(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
16 May 2013 (16.05.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/068582 A2

(51) **International Patent Classification**:
A47G 1/17 (2006.01) *E04F 13/08* (2006.01)
G09F 7/04 (2006.01)

(21) **International Application Number**:
PCT/EP2012/072373

(22) **International Filing Date**:
12 November 2012 (12.11.2012)

(25) **Filing Language**: English

(26) **Publication Language**: English

(30) **Priority Data**:

1119566.6	11 November 2011 (11.11.2011)	GB
1122122.3	22 December 2011 (22.12.2011)	GB
1201096.3	20 January 2012 (20.01.2012)	GB
1201183.9	23 January 2012 (23.01.2012)	GB
1202032.7	6 February 2012 (06.02.2012)	GB
1204697.5	16 March 2012 (16.03.2012)	GB
1206194.1	5 April 2012 (05.04.2012)	GB
1206357.4	11 April 2012 (11.04.2012)	GB
1216426.5	14 September 2012 (14.09.2012)	GB
1217519.6	1 October 2012 (01.10.2012)	GB
1217769.7	4 October 2012 (04.10.2012)	GB

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(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

WO 2013/068582 A2

(54) **Title**: MAGNETIC ATTACHMENT SYSTEM

(57) **Abstract**: A system for attaching an object to a panel or wall is described. Embodiments include arrangements having an elongate magnetic element guide and/or first and second magnetic elements connected to the panel or wall and spaced at a first predetermined distance from each other. Devices for holding an object in a position on a panel or wall are also described, which can comprise third and fourth magnetic elements spaced such that each can simultaneously attach to a respective one of said first and second magnetic elements connected to the panel or wall, or which can comprise a friction reducing element for enabling the device to move freely over the surface of the panel or wall without causing damage to the surface of the wall or panel. A device to be attached to a panel or wall for use as part of a magnetic attachment system is also described.

Magnetic Attachment System

Technical Field

The invention relates to a magnetic attachment system and components thereof. Particularly but not exclusively, the invention relates to an attachment system for attaching an object to a wall or panel using magnetic force, a magnetic element guide arrangement, a panel, a device for holding an object in a position on a panel or wall and a device for holding a picture frame in a position on a panel or wall.

Background

Conventional systems for attaching paintings, coat hooks, curtains or other objects to walls generally involve the use of nails, screws, bolts, adhesive, blue tack or the like which cause damage to the surface of the wall. This can be inconvenient when it is intended to move the object on the wall, or to remove the object from the wall entirely, since the area on which the object was attached would often need to be redecorated.

It is known to use magnetic force to hold objects on walls. However, known systems can be inconvenient to install and restrictive once the system has been installed, for instance in terms of changing the location on a wall where an object can be attached without damaging the wall and in terms of restrictions on the size and weight of objects which can be supported.

Summary

According to embodiments of the invention, there is provided a magnetic element guide arrangement for use as part of a system for attaching an object to a panel or wall, the magnetic element guide arrangement comprising a magnetic element supporting member which, when connected to a panel or wall, supports a magnetic element such that the magnetic element can move along a linear path parallel to the plane of the surface of the panel or wall.

Additional optional features of the magnetic element guide arrangement are set forth in claims 2 to 18 appended hereto.

According to embodiments of the invention, there is further provided a panel or wall comprising a magnetic element guide arrangement as described herein.

According to embodiments of the invention, there is further provided a system for attaching an object to a panel or wall, the system comprising a magnetic element guide arrangement as described herein and a magnetic element supported by said magnetic element supporting member.

Additional optional features of the system are set forth in claims 21 to 29 appended hereto.

According to embodiments of the invention, there is further provided a device to be attached to a panel or wall for use as part of a magnetic attachment system, the device comprising a magnetic element and an elongate connecting member comprising a connecting arrangement for connecting the magnetic element to a panel or wall.

Additional optional features of the device to be attached to a panel or wall are set forth in claims 31 to 34 appended hereto.

The magnetic element or magnetic elements can comprise permanent magnets or an electromagnet.

According to embodiments of the invention, there is further provided a device for holding an object in a position on a panel or wall, the device comprising a magnetic element for attaching the object, via magnetic force, to the panel or wall and a friction reducing element for enabling the device to move over the surface of the panel or wall without causing damage to the surface of the wall or panel.

Additional optional features of the device for holding an object in a position on a panel or wall are set forth in claims 37 and 38 appended hereto.

According to embodiments of the invention, there is further provided a system for attaching an object to a panel or wall, the system comprising first and second magnetic elements connected to the panel or wall and spaced at a first predetermined distance from each other and a device for holding an object in a position on a panel or wall, the device comprising third and fourth magnetic elements spaced such that each can simultaneously attach to a respective one of said first and second magnetic elements connected to the panel or wall so as to attach the object to the panel or wall.

According to embodiments of the invention, there is further provided a device for holding a picture frame in a position on a panel or wall, the device comprising a magnetic element for holding the picture frame, via magnetic force, in a position on a panel or wall and a connecting arrangement for connecting to said picture frame, said connecting arrangement at least partly disposed between inner sides of the frame when connected to the picture frame.

Additional optional features of the device for holding a picture frame in a position on a panel or wall are set forth in claims 43 to 48 appended hereto.

According to embodiments of the invention, there is further provided a magnetic element guide arrangement comprising a first magnetic element supporting member connected to a panel or wall and supporting a first magnetic element such that the first magnetic element can move along a first linear path parallel to the plane of the surface of the panel or wall and a second magnetic element supporting member connected to a panel or wall and supporting a second magnetic element such that the second magnetic element can move along a second linear path parallel to the first linear path; and wherein the first and second magnetic elements comprise permanent or electromagents and wherein the first magnetic element has its north pole facing away from the panel or wall and the second magnetic element has its south pole facing away from the panel or wall.

The first magnetic element supporting member can be connected side-by-side with the second magnetic element supporting member such that the first and second linear paths are adjacent to each other.

At least one of the one or more magnetic elements defined above can comprise a plurality of magnetic bodies attached to a ferromagnetic metal plate.

Brief Description of the Drawings

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

Figure 1(a) illustrates a magnetic element for mounting on a wall or panel as part of a magnetic attachment system;

Figure 1(b) is a plan view of a panel comprising a plurality of magnetic elements;

Figure 1(c) is a perspective view of a portion of the panel illustrated in Figure 1(b);

Figures 2(a) and 2(b) are perspective views of a magnetic device to be attached to a wall or panel for use as part of a magnetic attachment system;

Figure 3 is a perspective view of a plurality of magnetic elements for connecting to an object such that the object can be attached to a wall or panel for use as part of a magnetic attachment system;

Figure 4 is a perspective view of a ferromagnetic metal plate for connecting to an object such that the object can be attached to a wall or panel for use as part of a magnetic attachment system;

Figure 5(a) is a front view of a device for holding an object in a position on a wall or panel;

Figure 5(b) is a rear view of the device of Figure 5(a);

Figure 5(c) is a perspective view of an object supporting member for use with the device of Figures 5(a) and 5(b);

Figure 6(a) is a front view of a further device for holding an object in a position on a wall or panel;

Figure 6(b) is a rear view of the device of Figure 6(a);

Figure 6(c) is a top view of the device of Figures 6(a) and 6(b);

Figure 6(d) is a cross section of the device of Figures 6(a) to 6(c) through the line X-X of Figures 6(a) and 6(b);

Figure 7(a) is a cross sectional view of a connecting body of a multi-part device for holding a picture frame in a position on a wall or panel, the connecting body including a plurality of magnetic elements, the cross section being through the line X'-X' of Figure 7(b);

Figure 7(b) is a side view of the connecting body of Figure 7(a) from direction Y of Figure 7(a);

Figure 7(c) is a cross sectional view through the line X"-X" of Figure 7(a);

Figure 7(d) is a perspective view of a telescopic extension arm for use with the connecting body of Figures 7(a) to 7(c);

Figure 7(e) is a perspective view of a frame connector for use with the connecting body of Figures 7(a) to 7(c) and the telescopic extension arm of Figure 7(d);

Figure 7(f) is a perspective view of the connecting body of Figures 7(a) to 7(c), two of the telescopic extension arms of Figure 7(d) and two of the frame connectors of Figure 7(e) forming a multi-part device, connected to a picture frame;

Figure 7(g) is a side view of a further connecting body for use in the multi-part device of Figures 7(a) to 7(f);

Figure 7(h) is a cross sectional view of the further connecting body of Figure 7(g);

Figure 8(a) is a cross sectional view of the connecting body of a further multi-part device for holding a picture frame in a position on a wall or panel, the device including a single magnetic element, the section being through the line C-C of Figure 8(b);

Figure 8(b) is a side view of the connecting body of Figure 8(a) from the direction Y' of Figure 8(a);

Figure 8(c) is a cross sectional view through the line C'-C' of Figure 8(a);

Figure 8(d) is a perspective view of an alternative frame connector for use with the connecting bodies of Figures 7(a) to 7(c) and Figures 8(a) to (c);

Figure 8(e) is a perspective view of two of the connecting bodies of Figures 8(a) to 8(c), the telescopic extension arm of Figure 7(d) and two of the frame connectors of Figure 8(d) forming the further multi-part device, connected to a picture frame;

Figure 8(f) illustrates an extension locking device for the telescopic extension arm illustrated in Figure 7(d);

Figure 9(a) is a perspective view of a single-unit device for holding a picture frame in a position on a wall or panel;

Figure 9(b) is a cross sectional front view of a portion of the single-unit device of Figure 9(a);

Figure 10(a) is a front view of a single channel elongate magnetic element guide, mounted within a wall, holding a plurality of magnetic elements and spacer units;

Figure 10(b) is a front cross sectional view of the magnetic element guide of Figure 10(a);

Figure 10(c) is a cross sectional view of the magnetic element guide of Figures 10(a) and 10(b);

Figure 10(d) is a perspective cross sectional view of the magnetic element guide of Figures 10(a) to 10(d);

Figure 10(e) illustrates the magnetic element guide of Figures 10(a) to 10(d) connecting to a further magnetic element guide;

Figure 11 is a perspective illustration of the single-unit device of Figure 9 in use attaching to the single channel elongate magnetic element guide of Figures 10(a) to 10(d);

Figure 12 is a front cross sectional view of a single channel elongate magnetic element guide holding a plurality of magnetic elements and spacer units, and allowing multiple level object attachment;

Figures 13(a) to 13(c) are front cross sectional views of various multi-channel elongate magnetic element guides holding a plurality of magnetic elements and spacer units;

Figures 14(a) to 14(g) are front cross sectional views of various single and multi-

channel elongate magnetic element guides holding a plurality of magnetic element and/or spacer unit configurations;

Figure 14(h) is a front view of a further magnetic element;

Figure 15(a) is a perspective view of the front of a curtain hook for use with the single and multi-channel elongate magnetic element guides of Figures 10, 13 and 14;

Figure 15(b) is a perspective view of the rear of the curtain hook of Figure 15(a);

Figure 15(c) is a perspective view of the rear of a further curtain hook;

Figure 16 is a perspective cross sectional view of a single channel, single level elongate magnetic element guide, holding a plurality of magnetic elements, and a driving configuration for moving the magnetic elements;

Figure 17(a) is a perspective cross sectional view of a single channel, multi level magnetic element guide, holding a plurality of magnetic elements, and a driving unit for moving the magnetic elements;

Figure 17(b) is a perspective view of the driving unit of Figure 17(a);

Figure 18(a) is a front cross sectional view of a single channel, multi level magnetic element guide, holding a plurality of magnetic elements, and a first driving unit for moving the magnetic elements;

Figure 18(b) is a perspective view of the first driving unit of Figure 18(a);

Figure 19 is a front view of a remote control unit for controlling the driving units of Figures 16 to 18; and

Figures 20(a) to 20(d) are perspective illustrations of a single channel, single level magnetic element guide and a second driving unit, the second driving unit having magnetic elements connected thereto.

Detailed Description

Referring to Figure 1, a magnetic element 1 comprises a magnetic body 2 and a rough surface 3, the rough surface 3 being formed by a thin wire mesh 4 connected to a front face 5 of the magnetic body 2. In the present case, the magnetic body 2 is generally cylindrical in shape with an aperture 6 extending through the centre thereof. The magnetic element 1 has a rear face 7 and a north (N) and a south (S) pole at respective front and rear faces 5, 7.

In use, the magnetic element 1 is mounted within a recess in a wall or panel to which a magnetic object is to be attached, with the rough surface 3 facing outwards. The magnetic element 1 may be held inside the recess using adhesive or a connecting screw or bolt extending through the aperture 6. A thin layer of plaster, for instance 1 to 5mm

in thickness, can be applied over the magnetic element 1, adhering to the rough surface 3. The magnetic element 1 forms part of a magnetic attachment system. In particular, an object comprising a non-magnetised ferromagnetic metal, and/or a magnet or an electromagnet, where the magnet or electromagnet have their respective south poles facing the magnetic element 1, can be attached to the wall or panel using magnetic force. The object may be repeatedly removed from the wall or panel and reattached without any visible indication of the way in which the object is attached to the wall or panel.

Figures 1(b) and 1(c) illustrate a panel 10 comprising a plurality of magnetic elements 11 each mounted within a corresponding recess in the panel 10 and, in the present example, connected to the panel 10 with a respective connecting screw 12. In alternative examples, the magnetic elements 11 may be connected to the panel 10 using other connecting mechanisms such as bolts or adhesive. The plurality of magnetic elements 11 are arranged with their north (N) poles facing away from the panel 10 and in a substantially straight line across the panel 10, which in the present example has an elongate rectangular shape. The panel 10 may be formed from a material such as plasterboard 10' and the magnetic elements 11, in a similar manner to the magnetic elements 1 of Figure 1, have a rough surface 13 on their front face, in the present example formed by a thin wire mesh 14 connected to the front face of the magnetic elements 11. In alternative examples, the panel 10 may be constructed of other materials, and may, for instance, be a display panel for an exhibition, a ceiling panel or the like.

In use, the panel 10, when made from plasterboard, is used in a similar way to plasterboard, for instance connected to the frame of a stud partition wall or to a brick wall. The panel 10 can, for instance, be connected to the stud or brick wall such that the magnetic elements 11 extend along a horizontal line, although other orientations can be used. A thin layer of plaster, for instance 1 to 5mm in thickness, can be applied over the panel 10, adhering to the rough surface 13 of each magnetic element 11, and the resulting surface can be decorated. The panel 10 forms part of a magnetic attachment system. In particular, an object comprising a ferromagnetic metal or a magnet or electromagnet with its south pole facing the panel 10 can be attached to the panel 10 at any position corresponding to one of the magnetic elements 11. The object may be repeatedly removed from the panel 10 and reattached to any position corresponding to the position of a magnetic element 11 without any visible indication of the way in which

the object is attached to the panel 10.

Figures 2(a) and 2(b) are perspective views of a device 20 which can be attached to a wall or panel for use as part of a magnetic attachment system. A magnetic element 21 similar in shape to the magnetic element 1 of Figure 1, comprises a magnetic body 22 and a rough surface 23, the rough surface 23 being formed by a thin wire mesh 24 connected to a front face of the magnetic body 22. The magnetic element 21 has its north (N) pole at the front face, south (S) pole at the rear face and an aperture 25 extending through it, in the present example through the centre thereof. Part of an elongate connecting member 26 extends though the aperture 25. In the present example, the connecting member 26 has a first part 26(a) with a diameter greater than that of the aperture 25 which is held within a recess into the face of the magnetic body 22 on which the rough surface 23 is located. The first part 26(a) may comprise one or more slots 26(a)' in a surface thereof for engaging with a screw driver to enable at least part of the connecting member 26 to be turned. A second part 26(b) of the connecting member extends from the first part 26(a) through the aperture 25 and a third part 26(c) is located at the back of the magnetic body 22 and is used to connect the device 20 to a wall or panel 27.

In the present case, the third part 26(c) comprises a Molly Fastener™ arrangement. The third part 26(c) comprises an elongate cylindrical element 28 extending from the second part 26(b) of the connecting member 26 having a screw thread 29 on its external surface. A variable diameter backing member 30 has a first tubular section 31 which extends from a back surface 32 of the magnetic body 22, a plurality of linking arms 33 connected to the first tubular section 31 each formed of first and second sections 33(a), 33(b) separated by a weakened portion 33(c), and a second tubular section 34 at an opposite end of the variable diameter backing member 30 to the first tubular section 31. The second tubular section 34 has an internal thread (not shown) which engages with the external thread 29 of the elongate cylindrical element 28.

Figure 2(b) illustrates the device 20 attached to a plasterboard panel 27 forming part of a stud wall. The device 20 can be used in a similar way to the magnetic element 1 of Figure 1, being mounted within a recess or on the surface of the panel 27 to which a magnetic object is to be attached, with the rough surface 23 and north pole (N) facing outwards. An aperture 35 is formed in the panel 27 and the second and third parts 26(b), 26(c) of the connecting member 26 of the device 20 are pushed through the

panel aperture 35. The elongate cylindrical element 28 of the third part 26(c) of the connecting member 26 can be rotated using a screwdriver engaged with the slots 26(a)' of the first part 26(a). This causes the second tubular section 34 to move towards the magnetic body 22 and accordingly the linking arms 23 to bend in the location of the weakened portion 33(c) on each arm. The arms 33 are accordingly forced outwardly and push against a rear surface 36 of the panel 27, connecting the device 20 firmly to the panel 27. A thin layer of plaster can be applied over the magnetic body 22, adhering to the rough surface 23. An object comprising a ferromagnetic metal or a magnet having its south pole facing the panel 27 can be attached to the panel 27 as previously described.

Alternatives to the Molly Fastener™ arrangement can be used for the third part 26(c) of the connecting member 26, for instance a self-tapping screw which could, for example, be screwed into the timber frame of a stud wall or other suitable wall or panel material, or a bolt arrangement such as a butterfly bolt arrangement.

Figure 3 is a perspective view of first, second, third and fourth magnetic elements 40(a) to 40(d) for connecting to an object such that the object can be attached to a wall or panel for use as part of a magnetic attachment system as described herein. The magnetic elements 40(a) to 40(d) are each formed from a generally cylindrical magnetic body 41(a) to 41(d) with an aperture 42(a) to 42(d) extending through the centre thereof. The magnetic bodies 41(a) to 41(d) are, in the present example, neodymium magnets, for instance those available from the UK based company e-Magnets UK. The magnetic bodies 41(a) to 41(d) can alternatively be formed from magnetised ferromagnetic materials, or from a non-magnetised but magnetic material such as mild steel. The magnetic elements 40(a) to 40(d) have a diameter of 20mm and a 5mm depth, although other sizes of magnets can be used, for instance from 5mm in diameter to 100mm or greater in diameter and from 1mm in thickness to 50mm or greater in thickness. The apertures 42(a) to 42(d), in the present example, have a diameter of 6mm, although alternately the magnetic elements 40(a) to 40(d) may have no apertures or apertures from 1mm to 50mm or greater in diameter. The magnetic elements 40(a) to 40(d) have front and rear faces 43(a) to 44(d), 44 (a) to 44(d) and a south (S) and north (N) pole at the respective front and rear faces 43(a) to 43(d), 44(a) to 44(d). In use, the magnetic elements 40(a) to 40(d) can be attached to an object using screws or bolts extending though one or more of the respective apertures 42(a) to 42(d) or using an alternative attachment mechanism such as adhesive. The magnetic

elements 40(a) to 40(d) can be connected with their north poles facing the object and their south poles (S) facing away from the object. The resulting object can then be magnetically attached to a wall or panel as described herein which includes one or more magnetic elements with their north poles facing outwards.

Figure 4 is a perspective view of a ferromagnetic metal plate 50 for connecting to an object such that the object can be attached to a wall or panel for use as part of a magnetic attachment system as described herein. The metal plate 50, also referred to herein as a magnetic element, is generally rectangular in shape, includes a plurality of apertures 51 and is formed from non-magnetised but magnetically attracting mild steel in the present example. In alternative examples, the plate 50 can be formed from any magnetised or non-magnetised ferromagnetic material such as iron, nickel, cobalt, neodymium, samarium and/or gadolinium or alloys thereof. In use, the plate 50 can be attached to an object using screws or bolts extending though one or more of the respective apertures 51 or using an alternative attachment mechanism such as adhesive. The plate 50 may, for instance, comprise an adhesive backing. The resulting object can then be attached to a wall or panel as described herein which includes one or more magnetic elements. Although the plate 50 has been described as rectangular, other shapes can be used, such as circular shapes or non-uniformly shaped plates.

A friction reducing element, such as a material or device, may be applied to the side of the magnetic elements 40(a) to 40(d) or plate 50 which is not in contact with the object, to enable the magnetic elements 40(a) to 40(d) or plate 50 to move over the surface of the wall or panel without damaging the wall or panel. The friction reducing element can be a fabric, a fibrous material, such as felt, a rigid low friction material such as a plastic, nylon, or polytetrafluoroethylene (PTFE), or a rotatable element. For instance, the friction reducing element could be a layer of PTFE extending over a substantial part of the side of the magnetic elements 40(a) to 40(d) or of the plate 50 which is not in contact with the object. The layer may have a thickness of 0.2 to 5mm, preferably 1mm, and may have chamfered edges. The friction reducing element reduces the friction between the magnetic elements 40(a) to 40(d) and/or the plate 50 and a surface against which they are moved, for instance to locate the plate 50 over a magnetic element within a wall or panel. This can accordingly act to prevent damage to the surface of the wall or panel.

Figures 5(a) to 5(c) illustrate components of a device 60 for holding an object in a

position on a wall or panel as described herein which includes one or more magnetic elements. The device 60 comprises, in the present example, a generally parallelpiped body 61 on a front face 62 of which is located a first object support 63, in the present example a hook for an item such as a painting. The hook 63 is formed as a cut out in the wall of the front face 62 of the body 61. The hook 63 has, in the present example, a generally triangular shape, extending from one side on the front face 62 of the body 61 out to a point distal from the front face 62. Held inside the body 61 is a magnetic element 64, corresponding to one of the magnetic elements 40(a) to 40(d) described with reference to Figure 3. The magnetic element 64 has a north (N) and a south (S) pole on respective front and rear faces 64(a), 64(b). On the rear face 65 of the body 61 are located first and second friction reducing elements 66(a), 66(b). The first and second friction reducing elements 66(a), 66(b) each comprise a cylindrical element which is mounted within an aperture in the rear face 65 of the body 61 such that the axis of the cylindrical element is approximately within the plane of the rear face 65 of the body 61. The first and second friction reducing elements 66(a), 66(b) are connected to the body 61 in such a way that they can rotate about their respective axes and may be formed from relatively soft material such as rubber or plastic.

The front face 62 of the body 61 also comprises a connector for an optional second object support member, in the present case an aperture 67 into which part of a second object support may be inserted and held in position. An internal portion of the aperture 67 is threaded in the present example. Figure 5(c) illustrates an exemplary object support member 68, in the present case a hook for items such as coats. The object support member 68 comprises an externally threaded section 69(a) corresponding to the internal threaded section of the aperture 67 such that the object support member 68 can be screwed onto the body 61 for use when required and removed when not required. The object support member 68 also comprises supporting section 69(b), in the present example having a hook shape, although other shapes can be used depending on the required use of the device 60.

In use, the device 60 can be placed with its rear face 65 facing the surface of a wall or panel as described herein which includes one or more magnetic elements with their north (N) poles facing outwards. The first and second friction reducing elements 66(a), 66(b) contact the surface of the wall or panel and enable the device 60 to be moved easily across the surface of the wall or panel, without causing damage to the surface of the wall or panel, until the magnetic element 64 of the device moves into the magnetic

field of a magnetic element in the wall or panel. Accordingly, the device 60 is held in position on the wall or panel by the magnetic attraction between the respective magnetic elements. The friction reducing elements 66(a), 66(b) reduce the friction between the device 60 and the wall or panel against which the device 60 is moved, relative to the friction which would occur without the friction reducing elements 66(a), 66(b) being present. Although first and second friction reducing elements 66(a), 66(b) are described, in alternative embodiments one, three or more friction reducing elements 66(a), 66(b) can be used.

In alternative devices 60 for holding an object in a position on a wall or panel, the first or second object support members 73, 68 may be omitted. Also, the magnetic element 64 can comprise a non-magnetised magnetic metal such as mild steel. In such cases, the magnetic element 64 need not take the form of a cylindrical element but can comprise a plate either connected to the device 60 or forming a wall thereof such as the wall forming the rear face 65 of the device 60.

Figures 6(a) to 6(d) are views of a further device 70 for holding an object in a position on a wall or panel as described herein which includes one or more magnetic elements. The further device 70 is similar to the device 60 described with reference to Figures 5(a) and 5(b). The further device 70 has a generally elongate parallelpiped body 71 on the front face 72 of which is located a first object support 73 similar to that previously described. Held inside the body 71 are first and second magnetic elements 74, 74' each corresponding to one of the magnetic elements 40(a) to 40(d) described with reference to Figure 3, having a north (N) and a south (S) pole on respective front and rear faces 74(a), 74(b), 74'(a), 74'(b). On the rear face 75 of the body 71 are located first and second friction reducing elements 76(a), 76(b) corresponding to and connected to the body 71 in the same way as those previously described.

The front face 72 of the body 71 also comprises a connector 77 for an optional second object support member similar to that previously described and suitable for connection to the exemplary second object support member 68 illustrated in Figure 5(c).

The further device 70 is operated in the same way as the device 60 described with reference to Figure 5. However, the magnetic elements in the wall or panel are arranged to be spaced apart by approximately the same distance as the first and second magnetic elements 74, 74' in the further device 70. Accordingly, the device 70 can

simultaneously magnetically attach to more than one magnetic element in the wall or panel, resulting in the device being able to support a greater load for a given magnetic element size and magnetic field strength, and also providing greater horizontal stability when objects are supported by the first and/or second object support members 73, 68.

In alternative devices 70 for holding an object in a position on a wall or panel, the first or second object support members 73, 68 may be omitted. Also, one or both of the magnetic elements 74, 74' can comprise a non-magnetised magnetic metal such as mild steel. In such cases, the mild steel magnetic elements 74, 74' need not take the form of a cylindrical element but can for instance comprise a plate either connected to the device 70 or forming a wall thereof such as the wall forming the rear face 75 of the device 70.

Although the device 60 described with reference to Figures 5(a) and 5(b) and the further device 70 described with reference to Figures 6(a) to 6(d) each comprise magnetic elements arranged to attach to a wall at a single height or level, the devices 60, 70 can alternatively include magnetic elements arranged to be at more than one height or level in use, and accordingly capable of connecting simultaneously to corresponding magnetic elements within a wall or panel located at corresponding multiple heights or levels, as will be described in more detail below.

The friction reducing elements 66(a), 66(b), 76(a), 76(b) of the device 60 described with reference to Figures 5(a) and 5(b) and the further device 70 described with reference to Figures 6(a) to 6(d) are not limited to those described. The friction reducing elements 66(a), 66(b), 76(a), 76(b) can alternatively be a fabric, a fibrous material such as felt, a rigid low friction material, for instance a plastic, nylon, or polytetrafluoroethylene (PTFE), or an alternative rotatable element. For instance, the friction reducing element could be a layer of PTFE extending over a substantial part of the rear faces of the devices 60, 70. The layer may have a thickness of 0.2 to 5mm, preferably 1mm, and may have chamfered edges. The friction reducing element reduces the friction between the devices 60, 70 and a surface against which they are moved, for instance to locate the devices 60,70 over one or more magnetic element within a wall or panel. This can accordingly act to prevent damage to the surface of the wall or panel.

Figures 7(a) to 7(e) illustrate a multi-part device 80 for holding a picture frame or

similar object in a position on a wall or panel as described herein having a plurality of magnetic elements located therein.

The multi-part device 80 comprises one or more connecting bodies 81 (see Figures 7(a) to 7(c)), one or more telescopic extension arms 82 (see Figure 7(d)), and one or more frame connectors 83 (see Figure 7(e)).

The connecting body 81 has a generally elongate parallelpiped body 84 having a first wall 84(a) which, in use, faces towards the picture frame being held by the device 80 and a second wall 84(b) which, in use, faces towards the wall or panel to which the picture frame is being attached. Held inside the body 81 are first and second magnetic elements 85, 85' each corresponding to one of the magnetic elements 40(a) to 40(d) described with reference to Figure 3, having a north (N) and a south (S) pole on respective front and rear faces 85(a), 85(b), 85'(a), 85'(b). The first and second magnetic elements 85, 85' are located at opposite first and second internal ends 86(a), 86(a)' of the connecting body 81 and abut the inside surface of the second wall 84(b), the second wall 84(b), in use, facing towards the wall or panel to which the picture frame is being attached.

At respective external ends 87(a), 87(b) of the connecting body 81 are located first and second extension arm connectors 88(a), 88(b) for connecting to the respective first and second telescopic extension arms 82. In the present example, the first and second extension arm connectors 88(a), 88(b) comprise circular recesses in the end walls 84(c), 84(d) of the connecting body 81. The first and second extension arm connectors 88(a), 88(b) can also each receive a frame connector 83 described with reference to Figure 7(e), as described in more detail below. The first and second extension arm connectors 88(a), 88(b) can also each comprise an internal push-fit connector to hold the telescopic extension arm 82(a), 82(b) or frame connector 83 in place, for instance a spring clip mounted within the recesses of the extension arm connectors 88(a), 88(b). The telescopic extension arm 82(a), 82(b) and/or frame connector 83 can also have a corresponding dip, lip or recess (not shown) in their surface for forming a biasing force against a portion of the spring clip and therefore holding the telescopic extension arm 82(a), 82(b) and/or frame connector 83 in place.

Figure 7(d) illustrates a telescopic extension arm 82 for use with the connecting body 81. The arm 82 comprises first and second parts 90, 91, which are moveable relative to

one another. The first part 90 is generally tubular in shape and has a first end 90(a) having a connecting body connector 90(b) for connecting to one of the first and second extension arm connectors 88(a), 88(b) of the connecting body 81. The first part 90 has a second end 90(d) comprising an extension locking device 90(e), which selectively holds the first and second parts in fixed relation to each other. Various mechanisms can be used to implement this, and in the present example a clamping mechanism is used having an internal screw operated mechanism (not shown) which reduces and enlarges the inner circumference of the second end 90(d) of the first part 90, so that it selectively grips and releases the second part 91. The first part 90 also has a screw adjustment member 90(f) located between the first and second ends 90(a), 90(d), which further enables the length of the telescopic extension arm to be altered by twisting a portion 90(g) of the first part 90 when the extension locking device 90(e) is locked.

The second part 91 is generally tubular in shape and has a first end 91(a) which extends inside the first part 90 and a second end 91(b) which comprises a connecting lug 91(c) for connecting to the frame connector 83 illustrated in Figure 7(e) or for connecting to one of the first and second extension arm connectors 88(a), 88(b) of the connecting body 81.

Referring to Figure 7(e) the frame connector 83 is generally tubular in shape and has an open end 95 and a closed end 96. The open end 95 forms a recess into which one of the connecting lugs 91(c) of a telescopic extension arm 82 can be inserted. On the closed end 96 are located a plurality of metal pins 97. The frame connector 83 is shaped such that it can be received in one of the first and second extension arm connectors 88(a), 88(b) of the connecting body 81, in particular with the pins 97 extending away from the connecting body 81.

Figure 7(f) illustrates the connecting body 81, first and second telescopic extension arms 82(a), 82(b) and first and second frame connectors 83(a), 83(b) in use forming a multi-part device 80 connected to a picture frame. This is one example of the assembly of the multi-part device 80. In other configurations, a single telescopic extension arm 82 can be used and/or a plurality of connecting bodies 81 can be used.

To assemble the multi-part device 80 of Figure 7(f), the extension locking devices 90(e) are firstly unlocked and the second parts 91 of the first and second telescopic extension

arms 82(a), 82(b) are retracted inside the first parts 90. The connecting body connectors 90(b) of the first and second telescopic extension arms 82(a), 82(b) can then be inserted into the respective first and second extension arm connectors 88(a), 88(b) of the connecting body 81. The first and second frame connectors 83(a), 83(b) are each placed over the connecting lugs 91(c) of the respective first and second telescopic extension arms 82(a), 82(b). The multi-part device 80 can then be placed between first and second sides of a picture frame 99, in the present example first and second vertical members 98(a), 98(b) of the picture frame 99 and the second parts 91 of the first and second telescopic extension arms 82(a), 82(b) are extended until the pins 97 of the first and second frame connectors 83(a), 83(b) abut the inside faces 98(a)', 98(b)' of the first and second vertical members 98(a), 98(b) of the picture frame 99. The extension locking devices 90(e) are then locked. Finally, the screw adjustment members 90(f) of the telescopic extension arms 82(a), 82(b) are used, by twisting the respective portions 90(g) of the first parts 90, to push the connecting lugs 91(c) of the respective first and second telescopic extension arms 82(a), 82(b) outwardly such that the pins 97 are forced into the respective first and second vertical members 98(a), 98(b) of the picture frame 99.

The multi-part device 80 and picture frame 99, once connected, can be attached to a panel or wall as described herein having magnetic elements inserted therein with their north poles facing outwardly. Similarly to the device 70 described with reference to Figure 6, the magnetic elements in the wall or panel can be arranged to be spaced apart by approximately the same distance as the first and second magnetic elements 85, 85' in the multi-part device 80. Accordingly, the device 80 can simultaneously magnetically attach to more than one magnetic element in the wall or panel, resulting in the device being able to support a greater load for a given magnetic element size and magnetic field strength, and also providing greater horizontal stability. Furthermore, since the multi-part device 80 sits between the inner sides of the back of a picture frame 99, all or substantially all of the multi-part device 80 is set back from the rear surface 100 of the frame 99, meaning that the rear surface 100 can sit flush or substantially flush with the surface of the wall or panel to which the picture frame 99 is to be attached.

In alternative examples, the multi-part device 80 can be used with only a single telescopic extension arm 82 and with one of the first and second frame connectors 83(a), 83(b) inserted into the free extension arm connector 88(a), 88(b) of the

connecting body 81. In this case, first and second connecting bodies 81 can be used, each having one of the first and second frame connectors 83(a), 83(b) received in one of their first and second extension arm connectors 88(a), 88(b) and an end of a telescopic extension arm 82 received in the other. A configuration similar to this is illustrated in Figure 8(e) described below. Alternatively or in addition, the one or more telescopic extension arms 82 can be used without frame connectors 83(a), 83(b), for instance with the one or more lugs 91(c) being formed from rubber or other material that can grip the inside of the frame 99.

Figures 7(g) and 7(h) illustrate an alternative connecting body 110 for use in place of the connecting body 81 described with reference to Figures 7(a) to 7(c). In this example, the alternative connecting body 110 has a sloping wall 111 at the base of the body 110 extending from a position at the base of the body 110 on a first wall 113 which, in use, faces towards the picture frame being held by the device 80 to a position about half way up the body 110 on a second wall 112 which, in use, faces towards the wall or panel to which the picture frame is being attached. The sloping wall 111 has an included angle of 45 degrees to the second wall 113. In use, when removing the device 80 from a wall or panel to which a picture frame is attached, the connecting body 81 can be rotated relatively easily from a first position in which the second wall 112 lies flat against the surface of the wall or panel and in which the magnetic elements within the device each have a pole face parallel to the wall or panel, to a second position in which the sloping or inclined wall 111 lies flat against the surface of the wall or panel and the magnetic elements within the device have poles which are at an angle to the wall or panel. This weakens the magnetic attraction between the magnetic elements within the body 81 and those within the wall or panel, enabling the body 81 to be detached from the wall or panel more easily.

The sloping wall feature described above is not limited to use with the body 81 of the multi-part device 80, but can also be applied to the devices 60, 70 described with reference to Figures 5(a) to (c) and 6(a) to (d). The sloping wall can be arranged at either the top or bottom, in use, of the respective connecting body 81 or devices 60, 70, for instance while facilitating removal of the connecting body 81 or devices 60, 70 from a wall or panel to which they are attached. In addition, when the sloping wall is used at the top of a device such as the devices 60, 70 described with reference to Figures 5(a) to (c) and 6(a) to (d), it can form a hook onto which objects can be hung. In this example, the sloping wall can be arranged to slope downwardly towards the surface of the wall or

panel to which it is connected. If a corresponding sloping wall is used at the bottom of the respective connecting body 81, sloping downwardly and away from the picture frame in use, the sloping wall of the connecting body 81 can be placed in contact with the sloping wall of the device 60, 70 to hang the picture frame on the wall or panel. The connecting body 81 would accordingly not require magnetic elements. Alternatively, rather than using the connecting body 81 and the multipart device 80, the picture frame can have an alternative fitting connected to the frame which can hook over the sloping wall of the device 60, 70.

Figures 8(a) to 8(c) illustrate a further connecting body 120 for use in place of the connecting body 81 described with reference to Figures 7(a) to 7(c). Equivalent components are indicated with same reference numerals. The further connecting body 120 differs from that of Figures 7(a) to 7(c) in that it includes only a single magnetic element 121 located centrally between the first and second internal ends 86(a), 86(b) of the body 120.

Figure 8(d) is a perspective view of an alternative frame connector 125 for use with the connecting body 81 of Figures 7(a) to (c) and the further connecting body 120 of Figures 8(a) to 8(c). The alternative frame connector 125 comprises a plate shaped body 125(a) and a plurality of pins 125(b) extending from one side of the plate shaped body 125(a). In use, the alternative frame connector 125 is arranged to be slide over one of the external ends of the connecting bodies 81, 120 (e.g. faces 87(a), 87(b) of the connecting body 81), with the pins 125(b) pointing away from the body 81, 120, and connected to the body 81, 120 with a connecting mechanism. The connecting bodies 81, 120 can, for instance, have formed at the external ends thereof opposing 'U' shaped channels into which the edges of the alternative frame connector 125 can slide and therefore be held against the connecting body 81, 120.

Figure 8(e) is a perspective view of two of the connecting bodies 120(a), 120(b) of Figures 8(a) to 8(c), the telescopic extension arm of Figure 7(d) and two of the frame connectors 125(a)', 125(b)' of Figure 8(d) forming a multi-part device 105, connected to a picture frame 99.

To assemble the multi-part device 105 of Figure 8(e), the extension locking device 90(e) of the telescopic extension arm 82 is firstly unlocked and the second part 91 is retracted inside the first part 90. The connecting body connector 90(b) and the connecting lug

91(c) of the telescopic extension arm 82 can then each be inserted into a respective first and second extension arm connector 88(a), 88(b) of the respective connecting bodies 120(a), 120(b). At the other external ends of the respective connecting bodies 120(a), 120(b) an alternative frame connector 125(a)', 125(b)' are attached to the connecting bodies 120(a), 120(b) having their respective pins 125(b) facing away from the respective connecting bodies 120(a), 120(b). The multi-part device 105 can then be placed between first and second sides of a picture frame 99, in the present example first and second vertical members 98(a), 98(b) of the picture frame 99 and the second part 91 of the telescopic extension arm 82 is extended until the pins 125(b) of the respective first and second alternative frame connectors 125(a)', 125(b)' abut the inside faces 98(a)', 98(b)' of the first and second vertical members 98(a), 98(b) of the picture frame 99. The extension locking device 90(e) is then locked. Finally, the screw adjustment member 90(f) of the telescopic extension arm 82 is used, by twisting the portion 90(g) of the first part 90, to push the connecting lug 91(c) of the telescopic extension arm 82 outwardly such that the pins 125(b) of the first and second alternative frame connectors 125(a)', 125(b)' are forced into the respective first and second vertical members 98(a), 98(b) of the picture frame 99. Alternatively, where channels are used on the external ends of the respective connecting bodies 120(a), 120(b) to hold the alternative frame connectors 125(a)', 125(b)', the alternative frame connectors 125(a)', 125(b)' may have their pins pushed into the first and second vertical members 98(a), 98(b) of the picture frame 99 first and then the respective connecting bodies 120(a), 120(b) slid onto the alternative frame connectors 125(a)', 125(b)'.

The multi-part device 105 and picture frame 99, once connected, can be attached to a panel or wall as described herein having magnetic elements inserted therein with their north poles facing outwardly. Similarly to the device 70 described with reference to Figure 6, the magnetic elements in the wall or panel can be arranged to be spaced apart by approximately the same distance as the magnetic elements 121 in the multi-part device 105, in particular in the connecting bodies 120(a), 120(b). Accordingly, the device 105 can simultaneously magnetically attach to more than one magnetic element in the wall or panel, resulting in the device being able to support a greater load for a given magnetic element size and magnetic field strength, and also providing greater horizontal stability. Furthermore, since the multi-part device 105 sits between the inner sides of the back of a picture frame 99, all or substantially all of the multi-part device 105 is set back from the rear surface 100 of the frame 99, meaning that the rear

surface 100 can sit flush or substantially flush with the surface of the wall or panel to which the picture frame 99 is to be attached.

Figure 8(f) illustrates an alternative mechanism 92 for the extension locking device 90(e) of the telescopic extension arm illustrated in Figure 7(d). The mechanism 92 comprises a lever support 93 connected to a first part 90 of the telescopic extension arm. The lever support 93 comprises a connecting part 93(a) which extends around the first part 90 of the telescopic extension arm and is, in the present example, generally tubular in shape, and a supporting part 93(b) which forms a surface 93(b)' on which a lever 94(a) is pivotally connected via a connecting pin 94(b). The connecting part 93(a) has a first aperture 93(a)' therein, beneath which is disposed a second aperture 90' in the first part 90 of the telescopic extension arm. Beneath the second aperture 90' a portion 91'of the second part 91 of the telescopic extension arm is located. The lever 94(a) comprises an engaging surface 94(a)' which can selectively contact the portion 91'of the second part 91 of the telescopic extension arm as the lever 94(a) is moved from a first position 'A' shown in dotted outline, to a second position 'B' shown in solid outline.

In use, the lever 94(a) is placed in the first position 'A' shown in dotted outline and the first and second parts 90, 91 of the telescopic extension arm are moved relative to each other until the extension arm has a desired length. The lever 94(a) is then moved to the second position 'B' in which the engaging surface 94(a)' of the lever 94(a) contacts the portion 91'of the second part 91 of the telescopic extension arm. The friction between the engaging surface 94(a)' of the lever 94(a) and the portion 91'of the second part 91 of the telescopic extension arm locks the first and second parts 90, 91 of the telescopic extension arm in relation to each other.

Although the connecting body 81 described with reference to Figures 7(a) to 7(c) and the alternative connecting bodies 110, 120 described with reference to Figures 7(g), 7(h) and 8(a) to 8(c) each comprise magnetic elements arranged to attach to a wall at a single height or level, the connecting bodies 81, 110, 120 can alternatively include magnetic elements arranged at more than one height or level, and accordingly capable of connecting simultaneously to corresponding magnetic elements within a wall or panel located at corresponding multiple heights or levels, as will be described in more detail below.

Although the connecting body 81 described with reference to Figures 7(a) to 7(c) and the alternative connecting bodies 110, 120 described with reference to Figures 7(g), 7(h) and 8(a) to 8(c) each comprise one or more magnetic elements 85(a), 85(a)', 121 the or each of the magnetic elements 85(a), 85(a)', 121 can comprise a non-magnetised magnetic metal such as mild steel. In such cases, the mild steel magnetic elements need not take the form of a cylindrical element but can for instance comprise a plate either connected to the connecting bodies 81, 110, 120 or forming a wall thereof such as a rear wall having its external face facing the wall or panel in which magnetic elements are located.

Figures 9(a) and 9(b) illustrate a single-unit device 130 for holding a picture frame in a position on a wall or panel as herein described comprising a plurality of magnetic elements. The single-unit device 130 comprises a connecting body 131 and first and second extension arms 132, 133. The connecting body 131 comprises a generally square cross sectioned tubular member having first, second, third and fourth faces 131(a), 131(b), 131(c), 131(d), first and second magnetic elements 131(e), 131(e)' disposed on the first face 131(a) of the tubular member, and first and second friction reducing elements 131(f), 131(f)' also disposed on the first face 131(a) of the tubular member. The first and second magnetic elements 131(e), 131(e)' correspond to those described with reference to Figures 7(a) to 7(c) and are mounted with their south (S) poles facing away from the tubular member. The first and second friction reducing elements 131(f), 131(f)' correspond to, and are connected to the body 131 in the same way as, those previously described. First and second locking members are provided on the connecting body 131 for locking the respective first and second extension arms 132, 133 in position in relation to the body 131. The first locking member 131(h) is illustrated, located on the second face 131(b) of the body 131 and arranged to selectively lock the first extension arm 132. The first locking member 131(h) comprises an externally threaded screw which extends through an internally threaded aperture 131(g) in the second face 131(b) of the body 131 and selectively contacts the first extension arm 132 to lock the first extension arm 132 in position as the screw is tightened and released. The second locking member corresponds to the first locking member and is located on the fourth face 131(d) of the body 131.

The first and second extension arms 132, 133 are generally rectangular cross sectioned tubular members each comprising respective first and second opposite ends 132(a), 132(b), 133(a), 133(b), the first ends 132(a), 133(a) being disposed within the

connecting body 131 and comprising respective first and second end stops 132(c), 133(c) having opposing surfaces which abut in order to prevent the first and second extension arms 132, 133 from being pulled out of the body 131 . The second ends 132(b), 133(b) of the first and second extension arms 132, 133 each have a respective frame connector 134, 135 disposed thereon. The first and second frame connectors 134, 135 comprise respective first and second sets of metal pins 134(a), 135(a) mounted on respective first and second plates 134(b), 135(b). The first and second plates 134(b), 135(b) are in turn connected to plate supports 134(c), 135(c) which extend inside the ends of the respective first and second extension arms 132, 133. The first and second frame connectors 134, 135 further comprise respective first and second levers 134(d), 135(d) pivotally mounted on connecting pins 134(e), 135(e) which have plate engaging surfaces 134(d)', 135(d)' which selectively press against the respective rear surfaces 134(b)', 135(b)' of the plates 134(b), 135(b) when moved from the illustrated first position in which the levers 134(d), 135(d) are disposed at an angle to the first and second extension arms 132, 133 to a second position in which the levers 134(d), 135(d) extend in a parallel direction to the first and second extension arms 132, 133.

The single unit device 130 is connected to a picture frame by positioning the device 130 between the vertical members of the frame and extending the first and second extension arms 132, 133 until the pins 134(a), 135(a) mounted on respective first and second plates 134(b), 135(b) of the first and second extension arms contact the vertical members. The first and second locking members are then used to lock the respective first and second extension arms 132, 133 in position in relation to the body 131. The first and second levers 134(d), 135(d) are then moved from the illustrated first position in which the levers 134(d), 135(d) are disposed at an angle to the first and second extension arms 132, 133 to a second position in which the levers 134(d), 135(d) extend in a parallel direction to the first and second extension arms 132, 133. As this movement occurs, the plate engaging surfaces 134(d)', 135(d)' of the levers 134(d), 135(d) press against the respective rear surfaces 134(b)', 135(b)' of the plates 134(b), 135(b) pushing the pins 134(a), 135(a) into the vertical members of the framce.

Once connected to the frame, the device 130 can be attached to a panel or wall as described herein having magnetic elements inserted therein with their north poles facing outwardly. Similarly to the device 70 described with reference to Figure 6, the magnetic elements in the wall or panel are arranged to be spaced apart by approximately the same distance as the first and second magnetic elements 131(b),

131(b)' in the single unit device 130, with the advantages previously described. Also, the single unit device 130 sits between the vertical members of a picture frame and all or substantially all of the single unit device 130 is set back from the rear surface of the frame, meaning that the rear surface can sit flush or substantially flush with the surface of the wall or panel to which the picture frame is to be attached.

Although the single unit device 130 described with reference to Figures 9(a) and 9(b) comprises magnetic elements arranged to attach to a wall at a single height or level, the single unit device 130 can alternatively include magnetic elements arranged at more than one height or level, and accordingly capable of connecting simultaneously to corresponding magnetic elements within a wall or panel located at corresponding multiple heights or levels, as will be described in more detail below.

Although the single unit device 130 described with reference to Figures 9(a) and 9(b) comprises first and second magnetic elements 131(e), 131(e)', either or both of these can comprise a non-magnetised magnetic metal such as mild steel. In such cases, the mild steel magnetic elements need not take the form of a cylindrical element but can for instance comprise a plate either connected to the rear wall 131(c) of the device 130 or forming the rear wall 131(c) thereof.

The friction reducing elements 131(f) of the device 130 described with reference to Figures 9(a) and 9(b) are not limited to those described. The friction reducing elements can alternatively be a fabric, a fibrous material such as felt, a rigid low friction material, for instance a plastic, nylon, or polytetrafluoroethylene (PTFE), or an alternative rotatable element. For instance, the friction reducing element could be a layer of PTFE extending over a substantial part of the rear face 131(c) of the device 130. Cut outs may be provided in the layer at positions corresponding to the magnetic element locations in the devices to minimise any impact on the magnetic attraction when in use. The layer may have a thickness of 0.2 to 5mm, preferably 1mm, and may have chamfered edges. One or more friction reducing elements as described above may also be used with the connecting bodies 81, 110, 120 of the multi-part devices 80, 105 described with reference to Figures 7 and 8. The friction reducing element reduces the friction between the device 130 or connecting bodies 81, 110, 120 and a surface against which they are moved, for instance to locate the device 130 or connecting bodies 81, 110, 120 over one or more magnetic element within a wall or panel. This can accordingly act to prevent damage to the surface of the wall or panel.

Figures 10(a), 10(b), 10(c) and 10(d) illustrate a single channel elongate magnetic element guide 140, mounted within a wall 141, holding a plurality of magnetic elements 142 and spacer units 143. The magnetic element guide 140 has a generally parallelpiped shape and, in the present example, is a generally square cross sectioned tubular member having a first wall 140(a), in the present case forming a front wall of the guide 140, a second wall 140(b), in the present case forming a rear wall of the guide 140, a third wall 140(c), in the present case forming a bottom wall of the guide 140, and a fourth wall 140(d), in the present case forming a top wall of the guide 140. The magnetic element guide 140 can, for instance, be formed from plastic having a thickness of approximately 0.5mm up to 3mm. A wire mesh (not shown), similar to the wire mesh previously described, can be applied to the outside of the front wall 140(a) to facilitate the application and adhesion of plaster to the guide 140. In the illustrated example, the magnetic elements 142 and spacer units 143 have the same outer size and shape, with the magnetic elements 142 corresponding to the magnetic elements 40(a) to 40(d) described with reference to Figure 3 and having a diameter of 20mm and a thickness of 5mm. However, other sizes and shapes of magnetic elements can be used. The magnetic element guide 140 is large enough to allow the magnetic elements 142 to move freely when inserted into the guide 140 with their north poles (N) or south poles facing towards the front wall 40(a) and in the present example the guide 140 is arranged to have an internal height of 21mm and an internal depth of 6mm. The length of the guide 140 may vary according to its applications, but would typically be 10cm to 3m in length. The guide may be of a sufficient length to span at least two studs in a stud wall, for instance being greater than 50cm, 75cm or 1m in length. The magnetic element guide 140 also includes an optional access aperture 144 via which magnetic elements 142 and spacer units 143 can be inserted and removed.

Although the guide 140 illustrated in Figures 10(a) to 10(d) has first, second, third and fourth walls, alternative embodiments may have fewer walls, for instance including only the first wall 140(a), third wall 140(c) and fourth wall 140(d) and having a trough or 'U' shape, or including only the first wall 140(a) and third wall 140(c), and having an 'L' shape. Alternatively, first and second guide portions can each form a 'U' shape and be connected together to form the guide 140.

For use, the magnetic element guide 140 is mounted within a recess in a panel or wall 141, for instance such that the guide 140 extends horizontally, and covered with a thin

layer of plaster 145, for instance 1mm to 5mm thick. The optional access aperture 144 is not plastered over and may be covered by a flap (not shown). The magnetic elements 142 and spacer units 143, having cylindrical shapes, can roll along the inside of the magnetic element guide 140. However, other shapes of magnetic elements 142 and spacer units 143 can be used which can also move within the magnetic element guide 140. The magnetic elements 142 and spacer units 143 are either pre-inserted into the magnetic element guide 140 before mounting the guide 140 onto the wall 141, for instance via an open end of the guide 140, or elements 142 and spacer units 143 can be inserted into the guide 140 using the access aperture 144 if present. The magnetic elements 142 and spacer units 143 are inserted in a sequence according to the desired spacing between magnetic elements 142 in use, in the present example with each magnetic element 142 spaced apart by four spacer units 143. For spacer units 143 having a diameter of 20mm, this results in an 80mm space between each magnetic element 142. The guide 140 is not completely filled with magnetic elements 142 and spacer units 143, such that they have room to move longitudinally within the guide 140.

Once a desired configuration of magnetic elements 142 and spacer units 143 have been installed within the guide 140, a further magnetic element 142, or a device such as the device 60 described herein with reference to Figures 5(a) and 5(b), can be held against the plastered face of the wall 141 in a position corresponding to the magnetic element guide 140 and moved along the length of the magnetic element guide 140 in order to move the magnetic elements 142 and, via the force exerted on the magnetic elements 142, the spacer units 143, within the magnetic element guide 140 to a desired position.

The magnetic elements 142 can be used as part of a magnetic attachment system to attach objects to the wall 141. For instance, a device 60, 70, 80, 120 or 130 as described herein with reference to Figures 5 to 9 can be used to attach objects to the wall 141. If the device includes first and second magnetic elements such as the devices 70, 80, 130 described with reference to Figures 6, 7 and 9, these would be arranged to be separated by a distance corresponding to the distance between the magnetic elements 142 or multiples thereof. For instance, for the device 130 illustrated with reference to Figure 9, the distance between the first and second magnetic elements 131(e), 131(e)' would be 80mm or a multiple thereof such that each of the first and second magnetic elements 131(e), 131(e)' attaches to one of the spaced apart magnetic elements 142 held within the guide 140.

The magnetic element guide 140 is accordingly arranged to support one or more magnetic elements 142 such that the magnetic elements 142 can move along a linear path parallel to the plane of the surface of a wall 141 or a panel, in which the guide 140 is installed. In this manner, magnetic elements 142 held within a wall or panel to attach objects to the wall or panel can be moved from a first position to a second position along the linear path, after they have been installed in the wall or panel. This adds flexibility to the resulting magnetic attachment system. The object attached to the wall or panel may be done so for instance using the magnetic elements 40(a) to 40(d) described with reference to Figure 3, the plate 50 described with reference to Figure 4 or one of the devices 60, 70, 130 described with reference to Figures 5 and 6, one of the multi-part devices 80, 105 described with reference to Figures 7 and 8 or the single unit device 130 described with reference to Figure 9. The magnetic elements 142 can be moved prior to attaching the objects and/or the devices 60, 70, 80, 105, 130 to the wall or panel, for instance using a magnetic element moved longitudinally over the portion of the wall or panel corresponding to the magnetic element guide 140, or by moving the objects and/or devices 60, 70, 80, 105, 130 once they have been attached. The friction reducing elements

Although moving magnetic elements 142 have been described in the embodiment of Figures 10(a) to 10(d), the magnetic elements 142 may alternatively be fixed in position within the guide 140, and accordingly in such embodiments spacer units 143 may be omitted.

Although a single length of guide 140 has been illustrated in the example of Figures 10(a) to 10(d), multiple lengths can be used and aligned in an end-to-end manner in the wall 141 or in a panel to extend the length of the path along which the magnetic elements 142 and spacer units 143 can move. The guides 140 can have interlocking connecting members which, for instance, enable respective guides to be aligned and connected in an end-to-end or side-by-side configuration. Figure 10(e) illustrates an exemplary configuration in which a first guide 140 has apertures 146(a), 146(b) disposed in its front and rear walls 140(a), 140(b) close to the end of the guide 140 and a second guide 140' has first and second connecting elements 146(c), 146(d) extending from the end of its front and rear walls 140(a)', 140(b)'. The first and second connecting elements 146(c), 146(d) have portions 146(c)', 146(d) which are inserted into the apertures 146(a), 146(b) of the first guide 140 to connect the first and second guides 140, 140' together when their respective ends are brought together. In

particular, respective lips 146(c)", 146(d)" of the portions 146(c)', 146(d) of the first and second connecting elements 146(c), 146(d) contact the front edges 146(a)', 146(b)' of the apertures 146(a), 146(b) holding the first and second guides 140, 140' together in alignment with each other. The first and second guides 140, 140' can be released from each other by depressing the portions 146(c)', 146(d) of the first and second connecting elements 146(c), 146(d) so that the respective lips 146(c)", 146(d)" are released from the front edges 146(a)', 146(b)' of the apertures 146(a), 146(b).

Alternatively or in addition to the above interlocking arrangements, multiple lengths of guide 140 can be used at separate locations on a wall or panel, for instance at different heights on the wall or panel such that objects can be attached at different heights.

Figure 11 is a perspective illustration of the single-unit device 130 of Figure 9 in use attaching to the magnetic elements 142 of the single channel magnetic element guide 140 of Figures 10(a) to 10(d). In this example, the distance 'd' between the first and second magnetic elements 131(e), 131(e)' of the device 130 is 80mm such that each of the first and second magnetic elements 131(e), 131(e)' attaches to a corresponding one of the magnetic elements 142 held within the guide 140.

Figure 12 is a front cross sectional view of a single channel magnetic element guide 150, mounted within a panel 151, holding a plurality of magnetic elements 152 and spacer units 153, and allowing multiple level object attachment. In particular, the single channel magnetic element guide 150 comprises a first linear section 154 and a second linear section 155, each corresponding to the magnetic element guide 140 described with reference to Figures 10(a) to 10(d), and mounted within the panel 151 such that their internal magnetic element paths are parallel. The first linear section 154 and a second linear section 155 are, in the present example, each mounted on a first panel 151(a), which is formed from plasterboard and has the sections 154, 155 recessed into the surface thereof. The first and second linear sections 154, 155, in the present example, extend to the edges of the first panel 151(a). The first panel 151(a) is positioned on a wall such that that the first and second linear sections 154, 155 are horizontal, but at different heights.

The magnetic element guide 150 also comprises a first arcuate section 156 and a second arcuate section 157, each forming a semi-circular path, in the present example from an end of one of the first and second linear sections 154, 155, to the end of the other of the

first and second linear sections 154, 155. The first and second arcuate sections 156, 157 are each mounted on a respective second panel 151(b), formed from plasterboard in the present example, and having the sections recessed into the surface thereof. The first and second arcuate sections 156, 157 are each mounted on the respective second panels 151(b) such that they extend from a first edge of the respective second panels 151(b) back to the same edge of the respective panels 151(b).

The first panel 151(a) and the second panels 151(b) are aligned and connected together using connectors 158, and the first and second panels 151(a), 151(b) meet at respective intersections 159(a), 159(b). In particular, the first and second panels 151(a), 151(b) each comprise respective cut-outs 151(a)', 151(b)' in the edges thereof at the intersections 159(a), 159(b) which can be aligned with each other and, once so aligned, a plug connector 158 can be inserted into the aperture formed by the respective cut outs 151(a)', 151(b)'. Other connection arrangements can be used to align and connect adjacent panels 151(a), 151(b).

Magnetic elements 152 and spacer units 153 can be inserted into the magnetic element guide 150 can be moved between a first height or level on the first panel 151(a) corresponding to the first linear section 154 to a second height or level on the first panel 151(a) corresponding to the second linear section 155, via the first and second arcuate sections 156, 157 in the second panels 151(b). In the present example, since the guide 150 forms a closed loop, it can be completely filled, while still allowing movement of the magnetic elements 152 and spacer units 153 within the guide 150. An optional access aperture (not shown), such as the aperture 144 described with reference to Figure 10(a), can also be provided on the guide 150 such that the configuration of magnetic elements 152 and spacer units 153 can be changed as required.

In alternative embodiments, the first and second panels 151(a), 151(b) can have alternative configurations and can be connected in alternative manners to form different shapes of guide 150 depending on the requirements. For instance, the first panel 151(a) can have additional linear channel sections 154, 155, for instance first, second, third, fourth and fifth sections each corresponding to one of the first and second sections 154, 155. The first panel 151(a) can be, for instance, 2.4m high by 1.2m wide and the first, second, third, fourth and fifth sections can be spaced apart by 450mm. The second panels 151(b) can each comprise first and second arcuate sections and can, for instance, be 2.4m high and 600mm wide and have their arcuate sections

offset from each other. This can enable, for instance, the first linear section 154 in the first panel 151(a) to transfer magnetic elements 152 and spacer units 153 from a first end to a second end of the linear section 154, and a first arcuate section 156 in a first of the second panels 151(b) to transfer magnetic elements 152 and spacer units 153 along a first arcuate path from a second end of a first linear section 154 to a first end of a second linear section 155. A first arcuate section 157 in a second of the second panels 151(b) can transfer magnetic elements 152 and spacer units 153 along a second arcuate path from a second end of the second linear section 155 to a first end of a third linear section (not shown), and so on. In this manner, the guide 150 has sections forming multiple 'S' shaped paths which enable magnetic elements 152 and spacer units 153 to be positioned at multiple heights on the panel, five different heights or levels in the present example. Other configurations of guide are also possible, which can be formed from various designs of panel 151.

Figures 13(a) to 13(c) are front cross sectional views of various multi-channel elongate magnetic element guides holding a plurality of magnetic elements 152 and spacer units 153.

Referring to Figure 13(a), a multi-channel magnetic element guide 160 comprises a first magnetic element guide channel 161 and a second magnetic element guide channel 162, each of the first and second magnetic element guide channels 161, 162 corresponding to the magnetic element guide 140 described with reference to Figures 10(a) to 10(d). The first and second magnetic element guide channels 161, 162 are held in a panel 163 and arranged such that they extend parallel to and alongside each other. The first and second magnetic element guide channels 161, 162 are, in the present example, connected to each other using adhesive. In alternative examples, the first and second magnetic element guide channels 161, 162 may be separated by a uniform space, for instance with each mounted in a frame prior to insertion into a recess in a wall or panel. Alternatively, the first and second magnetic element guide channels 161, 162 can be inserted into recesses in a wall or panel with the recesses arranged to provide a required uniform, or otherwise, spacing between the channels 161, 162.

A plurality of magnetic elements 152 and spacer units 153 as herein described are inserted into each of the first and second magnetic element guide channels 161, 162. As illustrated, the magnetic elements 152 are, in the present example, inserted such that their north poles (N) face away from the panel 163.

The multi-channel magnetic element guide 160 can be used in a magnetic attachment system with an object attaching device such as those 40(a) to 40(d), 50, 60, 70, 80, 130 described herein, arranged to attach to the magnetic elements 152 in one of the first and second magnetic element guide channels 161, 162. Alternatively, the devices 40(a) to 40(d), 50, 60, 70, 80, 130 can include magnetic elements at first and second positions within the devices which are arranged such that a first attaches to a magnetic element in the first magnetic element guide channel 161 and a second attaches to a magnetic element in the first magnetic element guide channel 161.

Referring to Figures 13(b) and 13(c), the respective multi-channel magnetic element guides 170 and 180 illustrated comprise first, second and third magnetic element guide channels 171, 172 and 173 in respect of the guide 170 of Figure 13(b), and first, second, third and fourth magnetic element guide channels 181 to 184 in respect of the guide 180 of Figure 13(c). Each of the guide channels 171, 172, 173, 181 to 184 correspond to the magnetic element guide 140 described with reference to Figures 10(a) to 10(d). The first, second and third magnetic element guide channels 171, 172 and 173 in respect of the guide 170 of Figure 13(b) are held in a panel 174, arranged such that they extend parallel to and alongside each other and can be connected together and spaced apart in a similar way to the first and second magnetic element guide channels 161, 162 of Figure 13(a). The first, second, third and fourth magnetic element guide channels 181 to 184 in respect of the guide 180 of Figure 13(c) are held in a panel 185, arranged such that they extend parallel to and alongside each other and can also be connected together and spaced apart in a similar way to the first and second magnetic element guide channels 161, 162 of Figure 13(a).

A plurality of magnetic elements 152 and spacer units 153 as herein described are inserted into each of the magnetic element guide channels 171, 172, 173, 181 to 184. The magnetic elements 152 are, in the present example, inserted such that their north poles (N) face away from the respective panels 174, 185.

The multi-channel magnetic element guides 170,180 can be used in a magnetic attachment system with an object attaching element, plate or device such as those 40(a) to 40(d), 50, 60, 70, 80, 130 described herein, for instance arranged to attach to the magnetic elements 152 in one of the magnetic element guide channels 171, 172, 173, 181 to 184. Alternatively, the element, plate or device 40(a) to 40(d), 50, 60, 70, 80, 130

can be arranged to have magnetic elements at multiple positions on the wall or panel which are arranged such that each attaches to a respective magnetic element in one of the magnetic element guide channels of the multi-channel magnetic element guides 170,180.

Depending on the thickness of the adjacent walls of the adjacent channels 161, 162, 171, 172, 173, 181 to 184, the channels may be spaced apart from each other to avoid mutual repulsion between the like poles of the magnetic elements 152 in adjacent channels, for instance by more than 10mm or more than 15mm depending on the strength of the magnetic fields produced by the magnetic elements. Alternatively, the magnetic elements 152 in adjacent channels can have alternating poles facing the front of the channel, as will be described in more details below, such that there is attraction between magnetic elements in adjacent channels.

Figures 14(a) to 14(g) are front cross sectional views of various single and multi-channel elongate magnetic element guides holding a plurality of magnetic element and spacer unit configurations.

Referring to Figure 14(a), a magnetic element guide 190 has inserted therein a plurality of magnetic elements 152, separated from each other by first and second spacer units 153. The magnetic elements are oriented with their north poles (N) facing in front of the guide 190, such that they can be used to attach to object attaching devices such as those 40(a) to 40(d), 50, 60, 70, 80, 130 described herein comprising magnetic elements with their south poles facing the guide 190.

Referring to Figure 14(b), a magnetic element guide 200 has inserted therein a plurality of magnetic elements 152, separated from each other by first and second spacer units 153. The magnetic elements are oriented with their south poles (S) facing in front of the guide 200, such that they can be used to attach to object attaching devices such as those 40(a) to 40(d), 50, 60, 70, 80, 130 described herein, except comprising magnetic elements with their north poles facing the guide 200.

Referring to Figure 14(c), a magnetic element guide 210 has inserted therein a plurality of magnetic elements 152, which are not separated from each other by spacer units. The magnetic elements are oriented with their north poles (N) facing in front of the guide 210, such that they can be used to attach to object attaching devices such as those

40(a) to 40(d), 50, 60, 70, 80, 130 described herein, comprising magnetic elements with their south poles facing the guide 210. Although, in this example, spacer units are not used, the magnetic elements 152 have their respective north poles and south poles adjacent to each other. The north poles of adjacent magnetic elements 152 and the south poles of adjacent elements 152 accordingly repel each other, resulting in a space between the magnetic elements 152. The distance s between the magnetic elements 152 will be determined by the size and magnetic field strength of the magnetic elements 152. The distance 's' may, for instance, be between 10mm and 120mm, or between 20mm and 100mm, or approximately 80mm for a neodymium magnetic element having a diameter of 20mm.

Referring to Figure 14(d), a magnetic element guide 220 has inserted therein a plurality of magnetic elements 152 which, similarly to those of the magnetic element guide 210 of Figure 14(c), are not separated from each other by spacer units. The magnetic elements are oriented with their south poles (S) facing in front of the guide 220, such that they can be used to attach to object attaching devices such as those 40(a) to 40(d), 50, 60, 70, 80, 130 described herein, except comprising magnetic elements with their north poles facing the guide 220. The distance s' between the magnetic elements 152 will again be determined by the size and magnetic field strength of the magnetic elements 152 as previously described.

Referring to Figure 14(e), a magnetic element guide 230 has first and second magnetic element guide channels 231, 232 corresponding to the magnetic element guide 160 described with reference to Figure 12. The first and second magnetic element guide channels 231, 232 each have inserted therein a plurality of magnetic elements 152, separated from each other by first and second spacer units 153. The magnetic elements 152 in the first magnetic element guide channel 231 are oriented with their north poles (N) facing the front of the guide 230. The magnetic elements 152 in the second magnetic element guide channel 232 are oriented with their south poles (S) facing the front of the guide 230. The north poles (N) of one or more of the magnetic elements 152 in the first magnetic element guide channel 231 are attracted to the south poles (S) of a magnetic element 152 in the second guide channel 232. In this manner, at least some of the magnetic elements 152 in the first and second magnetic element guide channels 231, 232 are arranged to move together.

Figure 14(f) illustrates a magnetic element guide 240 which is similar to the magnetic

element guide 230 described with reference to Figure 14(e), except that it does not have any spacer elements inserted therein. The magnetic elements 152 in a first magnetic element guide channel 241 are oriented with their north poles (N) facing the front of the guide 240. The magnetic elements 152 in the second magnetic element guide channel 242 are oriented with their south poles (S) facing the front of the guide 240. Accordingly, in a similar manner to the magnetic elements 152 in the guides of Figures 14(c) and 14(d), adjacent elements 142 in each guide channel 241, 242, repel each other and are therefore spaced apart. Also, in a similar manner to the magnetic elements 152 in the guide 230 of Figure 14(e), the north poles (N) of one or more of the magnetic elements 152 in the first magnetic element guide channel 241 are attracted to the south poles (S) of a magnetic element 152 in the second guide channel 242. In this manner, at least some of the magnetic elements 152 in the first and second magnetic element guide channels 241, 242 are arranged to move together.

Figure 14(g) illustrates a magnetic element guide 250 which is similar to the magnetic element guide 240 described with reference to Figure 14(f), except that the magnetic elements 152 in a first magnetic element guide channel 251 are oriented with their south poles (S) facing the front of the guide 250. The magnetic elements 152 in the second magnetic element guide channel 242 are oriented with their north poles (N) facing the front of the guide 250.

It will be apparent that magnetic guide arrangements for use in a wall or panel can include more than one of the magnetic element guides described herein. For instance, two, three or more of the guides 240, 250 described with reference to Figures 14(f) and 14(g) can be used simultaneously, either spaced apart on a wall or panel, or arranged to extend such that their internal magnetic element paths are adjacent to each other. Connecting devices, such as those 40(a)-(d), 50, 60, 70, 80, 105, 130 described herein, can accordingly be arranged to simultaneously connect to a magnetic element in each of the magnetic element guide channels of the resulting magnetic guide arrangement.

Figure 14(h) illustrates an alternative magnetic element 255, for use with any of the embodiments described herein, for instance for use as one of the magnetic elements 152 used in a guide channel, or in a device for attaching an object to a wall or panel.

The magnetic element 255 comprises a plurality of magnetic bodies 256 arranged on a plate 257. In the present example, the plate 257 is formed from a ferromagnetic metal,

in particular mild steel, and has a circular shape with a diameter of 50mm and a 2mm thickness, although other sizes can be used. The plate 257 has an aperture 258 in its centre, although this can be omitted. The magnetic bodies 256 are cylindrically shaped and arranged around the outside of the plate 257 with one of their respective poles facing the plate 257 and the other facing away from the plate 257. The magnetic bodies 256 have a diameter of 15mm and a depth of 5mm in the present example, although other sizes can be used. The pole of each of the magnetic bodies 256 which faces away from the plate 257 differs from that of its immediate neighbours, such that, in the present example having six magnetic bodies, a first three have their north poles facing away from the plate 257 and a second three have their south poles facing away from the plate 257, and the first and second magnetic elements alternate around the outside of the plate 257. In use, the magnetic element 255 can, for instance, be positioned in a magnetic element guide as described herein with reference to Figures 10 to 14 with the magnetic bodies 256 facing the front of the guide. A plate corresponding to the plate 257 can be connected to an object and used to attach that object to the wall or panel in which the guide is installed.

A friction reducing element, such as a material or device, may be applied to one or both sides of the magnetic element 255 to enable the magnetic element to move over surfaces in which it comes into contact with, for instance the inside surface of the front wall of the magnetic element guides. The friction reducing element can be a fabric, a fibrous material such as felt, a rigid low friction material such as plastic, nylon of polytetrafluoroethylene (PTFE) or a rotatable element. For instance, the friction reducing element could be a layer of PTFE extending over a substantial part of the side of the magnetic element which is to be moved over a surface. The layer may have a thickness of 0.2 to 5mm, preferably 1mm, and may have chamfered edges.

Figure 15(a) is a perspective view of the front of a curtain hook 260 for use with the single and multi-channel elongate magnetic element guides of Figures 10, 13 and 14. The curtain hook 260 comprises a body 261 formed from a ferromagnetic metal, in the present case mild steel, and a hook portion 262. The body 261, forming a magnetic element as described herein, is a plate which is generally rectangular in shape and has a front face 261(a) and a rear face 261(b). Although rectangular in shape in this example, the plate forming the body 261 can have other shapes, for instance a circular shape such that it can be used in conjunction with the magnetic element 255 described with reference to Figure 14(h), which can be inserted into a guide as described herein

adapted to receive the element. The hook portion 262 is comprised of a first section 262(a) connected to the front face 261(a) of the body 261 at a first end 262(a)' and extending from the body 261 in a downwardly slanting direction. The hook portion 262 also has a second section 262(b) extending from a second end 262(a)" of the first section 262(a) in an upwardly slanting direction.

Figure 15(b) is a perspective view of the rear face 261(b) of the curtain hook 260 on which are disposed a plurality of ball bearings 263 set into pockets within the rear face 261(b) of the body 261. The ball bearings 263 are mounted such that they can rotate.

In use, a linear magnetic element guide such as those described herein with reference to Figures 10, 13 and 14 is installed such that it extends horizontally in a wall above a window in the location at which a curtain rail would usually be installed. The magnetic element guide may be plastered over as previously described. A plurality of curtain hooks 260 can be positioned with their rear faces 261(b) facing the magnetic element guide and such that the magnetic force of attraction between magnetic elements within the magnetic element guide and the body 261 cause the curtain hooks 260 to be attached in linear alignment across the wall. A curtain may then be hung from the hooks 260. The ball bearings 263 provide a reduced friction interface between the bodies 261 of the hooks 260 and accordingly enable the hooks 260 to be moved horizontally across the wall such that the curtains can be drawn.

Although ball bearings 263 have been described in the example illustrated in Figure 15(b), a reduced friction interface can alternatively be provided in other ways. For instance, referring to Figure 15(c), an alternative curtain hook 270 comprises cylindrical friction reducing members 271 mounted on the rear face 272 thereof. In other embodiments, other arrangements of friction reducing element can be used. The friction reducing element can, for instance, be a fabric, a fibrous material, such as felt, a rigid low friction material such as a plastic, nylon, or polytetrafluoroethylene (PTFE), or a rotatable element. For instance, the friction reducing element could be a layer of PTFE extending over a substantial part of the rear surface 272 of the curtain hook 270. The layer may have a thickness of 0.2 to 5mm, preferably 1mm, and may have chamfered edges. The friction reducing element reduces the friction between the hook and a surface against which it is moved, for instance when drawing or opening curtains hanging from a plurality of hooks 270. This can accordingly act to prevent damage to the surface of the wall or panel.

Figure 16 is a perspective cross sectional view of a single channel, single level elongate magnetic element guide 280, holding a plurality of magnetic elements 281, and a driving configuration 282 for moving the magnetic elements 281. The elongate magnetic element guide 280 corresponds to the guide 140 described with reference to Figures 10(a) to 10(d). The magnetic elements 281 are connected to each other by an elongate connecting member 283, which is in the present example a cord. Alternatively other connecting members can be used, such as a thick thread, a wire, or flexible plastic material. The magnetic elements 281 can be tied to the cord via apertures in the elements. At each end of the magnetic element guide 280 are disposed a respective first and second driving unit 280(a), 280(b), each comprising an electrical motor configured to drive a respective spindle 280(a), 280(b) to which the elongate connecting member 283 is attached and around which the connecting member 283 can wind.

In use, the magnetic element guide 280 is mounted within a recess within a wall or panel, as previously described with reference to Figures 10(a) to 10(d), and the first and second driving units 280(a), 280(b) are installed at either end of the guide 280. A connecting member 283 having one or more magnetic elements 281 connected thereto at spaced intervals is inserted within the guide 280 and the ends are wound around the first and second spindles 280(a)', 280(b)' at each end of the guide 280. The first and second driving units 280(a), 280(b) are controlled via a microcontroller (not shown) which receives user control signals from a user via a remote control, switch or other device indicating a direction in which the magnetic elements 281 are to be moved and which provides a corresponding driving signal to one of the driving units 280(a), 280(b) to activate the driving unit so as to turn the spindle and pull the magnetic elements 281 through the guide 280. First and second end stops 284(a), 284(b) may be provided at each respective end of the guide 280 which prevent magnetic elements from passing the end stop and therefore prevent magnetic elements 281 from wrapping around the spindles 282(a)', 282(b)'.

Figure 17(a) illustrates a single channel, multi level magnetic element guide 290, holding a plurality of magnetic elements 291, and a driving arrangement 292 for moving the magnetic elements 291. Figure 17(b) illustrates the driving arrangement 292.

The magnetic element guide 290 corresponds to the guide 150 described with reference to Figure 12. The magnetic elements 291 are each arranged to have their north poles (N) facing the front of the guide 150 and are spaced apart by the mutual repulsion between like poles of adjacent magnetic elements 291. The driving arrangement 292 comprises an electrical motor 293 configured to drive first and second spindles 294(a), 294(b). The driving arrangement 292 also comprises a belt 295 extending around and between the first and second spindles 294(a), 294(b) and which, in use, is driven by the first and second spindles 294(a), 294(b). The belt 295 has, in the present example, first, second and third magnetic elements 296(a), 296(b) and 296(c) attached thereto with their south poles (S) facing outwards and at spaced apart intervals corresponding to the spacing between the magnetic elements 291 in the guide 290.

In use, the magnetic element guide 290 is mounted within a recess within a wall or panel, as previously described with reference to Figure 12, and the driving arrangement 292 is installed such that the belt 295 extends longitudinally over a front or rear face of the guide 290. The electrical motor 293 is controlled via a microcontroller (not shown) which receives user control signals from a user via a remote control, switch or other device indicating a direction in which the magnetic elements 291 are to be moved and which provides a corresponding driving signal to the electric motor 293 so as to turn one of the spindles 294(a), 294(b) and rotate the belt 295. The north poles (N) of the magnetic elements 291 in the guide 290 are magnetically attracted to the south poles (S) of the first, second and third magnetic elements 296(a), 296(b) and 296(c) attached to the belt and accordingly move as the belt 295 is driven. In the guide 290, as a first magnetic element 291 is moved in a particular direction, a second magnetic element 291 in front of it is repelled from the first magnetic element. The second magnetic element, in turn, repels a magnetic element in front of it and, by this mechanism, all of the magnetic elements 291 in the guide 290 can be moved.

Figure 18(a) illustrates a single channel, multi level magnetic element guide 300, holding a plurality of magnetic elements 301, and a first driving unit 302 for moving the magnetic elements 301. Figure 18(b) illustrates the first driving unit 302.

The magnetic element guide 300 and magnetic elements 301 correspond to the guide 290 and elements 291 described with reference to Figure 17(a). The first driving unit 302 is, in the present example, a compact unit designed to move within the magnetic element guide 300. The first driving unit 302 comprises an electric motor 303, first

and second wheels 304(a), 304(b) extending from a first side 305 of the first driving unit 302, and third and fourth wheels 304(c), 304(d) extending from a second side 306 of the driving unit. The first driving unit 302 also includes a battery unit 307. The wheels 304(a) – (d) can, for instance, be made of plastic, with a rubber rim 304(a)' – (d)'. First and second rollers 308(a), 308(b) located on each of third and fourth sides 309, 310 of the first driving unit 302 are also provided. The first driving unit 302 also includes a receiving aerial (not shown) for receiving a wireless signal from a remote controller, and a microcontroller (not shown) for controlling the electric motor 303. The electric motor 303 is configured to drive the first and second wheels 304(a), 304(b) via respective first and second spindles (not shown). The third and fourth wheels 304(c), 304(d) are, in some embodiments, externally biased, for instance using springs (not shown) such that when the first driving unit 302 is installed within the guide 290, the first, second, third and fourth wheels 304(a) – (d) are pushed against opposite internal sides of the guide 290, enabling the first and second wheels 304(a), 304(b) to grip the inside surface of the guide 290.

In use, the magnetic element guide 300 is mounted within a recess within a wall or panel, as previously described with reference to Figure 12, and the first driving unit 302 and magnetic elements 301 are inserted into the guide 300. A user can send a control signal, using a remote control emitting a wireless signal such as a radio frequency signal which can pass through the walls of the element guide 300 and any plaster covering the guide 300, to the microcontroller to power the electric motor 303 such that the first and second wheels 304(a), 304(b) are driven in either a clockwise or anti-clockwise direction, causing the first driving unit 302 to move within the guide 300. As the first driving unit 302 pushes an adjacent first magnetic element 301 in a particular direction, a second magnetic element 301 in front of it is repelled from the first magnetic element. The second magnetic element, in turn, repels a magnetic element in front of it and, by this action, all of the magnetic elements 301 in the guide 300 can be moved.

Optionally, the first driving unit 302 can have mounted on each end, in use facing adjacent magnetic elements 301, a magnetic element having its north and south poles aligned with those of the magnetic elements 301, resulting in a repelling force which prevents contact between the first driving unit 302 and the magnetic elements 301 spaced within the guide 300.

Figure 19 is a front view of a remote control unit 310 for controlling the driving units 282(a), 282(b), 302 of Figures 16 and 18 and the driving arrangement 292 of Figure 17. A first button 311 is used to start and stop the respective motors of the driving units 282(a), 282(b), 302 and driving arrangement 292, a second button 312 is used to control the motors to drive their respective spindle(s) in a first direction and a third button 313 is used to control the motors to drive their respective spindle(s) in a second direction. Other configurations of buttons can be used, as would be apparent to those skilled in the art.

Figures 20(a) to 20(d) are perspective illustrations of a single channel, single level magnetic element guide 320 and a second driving unit 321, the second driving unit 321 having first and second magnetic elements 322(a), (b) connected thereto.

The second driving unit 321 has a elongate body 323 arranged to fit and move within the magnetic element guide 320. The body 323 has a generally parallelpiped shape and has connected thereto the first magnetic element 322(a) and the second magnetic element 322(b). In the present example, the first and second magnetic elements 322(a), (b) are mounted within respective recesses 324(a), (b) in a front face 325 of the body 323 such that a front face 325(a), 325(b) of the first and second magnetic elements 322(a), (b), in this case corresponding to the north poles of the elements 322(a), (b), are exposed at the front face 325 of the body 323. In the present example, the first and second magnetic elements 322(a), (b) are electromagnets which receive power via a power supply connection 326 described in more detail below.

The body 323 also has mounted thereon a plurality of wheels 327, in the present case a first pair of first and second wheels 327(a), (b) partly extending outside of the body 323 at respective opposite first and second sides 328(a), 328(b) of the body 323 and arranged at a first end 329(a) of the body 323, and a second pair of third and fourth wheels 327(c), (d) partly extending outside of the body 323 at the respective opposite sides 328(a), 328(b) of the body 323 and arranged at a second end 329(b) of the body 323. A driving wheel 333 partly extends outside of the body 323 at the first side 328(a) of the body 323. However, alternative wheel arrangements can be used.

The body 323 also houses a driving arrangement 330 comprising a motor 331 having a spindle (not shown) connected to a gear arrangement 332 which drives the driving wheel 333. The driving wheel 333 has a plurality of driving wheel teeth 333(a)

arranged, in the present example, between first and second wheel elements 333(b), 333(b)'. The gear arrangement 332 comprises a worm gear 332(a) axially connected to the spindle such that the spindle turns the worm gear 332(a) under the power of the motor 331. The worm gear 332(a) comprises a generally cylindrical body with an external thread. The worm gear 332(a) is positioned in an engaging relation to a drive gear 332(b), in the present case a cog having a plurality of drive gear teeth 332(b)'. The worm gear thread meshes with the drive gear teeth 332(b)' of the drive gear 332(b), which in turn mesh with the driving wheel teeth 333(a) of the driving wheel 333.

The motor 331 is powered via the power supply connection 326, which in the present example comprises first and second contact brushes 334(a), 334(b) which extend outside of the body 323 at respective opposite sides 328(a), 328(b) of the body 323 and are mounted within respective first and second contact brush housings 335(a), 335(b) containing biasing element (not shown), in the present case springs, which bias the contact brushes 334(a), 334(b) away from the body 323. The contact brushes 334(a), 334(b) are connected to power supply input terminals of the motor 331 via first and second power leads 336(a), 336(b).

The magnetic element guide 320 has a generally parallelpiped shape and, in the present example, is a generally rectangular cross sectioned tubular member having a first wall 337(a), in the present case forming a front wall of the guide 320, a second wall 337(b), in the present case forming a rear wall of the guide 320, a third wall 337(c), in the present case forming a bottom wall of the guide 320, and a fourth wall 337(d), in the present case forming a top wall of the guide 320. Extending longitudinally within the guide 320, in the present case connected to the inside of the third and fourth walls 337(c), 337(d), are disposed respective first and second power rails 338(a), 338(b) which are positioned in relation to the first and second contact brushes 334(a), 334(b) such that the first and second contact brushes 334(a), 334(b) contact the power rails 338(a), 338(d) when the second driving unit 321 is located in the guide 320. At a first external end 339 of the guide 320, first and second power input connectors 340(a), 340(b) are connected between the respective first and second power rails 338(a), 338(d) and a mains power supply (not shown), for instance via a fused plug or other electrical connection. When the second driving unit 321 is located within the guide 320, the driving wheel 333 is arranged to contact the inside surface of the third wall 337(c) of the guide.

The first and second magnetic elements 322(a), (b), in the present example electromagnets, receive power via additional power leads (not shown) connected from the first and second magnetic elements 322(a), (b) to the first and second contact brushes 334(a), 334(b) of the power supply connection 326.

The second driving unit 321 also includes a receiving aerial (not shown) for receiving a wireless signal from the remote controller 310, and a microcontroller 341 for controlling the electric motor 331.

In use, the magnetic element guide 320 is mounted within a recess within a wall or panel, as previously described with reference to Figure 12, and the second driving unit 321 is inserted into the guide 320, for instance depressing the first and second contact brushes 334(a), 334(b) against their respective springs to enable them to fit within the guide 320. A user can send a control signal, using the remote controller 310 emitting a wireless signal such as a radio frequency signal which can pass through the walls of the element guide 320 and any plaster covering the guide 320, to the microcontroller to power the electric motor 331. This, in turn, via the gear arrangement 332 causes the driving wheel 333 to turn in either a clockwise or anti-clockwise direction, causing the first driving unit 321, including its magnetic elements 322(a), 322(b) to move within the guide 320.

Although the magnetic elements 322(a), 322(b) are electromagnets in the example described with reference to Figures 20(a) to 20(d), in alternative examples permanent magnets or ferromagnetic materials such as mild steel can be used, or a mixture of electromagnets and permanent magnets can be used. This can have the advantage that the permanent magnets can act as a back-up attachment mechanism if there is a power cut which prevents the electromagnets from operating. A backup battery power supply, much like those used for servers in businesses, can alternatively or additionally be used to avoid the loss of electromagnetic power in the case of a power cut.

A clutch can be used with any of the motors described herein to avoid damage to the motor if overloaded. For instance, the clutch can form part of the gear arrangement 332. Multiple first and second driving units can be arranged to operate within the same guide channels, although this would require separate remote control signals for each or a driving unit selector switch on the remote control. A clutch would avoid motor burn out in the case that one driving unit is moved in an opposite path to another. Also, the

remote controller can include an arrangement, for instance indicator lights, which can indicate the location of driving units within a guide arrangement, for instance when moved over the guide arrangement.

The driving configuration 282 of Figure 16, the driving arrangement 292 of Figure 17, first driving unit 302 of Figure 18 and second driving unit 321 of Figure 19 enable magnetic elements to be moved automatically within guide channels as described herein. Accordingly, magnetic elements can be positioned automatically in a desired location in a guide channel installed in a wall or panel prior to use in attaching an object to the wall or panel. In addition, it is possible to move magnetic elements between first and second locations within a guide channel after attaching an object to the wall or panel using the magnetic elements, for instance curtains attached to the hook 270 described with reference to Figure 15.

The magnetic elements described herein can be permanent magnets, for instance a magnetised ferromagnetic or ferrimagnetic material, or electromagnets. If permanent magnets, the magnetic elements can be formed from iron, nickel, cobalt, neodymium, samarium and/or gadolinium or alloys thereof. Also, in some embodiments, the magnetic elements of the wall or panel mounted fittings described herein, or of the connecting devices described herein, can be formed from non-magnetised ferromagnetic metal, such as mild steel, with the other of the magnetic elements of the wall or panel mounted fittings described herein, or of the connecting devices described herein being permanent or electromagnetic magnets.

A friction reducing element, such as a material or device, may be applied to one side of the magnetic elements described herein, for instance those arranged to move within the magnetic element guides described herein, to enable the magnetic elements to move over surfaces in which they come into contact with, for instance the inside surface of the front wall of the magnetic element guides. The friction reducing element can be a fabric, a fibrous material such as felt, a rigid low friction material such as plastic, nylon, or polytetrafluoroethylene (PTFE) or a rotatable element. For instance, the friction reducing element could be a layer of PTFE extending over a substantial part of the side of the magnetic element which is to be moved over a surface. The layer may have a thickness of 0.2 to 5mm, preferably 1mm, and may have chamfered edges.

Although the magnetic elements have been described herein having a particular orientation of north and south poles, in particular with wall or panel mounted elements having their north poles facing away from the wall or panel and object mounted elements having their south poles facing towards the wall or panel, it will be recognised that the orientation of some or all of the magnetic elements can be reversed while achieving the same functionality.

The spacers described herein can be manufactured from a variety of suitable materials, preferably selected from those which are non-magnetic. For instance, the spacers can be manufactured from various types of plastic, nylon, stainless steel, aluminium, wood etc.

The walls and panels described herein, unless otherwise specified, cover any structure to which it is required to attach an object, for instance brick and plaster wall constructions, stud wall constructions, plasterboard panels, plywood panels, partitions, ceilings and ceiling panels, exhibition stands, display panels, vehicle panels and/or glass panels.

Although specific embodiments have been described herein, those skilled in the art will recognise that alterations and modifications can be made without departing from the scope of the claimed invention.

Claims

1. A magnetic element guide arrangement for use as part of a system for attaching an object to a panel or wall, the magnetic element guide arrangement comprising:

a magnetic element supporting member which, when connected to a panel or wall, supports a magnetic element such that the magnetic element can move along a linear path parallel to the plane of the surface of the panel or wall.

2. A magnetic element guide arrangement according to claim 1, wherein the magnetic element supporting member is connected to a panel.

3. A magnetic element guide arrangement according to claim 2, wherein the panel comprises a plasterboard panel.

4. A magnetic element guide arrangement according to claim 2 or 3, wherein the magnetic element supporting member is recessed at least partly into the panel.

5. A magnetic element guide arrangement according to any one of claims 1 to 4, wherein the magnetic element supporting member comprises a first magnetic element supporting member which, when connected to a panel or wall, supports a magnetic element such that the magnetic element can move along a first linear path parallel to the plane of the surface of the panel or wall; and further comprising:

a second magnetic element supporting member arranged to be connected to a panel or wall in association with the first magnetic element supporting member, and which, when connected to a panel or wall, supports a magnetic element such that the magnetic element can move along a second linear path parallel to the first linear path.

6. A magnetic element guide arrangement according to claim 5, wherein the first and second magnetic element supporting members are elongate members connected together in either an end-to-end configuration or such that a line from the first magnetic element supporting member perpendicular to the longitudinal direction of the first magnetic element supporting member intersects the second magnetic element supporting member.

7. A magnetic element guide arrangement according to claim 5 or 6, wherein at least one of the first and second magnetic element supporting members comprising a

connector arranged to connect to the other of the first and second magnetic element supporting members.

8. A magnetic element guide arrangement according to claim 5, 6 or 7, wherein the first magnetic element supporting member is connected side-by-side with the second magnetic element supporting member such that the first and second linear paths are adjacent to each other.

9. A magnetic element guide arrangement according to any one of claims 5 to 8, wherein the first and second magnetic element supporting members are each connected to a first panel.

10. A magnetic element guide arrangement according to any one of claims 5 to 8, wherein the first magnetic element supporting member is connected to a first panel and wherein the second magnetic element supporting member is connected to a second panel and wherein the first and second panels can be aligned such that a magnetic element in the first linear path can travel directly into the second linear path.

11. A magnetic element guide arrangement according to claim 9 or 10, wherein the first and second magnetic element supporting members are recessed at least partly into the panel to which they are connected.

12. A magnetic element guide arrangement according to any one of claims 5 to 11, further comprising a third magnetic element supporting member which supports a magnetic element such that the magnetic element can move along a third path between said first and second paths.

13. A magnetic element guide arrangement according to claim 12, wherein the first and second magnetic element supporting members are elongate members connected such that a line from the first magnetic element supporting member perpendicular to the longitudinal direction of the first magnetic element supporting member intersects the second magnetic element supporting member and wherein the third path comprises an arcuate path.

14. A magnetic element guide arrangement according to claim 13, wherein the third

path comprises a semi-circular path with a diameter substantially corresponding to a distance between the first and second paths.

15. A magnetic element guide arrangement according to claim 12, 13 or 14, wherein the first, second and third magnetic element supporting members are connected to a first panel.

16. A magnetic element guide arrangement according to claim 12, 13 or 14, wherein the first and second magnetic element supporting members are connected to a first panel, the third magnetic element supporting member is connected to a second panel and wherein the first and second panels can be aligned such that a magnetic element can travel from the first linear path to the second linear path via the third linear path.

17. A magnetic element guide arrangement according to any preceding claim, further comprising power supply connectors.

18. A magnetic element guide arrangement according to claim 17, wherein the power supply connectors comprise exposed conductive tracks extending within the guide arrangement.

19. A panel or wall comprising a magnetic element guide arrangement according to any preceding claim.

20. A system for attaching an object to a panel or wall, the system comprising:

a magnetic element guide arrangement according to any one of claims 1 to 18; and

a magnetic element supported by said magnetic element supporting member.

21. A system according to claim 20, further comprising a driving arrangement for moving said magnetic element.

22. A system according to claim 21, wherein said driving arrangement comprises a motor.

23. A system according to claim 21 or 22, wherein the driving arrangement is

arranged to be supported by the magnetic element supporting member.

24. A system according to claim 23, wherein the driving arrangement comprises a driving unit having said magnetic element mounted thereon.

25. A system according to any one of claims 20 to 24, wherein said magnetic element comprises a first magnetic element and further comprising a second magnetic element spaced from said first magnetic element by a predetermined distance.

26. A system according to claim 25, wherein said first and second magnetic elements are connected by an elongate linking member.

27. A system according to claim 25, further comprising one or more spacing elements arranged between said first and second magnetic elements.

28. A system according to any one of claims 20 to 27, wherein the magnetic element comprises a friction reducing member which, in use, contacts the magnetic element supporting member.

29. A system according to claim 28, wherein the friction reducing element comprises at least one selected from a fabric, a fibrous material, a rigid low friction material, plastic, nylon, felt, PTFE or a rotatable element

30. A device to be attached to a panel or wall for use as part of a magnetic attachment system, the device comprising:

a magnetic element; and

an elongate connecting member comprising a connecting arrangement for connecting the magnetic element to a panel or wall.

31. A device according to claim 30, wherein the magnetic element has an aperture formed therein and wherein the elongate connecting member has a first part extending though the aperture and a second part comprising the connecting arrangement.

32. A device according to claim 30 or 31, wherein said elongate connecting member comprises a threaded section for connecting the magnetic element to the panel or wall using a turning force.

33. A device according to claim 30, 31 or 32, wherein said connecting arrangement comprises a Molly Fastener arrangement.

34. A device according to any one of claims 30 to 32, wherein said connecting arrangement comprises a butterfly bolt.

35. A guide arrangement according to any one of claims 1 to 18, a panel according to claim 19, a system according to any one of claims 20 to 29, or a device according to any one of claims 30 to 34, wherein said magnetic element or magnetic elements comprise permanent magnets or an electromagnet.

36. A device for holding an object in a position on a panel or wall, the device comprising:

a magnetic element for attaching the object, via magnetic force, to the panel or wall;

and

a friction reducing element for enabling the device to move over the surface of the panel or wall without causing damage to the surface of the wall or panel.

37. A device according to claim 36, further comprising a supporting element for holding the object.

38. A device according to claim 36 or 37, wherein the friction reducing element comprises a fabric, a fibrous material, a rigid low friction material, plastic, nylon, felt, PTFE or a rotatable element.

39. A system for attaching an object to a panel or wall, the system comprising:

first and second magnetic elements connected to the panel or wall and spaced at a first predetermined distance from each other; and

a device for holding an object in a position on a panel or wall, the device comprising third and fourth magnetic elements spaced such that each can simultaneously attach to a respective one of said first and second magnetic elements connected to the panel or wall so as to attach the object to the panel or wall.

40. A system according to claim 39, wherein the device comprises a device

according to any one of claims 34 to 36.

41. A system according to claim 39 or 41, wherein the first and second magnetic elements are supported by the magnetic element supporting member of a magnetic element guide arrangement according to any one of claims 1 to 18.

42. A device for holding a picture frame in a position on a panel or wall, the device comprising:

a magnetic element for holding the picture frame, via magnetic force, in a position on a panel or wall; and

a connecting arrangement for connecting to said picture frame, said connecting arrangement at least partly disposed between inner sides of the frame when connected to the picture frame.

43. A device according to claim 42, wherein the device comprises a multi-part device and wherein a first part of the device comprises the magnetic element and a second part of the device comprises the connecting arrangement.

44. A device according to claim 42, wherein the device comprises a single unit device.

45. A device according to claim 43 or 44, wherein the connecting arrangement comprises at least one extendable arm for connecting to picture frames of different sizes.

46. A device according to claim 43, 44 or 45, wherein the connecting arrangement comprises one or more protruding elements for insertion into the picture frame.

47. A device according to claim 46, comprising a lever which can be moved from a first position to a second position so as to force the one or more protruding elements into the picture frame.

48. A device according to any one of claims 42 to 47, further comprising a friction reducing element for enabling the device to move over the surface of the panel or wall without causing damage to the surface of the panel or wall.

49. A device according to claim 36, 37 or 38, any one of claims 42 to 48, or a system

according to any one of claims 39 to 41, wherein said magnetic element or magnetic elements comprise permanent magnets, an electromagnet or a ferromagnetic metal.

50. A device according to claim 49, wherein said ferromagnetic metal comprises mild steel.

51. A system for attaching an object to a panel or wall, the system comprising at least one of:

a guide arrangement according to any one of claims 1 to 18;

a panel according to claim 19;

a system according to any one of claims 20 to 29; and

a device according to any one of claims 30 to 34,

the system further comprising at least one of:

a device according to any one of claims 36, 37 or 38;

a device according to any one of claims 42 to 48; and

a system according to any one of claims 39 to 41.

52. A system according to claim 51, further comprising one or more magnetic elements.

53. A system according to claim 52, wherein at least one of the one or more magnetic elements comprises a plurality of magnetic bodies attached to a ferromagnetic metal plate.

54. A magnetic element guide arrangement comprising:

a first magnetic element supporting member connected to a panel or wall and supporting a first magnetic element such that the first magnetic element can move along a first linear path parallel to the plane of the surface of the panel or wall; and

a second magnetic element supporting member connected to a panel or wall and supporting a second magnetic element such that the second magnetic element can move along a second linear path parallel to the first linear path; and wherein

the first and second magnetic elements comprise permanent or electromagents and wherein the first magnetic element has its north pole facing away from the panel or wall and the second magnetic element has its south pole facing away from the panel or wall.

55. A magnetic element guide arrangement according to claim 53, wherein the first magnetic element supporting member is connected side-by-side with the second magnetic element supporting member such that the first and second linear paths are adjacent to each other.

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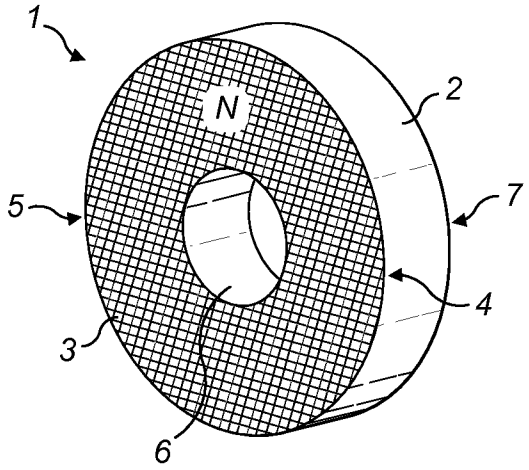


FIG. 1(a)

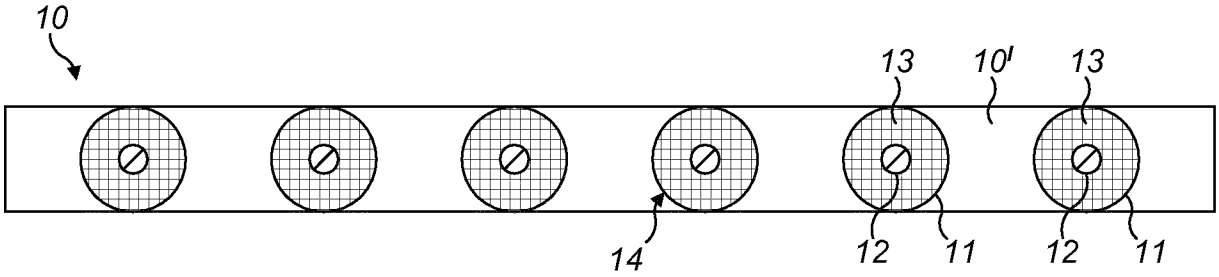


FIG. 1(b)

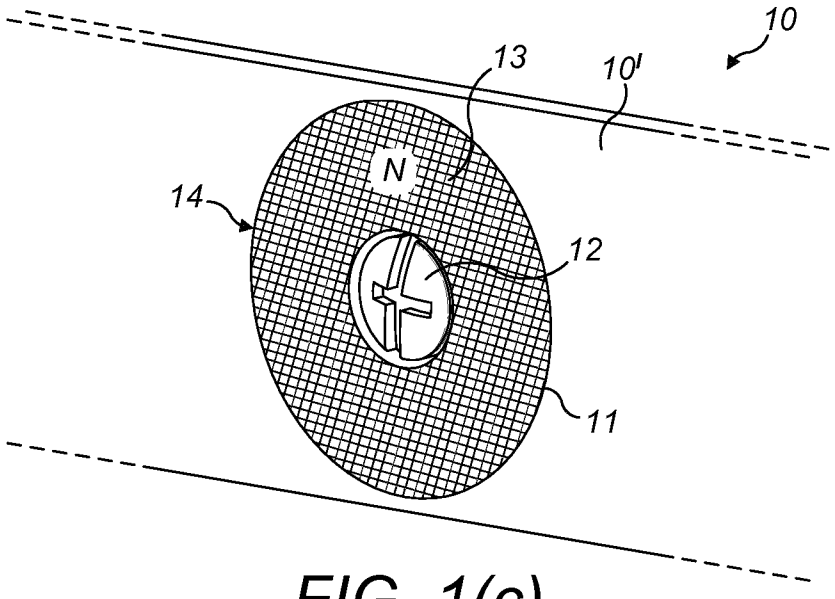


FIG. 1(c)

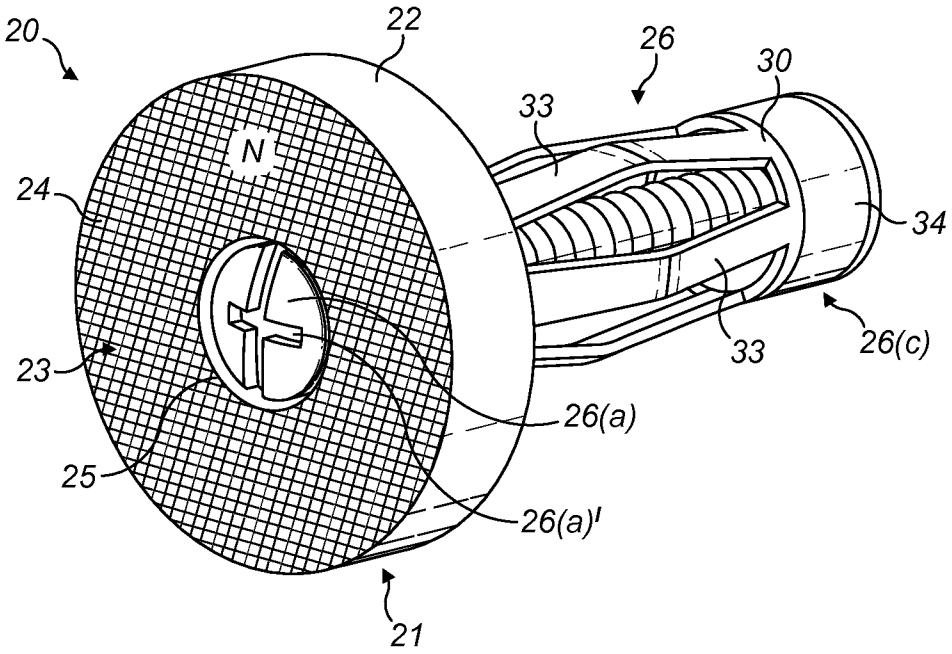

20
22
26
30
33
N
24
34
33
26(c)
23
26(a)
25
26(a)'
21

FIG. 2(a)

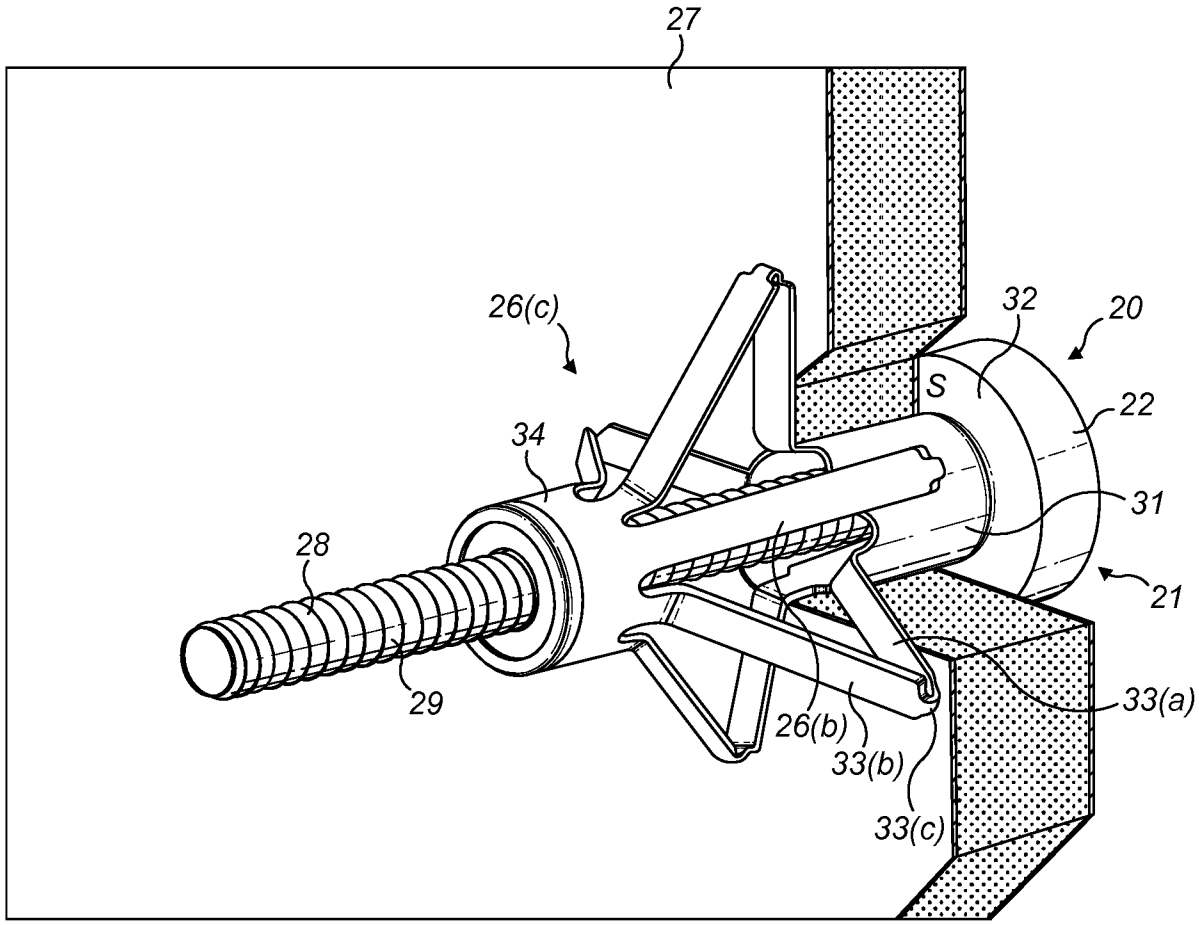

27
26(c)
32
20
S
22
34
31
28
21
29
33(a)
26(b)
33(b)
33(c)

FIG. 2(b)

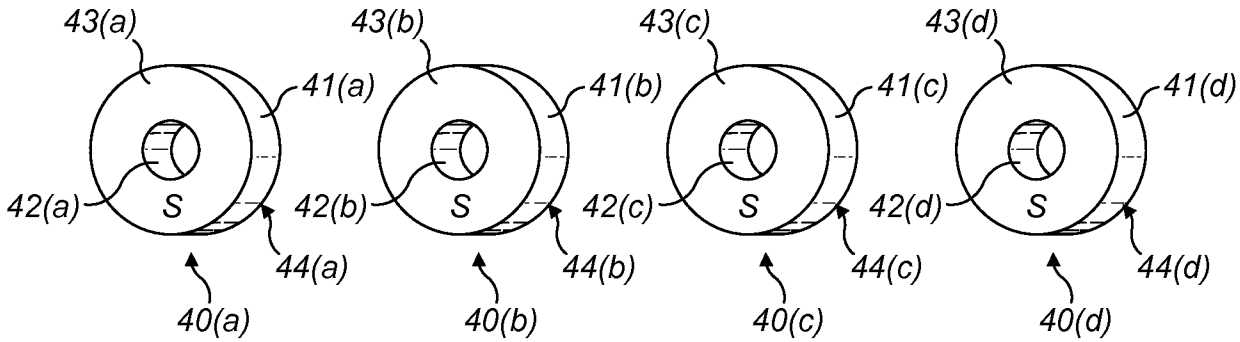
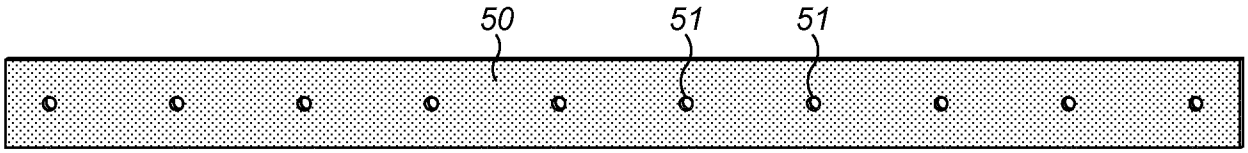

43(a)
43(b)
43(c)
43(d)
41(a)
41(b)
41(c)
41(d)
42(a)
42(b)
42(c)
42(d)
S
S
S
S
44(a)
44(b)
44(c)
44(d)
40(a)
40(b)
40(c)
40(d)

FIG. 3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51
51

FIG. 4

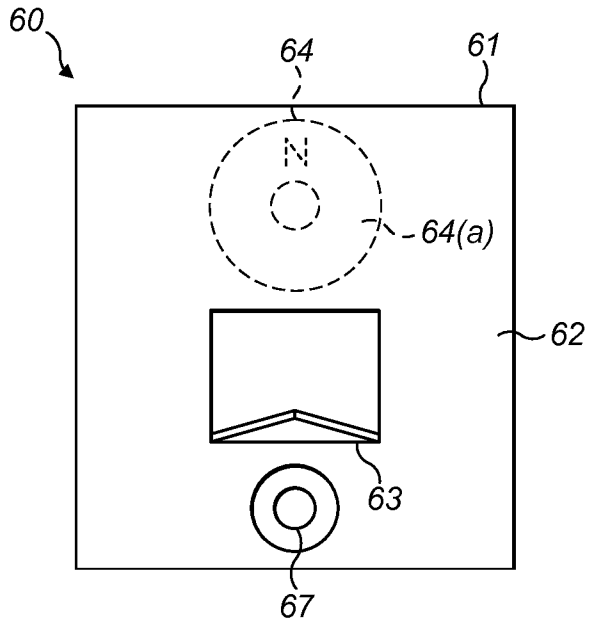


FIG. 5(a)

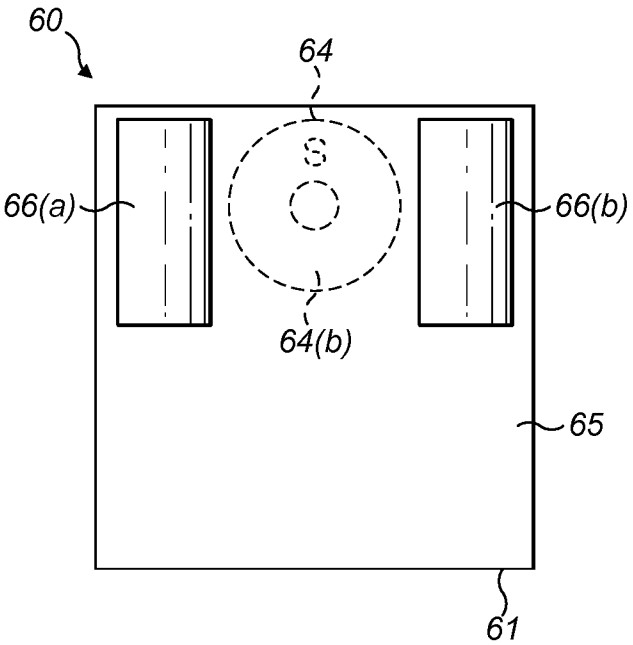


FIG. 5(b)

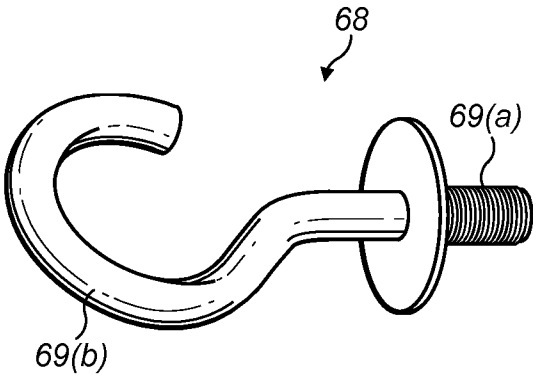


FIG. 5(c)

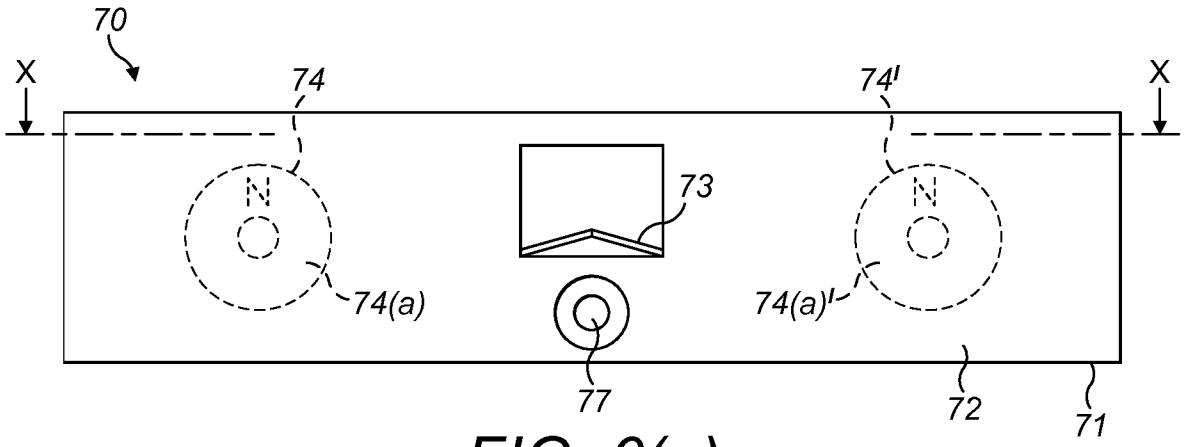


FIG. 6(a)

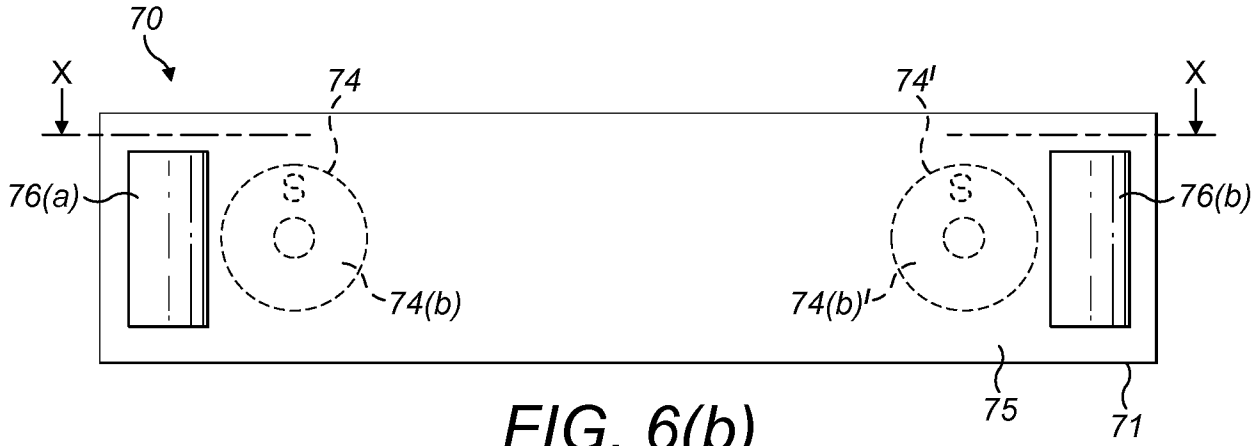


FIG. 6(b)

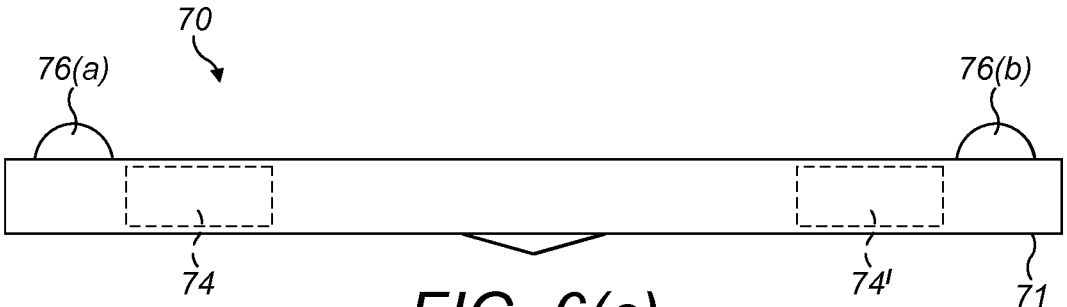


FIG. 6(c)

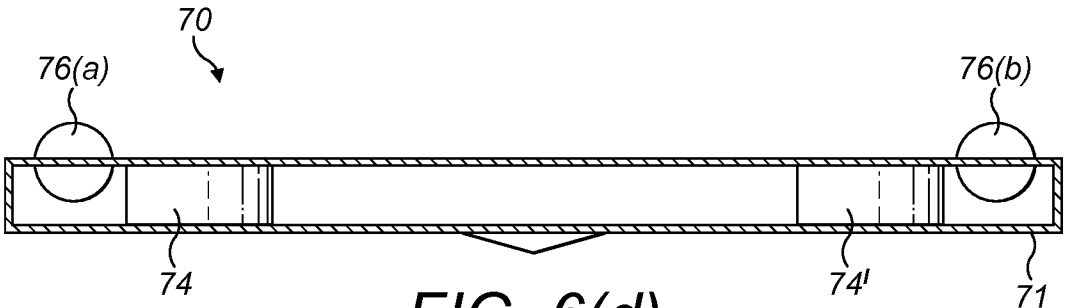


FIG. 6(d)

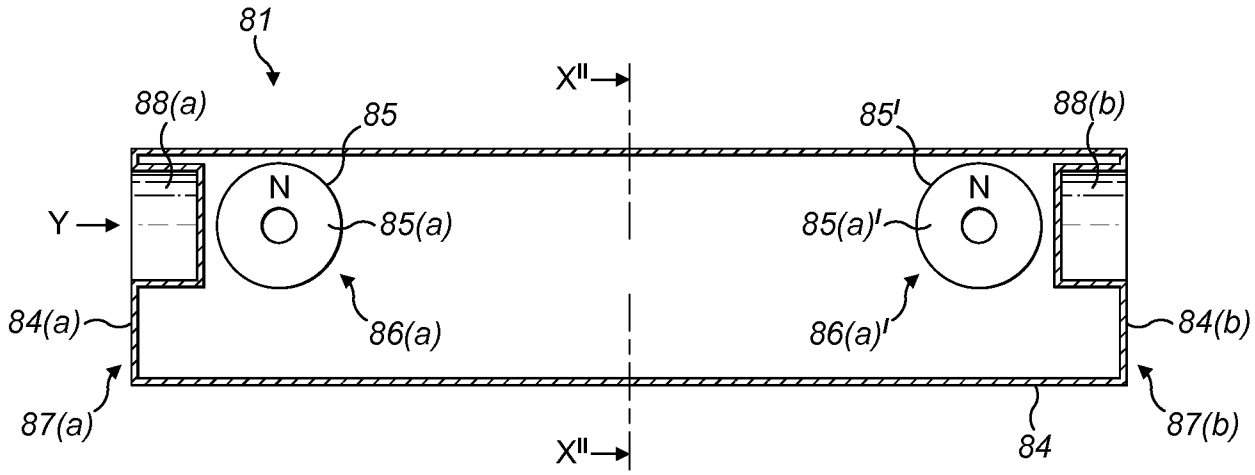


FIG. 7(a)

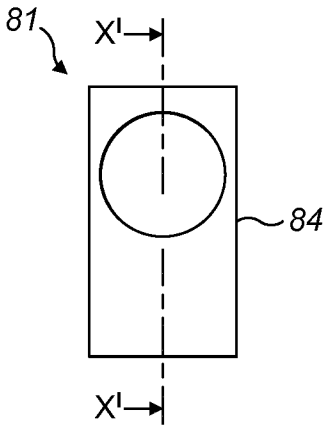


FIG. 7(b)

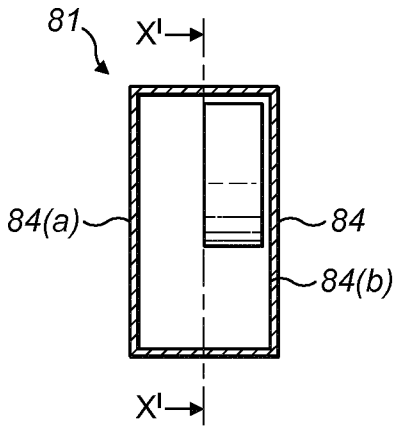


FIG. 7(c)

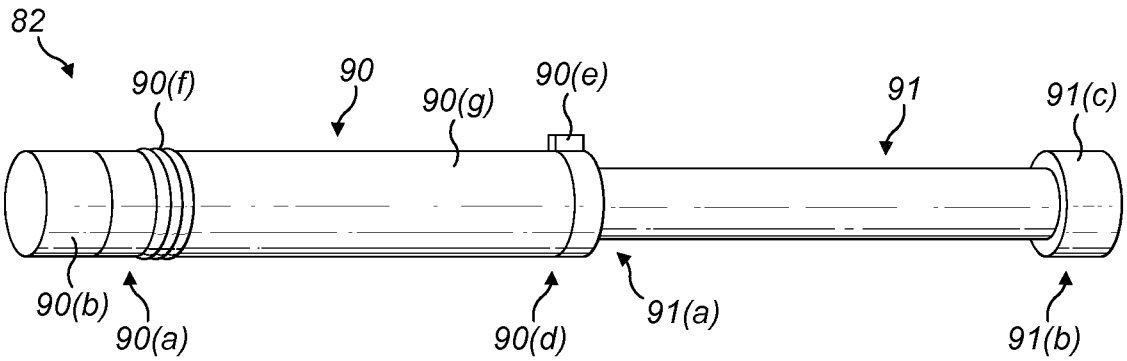


FIG. 7(d)

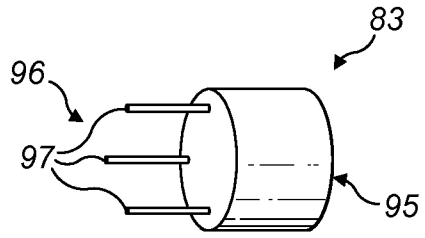


FIG. 7(e)

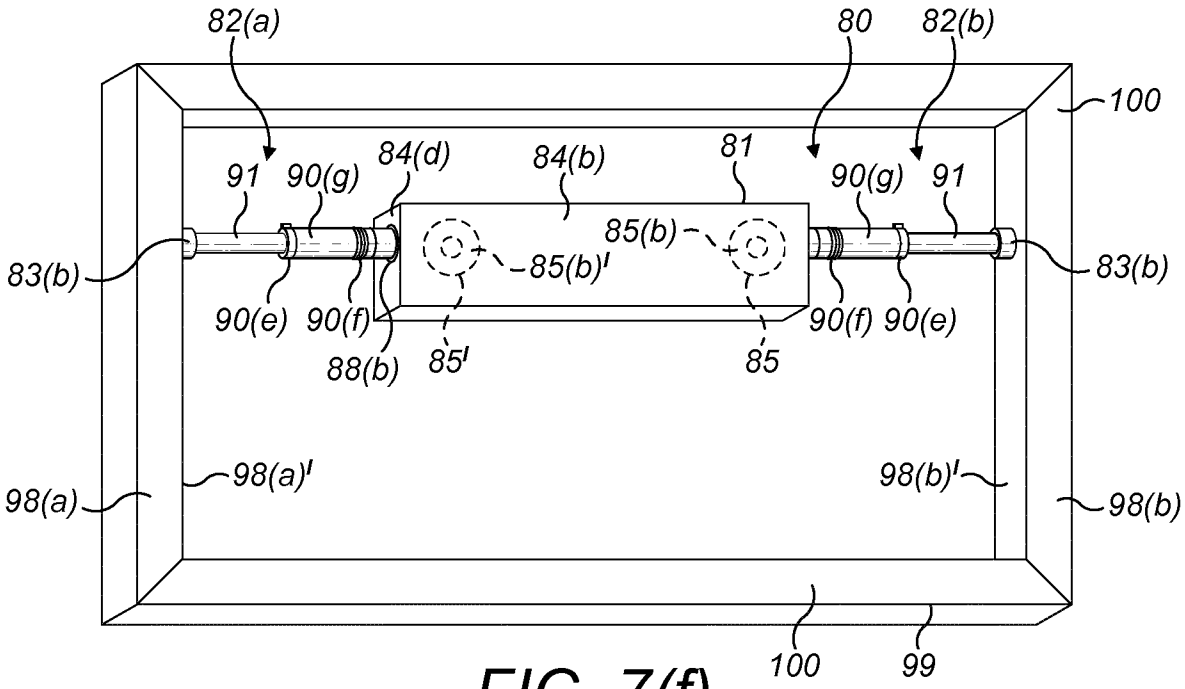


FIG. 7(f)

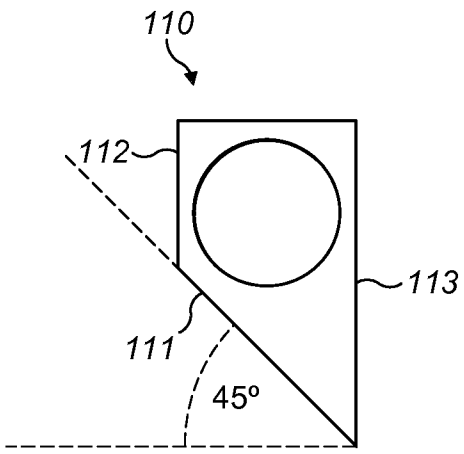


FIG. 7(g)

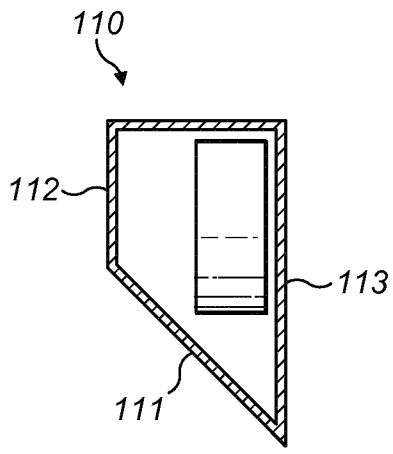


FIG. 7(h)

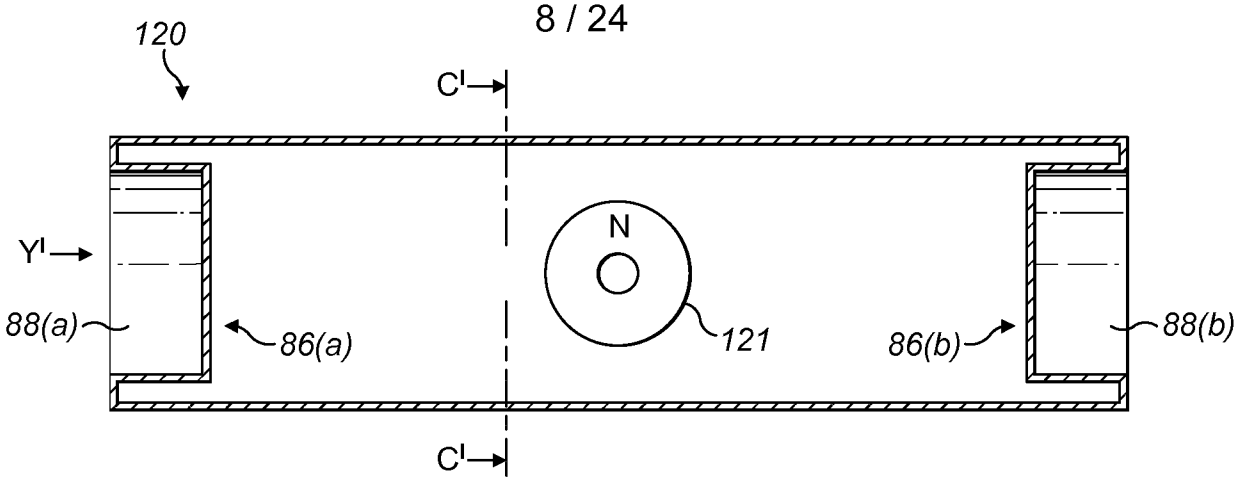


FIG. 8(a)

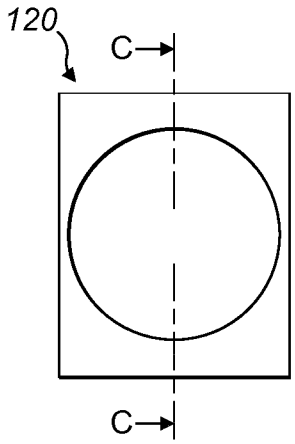


FIG. 8(b)

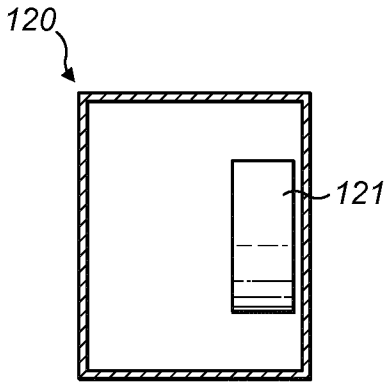


FIG. 8(c)

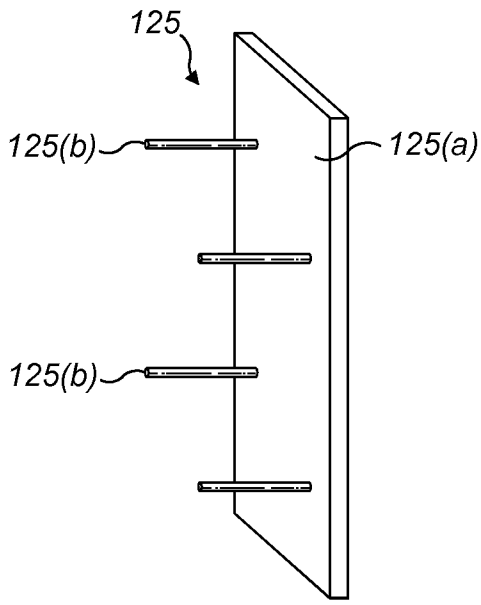


FIG. 8(d)

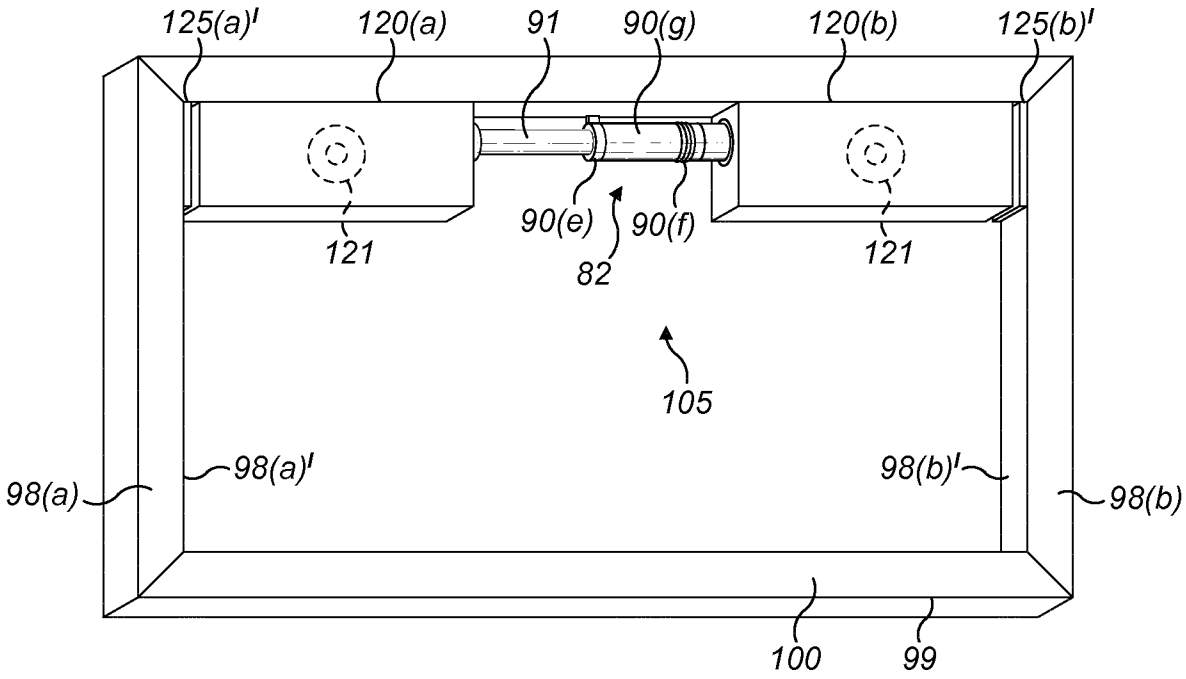

125(a)'
120(a)
91
90(g)
120(b)
125(b)'
121
90(e)
90(f)
82
121
105
98(a)
98(a)'
98(b)'
98(b)
100
99

FIG. 8(e)

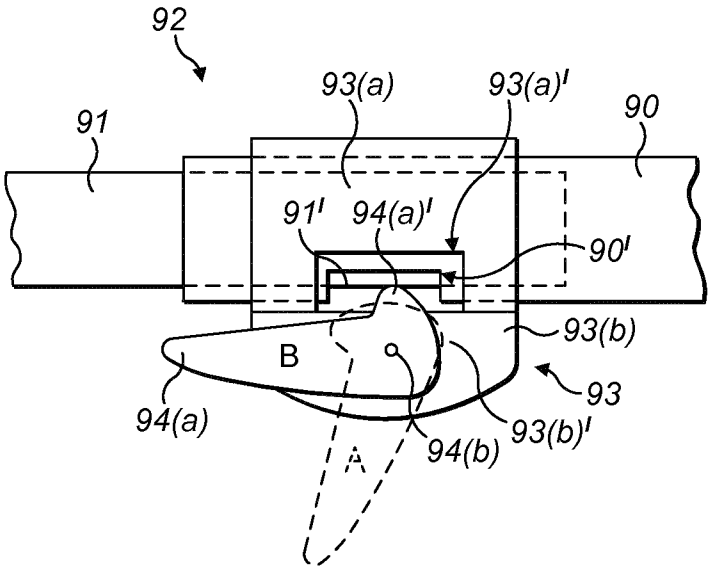

92
93(a)
93(a)'
90
91
91'
94(a)'
90'
93(b)
B
93
94(a)
93(b)'
94(b)
A

FIG. 8(f)

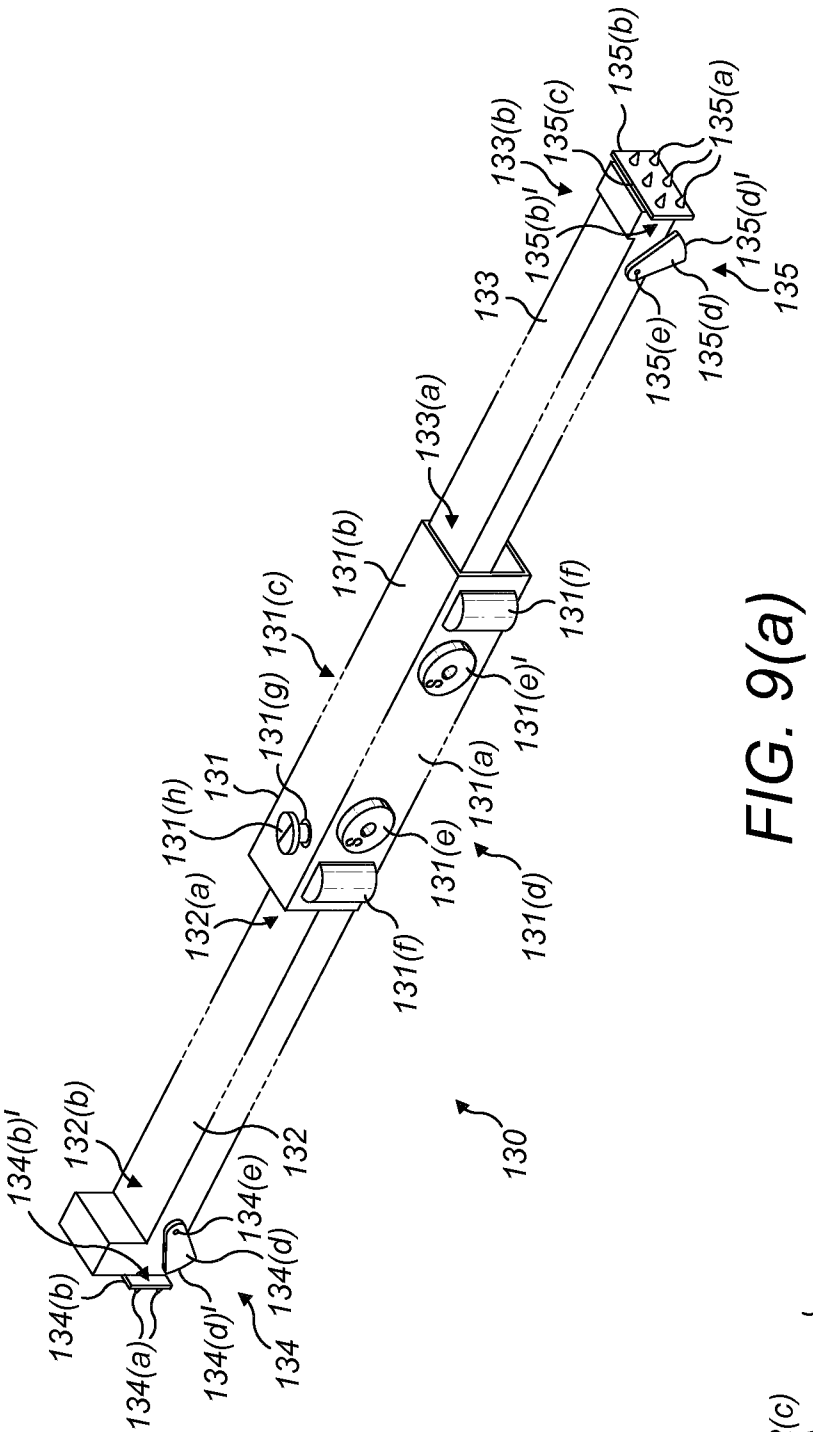

134(b)'
132(b)
134(b)
134(a)
134(d)'
134
134(d)
134(e)
132
130
132(a)
131(h)
131
131(g)
131(c)
131(b)
131(f)
131(e)
131(a)
131(d)
133(a)
131(e)'
131(f)
133
135(b)'
133(b)
135(c)
135(b)
135(a)
135(d)'
135
135(e)
135(d)

FIG. 9(a)

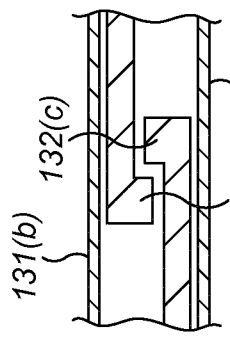

131(b)
132(c)
133(c)
131(d)

FIG. 9(b)

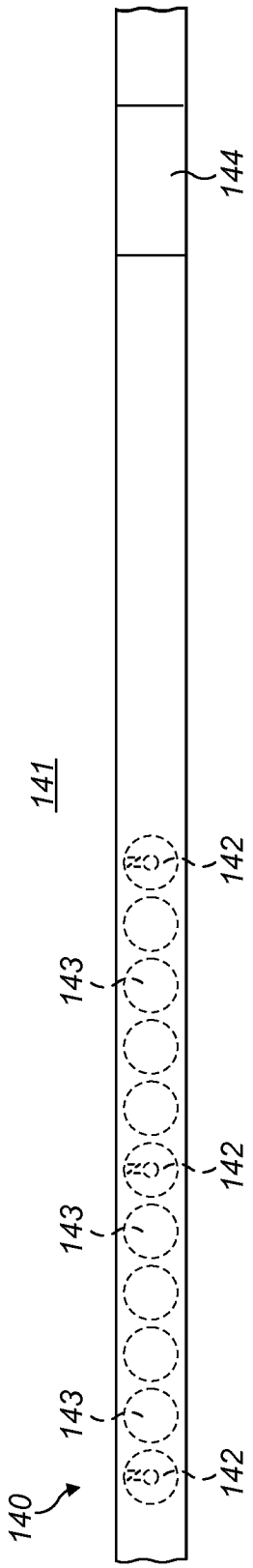


FIG. 10(a)

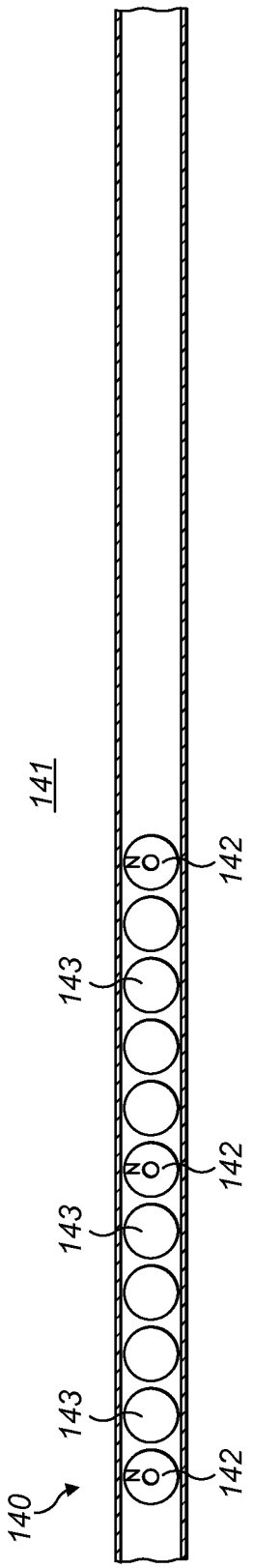


FIG. 10(b)

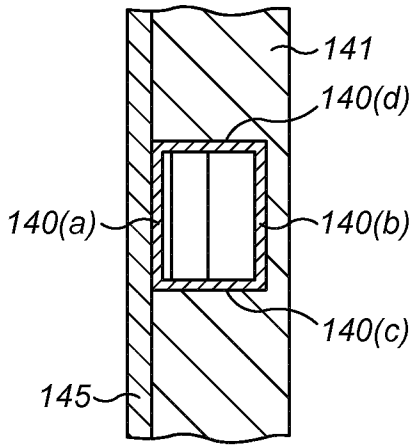


FIG. 10(c)

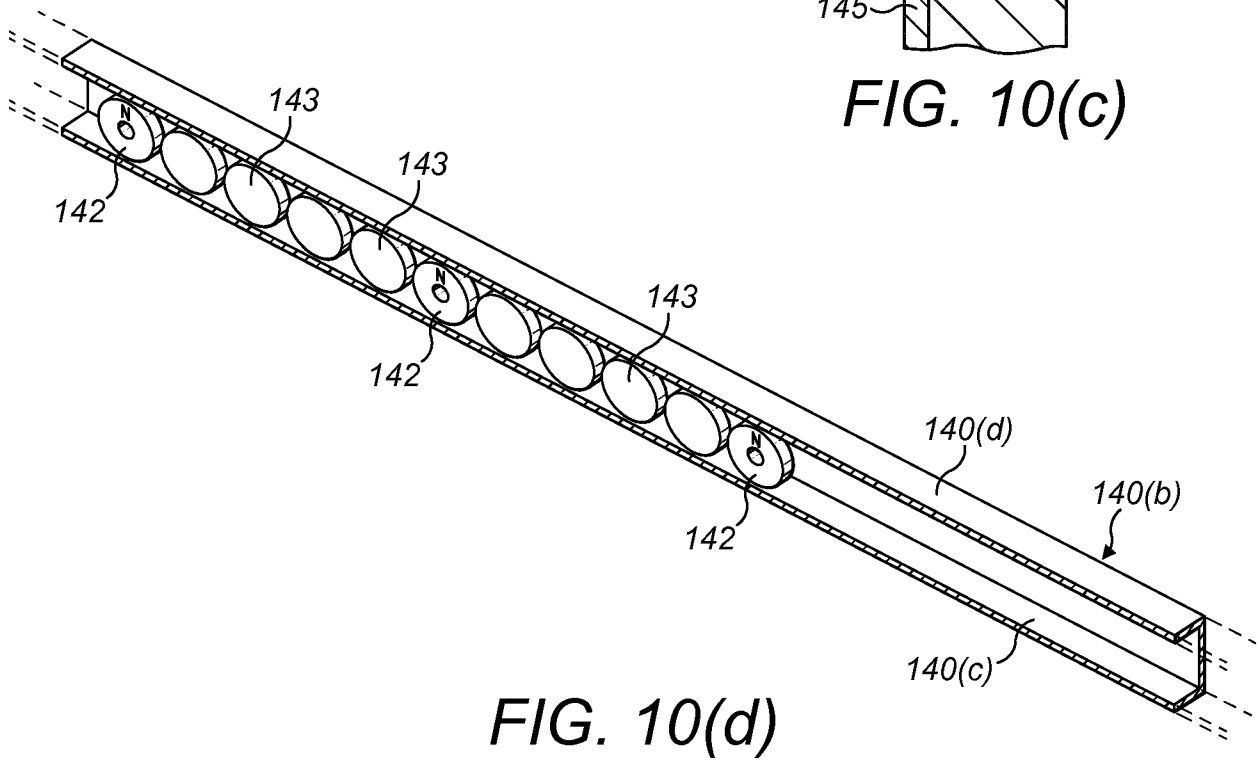


FIG. 10(d)

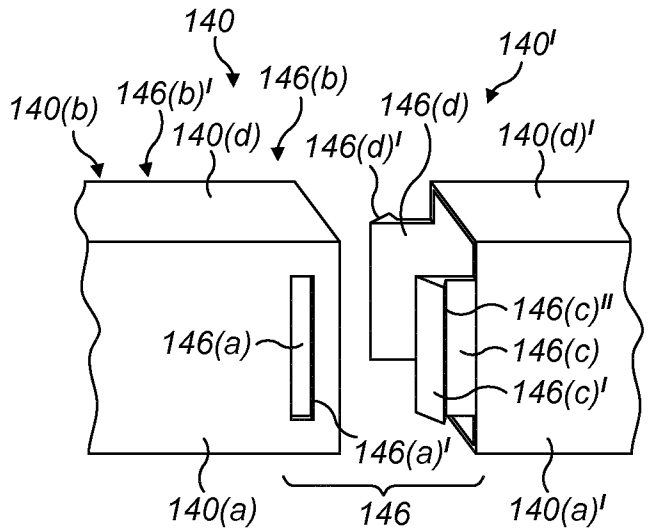


FIG. 10(e)

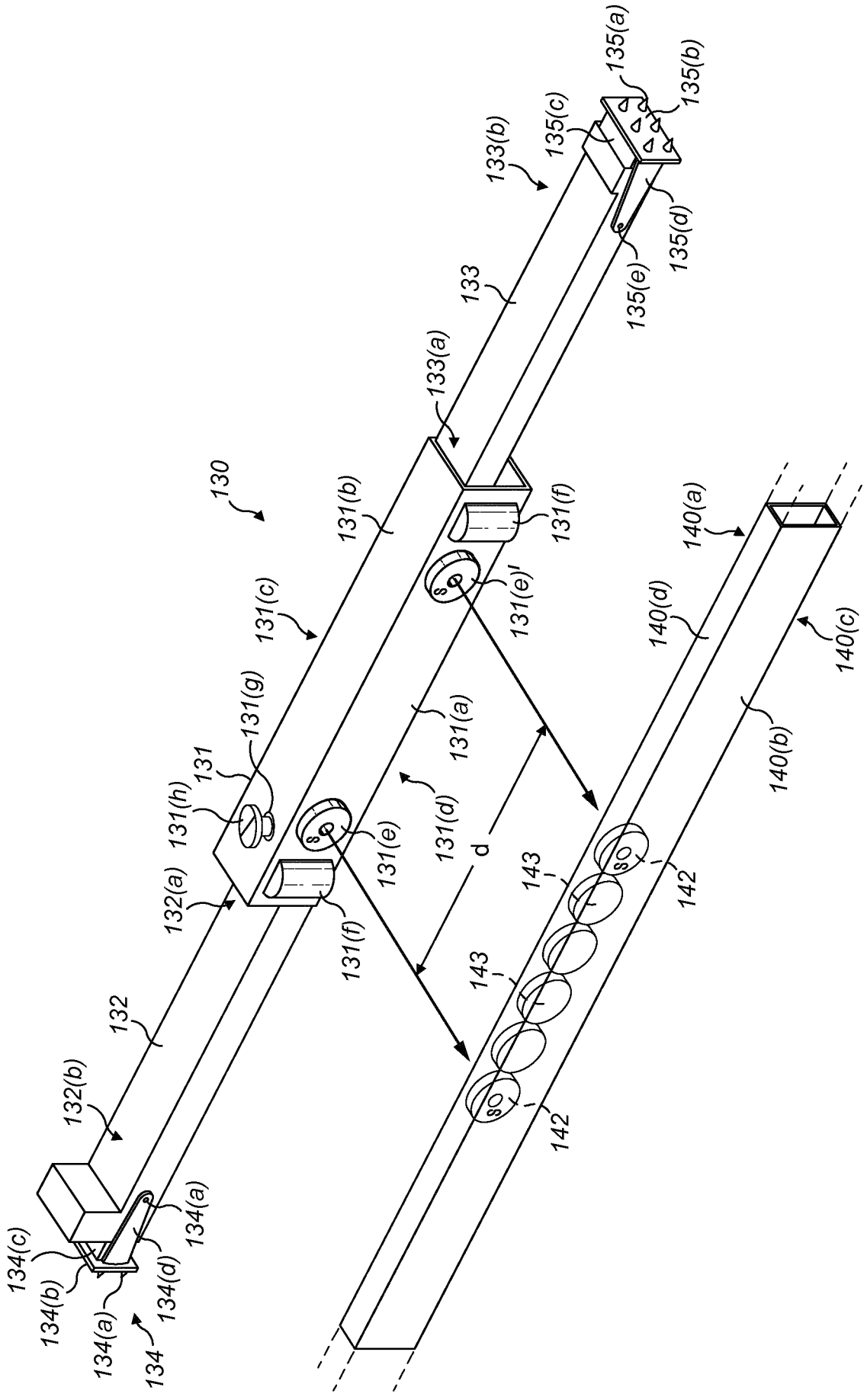

130
131
131(a)
131(b)
131(c)
131(d)
131(e)
131(e)'
131(f)
131(g)
131(h)
132
132(a)
132(b)
133
133(a)
133(b)
134
134(a)
134(b)
134(c)
134(d)
135(a)
135(b)
135(c)
135(d)
135(e)
140(a)
140(b)
140(c)
140(d)
142
143
d

FIG. 11

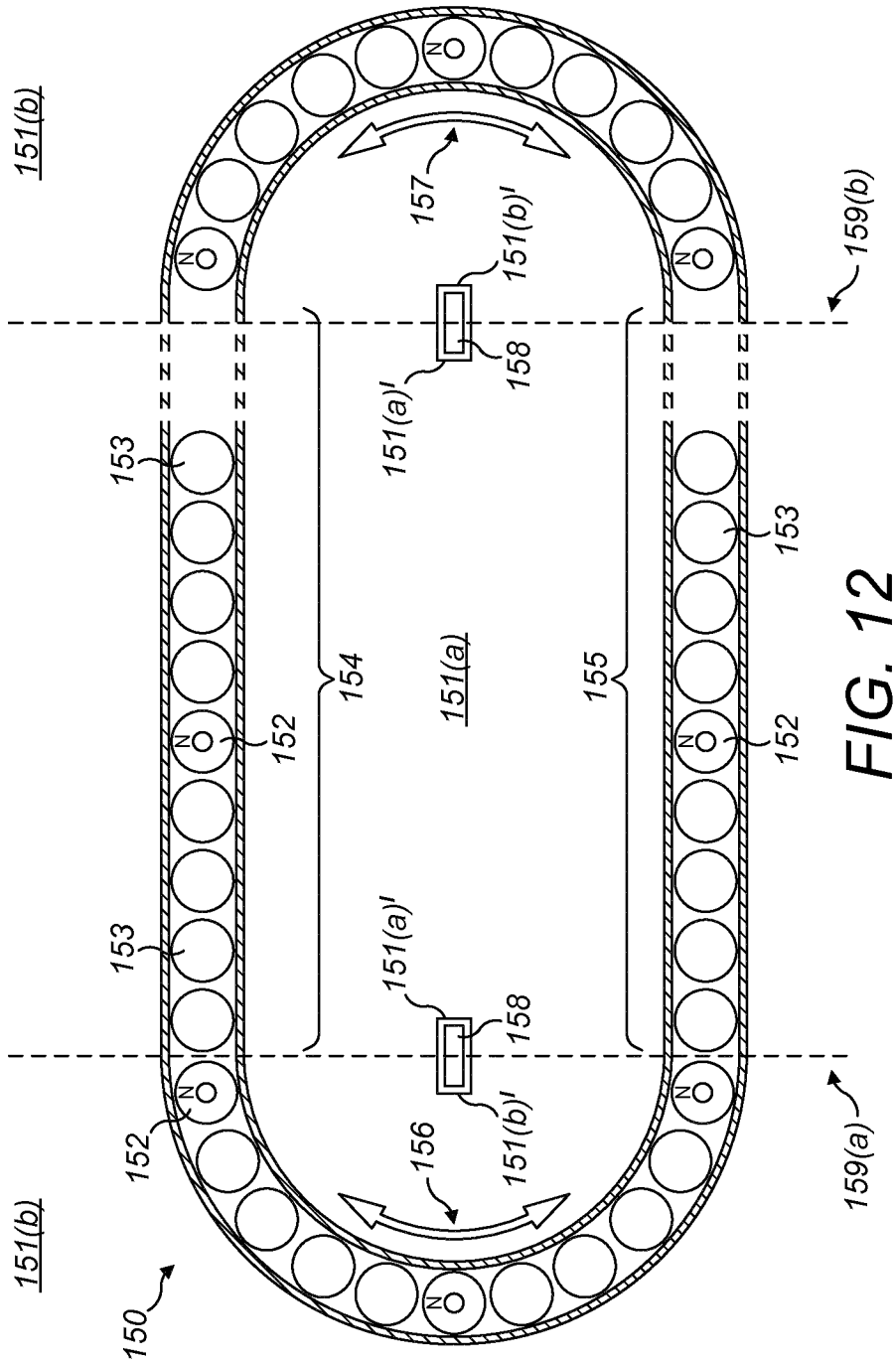

151(b)
157
151(b)'
159(b)
158
151(a)'
153
153
154
151(a)
155
152
152
151(a)'
153
158
156
151(b)'
152
151(b)
150
159(a)

FIG. 12

FIG. 13(a)

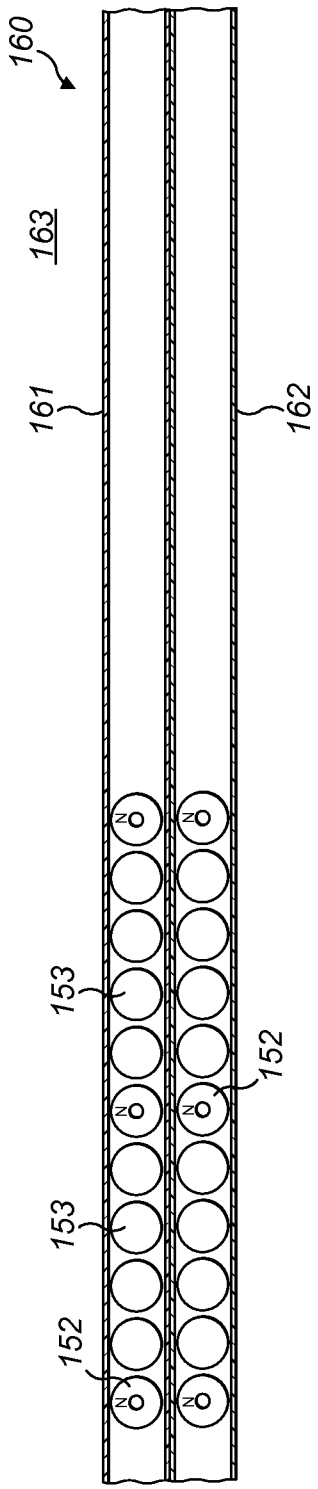


FIG. 13(b)

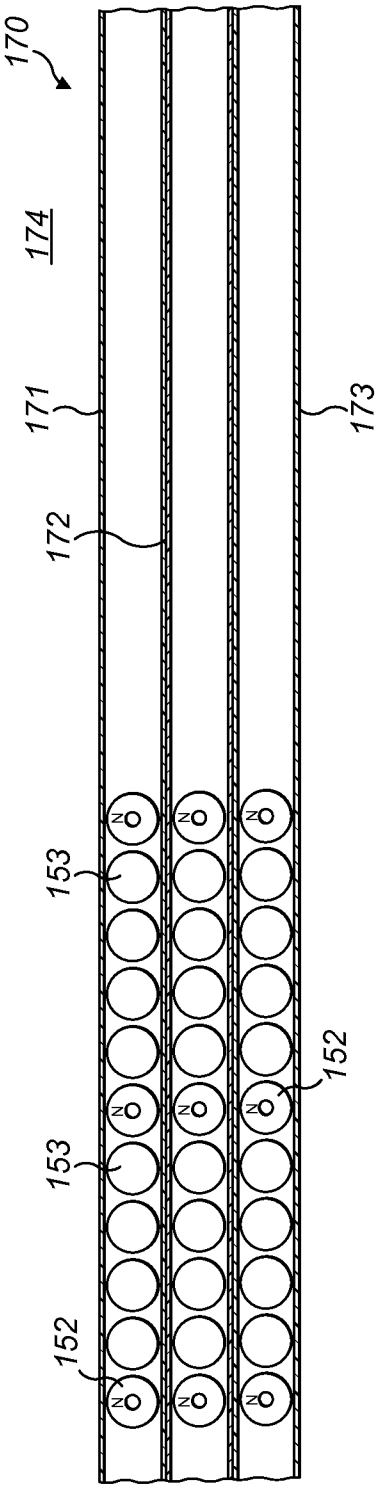
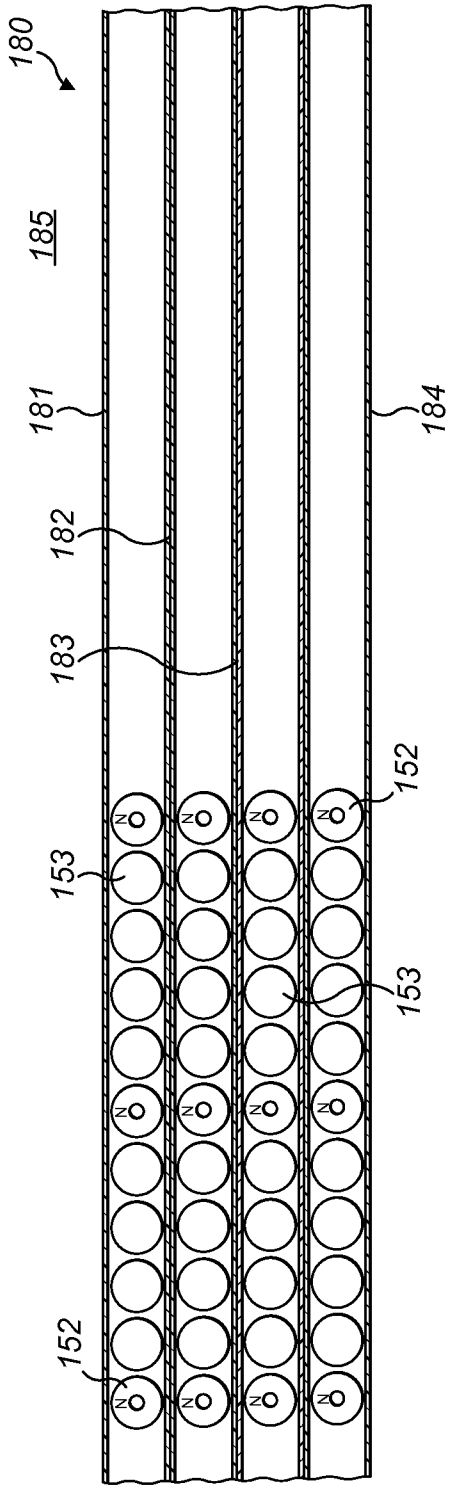


FIG. 13(c)



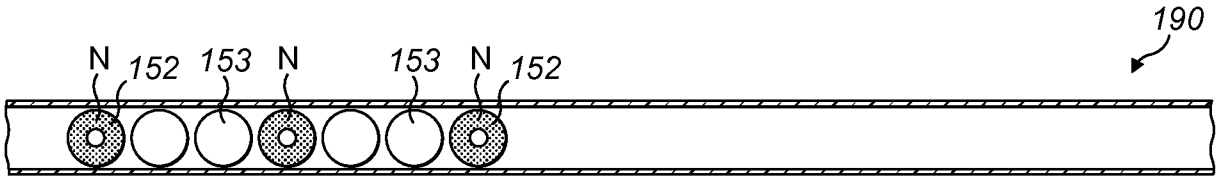


FIG. 14(a)

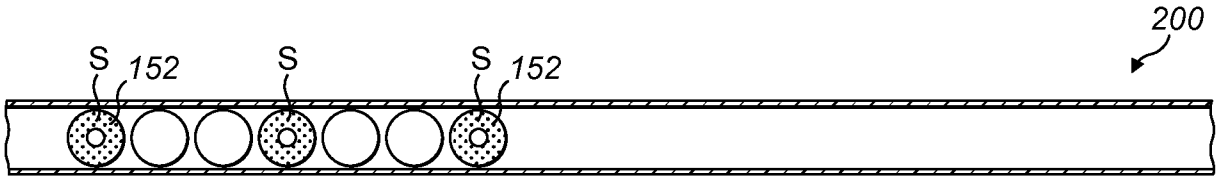


FIG. 14(b)

FIG. 14(c)

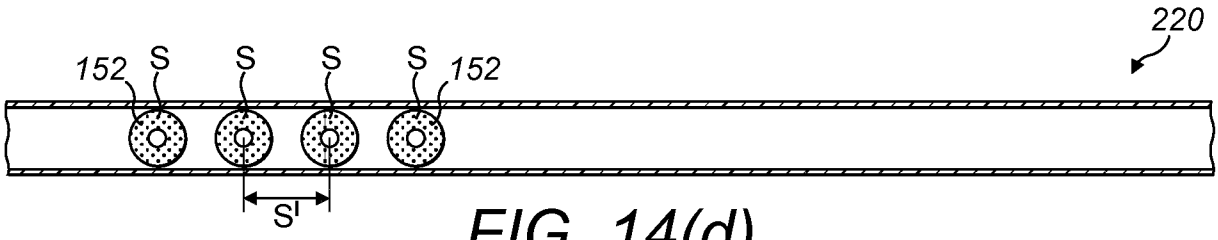


FIG. 14(d)

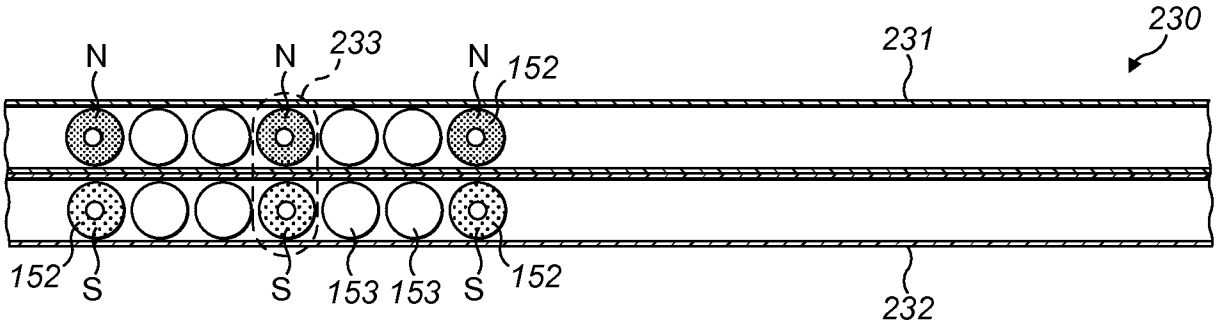


FIG. 14(e)

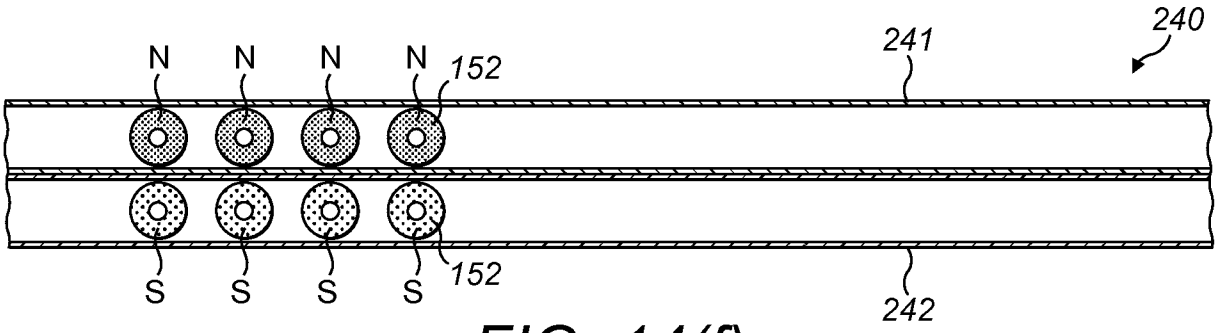


FIG. 14(f)

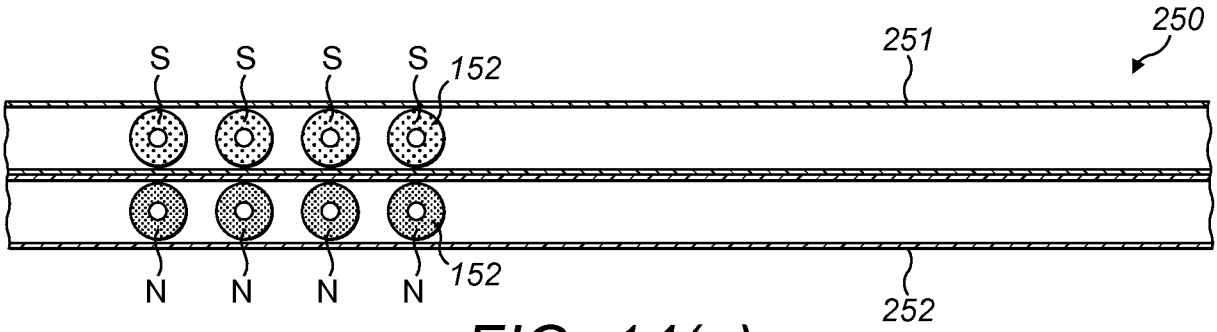


FIG. 14(g)

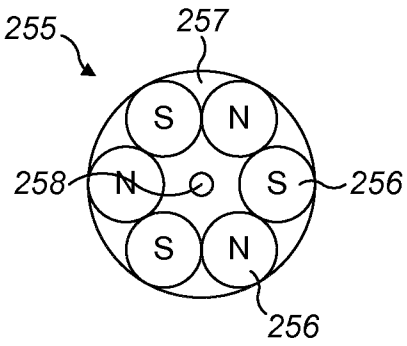


FIG. 14(h)

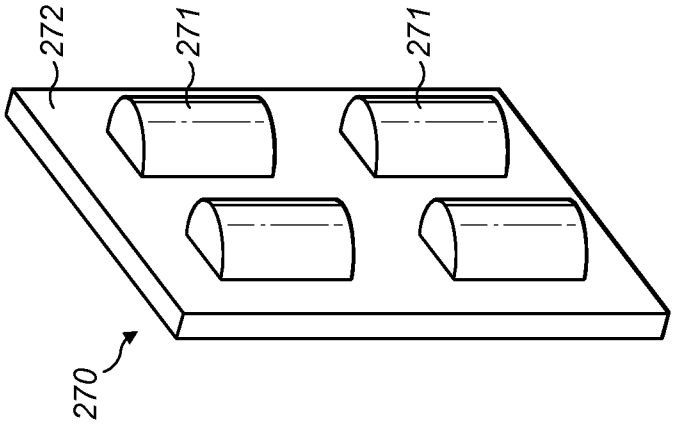


FIG. 15(c)

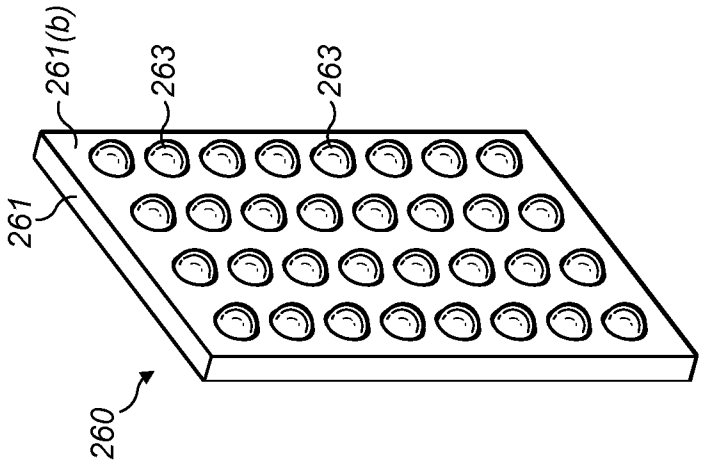


FIG. 15(b)

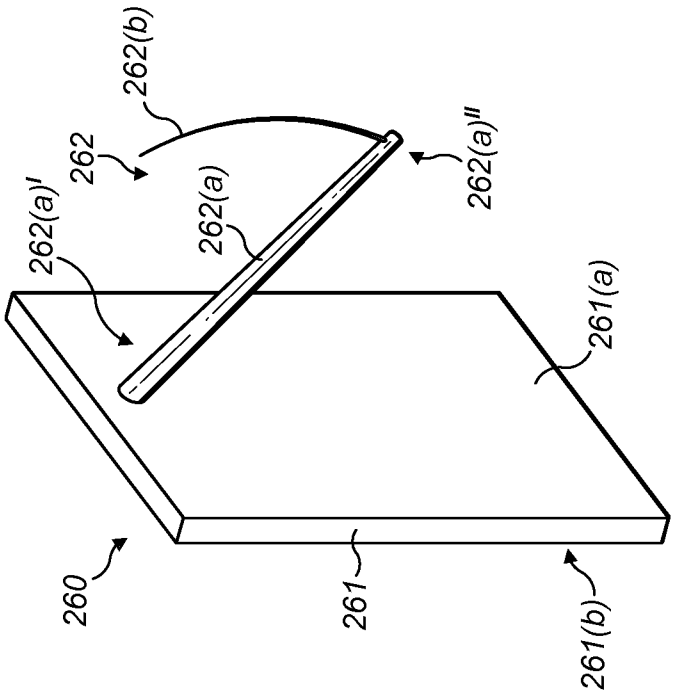


FIG. 15(a)

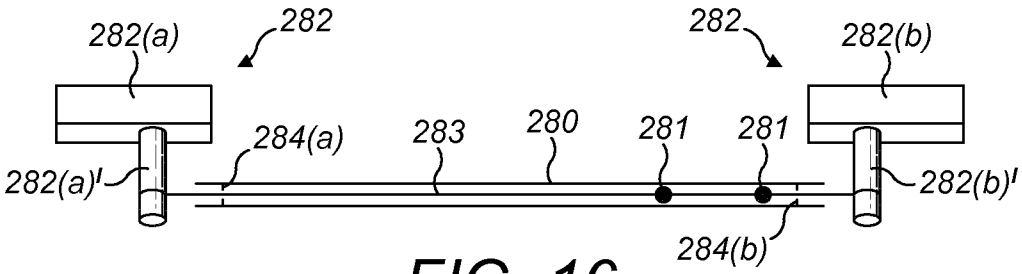


FIG. 16

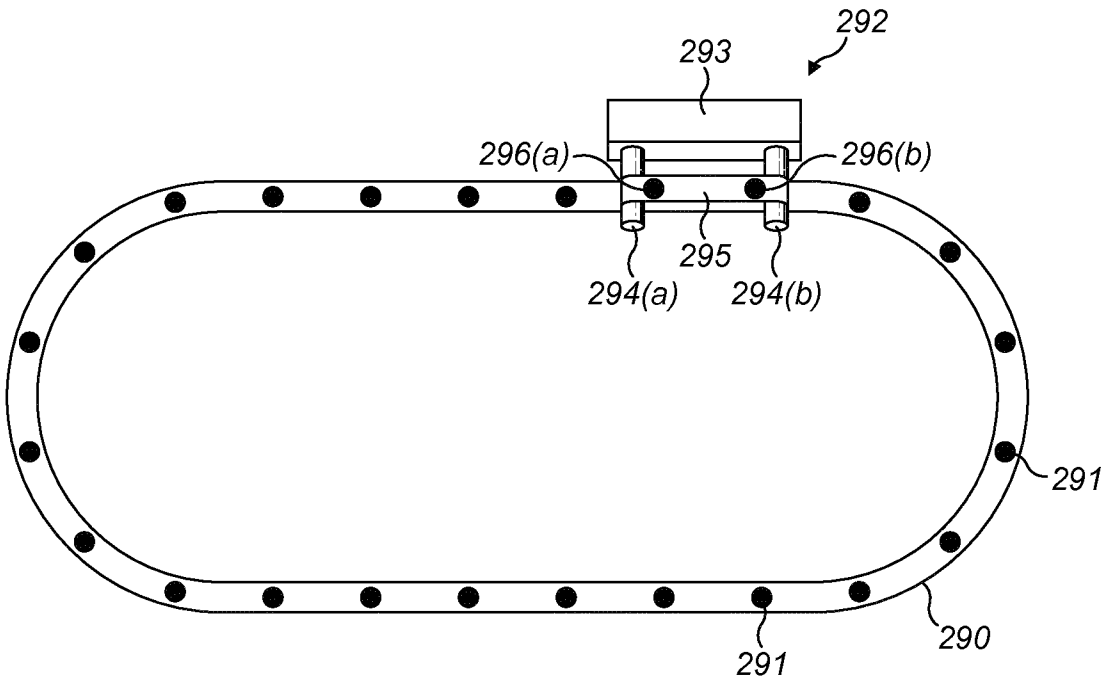


FIG. 17(a)

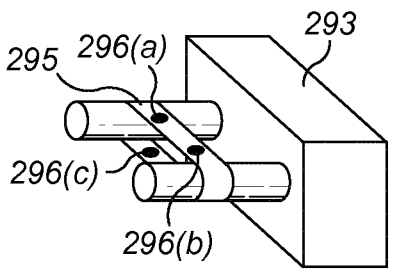


FIG. 17(b)

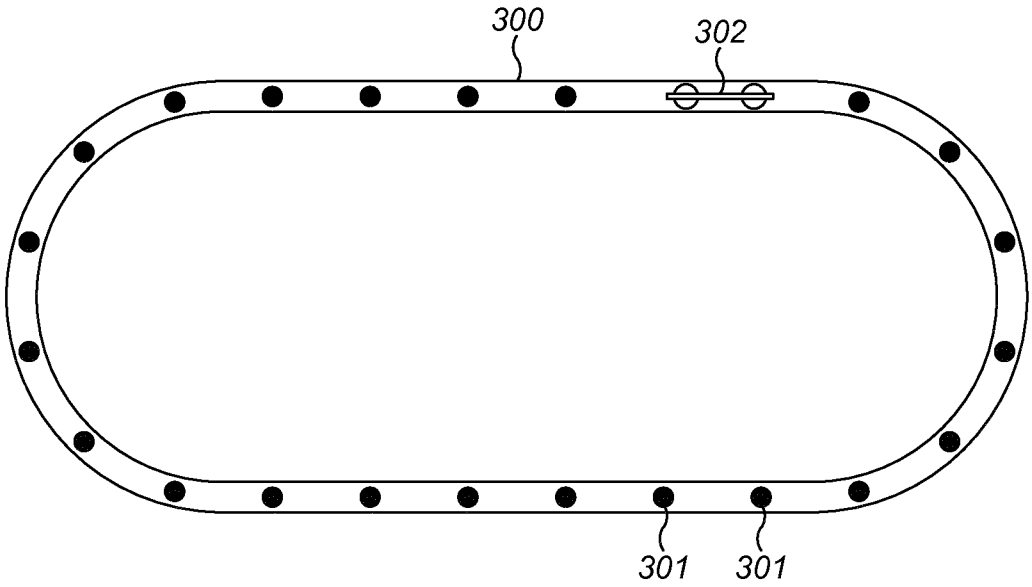


FIG. 18(a)

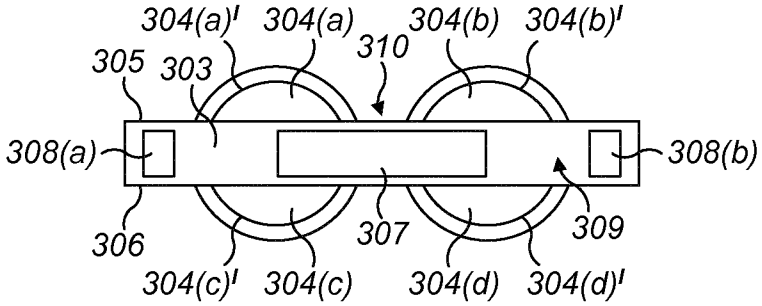


FIG. 18(b)

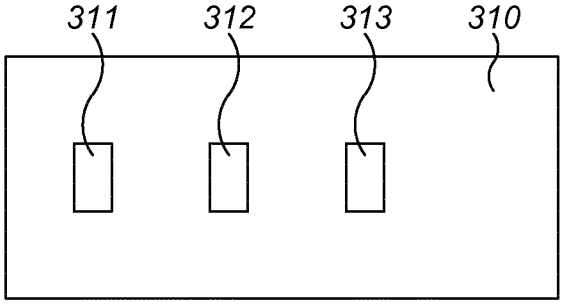


FIG. 19

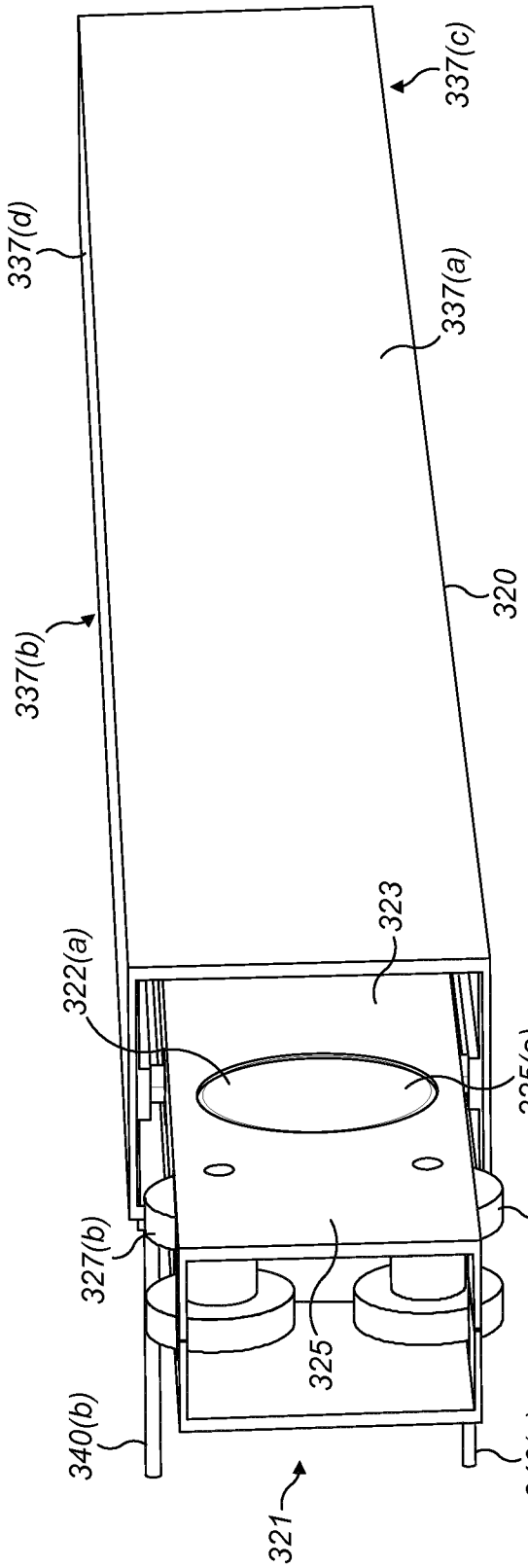

337(c)
337(d)
337(a)
320
337(b)
323
322(a)
325(a)
327(a)
327(b)
325
340(b)
340(a)
321

FIG. 20(a)

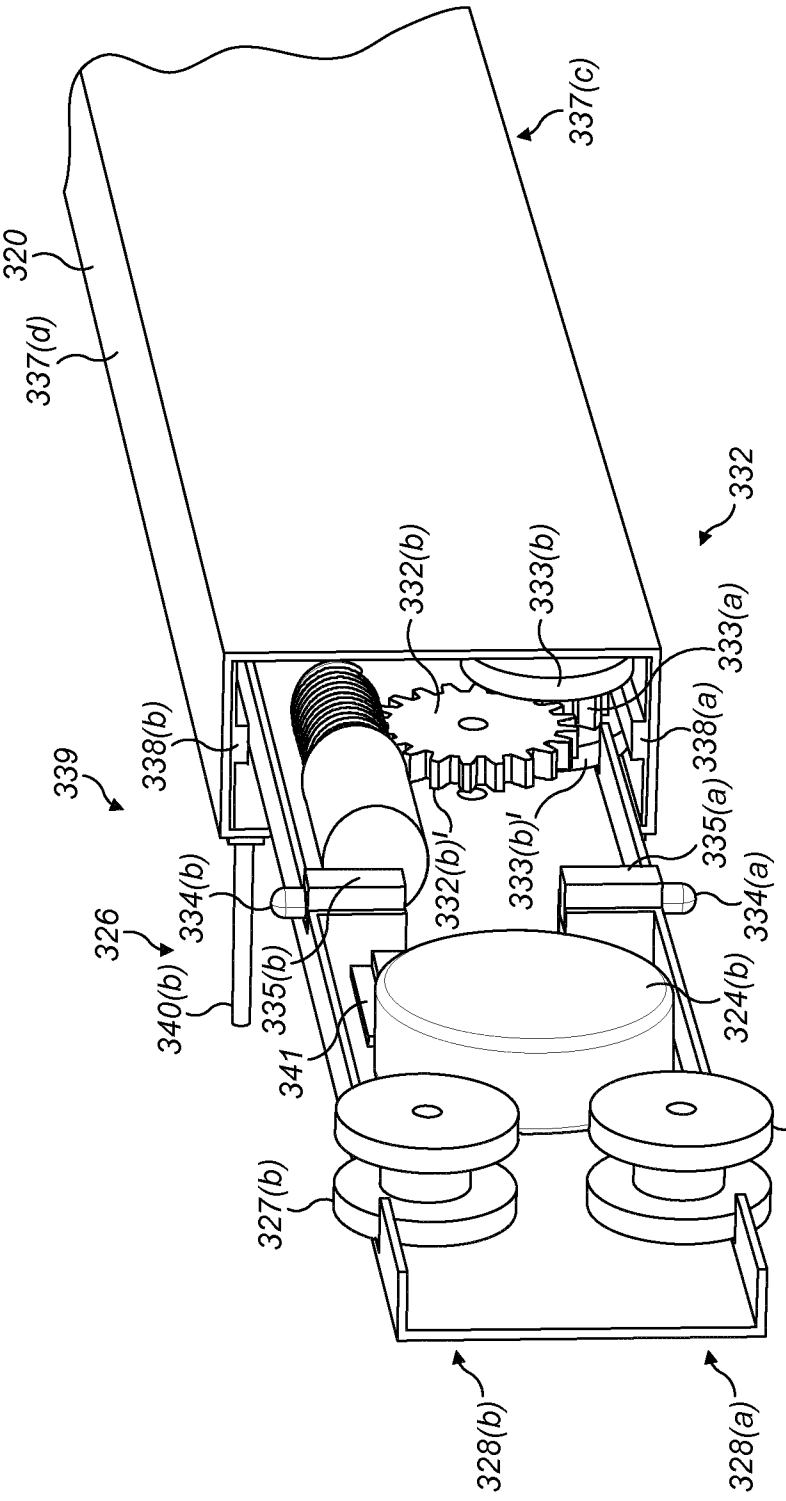

320
337(d)
337(c)
332
332(b)
333(b)
333(a)
338(b)
338(a)
339
335(a)
332(b)'
333(b)'
334(b)
334(a)
326
335(b)
340(b)
341
324(b)
327(b)
327(a)
329(a)
328(b)
328(a)

FIG. 20(b)

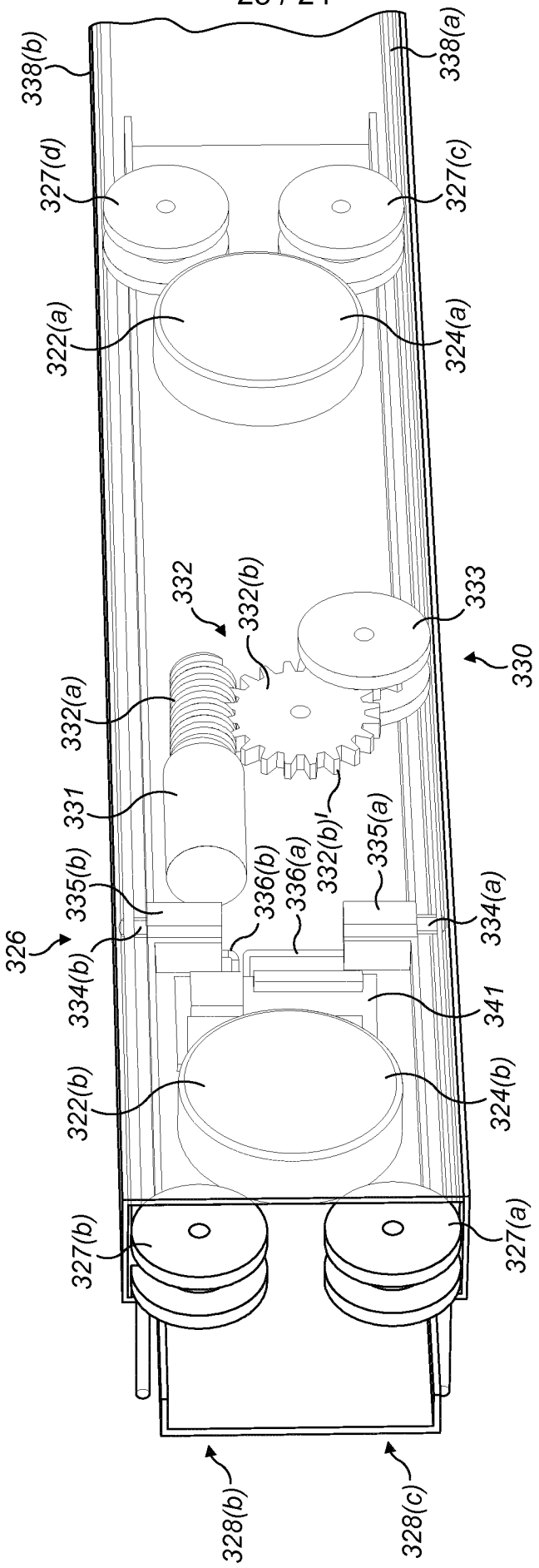

338(b)
338(a)
327(d)
327(c)
322(a)
324(a)
332
332(b)
333
330
332(a)
331
335(b)
336(b)
336(a)
332(b)'
335(a)
334(a)
326
334(b)
341
322(b)
324(b)
327(b)
327(a)
328(b)
328(c)

FIG. 20(c)

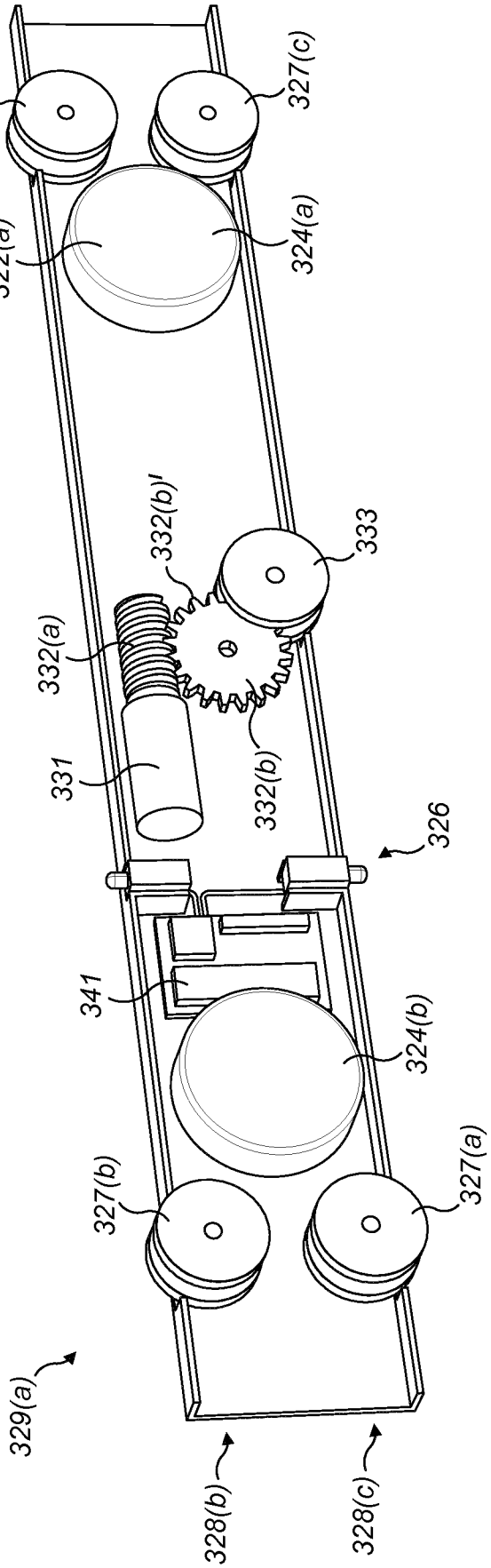

327(d)
327(c)
322(a)
324(a)
332(b)'
333
332(a)
331
332(b)
326
341
324(b)
327(b)
327(a)
329(a)
328(b)
328(c)

FIG. 20(d)