

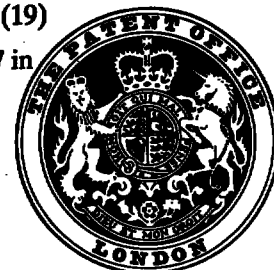
PATENT SPECIFICATION

(11)

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- (21) Application No. 1338/78/ (22) Filed 13 Jan. 1978 / (19)
 (31) Convention Application No. 52/041164 (32) Filed 11 Apr. 1977 in
 (33) Japan (JP)
 (44) Complete Specification Published 11 Feb. 1981
 (51) INT. CL. ³ G02F 1/17
 G03G 19/00
 (52) Index at Acceptance
 G2F 21C 23M 25A 25F 28M CK
 B6C SG
 B6P MAB



(54) DISPLAYING MAGNETIC PANEL AND ITS DISPLAY DEVICE/

(71) We, PILOT MAN-NEN HITSU KABUSHIKI KAISHA, a Japanese Company located at No. 7-3 Kyobashi 2-chome, Chuo-ku, Tokyo, Japan, do hereby declare the invention for which we pray that a Patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:-

5 This invention relates to a magnetic display panel and magnetic display devices including same. 5

Several methods of providing a display by utilizing magnetic fields are known in the art. In one such method, as disclosed in U.S. Re-issue Patent No. 25,822, magnetised balls each having differently coloured hemispheres are placed in respective pockets, and the balls are turned with a magnetic tip to make a display. U.S. Patent No. 3,103,751 discloses a method in 10 which magnetic pins placed in respective bores in a display unit are moved toward the front side of the display unit using a magnetic stylus to make a display. Furthermore, U.S. Patent Nos. 2,853,830 and 2,589,601 disclose a method in which magnetic fine grains are collected 15 on the front side of a display unit using a magnetic pen; U.S. Patent No. 3,322,482 discloses a system in which a magnetic field is applied to a liquid in which magnetic flakes are suspended so as to align the flakes in parallel thereby forming a display; and in U.S. Patent No. 3,229,281 a magnetic field is applied to a liquid in which fine magnetic grains are suspended to cause these grains to migrate, so that those grains to which the magnetic field is applied are increased in concentration, thereby forming a display. 20

The present invention is concerned with the type of magnetic display panel which comprises a sealed space containing a dispersion medium including fine magnetic grains, one side of the sealed space being defined by a substrate, and in which a magnetic field is applied to a front side of the panel in use. The fine magnetic grains are attracted only to those parts of the front side where the magnetic field is applied to form a display. 25

If the dispersion medium is prepared merely by suspending the fine magnetic grains in a dispersing liquid, the display is blurred because even those grains which are subjected to an extremely small magnetising force are attracted to the front side of the panel by the applied magnetic field. Furthermore, since the specific gravity of the fine magnetic grains is much greater than that of the dispersing liquid, upon removal of the magnetic field those grains 30 which were previously attracted are abruptly precipitated from the front side of the magnetic panel to the rear side thereof, as a result of which the display disappears; i.e. it is impossible to maintain a stable display. 30

If the viscosity of the dispersing liquid is increased in order to prevent the precipitation of the fine magnetic grains, migration of these grains under an applied magnetic field is decreased and thixotropy appears. As a result, the property of matter changes, and it is difficult to obtain a stable, fine display. 35

If the specific gravity of the dispersing liquid is allowed to approach that of the fine magnetic grains by adding a material which increases the specific gravity of the dispersing liquid, then immediate precipitation of the fine magnetic grains is decreased; however, the grains will still be precipitated over a long period of time. Furthermore, since those grains 40 which have been subjected to even a small magnetising force are attracted to the front side of the panel, the display is still blurred. In addition, the obtained display disappears upon application of an extremely light impact. 40

From the above, it will be appreciated that, in order to obtain an effective magnetic display panel which can maintain a stable display, it is absolutely necessary to prevent precipitation of 45

the fine magnetic grains, and it is furthermore necessary to control the magnetic response migration of the grains within a suitable range : these requirements are, however, ostensibly contradictory.

It is an object of the present invention to obviate or mitigate the above-mentioned difficulties and to satisfy the above-described requirements.

According to one aspect of the present invention, there is provided a magnetic display panel comprising a sealed space containing a dispersion medium, one side of the sealed space being defined by a substrate which is transparent or semi-transparent in at least a display section thereof, the dispersion medium including fine magnetic grains, a colouring agent, and a dispersing liquid to which is added a fine grain thickener, the resultant yield value of the dispersing liquid being greater than 5 dynes/cm².

The term "yield value" as used herein means the lowest stress required to cause a liquid to flow.

The present invention therefore makes use of a fine grain thickener to adjust the yield value of the dispersing liquid to higher than 5 dyne/cm². Upon the application of a magnetic field to a front side of the panel in use, only those fine magnetic grains which are subjected to a magnetising force of greater than a predetermined value are caused to migrate to the front side of the panel to form a display. When a magnetic field is applied to a rear side of the panel, the fine magnetic grains which were previously attracted to the front side now migrate to the rear side of the panel so that the display disappears.

The applicants have found that, in order that fine magnetic grains having a greater specific gravity are held stably at a particular position in the dispersion medium, and in order that the grains migrate only when a magnetic field greater than a predetermined value is applied thereto, it is not sufficient merely to adjust the viscosity of the dispersing liquid, to employ a dispersion stabilizer or protection colloid, or even to make the specific gravity of the dispersing liquid equal to that of the fine magnetic grains. In addition, the applicants have found that satisfactory performance can be obtained only when the yield value of the dispersing liquid is within a particular range. Furthermore, the applicants have reached a conclusion through study that a satisfactory result can be obtained by using a magnetic panel in which the dispersion medium includes a dispersing liquid whose yield value is adjusted by means of a fine grain thickener to be equal to or higher than 5 dyne/cm². If the yield value is lower than 5 dyne/cm², the display formed on the magnetic panel by application of magnetic field is blurred at all times; in addition, since the fine magnetic grains are abruptly precipitated, the display may be erroneously read or may be illegible, and furthermore disappears completely with the lapse of time.

This drawback is most significant in the case where a dispersing liquid is used without the addition of a fine grain thickener, e.g. a dispersing liquid having a yield value of 0 dyne/cm². This tendency is decreased as the yield value is increased by adding the fine grain thickener. Only when the dispersing liquid is made to have a yield value higher than 5 dyne/cm² can a very clear high-contrast display be obtained, and yet displaying and erasing are very simple. The display is not erased even if the magnetic field is removed; however, it can be completely erased by applying a magnetic field to the rear side of the panel (i.e. the side thereof opposite to the display side).

According to a second aspect of the present invention, there is provided a magnetic display device comprising the combination of a magnetic display panel as defined in the fifth preceding paragraph, and a display magnet for causing the fine magnetic grains to migrate in the dispersion medium of said panel to form a display visible through the display section of said substrate.

According to a third aspect of the present invention, there is provided a magnetic display device comprising the combination of two magnetic display panels as defined in the sixth preceding paragraph, the non-displaying surfaces of said panels being mutually facing and mutually spaced apart; a display magnet for causing the fine magnetic grains to migrate in the dispersion medium of each panel to form a respective display; and an erasing magnet disposed in the space between the two panels and operable to cause the fine magnetic grains to migrate back through the dispersion medium so as to erase said displays concurrently.

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a graph illustrating the relationship between the rate of shear and the shear stress for a dispersing liquid which is employed in this invention;

Figures 2 to 5 are respectively, schematic sectional views of four different embodiments of a magnetic display panel according to a first aspect of the present invention;

Figures 6 to 8 are respectively, schematic plan views of three different forms of multi-cell structure for use in either of the display panels shown in Figures 4 and 5;

Figure 9 is a perspective view of a magnetic display device according to a second aspect of the present invention;

Figure 10 is a section taken along the line II-II in Figure 9;

Figure 11 is an exploded perspective view of part of the display device shown in Figures 9 and 10;

Figure 12 is a schematic sectional view of a magnetic display device according to a third aspect of the present invention;

Figure 13 is a schematic view of a displaying and erasing device for use in either of the display devices shown in Figures 9 to 12;

Figure 14 is a schematic view of a modified form of displaying and erasing device; and

Figure 15 is a perspective view of a printing tool for use in either of the display devices shown in Figures 9 to 12.

Referring first to Figure 1, there is shown a graph of rate of shear vs. shear stress for a dispersing liquid which is used in the present invention. The dotted line represents the relationship between the rate of shear and the shear stress of the dispersing liquid before a fine grain thickener is added, and the full line represents this relationship after the thickener has been added. The gradients of these lines has been exaggerated for the purpose of illustration, and the dotted line intersects the ordinate at substantially zero. It will be seen that the effect of adding the fine grain thickener is to displace the line to the right so that it intercepts the abscissa at a point A. This point represents the yield value of the dispersing liquid. According to this invention, the yield value (i.e. the value of point A on the abscissa) must be greater than 5 dyne/cm².

A first example of a magnetic display panel which utilizes this dispersing liquid is shown in Figure 2. The panel, denoted 10, comprises a front substrate 11 and a rear substrate 12 between which is defined a space in which a dispersion medium 13 (which includes the dispersing liquid) is disposed. The space is sealed along peripheral portions of the substrates 11 and 12 by a sealing plate 14 which is provided between the substrates. The composition of the dispersion medium will be described in detail later.

A second example of a magnetic display panel is shown in Figure 3, and is generally similar to that described above with reference to Figure 2. In this example, however, the substrate 12 and the sealing plate 14 are replaced by a multi-cell substrate 15, i.e. a substrate having a multi-cell structure formed integrally therewith, to which the front substrate 11 is bonded. The dispersion medium 13 is now contained in the individual cells of the substrate 15. The substrate 15 may be employed on the front or the rear of the panel, and can be fabricated by etching a metallic plate, by locally melting a photo-sensitive resin, or by subjecting a plastic plate to extrusion moulding.

In a third example of a magnetic display panel, shown in Figure 4, a multi-cell plate 16, having therein a plurality of independent or separate small cells in the form of through-holes, is bonded to the rear substrate 12, and after the dispersion medium 13 has been placed in the cells of the plate 16, the front substrate 11 is bonded to the plate 16.

A fourth example of the magnetic panel 10 is shown in Figure 5. A cup-shaped substrate 18 has a marginal portion 17 around its periphery and a recessed portion 18a at its centre. A multi-cell plate 16 is placed in the recessed portion 18a, and the dispersion medium 13 is put in the cells of the plate 16. The front substrate 11 is placed over the multi-cell plate 16 and the substrate 18, the marginal portion 17 of the substrate 18 then being bonded to the substrate 11. The substrate 18 may be used on the front side or on the rear side of the panel.

The multi-cell plate 16 used in the examples of Figures 4 and 5 may be constituted by a honeycomb structure having hexagonal cells 16a, as shown in Figure 6, or by a rectangular grid structure having rectangular cells 16b as shown in Figure 7. Alternatively, as shown in Figure 8, the plate 16 can be made by disposing a plurality of corrugated strips 16c in side by side relation and bonding together the corrugations 16d of adjacent strips so as to form cells 16e therebetween.

In use, the surface of the rear substrate of each of the magnetic panels described above is scanned with a magnet to apply a magnetic field to the dispersion medium so as to attract fine magnetic grains therein towards the rear side of the panel. A magnet is then moved along the surface of the front substrate, so that the fine magnetic grains are instantaneously attracted toward the front side of the panel, following the movement or locus of the magnet. As a result, a contrast occurs in the dispersion medium and, if this operation is repeatedly carried out, displaying and erasing records on the magnetic panel can be repeatedly effected.

A variety of materials can be used in this invention as the fine particulate thickener that is added to the dispersing liquid to adjust its yield value. Most suitable examples include fine-powdered silicic acid or silicate, such as silicic anhydride, hydrated silicic acid, hydrated calcium silicate, hydrated aluminum silicate, silica powder, diatom earth, coaline, hard clay, soft clay, bentonite and organic bentonite, which can be used independently or in combination; alumina; micro fine calcium carbonate, slightly ground powdered calcium carbonate, micro fine activated calcium carbonate or heavy calcium carbonate; or basic magnesium carbonate. These fine powdered thickeners can be used individually or in combination. The

amount to be used varies slightly depending upon the kind of the dispersing liquid used and the thickeners themselves, but in general adding 2% or more of a thickener gives a polar dispersing liquid a yield value higher than 5 dyne/cm², and so does the addition of 0.5% or more of a thickener to a non-polar dispersing liquid.

- 5 A dispersing liquid which has fine magnetic grains dispersed in a high viscosity solution made by dissolving a high molecular substance, metal soap, surfactant or an organic gelatinizing agent in various solvents is thixotropic and so sensitive to the temperature that its physical properties can easily change, with the result that the fine magnetic grains contained therein become inactive and sedimentation occurs. 5
- 10 A colourant (which can be white pigment, yellow pigment or another dyestuff or pigment) is added to the dispersion medium so as to provide it with shielding properties and a colour tone, thereby to increase the contrast between the colour of the display formed by the fine magnetic particles and the background. The use of less than 10%, preferably less than 3%, of the colourant on the basis of the dispersion medium gives a sufficient increase in the contrast between the dispersing liquid and the fine magnetic particles to permit reading of a sharp display. If the colourant is excessively used, the display formed by the fine magnetic particles becomes less distinct. 10 15

Although not forming part of the present invention, no colourant need be added if the fine grain thickener has reasonable shielding properties as well as a colour tone giving high contrast with the fine magnetic grains. This particular feature is made the subject of our co-pending UK patent application no. 802882 (Serial No. 1584522) (our reference 101988J). 20

The dispersing liquid used in this invention may be polar or non-polar. Representative examples of a polar dispersing liquids which may be used in practice include water, alcohols, glycols, esters, ethers, ketones, and various hydrocarbons such as aliphatic solvents, aromatic solvents and chlorine-containing solvents. Representative examples of non-polar dispersing liquids which may be used in practice include certain organic solvents and oils such as plant oil, animal oil, mineral oil and synthetic oil. 25

Examples of suitable fine magnetic grains which can be used in this invention include magnetic oxide materials such as black magnetite, α -haematite, chromium dioxide and ferrite, and magnetic metal materials made of iron, iron-based alloy, cobalt, cobalt-based alloy, nickel or nickel-based alloy. The fine magnetic grains can be obtained by granulating any of these materials into fine grains. If necessary, the fine grains can be adjusted for their colour tone. 30

35 The smaller the size of the fine magnetic grains, the less active the magnetic force of a magnetic field which is applied to the panel and, as a result, the fine magnetic grains migrate so slowly that they become suspended in the dispersing liquid, thereby defacing the magnetic display panel. Table 1 shows the results of a series of tests for mark formation and erasure using a magnetic display panel fabricated in the following manner. Multiple separate through-cells were provided in a plate 1.3 mm thick. A transparent substrate was attached onto one side of the thus prepared multi-cell plate. The individual cells were filled with a dispersion medium containing fine magnetic grains of various sizes and a dispersing liquid having a yield value of 30 dyne/cm²: a substrate was then attached to the other side of the multi-cell plate to seal the dispersion medium between the two substrates. 40

Type of fine magnetic grains	Table 1 Results of recording and erasure test	
5	magnetic panel using dispersion medium comprising Fe_3O_4 particles having diameter of less than 5μ Fewer grains were attracted by the magnetic pole, and most grains remained suspended in the intermediate region of individual cells. The entire panel was defaced and not suitable for practical use.	5
10	magnetic panel using dispersion medium comprising Fe_3O_4 particles granulated to have a diameter of $10 - 44\mu$ The grains were not easily attracted by the magnetic pole, and some grains remained suspended in the intermediate region of individual cells.	10
15	The appearance of the entire panel was slightly spoiled, but the image quality was good. Slight decrease in the contrast was observed.	15
20	magnetic panel using dispersion medium comprising Fe_3O_4 particles granulated to have a diameter of $44 - 149\mu$ Migration was sufficiently good to enable complete recording and erasure. No defacement of the panel was observed. Both image quality and contrast were satisfactory.	20
25	magnetic panel using dispersion medium comprising stainless powder of $44 - 149\mu$ diameter Migration was sufficiently good to enable complete recording and erasure. No defacement of the panel was observed. Due to the colour of the stainless powder, both the image quality and contrast were slightly impaired.	25
30		30
35	From Table 1, the fine magnetic grains preferably have a diameter of greater than 10μ . In certain cases, fine magnetic grains having a diameter less than 5μ can be used, and grains having a diameter less than 10μ can also be used. Even if their size is smaller than 10μ , the fine magnetic grains may agglomerate in the dispersion medium to provide an apparent diameter of greater than 10μ . If this occurs, an advantageous result is often achieved. The most preferred size ranges from 10 to 200μ .	35
40	Granulation of the fine magnetic grains to have an apparent size in a specified range, by blending them with a resin solution followed either by drying and grinding or by spraying and drying, provides a sharper display. The resin solution may be replaced by inorganic materials such as gypsum and water glass. The granulated magnetic particles are also referred to as fine magnetic grains herein.	40
45	Of the two opposed substrates which compose the magnetic display panel, the substrate on the front side of the panel where a display is read is preferably made of a transparent material, but depending on the practical application, it may be made of a translucent material. In either case, a variety of plastics and glass can be employed. It is not necessarily required that the other substrate on the rear side of the panel be made of a transparent material, and various plastics, glass and metals can be employed. These plastics and glass may or may not be coloured. It is on the other hand necessary to prevent leakage of the dispersion medium from between the two substrates. For this purpose, the gap between the two substrates may be filled with sealing plates placed at their edges, or a bonding agent may be used to fix each substrate to an interposed multi-cell plate, or the substrates may be fused to each other at their marginal edges.	45
50		50
55	The space between the two substrates which contains the dispersion medium may be properly changed according to the specific purpose of the panel, but for providing a sharp display with high contrast and for effecting desired erasure, they may be spaced by a distance of 0.3 to 20 mm , most preferably from 0.5 to 2.0 mm . The amount of fine magnetic grains contained in the dispersion medium is preferably 10 parts or more on the basis of 100 parts of the dispersion medium. Using less of the grains tends to result in a discontinuous, broken display.	55
60	The arrangement of multiple independent small cells between two substrates and having a dispersion medium sealed within each cell provides a sharp image of an extremely high	60
65		65

contrast as compared with a magnetic panel having no such cells but merely a dispersion medium sealed between two substrates. The image thus provided is very stable and retains its quality for a long period under the severest conditions. The cross-section of each cell may be circular, semi-circular or polygonal. The thinner the partition wall that separates one cell from another, the better display having sufficient continuity can be obtained. The partition wall preferably has a thickness of less than 0.5 mm. The two substrates may be preformed with the multi-cell structure, or a multi-cell structure made of metal, synthetic resin or fibrous sheet (e.g. paper) may be disposed between the two substrates. It is desired that the multi-cell structure be bonded to the substrates by means of a bonding agent because in so doing, the dispersion medium is completely sealed within each cell. Examples of advantageous bonding agents are an epoxy adhesive, polyurethane adhesive, and vinyl adhesive.

A magnetic display panel according to the invention may be prepared by incorporating a dispersion medium including fine magnetic grains in cells so arranged as to provide picture elements, for example a seven segment alpha-numeric display, cells arranged so as to provide a dot matrix, or cells arranged so as to provide characters or geometrical patterns.

This invention also relates to a magnetic display device comprising a magnetic display panel as described above and a magnet for causing migration of the fine magnetic grains contained in the dispersion medium. The magnet may be a permanent magnet or an electromagnet. The function of both display and erasure may be achieved by one magnet, but for ease of handling, it is preferable that a separate erasing magnet is slidably disposed on the rear side of the panel. Of course, an erasing magnet having a relatively large surface may be used to effect full or partial erasure. In any event, the minimum requirement for the erasing magnet that can be used in this invention is that it is capable of attracting those fine magnetic grains on a display area that is no longer needed.

Shown in Figures 9, 10 and 11 is one embodiment of such a magnetic display device, which comprises a magnetic panel 10 mounted on a rectangular frame 21 which co-operates with a flat plate 20 to form a box. An erasing permanent magnet 22 is placed in a space defined by the rectangular frame 21 in such a manner that it confronts the rear substrate of the panel 10. An operating lever 24 is attached to the magnet 22 and extends through a guide slot 23 formed in the rectangular frame 21 parallel to the direction of movement of the magnet 22, so as to facilitate sliding movement of the magnet 22. The front substrate is employed as a display section 25 and is transparent or semi-transparent.

In this example, in order that the magnet 22 can be moved smoothly, two guide rods 26 and 27 lie across the space in the rectangular frame 21 and parallel to the rear substrate, the ends of each rod being secured to the rectangular frame. A block 28 and a supporting plate 29 are secured to the rear surface of the holding portion 18, the guide rod 27 being inserted into the block 28, while the guide rod 26 is brought into contact with the supporting plate 29. The length of the magnet 22 is such as to cover at least the display section 25.

In the case where the magnetic display panel 10 shown in Figure 5 is used in the display device, as shown in Figure 11, a plurality of through-holes 17a are formed in the marginal portion 17 (i.e. the peripheral portion of the panel 10), while a plurality of protrusions 21a are provided on the rectangular frame 21 in correspondence to the holes 17a. The protrusions 21a are engaged with the holes 17a so that the recessed portion 18a of the substrate 18 is placed in a rectangular frame 21. The engagement may be made by way of an adhesive or a screw.

With the display device thus formed, a magnetic field is applied to the dispersion medium by sliding the erasing permanent magnet 22 with the operating lever 24, as a result of which the fine magnetic grains are attracted towards the rear side of the panel 10. Then, if a displaying magnet in a pen-shaped holder 30 (hence forth referred to as a "pen-shaped magnet"), is moved on the surface of the display section 25, the fine magnetic grains which have been attracted towards the rear side are attracted toward the display side of the panel instantaneously following the locus of the pen-shaped magnet 30, as a result of which contrast occurs in the dispersion medium to display the locus.

Another embodiment of a magnetic display device according to the invention is shown in Figure 12, in which display or writing can be effected on both surfaces thereof, and which is provided with an erasing magnet in its interior. More specifically, the device comprises two magnetic panels 10 and 10' which are spaced apart from each other by means of a rectangular frame 21, or which are placed on opposite sides of the rectangular frame 21. The device is otherwise similar to that described above with reference to Figures 9 to 11. However, the magnet-holding portion of the operating lever 24 is modified so that an erasing permanent magnet 22' confronting the rear side of the magnetic panel 10' is additionally provided; i.e. the magnet-holding portion holds two permanent magnets 22 and 22' so that these magnets are slidably movable between the magnetic panels 10 and 10'. The substrate on the front side of each panel 10, 10' is transparent or semi-transparent.

The size of the surface of the displaying magnet which contacts the panels 10 and 10' in use

needs to be adjusted according to the specific purpose of the device, and generally a magnet having a diameter of 1-3 mm is preferred. A magnet having a diameter of the order of 10-80 mm may be preferred for writing big characters. One big problem in the use of a displaying magnet is the unnecessary leak of magnetic flux which attracts more fine magnetic grains than are necessary, and which therefore causes an indistinct written display to be obtained. The best way to solve this problem is to use a displaying magnet unit which has a portion thereof surrounded with, for example, a yoke made of a ferromagnetic material. Another effective means of representation is a printing tool that has a magnet shaped into a character, symbol or a geometrical figure. Examples of other applicable methods or devices are to effect recording by applying current through a pen-shaped electromagnet instead of a pen-shaped permanent magnet; a printing device that uses a magnetic plate having such patterns as geometrical figures and characters due to an electromagnet; a pen-shaped magnet that is modelled after a Japanese writing brush and employs a hairy magnetic material; and a recording device that combines a magnetic pattern having a magnetic shield with a permanent magnet or an electromagnet.

For erasing the display on the magnetic panel described above, an erasing magnet can be provided on the pen-shaped holder 30 in addition to the displaying magnet. However, if the dimensions of its erasing surface are substantially of the order of those of a displayed line, it is difficult to erase the displayed line. Shown in Figure 13 is one example of a device which is suitable for both displaying and erasing. In this example, a displaying magnet 32 having a round contact surface for engagement with the magnetic panel in use is provided at one end of a holder 31, while an erasing magnet 33 whose contact surface is larger than that of the displaying magnet 32 is provided at the other end of the holder 31. With this device, it is possible not only to write heavy letters but also to erase readily displayed lines because the contact surface of the erasing magnet 33 is larger than that of the displaying magnet 32.

The displaying magnet 32 described above can be difficult to machine and is liable to be broken when dropped, and in addition, it is difficult to maintain its strength. Shown in Figure 14 is a pen-shaped magnet which overcomes the above-described difficulties and which permits a free selection of writing angle. A displaying magnet 35 and a cylindrical yoke 36 clamping both sides of the displaying magnet 35 are embedded in one end of a holder 34, and the display magnet 35, the cylindrical yoke 36 and the end of the holder 34 are rounded to form a spherical surface. The magnet 35 can now be readily machined, lines can be drawn in desired directions, the writing angle can be selected as desired, and the sliding characteristics of the displaying magnet and accordingly the holder are improved. Furthermore, as unnecessary magnetic flux leakage is not prevented by the yoke 36, only the fine magnetic grains immediately adjacent magnet 35 are attracted in use, as a result of which clear writing and displaying can be obtained. Thus, the above-described device is suitable for writing extremely thin lines. However, for displaying lines having greater width, it is not always necessary to provide the yoke 36.

Figure 15 illustrates a printing tool 38 in the form of a stamp, in which a figure or character 37 made of a permanent magnet is provided on a surface thereof. The figure or character can be readily displayed on the magnetic display device by bringing the printing tool 38 into contact with the magnetic panel.

In any of the examples described above, if the two magnetic poles of the fine magnetic grains are coloured differently, a two-colour display can be obtained by appropriately selecting the magnetic polarity of the displaying magnet.

The magnetic panel and the display device according to the invention are considerably useful as they can be widely applied as toys for infants, teaching equipment, writing boards, various game boards, memorandum boards, record displaying boards, blackboards, whiteboards, dustless displaying boards, advertising boards, POP boards, or under-water record displaying boards utilising a recording and erasing system in which recording is effected without using liquid ink, being completely stable against water.

Now, various examples for a detailed description of the magnetic panel according to the invention will be described, however, it should be noted that the invention is not limited thereby or thereto.

EXAMPLE 1

Ninety-eight parts of Isopar M (trademark of Humble Oil and Refining Co. for an isoparaffin solvent), 1.25 parts of Aerosil-200 (trademark of Degussa, Inc. for a fine powder silicic acid) and one part of Tipaque CR-50 (titanium oxide made by Ishihara Sangyo K.K.) were kneaded with a T.K. homomixer : (which is a wet type dispersing machine made by Tokushukika Kogyo K.K.) to obtain a white liquid.

40 parts of Toda Colour KN-320 (which is a magnetite made by Toda Kogyo K.K.), and 25 parts of 40% methylethylketone of Epo-Tohto YD-017 (which is a solid epoxy resin made by

Toto Kasei K.K.) were kneaded to obtain a mixture. The mixture thus obtained was subjected to drying and grinding to obtain 30 parts of 100 - 325 mesh black fine magnetic grains. The fine magnetic grains were mixed and dispersed in the white liquid described above to obtain a dispersing liquid.

The yielding value of this dispersing liquid was 6.3 dyne/cm². A multi-cell plate 1.3 mm in thickness was provided. The sectional area of each cell was 4 mm square, and the wall thickness was 0.075 mm. The dispersing liquid was sealed in the cells by covering both surfaces of the multi-cell plate with polyester films 0.1 mm in thickness. Thereafter, the peripheral portion of the multi-cell plate was fixed with an epoxy adhesive to form a magnetic panel.

EXAMPLE 2

A magnetic panel was made similarly as in Example 1 with the exception that 1.5 parts of Aerosil-200 was used. The yielding value of the dispersing liquid was 10.9 dyne/cm².

EXAMPLE 3

A magnetic panel was made similarly as in Example 1 with the exception that 1.75 parts of Aerosil-200 was used. The yielding value of the dispersing liquid was 20.2 dyne/cm².

EXAMPLE 4

A magnetic panel was made similarly as in Example 1 with the exception that 2.0 parts of Aerosil-200 was used. The yielding value of the dispersing liquid was 35.0 dyne/cm².

EXAMPLE 5

A magnetic panel was made similarly as in Example 1 with the exception that 4.0 parts of Aerosil-200 was used. The yielding value of the dispersing liquid was 81.9 dyne/cm².

EXAMPLE 6

Eighty-two parts of Isopar M, 1.5 parts of Aerosil-200, and 0.8 part of Tipaque CR-50 were kneaded with the T.K. momomixer to obtain a white liquid.

Thirty parts of Toda Color KN-320, 8 parts of Polysol SH-502 (which is a vinyl acetate resin emulsion made by Showa Kobunshi K.K.) and eight parts of water were kneaded to prepare a mixture. This mixture was subjected to drying and grinding to obtain 16 parts of 100 - 325 mesh black fine magnetic grains. The fine magnetic grains thus obtained were mixed and dispersed in the aforementioned white liquid to obtain a dispersing liquid.

The yielding value of the dispersing liquid was 30.0 dyne/cm². A multi-cell plate 1.4 mm in thickness, the sectional area of each cell being 4 mm square, was provided a substrate having a recessed portion at the central part and a flange along its peripheral portion was provided. The multi-cell plate was bonded to the recessed portion of the substrate to fabricate a container. The dispersing liquid was put in the container, and then the other surface of the container was covered with a vinyl chloride resin sheet coated with an epoxy adhesive to completely seal the dispersing liquid therein. Thereafter, the peripheral portion of the container was subjected to high-frequency welding to fabricate a magnetic panel.

EXAMPLE 7

One hundred parts of mineral spirit, 6 parts of Silnex P-52 (which is a fine powder silicate made by Mizusawa Kagaku Kogyo K.K.) and one part of Tipaque CR-50 were kneaded with the T.K. momomixer to prepare a white liquid. Then, 24 parts of MRM-400 (which is a α -hematite made by Toda Kogyo K.K.) and 30 parts of 20% aqueous solution of Gohsenol GM-14 (which is a polyvinylalcohol made by Nippon Goseikagaku Kogyo K.K.) were kneaded with three rolls to prepare a mixture. The mixture was subjected to drying and grinding to obtain 23 parts of 100 - 250 mesh brown fine magnetic grains. The brown fine magnetic grains were mixed and dispersed in the aforementioned white liquid to obtain a dispersing liquid.

The yielding value of the dispersing liquid was 13.4 dyne/cm². A multi-cell plate 1.5 mm in thickness of the type shown at 15 in Figure 3 was provided, the sectional area of each cell being 4 mm square and the wall thickness between adjacent cells being 0.02 mm. The dispersing liquid was then sealed in these cells to fabricate a magnetic plate. The other surface of the plate was covered with a vinyl chloride sheet by using an epoxy adhesive and the

peripheral portion of the multi-cell plate covered with the vinyl chloride sheet was subject to high frequency welding, thereby fabricating a magnetic panel.

EXAMPLE 8

First, 100 parts of mineral spirit, 3 parts of aluminum oxide C (which is an aluminum oxide made by Nippon Aerosil K.K.), and 0.1 part of Seikafast yellow-200 (which is a yellow pigment made by Dainichi Seika Kogyo K.K.) were kneaded by the T.K. homomixer to to prepare a mixture. Then, 30 parts of the same fine magnetic grains as those used in Example 1 were mixed and dispersed in the mixture thus prepared to obtain a dispersing liquid.

The yielding value of the dispersing liquid was 26 dyne/cm². Similarly as in the case of Example 1, the dispersing liquid was put in the cells of the multi-cell plate. Thereafter, the peripheral portion of the multi-cell plate was fixed with a urethane adhesive to form a magnetic panel.

EXAMPLE 9

First, 100 parts of toluene, 3 parts of S-Ben (which is an organic bentonite made by Hojun Yoko Co.), one part of Tipaque CR-50, and 0.2 part of A110 Red (which is a red pigment made by Dainichi Seika Kogyo K.K.) were kneaded with the T.K. homomixer to prepare a mixture. Then, 40 parts of 100 - 325 mesh stainless powder was mixed and dispersed in the mixture to prepare a dispersing liquid.

The yielding value of the dispersing liquid was 33.6 dyne/cm². Similarly as in the case of Example 1, the dispersing liquid was sealed in the cells of the multi-cell plate to provide a magnetic panel.

EXAMPLE 10

First, 50 parts of water 50 parts of ethylene glycol, 10 parts of Aerosil-200, and 2.5 parts of Tipaque yellow TY-50 (which is a yellow pigment made by Ishihara Sangyo K.K.) were thoroughly kneaded in a container with an agitating bar to prepare a yellow liquid. Then, 30 parts of MRMB-450 (which is a magnetite made by Toda Kogyo K.K.) and 40 parts of 20% toluene solution of Acrypet VK-001 (which is a methacrylic resin made by Mitsubishi Rayon K.K.) were kneaded with three rolls to prepare a mixture. The mixture was subjected to drying and grinding to obtain 25 parts of 100 - 250 mesh black fine magnetic grains. The fine magnetic grains thus obtained were mixed and dispersed in the aforementioned yellow liquid to prepare a dispersing liquid.

The yielding value of the dispersing liquid was 42 dyne/cm². Similarly as in the case of Example 1, the dispersing liquid was sealed in the cells of the multi-cell plate to provide a magnetic panel.

EXAMPLE 11

First, 100 parts of water, 10 parts of Airosil-200, and one part of Tipaque R-550 were kneaded in a container with an agitating bar to prepare a white liquid. Then, 36 parts of stainless powder (100 - 325 mesh), 9 parts of Tipaque R-550, 3 parts of A110 Red, and 15 parts of 40% methylethylketone solution of Epo-Tohto YD-014 (which is a solid epoxy resin made by Toto Kasei K.K.) were kneaded to prepare a mixture. The mixture was subjected to drying and grinding to obtain 35 parts of 100 - 325 mesh red fine magnetic grains. The fine magnetic grains thus obtained were mixed and dispersed in the aforementioned white liquid to obtain a dispersing liquid.

The yielding value of the dispersing liquid was 39.5 dyne/cm². Similarly as in the case of Example 1, the dispersing liquid was sealed in the cells of the multi-cell plate to fabricate a magnetic panel.

EXAMPLE 12

First, 100 parts of Isopar M100, 14 parts of soft calcium carbonate, and one part of Tipaque CR-50 were kneaded by the T.K. homomixer to prepare a mixture. Then, 30 parts of the same fine magnetic grains as those employed in Example 1 was mixed and dispersed in the mixture thus prepared to obtain a dispersing liquid.

The yielding value of the dispersing liquid was 14.7 dyne/cm². Similarly as in the case of Example 1, the dispersing liquid was sealed in the cells of the multi-cell plate to provide a magnetic panel.

Then, a magnetic panel in which a dispersing liquid having no yielding value was sealed was

provided. The dispersing liquid was obtained by dispersing only the magnetic fine grains in a coloured dispersing agent in which a colouring agent was dissolved or dispersed. In addition, a magnetic panel in which a dispersing liquid was sealed was provided. This dispersing liquid was made up of fine magnetic grains, a dispersing agent, a fine grain thickener, and a colouring agent and had a yielding value less than 5 dyne/cm². These panels thus provided were compared with the magnetic panels according to the invention. In all of the magnetic panels, a multi-cell plate 1.3 mm in thickness having separate or independent cells, each cell being in the form of a through hole, the sectional area of each cell being 4 mm square, and two surfaces of the multi-cell plate were covered with transparent polyester films.

REFERENCE EXAMPLE 1

To 100 ml of distilled water wherein 1 g of sodium hexametaphosphate was dissolved was added 10 g of a fine powder of anatase-type titanium dioxide and 4 g of chromium dioxide followed by blending in a ball mill to obtain a dispersion. The dispersion thus obtained was distributed among the individual cells of a multi-cell plate. A polyester film was bonded to both sides of the multi-cell plate with an epoxy adhesive to provide a magnetic panel.

REFERENCE EXAMPLE 2

To a solution of 170 g of polystyrol in 500 ml of benzene was added 200 g of α -hematite and 100 g of titanium dioxide, and blended in a ball mill to prepare a paste. While a magnetic field was applied to the paste in a given direction, the paste was dried and cured. The solid product was ground by a grinder to produce fine powdered magnetic particles. A mixture of 0.3 g of an oil blue dyestuff and 0.1 g of cobalt naphthenate was dissolved in 100 ml of tetrafluorodibromo ethane (specific gravity of 2.18). To the solution was added 7 ml of olive oil and 8 g of the previously prepared magnetic particles, and mixed in a paint shaker to produce a dispersion. The dispersion was used to make a magnetic panel in the same manner as in Reference Example 1.

REFERENCE EXAMPLE 3

A sample of 100 g of Isopar M (isoparaffin solvent) was mixed with 1 g of titanium dioxide and 25 g of granulated ferrosferic oxide having a particle size of 44-149 μ in a homomixer to prepare a dispersion. According to the same method as used in Reference Example 1, a magnetic panel was prepared using this dispersion.

REFERENCE EXAMPLE 4

To 100 g of Isopar M were added 1 g of titanium dioxide, 25 g of granulated ferrosferic oxide having a particle size of 44-149 μ , and 0.75 g of Aerosil-200, and mixed in a homomixer to prepare a dispersion. According to the same method as used in Reference Example 1, a magnetic panel was prepared using this dispersion.

REFERENCE EXAMPLE 5

To 100 g of Isopar M were added 1 g of titanium dioxide, 14 g of ferrosferic oxide granulated to have a particle size of 44-149 μ , and 1 g of Aerosil-200, and mixed in a homomixer to prepare a dispersion. A magnetic panel was prepared using this dispersion according to the same method as used in Reference Example 1.

Measurement of the yielding values was carried out according to a direct method with a Brook Field BL viscometer (made by Tokyo Keiki K.K.). The method is as follows: the rotor of the viscometer is immersed into the dispersing liquid, and only the dispersing liquid is allowed to move around the rotor at a very slow rate of 0.2 r.p.m without rotating the rotor. In this case, the spring of the rotor is twisted, as a result of which both the rotor and the dispersing liquid are turned. However, when the rotor is twisted to a certain angle, the dispersing liquid is caused to slide along the rotor. At this time, the angle of torsion of the rotor is measured. The yielding value is obtained through conversion from the angle of torsion of the rotor, the constant torsion of the spring of the rotor, and the configuration and area of the rotor. The converting equations are as follows:

Rotor Number	Yielding Value
No. 1 rotor	0.168 θ
No. 2 rotor	0.840 θ
No. 3 rotor	3.360 θ

where θ is the angle of torsion of the rotor measured.

Displays which were recorded at a recording speed 25 cm/sec with a permanent magnet corresponding to MPB 380 in JIS C2502 were visually observed. A difference in brightness between the colour of the entire panel and the display recorded according to the same method as that for determining the clearness of display was visually observed.

Recording was carried out by applying a sufficient magnetic field to the panel, and the panel was allowed to stand still. In a certain period of time, the sedimentation velocity of the magnetic fine grains was visually observed. In addition, the sedimentation velocity of the fine magnetic grains obtained when the panel on which recording has been carried out similarly was vibrated manually (with a frequency of once per second and an amplitude of 200 mm) was visually observed. The density of a display recorded by changing the magnetic field applied to the panel (the amount of fine magnetic grains allowed to migrate) was visually observed.

Table II shows the performance of the magnetic panels prepared according to this invention and those prepared in the above Reference Examples.

Table II

Items tested Specimen	Yield value of dispersion dyne/cm ²	minimum strength of magnetic field at which magnetic particles start to move	display retention of (sedimentation of magnetic particles)
Ex. 1	6.3	all particles started to move as soon as the strength exceeded 0.04 KG.	no sedimentation occurred at either stationary or vibrational condition. Display was stable.
Ex. 2	10.9	all particles started to move as soon as the strength exceeded 0.05 KG.	"
Ex. 3	20.2	all particles started to move as soon as the strength exceeded 0.06 KG	"
Ex. 4	35.0	all particles started to move as soon as the strength exceeded 0.08 KG	"
Ex. 5	81.9	all particles started to move as soon as the strength exceeded 0.2 KG	"

Table II con'd.

Items tested Specimen	Yield value of dispersion dyne/cm ²	minimum strength of magnetic field at which magnetic particles start to move	display retention of (sedimentation of magnetic particles)
Ref. Ex. 1	0	less than 0.001 KG	30 seconds after recording, sedimentation of the particles occurred and display disappeared.
Ref. Ex. 2	0	less than 0.001 KG	some degree of sedimentation of the particles occurred under vibrational condition, and display became less distinct.
Ref. Ex. 3	0	less than 0.001 KG	30 seconds after recording, almost all particles formed sediment and display disappeared.
Ref. Ex. 4	1.5	less than 0.01 KG	some degree of sedimentation occurred under vibrational condition, and display became less distinct.
Ref. Ex. 5	2.5	less than 0.01 KG	slight sedimentation of the particles occurred under vibrational condition, and display became slightly dull.

Table II (continued)

sharpness of display	Contrast between display and background	migration of the magnetic particles
Ex. 1 sharp display obtained	clear	good
Ex. 2 "	"	"
Ex. 3 "	very clear	very good
Ex. 4 very sharp display obtained	"	"
Ex. 5 "	"	"
Ref.Ex.1 since sedimentation occurred very soon, only a broken and dull display was obtained for a very short period.	repetition of recording and erasure resulted in some defacement of the background.	the particles showed good migration, but soon enough, sedimentation occurred to give low density.
Ref.Ex.2 broken and rough display obtained.	repetition of recording and erasure resulted in defaced and indistinct background.	the particles were not easily attracted by the magnetic pole. They remained dispersed throughout the solution.
Ref.Ex.3 dull display obtained only for a short period.	repetition of recording and erasure resulted in some defacement of the background.	the particles showed good migration, but soon enough, sedimentation occurred to give low density.
Ref.Ex.4 only dull display obtained	"	"
Ref.Ex.5 dull, discontinued and broken display obtained.	repetition of recording and erasure resulted in slight defacement of the background.	"

As is apparent from the above-described results, the magnetic panels fabricated by scaling in the dispersing liquid having a yielding value higher than 5 dyne/cm² showed excellent performance. Thus, the magnetic panels according to the invention are considerably useful.

5 WHAT WE CLAIM IS:-

1. A magnetic display panel comprising a sealed space containing a dispersion medium, one side of the sealed space being defined by a substrate which is transparent or semi-transparent in at least a display section thereof, the dispersion medium including fine magnetic grains, a colouring agent, and a dispersing liquid to which is added a fine grain thickener, the resultant yield value of the dispersing liquid being greater than 5 dynes/cm².
2. A magnetic display panel as claimed in claim 1, wherein the dispersion medium is contained in the individual cells of a multi-cell structure.
3. A magnetic display panel as claimed in claim 2, wherein the cells are hexagonal.
4. A magnetic display panel as claimed in Claim 2, wherein the cells are rectangular.
5. A magnetic display panel as claimed in claim 2, wherein the cells are formed by a plurality of corrugated strips arranged side by side, the corrugations in adjacent strips being bonded together.
6. A magnetic display panel as claimed in any one of claims 2 to 5, wherein the multi-cell structure is made of metal, synthetic resin or fibrous sheet.
7. A magnetic display panel as claimed in any one of claims 2 to 6, wherein the multi-cell structure is bonded to said substrate by means of an adhesive.
8. A magnetic display panel as claimed in any one of claims 2 to 6, wherein the multi-cell structure is integral with said substrate or with a further substrate which is spaced from and opposed to the first-mentioned substrate.
9. A magnetic display panel as claimed in any one of claims 2 to 7, wherein the multi-cell structure is interposed between said substrate and a further substrate which is spaced from and opposed to the first-mentioned substrate.
10. A magnetic display panel as claimed in any preceding claim, wherein the fine magnetic grains are of black magnetite, α -haematite, chromium dioxide, ferrite, iron, iron-based alloy, cobalt, cobalt-based alloy, nickel or nickel-based alloy, or are obtained by granulating any of these materials into fine grains.
11. A magnetic display panel as claimed in any preceding claim, wherein the fine magnetic grains have a particle size of 10 μ to 200 μ .
12. A magnetic display panel as claimed in any preceding claim, wherein the fine grain thickener is composed of silicic acid, silicate, alumina, calcium carbonate or magnesium carbonate, used either individually or in combination.
13. A magnetic display panel as claimed in any preceding claim, wherein the colouring agent is a white, yellow or red pigment.
14. A magnetic display panel as claimed in any preceding claim, wherein the colouring agent includes titanium oxide.
15. A magnetic display panel as claimed in any preceding claim, wherein the thickness of said sealed space is 0.3mm to 20mm.
16. A magnetic display panel as claimed in any preceding claim, wherein the thickness of said sealed space is 0.5mm to 2.0mm.
17. A magnetic display device comprising the combination of a magnetic display panel as claimed in any preceding claim, and a display magnet for causing the fine magnetic grains to migrate in the dispersion medium to form a display visible through the display section of said substrate.
18. A magnetic display device as claimed in claim 17, further comprising an erasing magnet operable to cause the fine magnetic grains to migrate back through the dispersion medium so as to erase said display.
19. A magnetic display device as claimed in claim 18, wherein the erasing magnet is an electromagnet disposed on a surface of the magnetic display panel remote from said substrate.
20. A magnetic display device as claimed in claim 18, wherein the erasing magnet is a permanent magnet which is slidable over the surface of the magnetic display panel.
21. A magnetic display device as claimed in any one of claims 17 to 20, wherein the display magnet is an electro-magnet.
22. A magnetic display device as claimed in any one of claims 17 to 20, wherein the display magnet is a permanent magnet mounted on an end of a pen-like holder.
23. A magnetic display device as claimed in claim 17, wherein the display magnet is a permanent magnet mounted on an end of a pen-like holder, and an erasing magnet is mounted on the opposite end of the holder and is arranged when engaged with the magnetic display panel in use to cause the fine magnetic grains to migrate back through the dispersing liquid to erase said display, the area of the erasing magnet which engages the magnetic display



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As is apparent from the above-described results, the magnetic panels fabricated by scaling in the dispersing liquid having a yielding value higher than 5 dyne/cm² showed excellent performance. Thus, the magnetic panels according to the invention are considerably useful.

5 WHAT WE CLAIM IS:-

1. A magnetic display panel comprising a sealed space containing a dispersion medium, one side of the sealed space being defined by a substrate which is transparent or semi-transparent in at least a display section thereof, the dispersion medium including fine magnetic grains, a colouring agent, and a dispersing liquid to which is added a fine grain thickener, the resultant yield value of the dispersing liquid being greater than 5 dynes/cm². 5
2. A magnetic display panel as claimed in claim 1, wherein the dispersion medium is contained in the individual cells of a multi-cell structure. 10
3. A magnetic display panel as claimed in claim 2, wherein the cells are hexagonal.
4. A magnetic display panel as claimed in Claim 2, wherein the cells are rectangular.
- 15 5. A magnetic display panel as claimed in claim 2, wherein the cells are formed by a plurality of corrugated strips arranged side by side, the corrugations in adjacent strips being bonded together. 15
6. A magnetic display panel as claimed in any one of claims 2 to 5, wherein the multi-cell structure is made of metal, synthetic resin or fibrous sheet.
- 20 7. A magnetic display panel as claimed in any one of claims 2 to 6, wherein the multi-cell structure is bonded to said substrate by means of an adhesive. 20
8. A magnetic display panel as claimed in any one of claims 2 to 6, wherein the multi-cell structure is integral with said substrate or with a further substrate which is spaced from and opposed to the first-mentioned substrate.
- 25 9. A magnetic display panel as claimed in any one of claims 2 to 7, wherein the multi-cell structure is interposed between said substrate and a further substrate which is spaced from and opposed to the first-mentioned substrate. 25
10. A magnetic display panel as claimed in any preceding claim, wherein the fine magnetic grains are of black magnetite, α -haematite, chromium dioxide, ferrite, iron, iron-based alloy, cobalt, cobalt-based alloy, nickel or nickel-based alloy, or are obtained by granulating any of these materials into fine grains. 30
11. A magnetic display panel as claimed in any preceding claim, wherein the fine magnetic grains have a particle size of 10 μ to 200 μ .
12. A magnetic display panel as claimed in any preceding claim, wherein the fine grain 35 thickener is composed of silicic acid, silicate, alumina, calcium carbonate or magnesium carbonate, used either individually or in combination. 35
13. A magnetic display panel as claimed in any preceding claim, wherein the colouring agent is a white, yellow or red pigment.
14. A magnetic display panel as claimed in any preceding claim, wherein the colouring 40 agent includes titanium oxide. 40
15. A magnetic display panel as claimed in any preceding claim, wherein the thickness of said sealed space is 0.3mm to 20mm.
16. A magnetic display panel as claimed in any preceding claim, wherein the thickness of said sealed space is 0.5mm to 2.0mm.
- 45 17. A magnetic display device comprising the combination of a magnetic display panel as claimed in any preceding claim, and a display magnet for causing the fine magnetic grains to migrate in the dispersion medium to form a display visible through the display section of said substrate. 45
18. A magnetic display device as claimed in claim 17, further comprising an erasing magnet operable to cause the fine magnetic grains to migrate back through the dispersion 50 medium so as to erase said display. 50
19. A magnetic display device as claimed in claim 18, wherein the erasing magnet is an electromagnet disposed on a surface of the magnetic display panel remote from said substrate.
20. A magnetic display device as claimed in claim 18, wherein the erasing magnet is a 55 permanent magnet which is slidable over the surface of the magnetic display panel. 55
21. A magnetic display device as claimed in any one of claims 17 to 20, wherein the display magnet is an electro-magnet.
22. A magnetic display device as claimed in any one of claims 17 to 20, wherein the 60 display magnet is a permanent magnet mounted on an end of a pen-like holder. 60
23. A magnetic display device as claimed in claim 17, wherein the display magnet is a permanent magnet mounted on an end of a pen-like holder, and an erasing magnet is mounted on the opposite end of the holder and is arranged when engaged with the magnetic display panel in use to cause the fine magnetic grains to migrate back through the dispersing 65 liquid to erase said display, the area of the erasing magnet which engages the magnetic display 65

panel in use being greater than the area of the display magnet which engages the magnetic display panel in use.

24. A magnetic display device as claimed in claim 22 or 23, wherein the display magnet is embedded in said end of the holder, and a surface thereof which is engaged with the magnetic display panel in use is rounded and flush with the surface of said end of the holder, which is also rounded.

25. A magnetic display device as claimed in any one of claims 17 to 20, wherein the display magnet is a printing tool on a surface of which a figure or character made of permanent magnets is provided.

26. A magnetic display device comprising the combination of two magnetic display panels as claimed in any one of claims 1 to 16, the non-displaying surfaces of said panels being mutually facing and mutually spaced apart; a display magnet for causing the fine magnetic grains to migrate in the dispersion medium of each panel to form a respective display; and an erasing magnet disposed in the space between the two panels and operable to cause the fine magnetic grains to migrate back through the dispersion medium so as to erase said displays concurrently.

27. A magnetic display device as claimed in claim 26, wherein the erasing magnet is a permanent magnet slidably disposed in said space.

28. A magnetic display panel substantially as hereinbefore described with reference to any one of Figures 2 to 8 of the accompanying drawings.

29. A magnetic display device substantially as hereinbefore described with reference to Figures 9 to 11, or Figure 12, or Figures 9 to 11 as modified by Figure 13, Figure 14 or Figure 15 of the accompanying drawings.

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