PERMANENT MAGNET LIFTING DEVICE

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This invention relates to devices for lifting materials and, more particularly, to such devices incorporating permanent magnet means for use in the lifting of magnetizable metals.

There have in the past been developed various devices of the permanent magnet type for lifting metallic metals. One of the primary difficulties encountered in the provision of a permanent magnetic lifting device is concerned with the manner in which the device is rendered inoperative so as to effect the release of work being held by the device.

Accordingly, it is the primary object of this invention to provide a permanent magnet lifting device of the permanent magnet type having novel and improved means for conditioning the device in on and off conditions corresponding respectively to the holding and releasing of magnetizable material by the device.

It is another object to provide a novel and improved permanent magnet lifting device of the type described having a novel and improved construction and arrangement of elements which will provide a more compact and economical structure.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features, combination of elements and arrangement of parts which will be exemplified in the construction hereinafter set forth and the scope of the application of which will be indicated in the appended claims.

In the drawings:

FIG. 1 is a cross sectional view of a permanent magnet lifting device constructed in accordance with the present invention, the operative elements of the device being positioned to place the device in work holding condition;

FIG. 2 is a fragmentary cross sectional view of the device of FIG. 1 with one of the operative elements in an intermediate position corresponding to an intermediate condition of the device between its work holding and work releasing condition;

FIG. 3 is a fragmentary cross sectional view of the device of FIG. 1 with the operative elements in the position corresponding to a work releasing condition of the device;

FIG. 4 is a fragmentary cross sectional view of a modification of the embodiment of FIGS. 1 to 3:

FIG. 5 is a cross sectional view of an alternative embodiment of the invention;

FIG. 6 is a fragmentary cross sectional view of a further alternative embodiment of the invention;

FIG. 7 is an enlarged cross sectional view of a modified form of a portion of the device of FIG. 6;

FIG. 8 is an enlarged cross sectional view of another modified form of a portion of the device of FIG. 6;

FIG. 9 is a cross sectional view of another alternative form of the embodiment of the invention;

FIG. 10 is a cross sectional view of another alternative embodiment of the invention; and

FIG. 11 is a cross sectional view of a further alternative embodiment of the invention.

With reference to FIGS. 1 and 3 of the drawings, a preferred embodiment of a permanent magnet lifting device constructed in accordance with this invention comprises a housing or frame 10 including a pair of rectangular plate-like side walls 12 fabricated of ferromagnetic material and spaced apart end walls 14, only one of which is shown, fabricated of non-ferromagnetic material. The side walls and end walls cooperate to form a generally rectangular enclosure. A ferromagnetic top plate 16 extends across and is fixed to the top of the enclosure formed by the side walls and end walls. The lower end surfaces of the side walls form spaced apart parallel pole faces 18 and 19 extending longitudinally of the housing. The lower open end of the enclosure formed by the side and end walls is closed by a non-ferromagnetic member 20 extending between the side and end walls and mounted on the end walls. An elongated rectangular plate-like flux conductive member 22 of ferromagnetic material is suitably supported by the end walls, such as by bolting, and is received within the non-ferromagnetic member 20. The flux conductive member 22 extends parallel to the side walls 12 and centrally of the non-ferromagnetic member 20 so as to be spaced from and between the side walls 12. The lower surface of the flux conductive member 22 forms a pole face 24 facing in the same direction as the pole faces 18 and 19 but spaced laterally therefrom. It is provided that the area of the center pole face 24 be substantially equal to the combined areas of the side pole faces 18 and 19. As can be seen from the drawing, the pole faces 18, 19 and 22 as well as the outwardly facing surface of the non-ferromagnetic member 20 separating the pole faces are disposed in coplanar relationship so as to form a working supporting surface which is engangeable with work to be held by the device. While the working supporting surface of the device is shown as lying in a flat plane, it will, of course, be apparent that if desired the working supporting surface might be otherwise configured—for example, curved.

The inner end of the flux conductive member 22 provides a surface 26 which is cooperable in flux conductive relation with the end surface 28 of a flux conducting member 30. The member 30 is movable at right angles toward and away from the working contacting surface of the device so as to move the surface 28 in and out of engagement. The flux conducting member 30 includes a non-ferromagnetic projection 32 extending upwardly through the top plate 16 and engageable at its upper end with a crank member 34 journaled on the frame 10. The crank 34 is provided with a wrench engageable portion 36 for the manual rotation of the crank member and attendant movement of the conducting member 30 relative to the frame. A lifting eye 38 is also provided on the frame for attachment to a cable or the like for raising and lowering the device and work held thereby.

Also located within the enclosure formed by the side and end walls of the frame are a plurality of permanent magnets 40 disposed on opposite sides of the flux conducting member 30 and between the flux conducting member and the side walls 12. As can be seen from FIGS. 1 to 3, the magnets 40 are polarized in a direction extending parallel to the work contacting surface of the device or, in other words, at right angles to the direction of movement of the flux conducting member 30. It has been found that rectangular plate-like permanent magnets of the ceramic type which are polarized across a minor transverse dimension thereof are particularly suitable for use in devices of this invention. However, it is of course understood that the invention is not limited to the use of such magnets. However, where ceramic magnets are used, as in the embodiment of FIGS. 1 to 3, it is preferred that the magnets be provided with pole pieces 41 and 42, of ferromagnetic metal, in order to protect the ends of the magnets. The pole
3 pieces 41 are slidably engaged with the side walls 12, while the pole pieces 42 are slidably engaged with the flux conducting member 30. According to a magnetic standpoint, the pole pieces 41 and 42 are integral parts of the magnets 49. In accordance with the invention, the flux conducting member 30 and magnets 49 are drivenly connected by a lost-motion connection comprising a pin 44 extending laterally of the flux conducting member and perpendicular to its direction of movement. The ends of the pin extend outwardly of the flux conducting member 30 and are received within elongated recesses 46 in the poles 42. The recesses 46 extend in the direction of movement of the flux conducting member 30 and are of a length greater than the diameter of the pin 44 as to permit the lost motion desired.

The operation of the embodiment of FIGS. 1 to 3 will now be described. In FIG. 1 the device is in a work holding condition, in which condition of the device the magnets 40 are bottomed on the upper or inward facing surface of the non-ferromagnetic member 20 and the surfaces 26 and 28 are in engagement. Accordingly, there will be a flux field provided through the magnets 40 to the side walls 12, through the side walls to the pole faces 18 and 19, from the pole faces 18 and 19 to the central pole face 22 and through the flux conducting member 24 and flux conducting member 23 to the pole piece 42. As will be apparent from FIG. 1, this flux field extends in part beyond the work contacting surface of the device so that ferromagnetic material engaged with said work contacting surface will be held thereon by the flux field. When it is desired to release work held by the device, the crank member 34 is rotated to lift the flux conducting member. The initial movement of the flux conducting member 30 away from the work contacting surface will, as can be seen from FIG. 2, result in disengagement of the cooperating surfaces 26 and 28 on the flux conducting member 24 and flux conducting member 23, and can be seen from the drawings, it is preferred that the portion of the cooperating surface 26 which is engageable by the surface 28 on the flux conducting member be substantially larger in area than the pole face 24. This increase in surface area of the cooperating surfaces 26 and 28 as compared to the pole face 24 results in a reduction in the force necessary to separate these surfaces as compared to the situation where the cooperating surfaces 26 and 28 are of the same area as the pole face 24.

After the flux conducting member 30 has been moved away from the work supporting surface a distance sufficient to engage the pin 44 with the pole piece 42, the force necessary to slide the magnets along the side walls 12 will also be substantially reduced. When the flux conducting member has been raised sufficiently, it will, as can be seen in FIG. 3, engage the top plate 16 which will then act as a shunting member with respect to the magnetic flux from the magnets 49, thus further reducing, if not substantially eliminating, the flux field extending beyond the work contacting surface of the device. Accordingly, any work engaged with the work supporting surface will be released. As the flux conducting member approaches the shunting member or plate member 16, the magnets 40 will, of course, also be brought into close adjacent relationship with the shunting member. Accordingly, the magnets 40 may move upwardly relative to the flux conducting member 30 and toward engagement with the shunting member 16. In order to prevent engagement of the magnets with the shunting member, pins or stop members 48 of non-ferromagnetic material are mounted on the pole pieces 42 to insure spacing of the magnets from the shunting member 16 in the work releasing position of FIG. 3. The spacing of either the magnets or the flux conducting member needed for the engagement of the magnetic elements of the device are in work releasing position is desired in order that the magnetic circuit completed through the shunting member 16 will not be excessively strong so as to require excessive force for separation of the elements during shifting of the device to work holding position.

The permanent magnet lifting device shown in FIG. 4 is generally similar to the embodiment of FIG. 1, and accordingly like members will be identified by like reference numerals. As in the embodiment of FIGS. 1 to 3, the embodiment of FIG. 4 comprises a frame or housing 10 including ferromagnetic side walls 12 and non-ferromagnetic end walls 14, with the lower end surfaces of the side walls forming parallel elongated pole faces 18 and 19 lying in coplanar relationship with the outwardly facing surface of the non-ferromagnetic member 20. Also included is the elongated flux conducting member 22 forming the elongated pole face 24 on the work contacting surface of the device. Mounted within the enclosure formed by the end walls and side walls is the flux conducting member 30 which is movable at right angles to the work contacting surface of the device and which is movable into and out of engagement with the flux conducting member 22. However, as shown in FIG. 4, the pole pieces 41 and 42 are suitably supported in fixed relation relative to the side walls 12. In the embodiment of FIG. 4, the flux conducting member 30 is provided with a non-ferromagnetic spacer or stop member 48 which is engageable with the shunting member 16 to prevent engagement between the shunting member and the flux conducting member. Accordingly, in the work releasing position of the device, the flux conducting member is maintained out of engagement with the shunt member in order to reduce the force necessary for subsequent downward movement of the flux conducting member and movable pole pieces.

The embodiment of FIG. 5 is similar to the embodiment of FIG. 1 in that it comprises a housing 10 including ferromagnetic side walls 12 and non-ferromagnetic end walls 14 and a top plate or shunting member 16. Also in this embodiment of the invention the lower ends of the side walls 12 form parallel spaced apart elongated pole faces 18 and 19 lying in the same plane as the pole face 24 and outer surface of the non-ferromagnetic member 20 separating the pole faces. This embodiment also includes the flux conducting member 30 which is movable toward and away from the work contacting surface of the device, the crank member 34 which in the embodiment of FIG. 5 is provided with a manually operable lever 50. However, in this embodiment of the invention the magnets 40 are fixedly connected to the flux conducting member 30 so as to be drivenly connected for movement therewith and the inwardly facing poles of the magnets are directly engaged with the flux conducting member. The external surfaces of the magnets are provided with a protective shield 54 of ferromagnetic material, with the shield being slidably engaged with the inner surface of the side walls 12. In accordance with the invention, a coil compression spring 56 is engaged between flux conducting member 30 and flux conducting member 22 and urges the same in a separating direction. The spring 56 thus reduces the externally applied force necessary to separate the members 22 and 30 by biasing these members in a direction opposite the flux field caused magnetic attractive force between these members. Also, to assist in movement of the flux conducting member and magnets 40 from a work releasing to a work holding position, a spring 58 is provided between the shunt member 16 and flux conducting member 30. As should be apparent, it is within the scope of the invention to utilize springs corresponding to either the spring 56 or spring 58 in the em-
bodiments of FIGS. 1 or 4 for the same purpose as in the embodiment of FIG. 5.

The embodiment of FIG. 6 is generally similar to the embodiment of FIG. 5 with the exception that the magnets 40 are provided with outer pole pieces 41 which are slidably engageable with the inner surfaces of the side walls 12. Further, the side walls 12, instead of being fabricated entirely from ferromagnetic material, include a lower end portion 69 of ferromagnetic material, a central portion 62 of non-ferromagnetic material, and an upper portion 64 of non-ferromagnetic material. As can be seen from FIG. 6, with the device in work holding position, the pole pieces 41 will be in engagement with the lower ferromagnetic side wall portion 69 to complete the magnetic circuit between the pole faces 18 and 24. The lower ferromagnetic side wall portion 69, which is engageable by the pole piece 41 when the device is in work holding position, has a length in the direction of movement of the flux conducting member 30 which is less than the stroke of the flux conducting member. Therefore, after a predetermined upward movement of the flux conducting member and magnets, the pole pieces 42 will clear alignment of the invention similar to the embodiment that breaks the magnetic circuit linking the pole faces. Also, during upward movement of the magnets the pole pieces 41 will become slidably engaged with the upper ferromagnetic side wall portion 64 to provide a shunting of the magnets so as to complete the placing of the device into work releasing condition.

It will be observed that in the embodiments of FIGS. 4, 5 and 6 the cooperating engageable surfaces of the flux conducting member 30 and flux conducting member 22 are substantially larger than the area of the pole face 24, as in the case of the embodiment of FIG. 1. As has been mentioned, this relationship of areas reduces the force necessary to separate the flux conducting member 30 and flux conducting member 22. In FIG. 7 there is illustrated a modified form of the flux conducting member 30 and flux conducting member 22 whereby the lower end of the flux conducting member 30 is enlarged to provide a surface having an area substantially larger than the cross-sectional area of the remainder of the conducting member 30. In this manner it can be seen that the area of the cooperating surfaces of the flux conducting member 30 and flux conducting member 22 may be further enlarged without resulting in any increased overall size of the device. Another means of accomplishing the desired increase in the area of the cooperating surface of the flux conducting member 30 and flux conducting member 22 is shown in FIG. 8. In the modification of FIG. 8, the lower end of the flux conducting member 30 is provided with a cavity of conical configuration in which is engageable a complementally shaped projection on the pole face forming conducting member 22. It will, of course, be apparent that the configurations of flux conducting member 30 and flux conducting member 22 as shown in FIGS. 7 and 8 could be utilized in all embodiments of the invention herein described.

In FIG. 9 of the drawings there is shown an alternative embodiment of FIG. 5, with the exception that the magnet 40 is fixed relative to the side walls 12, and the flux conducting member 30 is slidably engaged between oppositely inwardly facing poles of the magnets for movement of the flux conducting member toward and away from the work supporting surface of the device. Also, in the embodiment of FIG. 9 a non-ferromagnetic stop member or spacer 48 is carried by the flux conducting member 30 and is engageable with the shunting member 16 to preclude engagement of the flux conducting member 30 and shunting member during upward movement of the flux conducting member. A ferromagnetic shield 54 is preferably provided between the magnets and the flux conducting member, particularly when the magnets are of the ceramic type, to provide protection of the poles of the magnets.

The embodiment of FIG. 10 is generally similar to the embodiment of FIG. 9 except that the side walls 12 are in the form of a single wall and one end of the cylinder forms an annular pole face on the work supporting surface of the device. The magnets 40 which are generally in the shape of sectors are polarized in a direction radially of the cylinder 12 and are disposed between the inner wall of the cylinder 12 and a cylindrical flux conducting member 30 extending coaxially of the cylinder 12 and movable coaxially of the cylinder 12. The member 30 is, of course, associated with a central pole face on the work supporting surface of the device. It will be apparent from FIG. 10 that any of the embodiments of FIGS. 1, 5, 6 and 9 could be arranged in the configuration of FIG. 10 rather than in a rectangular configuration.

The embodiment of FIG. 11 comprises a rectangular housing including ferromagnetic side walls 70 and non-ferromagnetic end walls 72, with the lower ends of the side walls forming parallel, spaced apart, elongated pole faces 74 and 75. A pair of non-ferromagnetic plate members 84, fixed relative to the side walls 72, are disposed between the side walls 70 and magnet 80 as to support the magnet for movement at right angles toward and away from the work contacting surface of the device and into and out of engagement with the inwardly facing surface of the flux conducting member 78. In the embodiment of FIG. 11, the magnet 80 is polarized in the direction of movement thereof, or, in other words, at right angles to the work engageable surface of the device. Adjacent the top of the magnet and mounted for movement therewith are a pair of flux conducting members or pole pieces 85 which are also slidably engageable with the side walls 72. Thus it can be seen from FIG. 11, wherein the magnet is in its lower work holding position, that the pole pieces 85 are in flux conductive relation with the magnet and connect the magnet and side walls 70 to complete the magnetic circuit providing a flux field extending between the pole faces 74 and 75. A rod 83 is connected to the top of the magnet 82 and is connected to suitable means for raising and lowering the same for provide for movement of the magnet relative to the frame.

In accordance with the invention, the side walls 70 include, at their upper ends, non-ferromagnetic portions 90 which are slidably engageable by the pole pieces 85 in response to upward movement of the magnet 82, corresponding to the spring 56 previously described, is provided to bias the magnet 82 and flux conducting member 78 in a disengaging direction. It will be apparent that as the pole pieces 85 are moved upwardly away from the work supporting surface they will engage the non-ferromagnetic portions 90 of the side walls and lock the magnetic circuit through the frame to this condition the device for release of the work.

Although the invention has been described in terms of the specific embodiments shown in the accompanying drawings, it will be apparent to those skilled in the art that various modifications and changes can be made in the structures shown and described and that the characteristic feature or features of each of the specific embodiments shown and described might be incorporated in
other of the specific embodiments without departing from the scope of the invention. Therefore, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the language in the following claims is intended to cover all of the general and specific features of the invention herein described and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

We claim as our invention:

1. A permanent magnetic work holding device comprising: a frame having a work contacting surface controllable work to be held by the device; and permanent magnetic means on the frame for providing a magnetic flux field extending in part beyond said work contacting surface and including a permanent magnet and spaced apart pole faces on said work contacting surface associated with the poles of said magnet, a flux conducting member for linking one of said pole faces with the respective associated pole of the magnet, means mounting said flux conducting member and magnet for movement toward and away from said work contacting surface and relative to each other, means connected to said flux conducting member for effecting movement of the same relative to said surface, and a lost motion driving connection between said flux conducting member and said magnet.

2. A permanent magnetic work holding device comprising: a frame having a work contacting surface engageable with work to be held by the device; and permanent magnetic means on the frame for providing a magnetic flux field extending in part beyond said work contacting surface and including a permanent magnet and spaced apart pole faces on said work contacting surface associated with the poles of said magnet, a flux conducting member for linking one of said pole faces with the respective associated pole of the magnet, means mounting said flux conducting member and magnet for movement toward and away from said work contacting surface and relative to each other, means connected to said flux conducting member for effecting movement of the same relative to said surface, a lost motion driving connection between said flux conducting member and said magnet, and a flux shunting member in flux conducting relation with another pole of said magnet and disposed in the path of movement of one of said flux conducting member and magnet during movement of the same away from said surface.

3. A permanent magnetic work holding device comprising: a frame having a work contacting surface engageable with work to be held by the device; and permanent magnetic means on the frame for providing a magnetic flux field extending in part beyond said work contacting surface and including a permanent magnet and spaced apart pole faces on said work contacting surface associated with the poles of said magnet, a flux conducting member for linking one of said pole faces with the respective associated pole of the magnet, means mounting said flux conducting member and magnet for movement toward and away from said work contacting surface and relative to each other, means connected to said flux conducting member for effecting movement of the same relative to said surface, a lost motion driving connection between said flux conducting member and said magnet, a flux conducting member for linking one of said pole faces with the respective associated pole of the magnet, means mounting said flux conducting member and magnet for movement toward and away from said work contacting surface and relative to each other, means connected to said flux conducting member for effecting movement of the same relative to said surface, a lost motion driving connection between said flux conducting member and said magnet, and a flux shunting member in flux conducting relation with another pole of said magnet and disposed in the path of movement of one of said flux conducting member and magnet during movement of the same away from said surface.

4. A permanent magnet lifting device comprising a frame having a work contacting surface for engaging work to be lifted by the device, a permanent magnet polarized in a direction generally parallel to the plane of said work contacting surface, a pair of fixed flux conductive members respectively forming a pair of pole faces on said work contacting surface respectively associated with the poles of said magnet, one fixed flux conductive member having a surface extending at right angles to said work contacting surface and in sliding engagement with one pole of said magnet, a flux conducting member in flux conducting relation with the other pole of said magnet and having a surface in flux conducting engagement with the other pole of said magnet, a flux conducting member and magnet being connected for movement together in a direction toward and away from said work contacting surface to provide for separation of said flux conducting member and said other flux conductive member, and compression spring means urging said flux conducting member and said other flux conductive member in a separating direction when these members are in engagement.

5. A permanent magnet lifting device comprising a frame having a work contacting surface for engaging work to be lifted by the device, a permanent magnet fixed to the frame for movement of the same toward and away from said work contacting surface, a pair of flux conductive members fixed on the frame and respectively forming a pair of spaced apart pole faces on said work contacting surface associated with the poles of said magnet, a flux conducting member in flux conductive relation with one of said pole faces for driving the device, and a flux shunting member in flux conducting relation with the other pole of said magnet and parallel to said surface and in the path of movement of said flux conducting member for engagement with said cooperating surface, means connected to said flux conducting member to effect movement of the same, and a flux shunting member in flux conductive relation with the other pole of said magnet and parallel to said surface and in the path of movement of said flux conducting member for engagement thereby during movement of the flux conducting member away from said one of the pole faces.

6. In a permanent magnet work holding device having a work contacting surface, permanent magnet means including a magnetic circuit for providing a magnetic flux field extending at least in part beyond the work contacting surface of the device, said magnetic circuit including a pair of relatively movable members, means for moving one of the members from a work holding position wherein it is magnetically attracted to the other of said members to a work release position wherein said flux field is at least substantially weakened as compared to the strength of the flux field when said one of the members is in said work holding position, and spring means urging said one of the members toward said work releasing position when said one of said members is in said work holding position.

7. In a permanent magnet work holding device having a work contacting surface, permanent magnet means including a magnetic circuit for providing a magnetic flux field extending at least in part beyond the work contacting surface of the device, said magnetic circuit including a flux conducting member movable between a work holding position and a work releasing position corresponding to the work holding and work releasing conditions of the device, a flux conducting member and magnet during movement of the same away from said surface, and means to prevent engagement of the other of said flux conducting member and magnet with said shunting member.

8. In a permanent magnet work holding device comprising a frame having a work contacting surface for engaging work to be lifted by the device, a permanent magnet polarized in a direction generally parallel to the plane of said work contacting surface, a pair of fixed flux conductive members respectively forming a pair of pole faces on said work contacting surface respectively associated with the poles of said magnet, one fixed flux conductive member having a surface extending at right angles to said work contacting surface and in sliding engagement with one pole of said magnet, a flux conducting member in flux conducting relation with the other pole of said magnet and having a surface in flux conducting engagement with the other pole of said magnet, a flux conducting member and magnet being connected for movement together in a direction toward and away from said work contacting surface to provide for separation of said flux conducting member and said other flux conductive member, and compression spring means urging said flux conducting member and said other flux conductive member in a separating direction when these members are in engagement.
tion when said flux conducting member is in said work releasing position.

8. A permanent magnet lifting device comprising a housing including a work contacting surface and a pair of spaced apart parallel side walls at least in part fabricated of ferromagnetic material and extending vertically from said work contacting surface, the lower ends of said side walls forming a pair of parallel elongated spaced apart pole faces on said work contacting surface, a flux conductive member forming a central third pole face on said work contacting surface extending parallel to and spaced between said pair of pole faces, a vertically arranged plate-like flux conducting member disposed within the housing in overlying engagement with said flux conducting member and side walls in flux field producing relation therewith, said magnets being polarized in a direction extending between said flux conducting member and side walls, said magnets and flux conducting member being movable vertically relative to said work supporting surface, and a lost motion driving connection between said magnets and flux conducting member.

12. In a permanent magnet lifting device, a flux conducting generally cylindrical member, means providing a work contacting surface extending across one end of said cylindrical member, the end surface of said cylindrical member providing an annular pole face on said work supporting surface, a flux conducting member disposed coaxially within said cylindrical member, means providing a central pole face on said work contacting surface including a flux conductive member engaged by one end of said flux conducting member, a plurality of permanent magnets arranged angularly about said flux conducting member in flux field producing relation with said flux conducting member and said cylindrical member, said magnets being polarized in a direction extending radially of said cylindrical member, and means to move said flux conducting member longitudinally of said cylindrical member.

13. In a permanent magnet lifting device, a frame including a pair of parallel spaced apart vertically extending side walls, means providing a work contacting surface extending across the lower ends of said side walls, the lower ends of said side walls providing a pair of spaced apart pole faces on said work contacting surface, means providing a central pole face on said work contacting surface spaced from and between said pair of pole faces including a flux conductive member fixed relative to said work contacting surface, a permanent magnet supported for vertical movement relative to said side walls and into and out of engagement with said flux conductive member, said pole piece means being slidable on said side walls, each of said side walls including a first ferromagnetic portion for magnetically connecting said pole piece means and said pair of pole faces, and a non-ferromagnetic second portion extending from the first portion in the direction of movement of said magnet and slidable engageable with said pole piece means during movement of the magnet away from said flux conductive member.

14. A permanent magnet lifting device comprising a frame including parallel spaced apart side walls and a work contacting surface extending between the side walls, each of said side walls having a lower ferromagnetic portion forming a pole face on said work contacting surface, each side wall further having a non-ferromagnetic portion extending upwardly from said lower portion and a second ferromagnetic portion extending upwardly from said non-ferromagnetic portion, means providing a central pole face on said work contacting surface spaced between the pole faces formed by the lower portion of the side walls, permanent magnet means disposed between and slidable engaged with said side walls, means for moving said magnet means toward and away from said work contacting surface over a predetermed stroke and into and out of flux conducting member, said central pole face, said magnet means being polarized in a direction extending between said side walls, lower portion of each side wall having a height less than said stroke,
said second ferromagnetic portion of each side wall being slidably engageable by said magnet means during movement of the magnet means in a vertically upward direction, and shunting means magnetically connecting the second ferromagnetic side wall portions and the pole of said magnet means corresponding to said central pole face.

15. In a permanent magnet lifting device of the type having a work contacting surface for engaging work to be lifted by the device; a permanent magnet polarized in a direction extending parallel to said surface, said surface including spaced apart pole faces respectively associated with the poles of said magnet, a flux conducting member associated with one of the pole faces and the respectively associated one of the poles of the magnet and mounted for movement generally at right angles to said surface and into and out of flux conductive relationship with said one of the pole faces, and a flux shunting member in flux conductive relation with the other pole of said magnet and disposed on the side of said magnet opposite said surface and in the path of movement of said flux conducting member, said shunting member forming a portion of the magnetic circuit only when in shunting relation between said flux conducting member and said other pole of the magnet in response to movement of said flux conducting member away from said surface.

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