tape transport mechanism. A central horizontal section shows a series of rectangular tape segments labeled 101 through 107. Above this section, three dimension groups are defined: E_1 (covering segments 101-103), F_1 (covering segments 104-106), and G_1 (covering segment 107). To the right of the main tape path, a vertical dimension $L_B + L_B$ is shown. Below the tape path, a series of dimensions $D_{1(M-1)}, D_{11}, D_{12}, D_{13}$ are indicated by dashed lines. Two large circular reels, 73L and 73R, are positioned at the ends of the tape path. Reel 73L rotates clockwise, while reel 73R rotates counter-clockwise. A central square component, labeled 75, is located between the reels. Arrows indicate the direction of tape movement from left to right.



European Patent
Office

EUROPEAN SEARCH REPORT

0062534

Application number

EP 82 30 1809

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Y	US-A-3 267 595 (MAURICE M.LEVY) *Claims 1-9; column 4, lines 28-62; column 7, lines 7-75; column 8, lines 1-7; column 10, lines 22-50; figures 7-13,26*	1-6	G 09 F 9/37
Y	FR-A-2 426 950 (WAKATAKE YOSHIMASA) *Claims; page 2, lines 34-38; pages 3,4; page 5, lines 1-10; page 13, lines 29-38; page 14, lines 1-13; figures 2,4-7* & GB - A - 2 025 675	1,2,4,5	
Y	FR-A-2 378 327 (NIHON ADVANCED PRODUCTS KABUSHIKI KAISHA) *Claims 1,3,5,7; page 3, lines 23-38; page 4; page 5, lines 1-33; page 11, lines 13-38; page 12, lines 1-24; figures* & US - A - 4 177 458	1,2,4,5	
A	US-A-3 335 512 (ROBERT P.NEWMAN) *Column 5, lines 61-75; column 6, lines 1-26; figures 7,10,11*	1	
P,X	GB-A-2 081 954 (YUGEN KAISHA WAKATAKE GIKEN) *The whole document* & JP - A - 57 014,888 & FR - A - 2 486 285 & DE - A - 3 126 010	1-6	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 29-06-1982	Examiner MIOT F.P.
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X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	