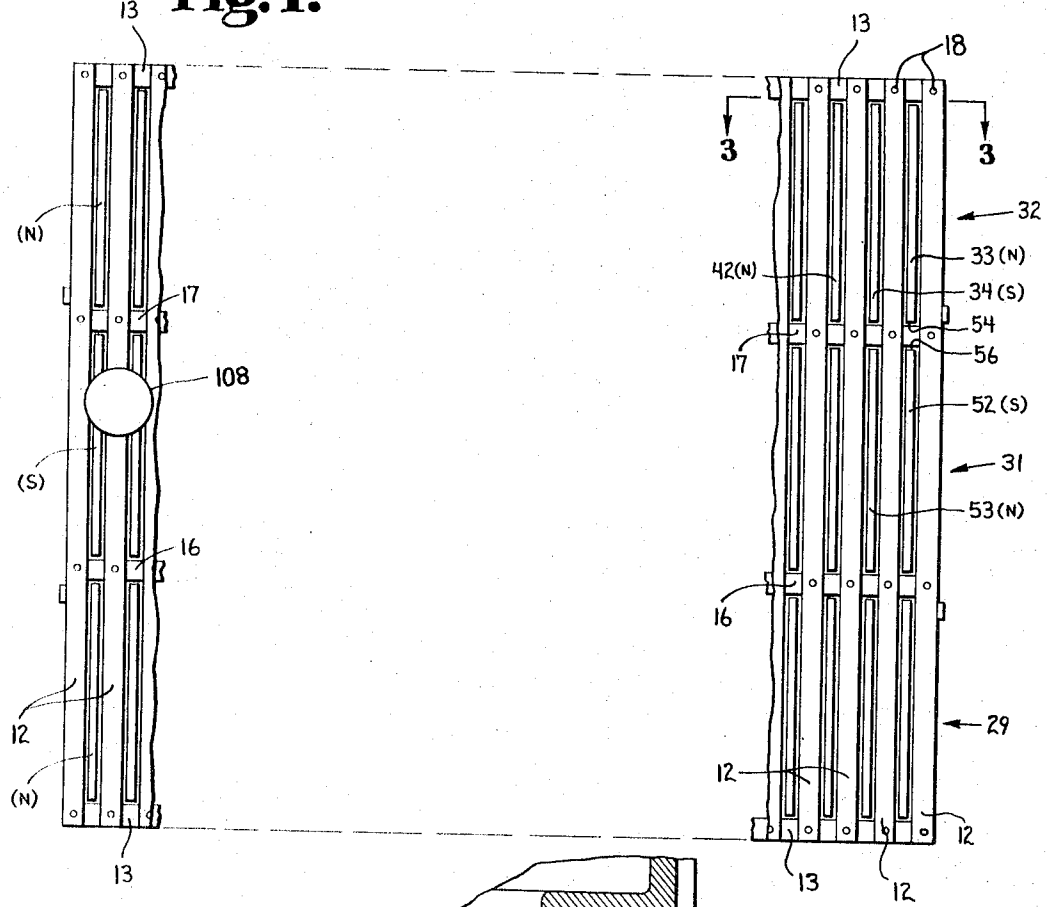
Nov. 28, 1967 C. L. RICHARDS, JR., ET AL 3,355,209

MATERIAL HANDLING DEVICE

Filed May 10, 1965 4 Sheets-Sheet 1

Fig. 1.



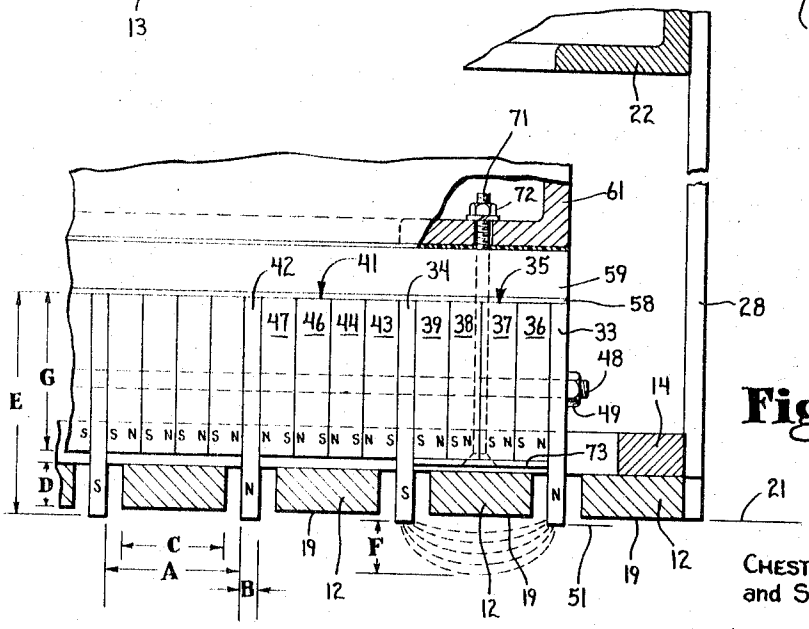


Fig. 3.

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MATERIAL HANDLING DEVICE

Filed May 10, 1965 4 Sheets-Sheet 2

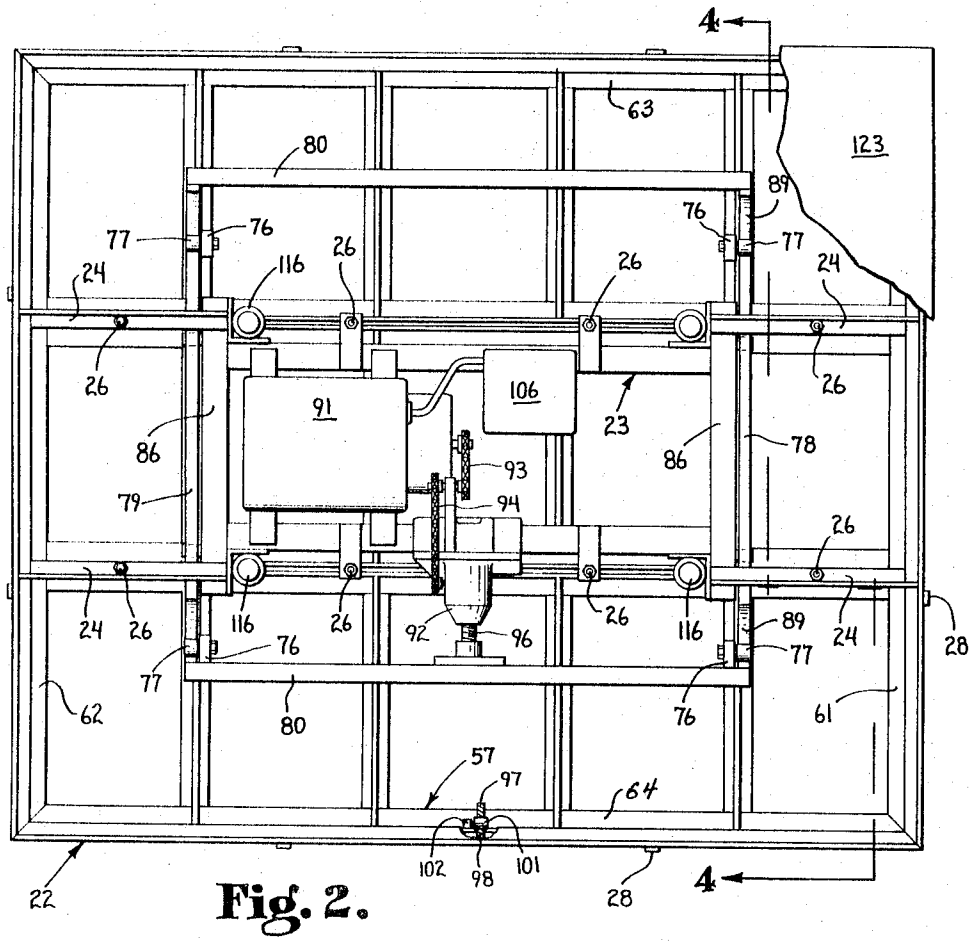


Fig. 2.

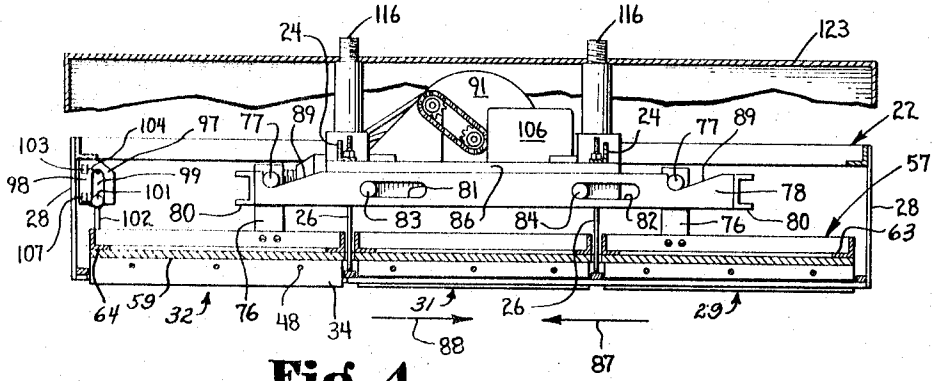


Fig. 4.

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MATERIAL HANDLING DEVICE

Filed May 10, 1965 4 Sheets-Sheet 3

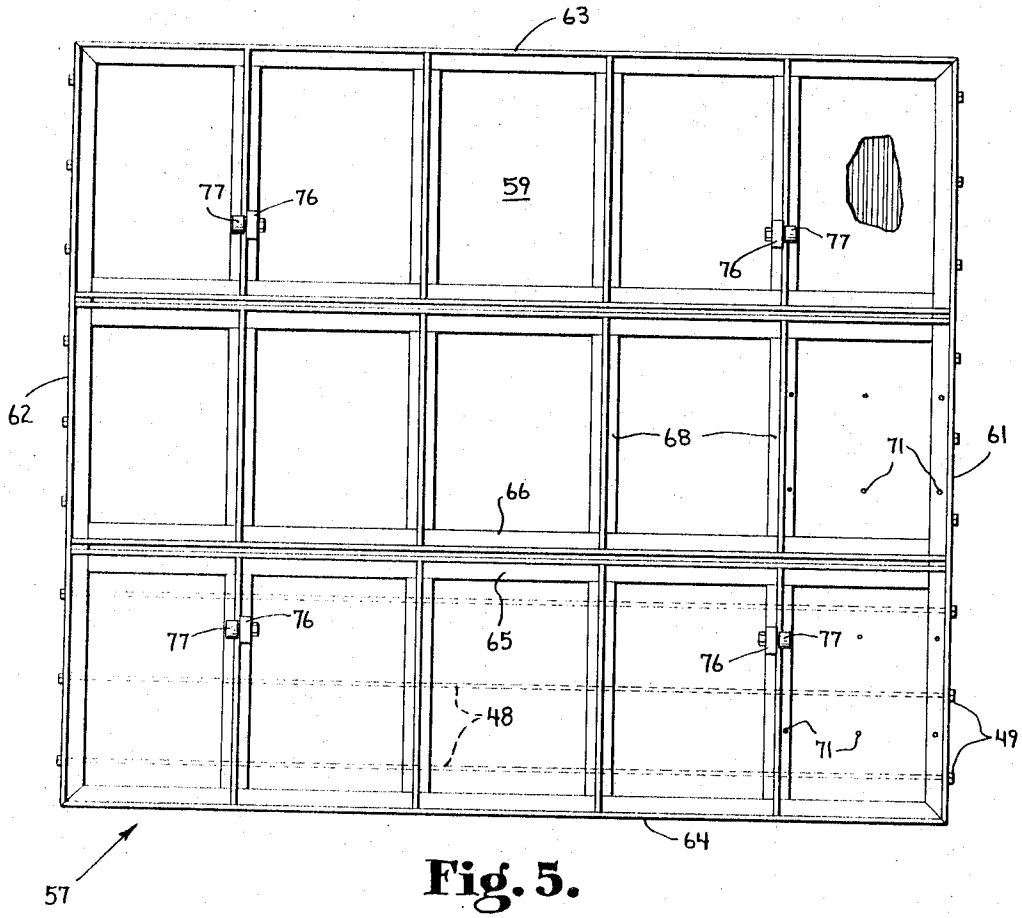


Fig. 5.

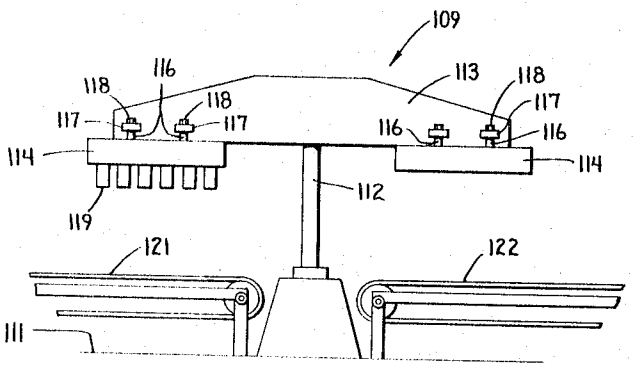


Fig. 6.

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MATERIAL HANDLING DEVICE

Filed May 10, 1965 4 Sheets-Sheet 4

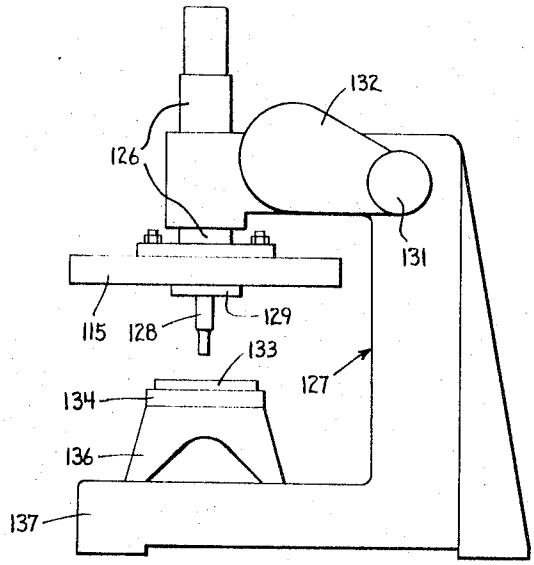


Fig. 7.

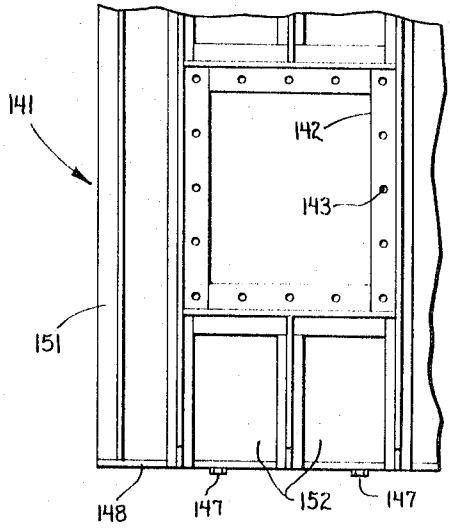


Fig. 8.

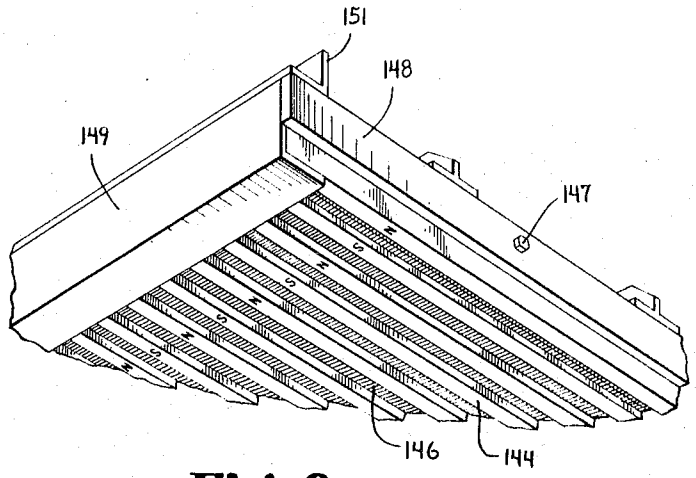


Fig. 9.

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United States Patent Office 3,355,209 Patented Nov. 28, 1967

3,355,209

MATERIAL HANDLING DEVICE

Chester L. Richards, Jr., and Sherman S. Smith, Indianapolis, Ind., assignors to Magnetic Devices, Inc., Indianapolis, Ind., a corporation of Indiana

Filed May 10, 1965, Ser. No. 454,520
5 Claims. (Cl. 294—65.5)

This invention relates generally to material handling equipment and more particularly to a device or "head" useful on machines for lifting, carrying and depositing a plurality of units of ferromagnetic materials such as steel cans, for example, without disturbing their arrangement.

In various industries, such as the food packing industry, for example, it is necessary to lift and carry and deposit groups of cans or can lids or other metal articles. For example, it is frequently desirable to lift a pallet load of cans from one place to another, and move cans from pallets, layer by layer, to other pallets, conveyors, or cartons. In many instances it is advantageous to be able to lift the cans from above, and magnetic can lifters or "heads" have been devised for this purpose. Difficulties encountered with such devices have included inadequate field strength for reliable operation, inadequate control of the magnetic fields established, and, upsetting or otherwise disturbing the arrangement of the cans in a group during handling thereof.

It is therefore a general object of the present invention to provide a magnetic device easily installed on machines for lifting, supporting, and carrying, various items, without contacting any other than the uppermost top surfaces of the items.

A further object is to provide a device having characteristics enabling material handling machines to pick up, move, and deposit arrays of individual ferromagnetic units without disturbing the pattern or positions of the various units in the array.

A still further object is to provide a compact device achieving the foregoing objects and having a high capacity.

A still further object is to provide a device achieving the foregoing objects and capable of a long, trouble-free, service life.

Described briefly, a typical embodiment of the present invention employs a magnet assembly including a plurality of horizontally spaced pole pieces, these pole pieces being typically arranged in three rows. Permanent magnets are sandwiched between every two pole pieces in a row, and oriented so that the successive pole pieces in a row have opposite magnetic polarity. One pole piece in each row is coplanar with a pole piece in each of the other two rows. The pole pieces are actually upstanding generally rectangular ferromagnetic plates with the lower edges thereof in a common plane and closely spaced. Adjacent pole pieces in a row and across rows are of opposite polarity, so that the rim of a ferromagnetic can, when contacting any two adjacent pole pieces, completes a magnetic circuit therebetween.

A stripper is provided in the form of a grid of elongated parallel horizontally spaced non-magnetic stripper bars disposed in the space between each pole piece and the next pole piece in the row. These stripper bars are affixed to a support frame which is mountable by bolts to a material handling machine such as a crane or can handling machine, for example.

The stripper support frame supports a cam frame which, in turn, supports the magnet assembly so that the plane of the lower edges of the pole pieces is normally slightly below the plane of the lower face of the stripper grid. However an electric motor and appropriate drive are provided to move the cam frame horizontally with respect to

both the grid support frame and magnet assembly. Cam followers connected to the magnet assembly and by means of which it is supported on the cam frame, are thereby lifted. The lifting of the cam followers lifts the magnet assembly so that the plane of the lower edges of the pole pieces is raised above the stripper grid face plane, serving to move the magnetic field up to such an extent that the portion intercepted by the can or other device supported by the magnet assembly is no longer of sufficient strength to support the weight of the can, whereupon the can is released.

The full nature of the invention will be understood from the accompanying drawings and the following description and claims:

FIG. 1 is a bottom plan view of a typical embodiment of the present invention.

FIG. 2 is a top view thereof with most of the enclosure housing sheeting removed.

FIG. 3 is an enlarged fragmentary section therethrough taken along the line 3—3 in FIG. 1 and viewed in the direction of the arrows.

FIG. 4 is a section therethrough taken along the line 4—4 in FIG. 2 and viewed in the direction of the arrows.

FIG. 5 is a top plan view of the magnet frame and assembly.

FIG. 6 is an elevational view, on a much smaller scale, of the units installed on a can handling machine.

FIG. 7 is an elevational view of another embodiment of invention installed on a punch press.

FIG. 8 is an enlarged fragmentary view of the top of the embodiment of FIG. 7.

FIG. 9 is an enlarged fragmentary view of the bottom of the embodiment of FIG. 7.

Referring now to the drawings in detail, and particularly to the bottom view of the device as shown in FIG. 1 a stripper is provided in the form of a grid including the stripper grid face bars **12** which are parallel horizontally-spaced rigid bars of a non-magnetic material such as stainless steel or aluminum. These bars are fastened at their ends to the non-magnetic side members **13** of a grid perimeter frame, and intermediate their ends they are fastened to non-magnetic (usually stainless steel) grid support bars **16** and **17** extending the length of the grid parallel to the grid perimeter frame side members. The fastening may be accomplished by recessed head screws **18** and the result is that a rigid stripper grid is thus completed. The lower faces **19** of the grid face bars are coplanar in what will be hereinafter referred to as the stripper plane **21**.

A stripper support frame is provided and includes the upper frame **22** (FIG. 2) which is affixed to the central frame **23** by means of the angle sections **24**. This stripper support frame is typically made of steel angle and channel sections welded together. It is affixed to and thereby supports the stripper grid by means of the non-magnetic grid support pins **26** affixed to the grid support bars **16** and **17**, and by the non-magnetic hangers **28** affixed to the upper frame **22** and to the grid perimeter frame side members **13** and end members **14**. By means of these pins and hangers, the stripper grid is affixed to the central stripper support frame **23**.

In the illustrated embodiment of the invention, for a magnet assembly approximately 51 inches long by 45 inches wide, the magnets may be provided in three rows **29**, **31** and **32**, only the pole pieces of the magnets in each of these rows being visible in the bottom view of the device of FIG. 1. The construction of the magnet rows is substantially identical and can be better appreciated from the sectional views of FIGS. 3 and 4. As illustrated in FIG. 3, the magnet row **32** includes a pole piece **33** and a pole piece **34** with four sheet strips of permanent magnet material **36**, **37**, **38** and **39** sandwiched therebetween.

As indicated in FIG. 4, pole piece 34 is an elongated rectangular plate of ferromagnetic material, excellent results being achieved with cold rolled steel ⅛ inch thick. Pole piece 33, as well as the other pole pieces of the three rows are like pole piece 34. The magnet sheets may be ¼ inch thick elongated solid strips of a molded material incorporating an oriented barium ferrite suspended in a thermoplastic binder. These dimensions are provided for purposes of example. Each of these sheets has a north and a south pole face, as indicated in FIG. 3, and the sheets are stacked so that the north pole face of one abuts the south pole face of the other. This stack of sheets provides a magnet 35 and the pole piece 33, being in abutment with the north pole face of sheet 36 becomes a north pole piece and the pole piece 34 being in abutment with the south pole face of magnet 39 becomes a south pole piece. This completes one magnet unit. With materials of the above dimensions the pole pieces are disposed on 1⅛ inch centers. The next magnet in the row, designated generally by reference numeral 41 has pole piece 34 for its south pole piece and pole piece 42 for its north pole piece. This magnet includes the individual strip magnets 43, 44, 46 and 47 with their pole faces oriented as shown so that the pole piece 34 sandwiched between magnets 35 and 41 abutingly engages south pole faces of these magnets. So it is seen that the second magnet unit in row 32 shares pole piece 34 with the first magnet unit.

All of the magnets in row 32 are tied together by three horizontal tie rods 48 of non-magnetic material (such as 300 series stainless steel for example) extending from one end pole piece 33 to the pole piece at the opposite end of the row. A nut such as 49 is secured to each end of the rod at the opposite end pole pieces. The lower edges of the pole pieces are ground in an assembly so that they are precisely coplanar in the plane 51 hereafter referred to as the "magnet plane."

The magnet row 29 is constructed in a manner identical to the construction of magnet row 32 and so is magnet row 31. However in the case of magnet row 31, the magnets are arranged so that the pole piece 52 adjacent to and coplanar with pole piece 33, is a south pole piece. Pole piece 53 next adjacent pole piece 52 in row 31 is a north pole piece and the polarity of successive pole pieces thus alternates in this row. The pole piece at the opposite end of this row is a south pole piece, whereas the pole pieces at the opposite ends of rows 29 and 32 are north pole pieces. In this way, there is an active flux path provided across the gap between the pole piece of each row and the coplanar pole piece of the adjacent row. The gaps between rows accommodate the grid support bars 16 or 17. In other words, there is a magnetic flux path available between the pole piece 33 and the coplanar pole piece 52 of the next adjacent row 31. This assures that a can bridging the gap between rows will nevertheless be secured to the magnet assembly, and usually the space between facing ends of pole pieces of adjacent rows such as the end 54 of pole piece 33 and the end 56 of pole piece 52 is less than 1 inch.

Each row of magnets is mounted to the magnet frame 57 of FIG. 5, which is a welded assembly of aluminum angle sections. The manner of attachment of the magnet assemblies will now be described. Each row of magnets, secured together by tie rods 48 has an epoxy cement applied to the upper surface thereof in a layer 58, and a sheet of tempered hardboard 59 is placed on top of this, the hardboard sheet being of length and width corresponding to that of the magnet frame 57. Then additional epoxy material may be placed under the various side and end members and cross members of the magnet frame, such as end members 61 and 62, side members 63 and 64, members 65 and 66 and members 68. Then at suitable places, a flat headed screw 71 (FIG. 3) of non-magnetic material is passed up through the magnet material and through the horizontally extending flange of one of the angle sections of the magnet frame such

as angle section 61 in FIGS. 3 and 5 and secured by a nut 72. To provide a good bearing surface on the lower edges of the magnet sheets, a bearing plate 73 of non-magnetic material 1/16 inch thick, for example, may be provided as shown in FIG. 3. These screws 71 are provided in whatever number and location are desired to secure the magnets to the magnet frame, and then the assembly is baked to set the epoxy. Several possible screw locations are shown in FIG. 5, for example. When completed, the lower edges of the pole pieces are coplanar in plane 51, as described above.

To provide support for the magnet assembly, four upstanding posts 76 are affixed to the magnet frame, and at the upper end of each of these posts is a cam follower needle bearing 77 having a horizontal axis of rotation. Each of these needle bearings is received in a notch in one or the other of two identical cam bars 78 and 79.

The form of the notches is such that each provides a pocket for one of the needle bearings 77 which rests at the bottom of the pocket. These cam bars have cross members 80 affixed to the ends thereof to form a cam frame. Each of the cam bars has a pair of horizontally extending slots 81 and 82 receiving cam follower needle bearing 83 and 84 mounted on horizontal shafts affixed to the central frame members 86, by which the cam bars are supported to the stripper central support frame.

Supported as it is on the cam frame support needle bearings such as 83 and 84, the cam frame can be moved horizontally in the direction of the arrow 87 with respect to the stripper frame, and then back again in the direction of the arrow 88, with the central frame members 86 not only supporting the cam frame through the needle bearings, but also serving as guides for the cam bars by reason of the closely spaced facing vertical surfaces between the members 86 and the cam bars. The possible extent of horizontal motion is determined by the length of the slots 81 and 82 in the cam bars. During movement of the cam frame in this manner, if horizontal movement of the magnet frame (and therefore the posts or lower cam hangers 76 thereof) is prevented, the ramps 89 of the notches receiving the cam follower needle bearings 77 will cause these needle bearings to be lifted, thereby lifting the magnet frame and magnets. Usually a 15 degree slope is provided on these ramps. As the cam frame is returned in the direction of the arrow 88, the cam follower needle bearings 77 descend the slopes to again lower the magnet frame and magnet assembly.

In order to drive the cam frame in this direction, a reversible electric motor 91 mounted to the central frame and which may include a magnetic clutch, drives a transmission unit 92 by means of the drive chains 93 and 94. The transmission unit may include a recirculating ball drive nut on a lead screw 96 which converts the rotary motion derived from the motor 91 to linear motion of the lead screw 96 affixed to one cross member 80 of the cam frame. In this manner the cam frame may be moved back and forth in the direction of the arrows 87 and 88.

To prevent the cam frame from causing the magnet assembly to move horizontally, as it rises vertical guide means are provided such as the guide members 97 and 98 shown in FIGS. 4 and 5, and affixed to the upper stripper outer frame and having the vertically extending guide slots 99 therein. These slots receive the vertical guide cam follower needle bearings 101 mounted to the upstanding posts 102 affixed to the magnet frame. If it is desired to control the amount of rise of the magnet frame by employing limit switches, such limit switches 103 may be mounted to the member 97 operated by the projecting portion of the cam follower needle bearing 101 when it contacts the operating member 104 of the limit switch. This limit switch can be connected to suitable control circuitry in the control box 105 connected to the motor 91 for deenergizing the motor and terminating the drive of the cam frame in the direction of the arrow 87, at the desired time. Limit switch 107 can be used if desired to ter-

minate drive of the motor in the opposite direction when the magnet supporting cam follower needle bearings **77** have moved to the bottom of their respective notches in the cam frame when the magnet is lowered.

As an example, referring to FIG. 3, a very acceptable unit is obtained when the spacing between adjacent pole pieces (inter-pole spacing dimension A) is 1 inch, the pole piece thickness (dimension B) is ⅛ inch. With this combination, the width of the aluminum or stainless steel stripper grid face bars (dimension C) is ¾ inch and their height (dimension D) is about 3/16 inch. The overall height of the pole pieces (dimension E) is 1⅝ inches and the height of the magnets (dimension G) is 1¼ inches. The magnet plane **51**, when the magnets are in their lowermost position (cam follower bearing at the bottom of the notches), is approximately 1/16 inch below the stripper grid face **21**. From this position, when the cam frame is moved in the direction of the arrow **87**, the magnet plane **51** may be moved upwardly to the extent permitted by the length of the slots **81** and **82** and by the rise of the slope **89**, factors which can be selected, as desired, and a distance of 1 inch to 1¼ inch has been found quite effective. Thus the location of the upper limit switch can be such as to turn off the motor when the cam frame has lifted the magnet assembly 1¼ inch from its initial position.

By thus employing downwardly extended poles on the magnets and recessing the grid face bars in the spaces between the extended poles, the poles can come directly in contact with the uppermost top surface of the can (whether it be the lid or the rim) to achieve the maximum possible holding effect.

Because the cam follower bearing **77** are in pockets, and not confined from above, the magnet assembly can tip slightly when the pole pieces contact can tops if they happen to be in a plane at a slight angle to the plane of the gride face, as the head is lowered to contact and pick up the cans.

Throughout the description to this point, the cam followers have been referred to as needle bearings. However other types of cam followers may also be employed, if desired. By reason of the close spacing of the poles of alternate polarities, the magnetic fields can be made strong, but shallow, such as ⅜ inch (dimension F in FIG. 3), so that jumping of the cans vertically or horizontally can be minimized even for small sizes of cans such as can **108** (FIG. 1), so that the pattern thereof on a pallet is not disturbed during handling.

A typical installation of the above described can head is illustrated in the elevational view of FIG. 6 wherein a can handling machine **109** mounted on the floor **111** includes a central post **112** having outwardly extending arms **113** thereon to which the can heads **114** are affixed by means of the four bolts **116** received in ears **117** and secured by nuts **118**. As indicated in FIG. 2, these bolts **116** are welded to the central stripper frame.

The can handling machine is capable of lifting and turning on it post **112** to move loads of cans **119**, for example, from conveyor **121** to conveyor **122**, or between pallets or otherwise, as desired.

As illustrated in FIG. 6, the frames of the can heads are covered from the perimeter frame up to the upper frame and across the top by a sheet aluminum housing to provide a neat appearing unit. A portion of the sheet aluminum cover is shown at **123** in FIG. 2.

FIG. 7 shows another embodiment of a magnetic head **115** mounted to the ram **126** of a punch press **127**. In this embodiment, a tool **128** mounted in a ferromagnetic block **129** is mounted to the head by the magnetic attraction. Other tools for other purposes can also be mounted to the head in the same way thus providing a convenient means for changing tools for a variety of low volume press operations. In the press of FIG. 7, the ram **126** is driven bp the motor **131** and gearing **132** downwardly toward the die-block **133** secured to a die-shoe **134** which is, in turn, secured to the bolster **136** on the base **137**. Thus the press arrangement is conventional except for the fact that the tool is mounted thereto by the magnetic head **115**. Tools for punching, forming, creasing, cutting, and other light press operations can be conveniently mounted in this way by means of the present invention.

The particular construction of the magnetic head for this purpose is better shown in FIGS. 8 and 9 where the magnet frame **141** is a welded construction of angle and channel sections and has a central rectangular mounting frame **142** tapped at **143** for mounting to the ram of the press. The active magnet portion of the magnetic head includes a horizontally stacked assembly of pole pieces **144** and magnet strips **146**, with adjacent pole pieces being of opposite magnetic polarity and alternate pole pieces being of the same polarity, as indicated in FIG. 9. The pole pieces and magnet material may be of the same materials described with reference to the first embodiment of the invention, and are held together in a horizontally extending stack by tie bolts or screws **147** extending from the plate **148** at one end of the unit to an identical plate at the other end of the unit. The stacked array of pole pieces and magnets is secured to the magnet frame by the angle sections **149**, the horizontally extending flanges of which extend under the ends of the magnets and pole pieces and the vertically extending flanges of which are welded to angle sections such as **151** of the magnet frame. The board **152** disposed between the magnet frame and the assembly of magnets and pole pieces is provided throughout the area of the assembly as with the previously described embodiment. For convenience of assembly, the pole pieces may extend downwardly somewhat from the magnets, this being exaggerated in FIG. 9, but they may be flush, if desired.

While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, as other modifications may readily suggest themselves to persons skilled in this art and within the broad scope of the invention, reference being had to the appended claims.

What is claimed is:

1. A material handling device comprising:

a rigid stripper grid including a plurality of parallel horizontally spaced elongated face bars of non-magnetic material of rectangular cross section,

and said stripper grid including a plurality of horizontally spaced support bars on top of said face bars and transverse thereto, said support bars being of non-magnetic material and affixed to said face bars to complete a rectangular stripper grid, each of said face bars having throughout its length a flat lower face, all of said flat lower faces being disposed in a first horizontal plane;

a rigid stripper frame disposed above said stripper grid and including a generally rectangular central stripper frame portion connected to said central frame portion and having a grid perimeter frame portion, said central frame and upper frame portions having hangers affixed thereto and depending therefrom and affixed to said support bars and to said perimeter frame portion to rigidly attach said stripper grid to said stripper frame;

a magnet assembly mounted above said stripper grid and below said central and upper stripper frame portions, said magnet assembly including rows of magnet units, each row including a plurality of flat ferromagnetic plates disposed in vertical planes with the lower marginal edges thereof disposed in a second horizontal plane, said plates providing pole pieces and extending down through the spaces between said grid face bars and grid connector bars, said pole pieces being movable vertically in said spaces between the grid face bars and grid connector bars to move said second horizontal plane up and down with respect to said first horizontal plane,

each row of said magnet assembly further including a

plurality of horizontally stacked elongated sheets of magnetic material, each of said sheets having a north-pole face and a south-pole face in parallel vertical planes and arranged so that the south-pole face of one sheet is in contact with the north-pole face of the next adjacent sheet, each said magnet unit including a stack of said sheets above one of said grid face bars and sandwiched between two parallel horizontally spaced pole pieces in such manner that the outermost faces of each stack are of opposite magnetic polarity, each magnet unit of a row sharing a pole piece with the next adjacent magnet unit of the row, and the outermost faces of two stacks in contact with a single pole piece being of the same polarity so that alternate pole pieces in a row are of the same polarity, and each pole piece of one row being coplanar with a pole piece of opposite polarity in the next adjacent row, and the magnetic fields between the pole pieces being selected to provide control of field depth, to produce a negligible value of field depth at distance below said second horizontal plane greater than 3/8 inch, when desired, each row of magnets including tie rods extending through said magnet sheets and pole pieces of the row, holding the sandwiched relation between the pole pieces and magnet sheets;

said magnet assembly including a rigid magnet frame of non-magnetic material above said rows of magnet units, and a rigid face board between said rows and said frame; said magnet assembly including non-magnetic bolts passing vertically through said magnets and said frame and affixing said rows of magnet units to said magnet frame; and said magnet assembly including four upstanding hanger posts affixed to said magnet frame, each of said posts having low friction cam followers projecting horizontally therefrom, said followers having parallel rotational axes;

a cam frame having four horizontally extending slots therein received on bearings mounted on said stripper central frame portion whereby said cam frame is provided with vertical support and enabled to move horizontally, guided by said central stripper frame and supported by said bearings for low friction linear movement, said cam frame including four notches in upper edges thereof, said notches having slopes inclined in the same direction at 15 degrees from horizontal, said notches receiving said cam followers mounted to said upstanding posts of said magnet assembly, said cam followers being in a fixed position relative to said second plane and, when resting in the bottom of said notches, supporting said second plane defined by the lower edges of said pole pieces below said first plane defined by the lower faces of said grid face bars, whereby ferromagnetic pieces suspended by the handling device directly contact said pole pieces;

said magnet assembly and stripper frame having vertical guide means thereon cooperating to permit relative vertical movement between said magnet assembly and said stripper grid and prevent relative horizontal movement therebetween, said cam frame being thereby employed to vertically support the magnet assembly and being operable when moved horizontally to raise said magnet assembly with respect to said stripper grid face bars to raise the flux field with respect to said first plane and reduce the holding power thereof with respect to ferromagnetic pieces coming in contact with the lower face of said stripper grid face bars;

a reversible electric motor affixed to said central stripper frame portion;

a rotary-to-linear motion transmission means coupling said motor to said cam frame, whereby said motor is operable, when energized, to move said cam frame horizontally, said motor being reversible to enable bi-directional operation of said cam frame to selectively raise and lower the magnet assembly for stripping material suspended by the magnet assembly from the pole pieces.

2. A material handling device comprising:

a rigid stripper grid including a plurality of parallel horizontally spaced elongated face bars of non-magnetic material,

and said stripper grid including a plurality of horizontally spaced support bars on top of said face bars and transverse thereto, said support bars being of non-magnetic material and affixed to said face bars to complete a rectangular stripper grid, each of said face bars having throughout its length flat lower face with the lower faces of said face bars being disposed in a first horizontal plane;

a rigid stripper frame disposed above said stripper grid and including a generally rectangular central stripper frame portion, and a rectangular upper stripper frame portion affixed to said central frame portion, and having a grid perimeter frame portion, said central frame and upper frame portions having hangers affixed thereto and depending therefrom and affixed to said support bars, and to said perimeter frame portion to rigidly attach said stripper grid to said stripper frame;

a magnet assembly mounted above said stripper grid and below said central and upper stripper frame portions, said magnet assembly including rows of magnet units, each row including plurality of flat ferromagnetic plates disposed in vertical planes with the lower marginal edges thereof disposed in a second horizontal plane, said plates providing pole pieces and extending down through the spaces between said grid face bars and grid connector bars, said pole pieces being movable vertically in said spaces between the grid face bars and grid support bars to move said second horizontal plane up and down with respect to said first horizontal plane,

each row of said magnet assembly further including a plurality of horizontally stacked sheets of permanent magnet material, each of said sheets having a north-pole face and a south-pole face in vertical planes and arranged so that the south-pole face of one sheet is in contact with the north-pole face of the next adjacent sheet, each said magnet unit including a stack of said sheets above a portion of one of said grid face bars and sandwiched between two parallel horizontally spaced pole pieces in such manner that the outermost faces of each stack are of opposite magnetic polarity whereby said pole pieces provide horizontally spaced magnetic poles extending below the magnets, alternate spaced poles in a row being of the same polarity, and each pole piece of one row being of polarity opposite that of the pole piece nearest thereto in the next row, the maximum distance between any two adjacent pole pieces in a row and between one row and the next row being minimized and the magnetic fields between the pole pieces being such that the flux pattern formed thereby has a negligible strength at distances below said second horizontal plane greater than a predetermined maximum, each row of magnet units including tie rods extending through the magnet sheets and pole pieces and holding the sandwiched relation between pole pieces and magnet sheets;

and said magnet assembly including a rigid magnet frame of non-magnetic material above said rows, with said rows being affixed thereto;

said magnet assembly including four upstanding hanger posts affixed to said magnet frame, each of said posts having a cam follower bearing projecting horizontally therefrom, said bearings having parallel axes;

a cam frame having four horizontally extending slots therein received on bearings mounted on said stripper central frame portion whereby said cam frame is provided with vertical support and enabled to move horizontally, guided by said central stripper frame and supported for low friction movement, said cam frame including four notches in an upper edge thereof, said notches having ramps inclined in the same direction and receiving cam follower bearings mounted to said upstanding posts of said magnet assembly, said cam follower bearings being in a fixed position relative to said second plane and, when resting in the bottoms of said notches, supporting said magnet pole pieces defining said second horizontal plane slightly below said first horizontal plane, enabling direct contact between said pole pieces and ferromagnetic pieces suspended by them;

said magnet assembly and stripper frame having vertical guide means thereon cooperating to permit relative vertical movement between said magnet assembly and stripper grid and prevent relative horizontal movement therebetween, said cam frame thereby vertically supporting the magnet assembly and being operable, when moved horizontally, to raise said magnet assembly with respect to said stripper grid face bars to raise the magnetic field thereof with respect to said first plane;

and reversible drive means connected to said stripper frame portion and to said cam frame and operable, when energized, to move said cam frame horizontally to enable bi-directional operation of said cam frame to selectively raise and lower the magnet assembly for stripping material suspended by the magnet assembly from said pole pieces.

3. A material handling device comprising:

a rigid stripper grid including a plurality of parallel horizontally spaced non-magnetic elongated face bars and a plurality of horizontally spaced non-magnetic support bars affixed on top of said face bars and transverse thereto, the face bars thereof having lower margins defining a first plane;

a rigid stripper frame spaced above said stripper grid and affixed thereto and having mounting means thereon adapted to attachment to a material handling machine;

a magnet assembly mounted above said stripper grid and below said stripper frame, said magnet assembly including a plurality of flat ferromagnetic plates disposed in horizontally spaced vertical planes with the lower marginal edges thereof disposed in a second horizontal plane, said plates providing pole pieces and extending down through the spaces between said grid face bars and grid support bars, said pole pieces being movable vertically in said spaces between the grid face bars and grid support bars to move said second horizontal plane up and down with respect to said first horizontal plane;

said magnet assembly further including a plurality of magnets each having a north-pole face and a south-pole face in vertical planes and arranged so that the south-pole faces of two of the magnets are in contact with one of said pole pieces sandwiched therebetween and the north-pole faces of two of the magnets are in contact with another of said pole pieces sandwiched therebetween, the magnets being arranged so that alternate horizontally spaced pole pieces are of the same polarity and successive horizontally spaced pole pieces are of opposite magnet polarity, the maximum distance between any two adjacent pole pieces being minimized and the magnetic fields between the pole pieces being such that the flux pattern formed thereby is shallow;

the magnet assembly means holding a tightly sandwiched relation between pole pieces and magnets;

said magnet assembly further including a rigid magnet frame above said magnets and affixed thereto;

and said magnet assembly including hanger means including cam followers;

a cam frame being received on bearings mounted on said stripper frame, whereby said cam frame is supported and enabled to move horizontally, guided by said stripper frame and supported thereby for low friction movement, said cam frame including upwardly facing pockets receiving and supporting said cam followers whereby said magnet assembly is supported, said pockets having upwardly facing and upwardly inclined cam surfaces therein;

the vertical distance of said cam followers from said second plane being fixed and the vertical distance of the bottoms of said pockets from said first plane being fixed so that when said followers are resting in the bottoms of said pockets, said second plane is slightly below said first plane, said followers being freely movable upwardly from the bottoms of said pockets to accommodate non-parallelism of said first and second planes;

said magnet assembly and stripper frame having vertical guide means thereon cooperating to permit relative vertical movement between said magnet assembly and stripper grid and limit relative horizontal movement therebetween, said cam frame thereby supporting the magnet assembly and being operable, when moved horizontally to raise said magnet assembly with respect to said stripper grid face bars to raise the magnetic field thereof with respect to said first plane;

reversible drive means connected to said stripper frame and to said cam frame and operable, when energized, to move said cam frame horizontally to provide bi-directional operation of said frame to selectively raise and lower the magnet assembly for stripping material suspended by the magnet assembly from said pole pieces.

4. A material handling device comprising:

a rigid stripper grid including a plurality of horizontally spaced elongated face bars and a plurality of horizontally spaced support bars affixed thereto, said face bars having lower surfaces defining a first plane;

a rigid stripper frame spaced above said stripper grid and affixed thereto and having mounting means thereon for attachment to a material handling machine;

a magnet assembly mounted above said stripper grid and below said stripper frame and having a plurality of magnets above said grid, said magnets having pole pieces thereof extending below the magnets and down through the spaces between said grid face bars and grid support bars, lower margins of said pole pieces defining a second horizontal plane, said pole pieces being movable vertically in said spaces between the grid face bars and grid support bars to move said second horizontal plane up and down with respect to said first horizontal plane,

successive pole pieces being of alternate magnetic polarity, and the distance between any two adjacent pole pieces being minimized;

said magnet assembly including hanger means with cam followers thereon;

cam means mounted on said stripper frame and movable thereon and supported thereby for low friction movement, said cam means receiving and supporting said cam followers whereby said magnet assembly is supported, said cam means thereby normally supporting said second plane slightly below said first plane, said follower means being movable upwardly relative to said cam means permitting support of said second plane from below said grid at an angle with respect to said first plane;

said cam means being operable when activated to raise said magnet assembly with respect to said stripper

face bars to raise the magnetic field thereof with respect to said first plane;

and drive means connected to said stripper frame and to said cam means and operable, when energized, to activate said cam means to raise the magnet assembly for stripping material suspended by the magnet assembly from said pole pieces.

5. In a magnet assembly, the combination comprising:

a plurality of magnet units of permanent magnet material incorporating oriented ferrite suspended in a thermoplastic binder, each of said units having a north-pole face and a south-pole face in vertical planes;

a plurality of horizontally spaced ferromagnetic pole pieces, each pole piece being sandwiched between two of said magnet pole faces of like magnetic polarity, alternate pole pieces thereby being of the same polarity;

a rigid ferromagnetic magnet frame above said units and affixed thereto;

and a thin non-magnetic board sandwiched between

said frame and said units, preventing loss of magnetic flux from said magnet units.

References Cited

UNITED STATES PATENTS

1,331,030	2/1920	Ryan	279—1
2,228,195	1/1941	Blood	279—1
2,343,697	3/1944	Opie	83—916 X
2,404,710	7/1946	Hitchcock	317—159
2,466,693	4/1949	Fischer	214—309
2,912,249	11/1959	Eckold	279—1
2,954,257	9/1960	Besuch et al.	294—65.5
3,163,596	12/1964	Ferris et al.	317—201
3,198,566	8/1965	Floros et al.	294—65.5
3,231,789	1/1966	Engelsted	317—159
3,257,586	6/1966	Steingroever	335—303
3,300,065	1/1967	Witmer	214—6

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