July 16, 1946. S. KARASICK 2,404,072

MAGNETIC DEVICE

Filed May 19, 1943 2 Sheets-Sheet 1

Fig. 1

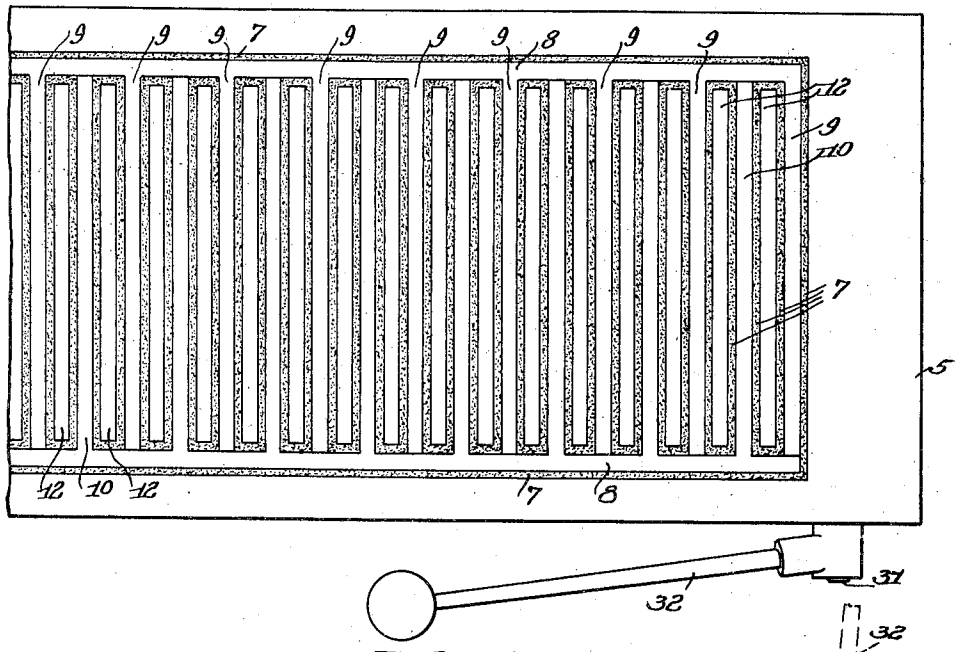


Fig. 2

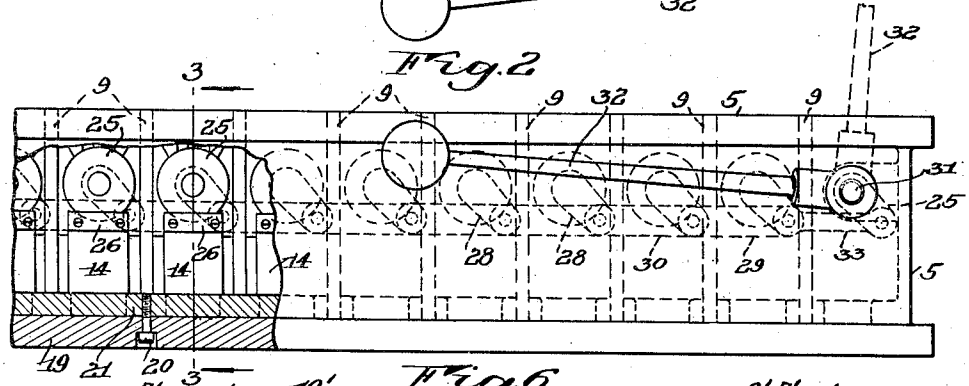
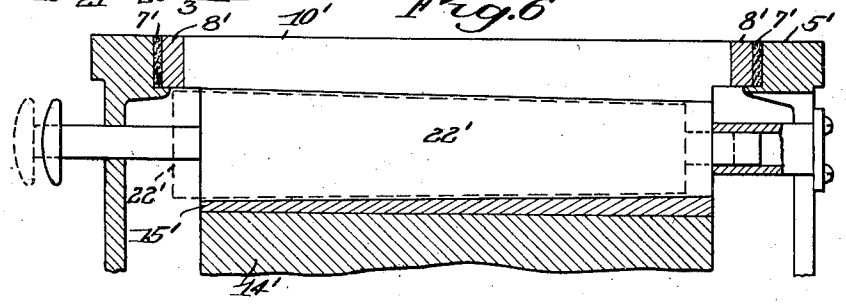


Fig. 6



INVENTOR.
Samuel Karasick

BY D. Clyde Jones
his Attorney

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Fig. 3

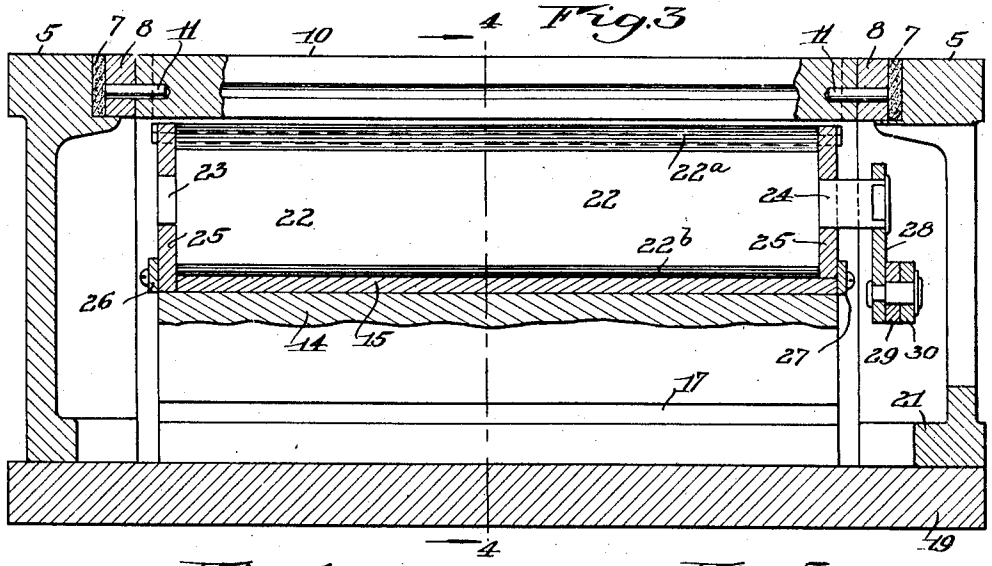


Fig. 4

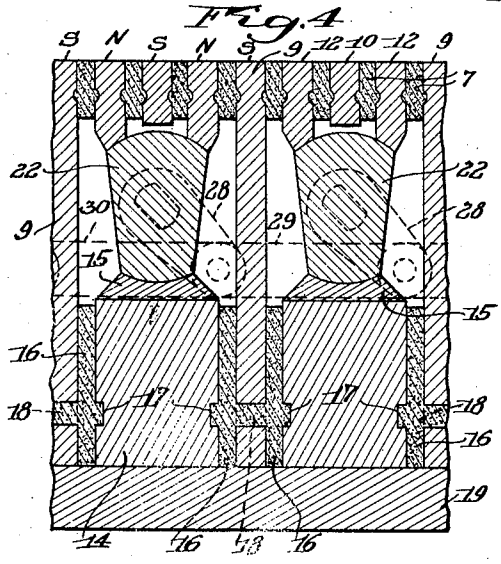


Fig. 5

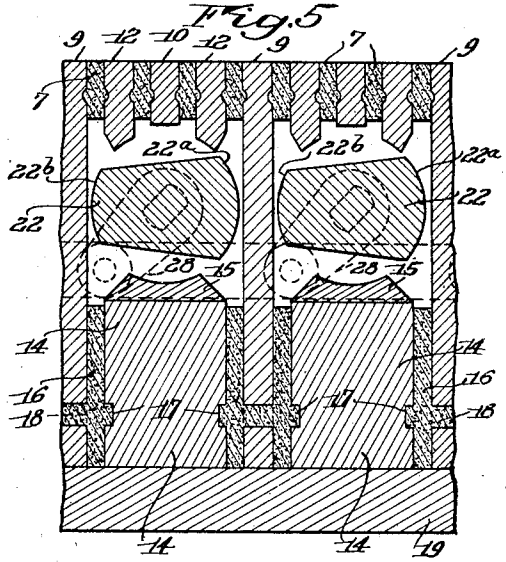
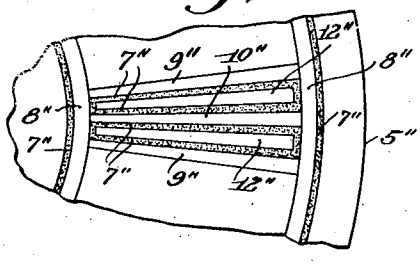


Fig. 7



INVENTOR.
Samuel Karasick
D. Clyde Jones
his Attorney

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UNITED STATES PATENT OFFICE

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MAGNETIC DEVICE

Samuel Karasick, Great Barrington, Mass.

Application May 19, 1943, Serial No. 487,838

5 Claims. (Cl. 175—367)

1

This invention relates to magnetic work-holding devices, and more particularly to magnetic chucks of the so-called permanent magnet type.

In permanent magnet chucks such as disclosed in the patent to Bower No. 2,053,177 and in the Karasick Patent No. 2,187,240, as well as in certain commercial chucks of the permanent magnet type, it is the practice to move the entire magnet assembly with respect to the work-holding table in order to deenergize the upper surface of the table. This magnet assembly has substantial weight and its lower surface must fit accurately the bottom of the chuck case on which the assembly slides and its upper ends must accurately fit the under surface of the work-holding table. If the fits at these surfaces are so inaccurate that large clearances result, the flux therethrough will be greatly reduced, with a consequent lowering of the holding power, while if the fits are very close, thereby providing small clearances, the frictional effects will be large. These frictional effects together with the magnetic pull across the surfaces will require considerable effort to move the heavy magnetic assembly. Consequently, chucks of the order of twelve by thirty-six inches or larger require special friction-reducing means with such a resulting increase in cost of manufacture that chucks of this size are somewhat impractical.

In accordance with the main feature of the present invention, a novel chuck of the permanent magnet type is provided in which not only the work-supporting table but also the permanent magnet assembly thereof are fixed with respect to each other, while a mechanically movable member or members of small mass and operable with a minimum of effort, function as flux-switching means. This flux-switching means serves to open and close the flux paths from the magnet assembly through the work-holding pole-pieces as well as through the work so that it can be easily placed on the chuck and removed therefrom.

Another feature of the invention relates to a chuck construction which eliminates the need for an accurately machined surface at the underside of the work-holding table and materially reduces the amount of accurate machining in the entire chuck.

A further feature of the invention relates to a chuck of the permanent magnet type in which chuck sections or units can be brought together in a chuck assembly of any desired size.

Other features and advantages of the invention will be more fully understood from the description and claims when taken with the drawings in which:

Fig. 1 is a plan view of the magnetic chuck of the present invention;

2

Fig. 2 is a front view thereof partially in section;

Fig. 3 is a vertical section taken substantially on the line 3—3 of Fig. 2;

Figs. 4 and 5 are sectional views taken on the line 4—4 of Fig. 3 partially illustrating the arrangement of two adjacent units of the assembly, Fig. 4 showing the magnetic circuits closed and Fig. 5 showing the magnetic circuits open;

Fig. 6 is a sectional view of a modified form of the invention; and

Fig. 7 is a view of a further modified form of the invention.

In Figs. 1 to 5 inclusive, the chuck of the present invention is shown as including a case 5 in the form of a shallow box of non-magnetic material, preferably molded as a unit from aluminum. This box is open at its top and bottom and its back is partially open for a purpose to be set forth. The top of the case is closed by a work-holding table which is anchored in spaced relation therein by suitable fusible non-magnetic material 7, such as Babbitt metal. The work holding table proper is in the form of a grid comprising two side rails 8 and cross members 9 and 10, all formed of flat plates of ferromagnetic material set on edge with the ends of the cross members preferably joined by dowels 11 (Fig. 3) to the side rails 8 and also welded together to provide a good magnetic circuit. It should be pointed out that the cross members 9 project to the bottom of the case, as shown in Figs. 4 and 5. While cross members 10 extend only a short distance below the bottom of the work-holding table. In the space between two adjacent cross members, there is mounted the pole piece 12. These parts comprising the cross members 9 and 10 together with the pole pieces 12, when arranged in accordance with the pattern shown in Fig. 1, have non-magnetic material, such as Babbitt metal poured therebetween to anchor them in the position illustrated.

The flux producing members of the chuck are in the form of block magnets 14 which are preferably formed of Alnico, and which have a length equal to that of the pole-pieces 12. The upper end of each permanent magnet has attached thereto a beveled pole top 15 of high permeability which serves as a flux-concentrating member. This pole top is attached to the magnet proper, preferably by a brazing operation at such low temperature that there is no reaction on the Alnico or other heat-treated magnetic material of which the permanent magnet is formed. The permanent magnets are arranged in the relation shown in Figs. 4 and 5 and are anchored in this position by fusible non-magnetic material 16 in which each magnet is imbedded. In order to insure secure anchoring of the magnets in this position, each magnet is provided in each of its

sides with a longitudinal groove 17 while each adjacent cross member 9 is provided with a series of holes 18 so that the non-magnetic material 16 can be locked in these grooves and holes. The bottom of the case 5 is closed by a plate 19 of magnetic material which should have a tight contact with the lower ends of the permanent magnets and of the cross members 9, the bottom plate being held in position in the case by suitable screws 20 passing through this plate and engaging suitable lugs 21 on the case (Fig. 2). When the top plate and the magnets are thus assembled, the bevelled top piece 15 of each permanent magnet and the lower ends of the two related pole pieces 12 are reduced by a boring operation, performed through the open side of the case, to have arcuate surfaces which will accurately engage the cylindrical surface portions of a valve element 22 to be described. It will be noted that the construction of the work table is such that poles comprising the members 9, 10 and 12, while spaced, may be assembled close together, so that small work pieces may be held thereon without adapters, although the width of the permanent magnet 14 is large, as compared with the center distances between the pole pieces and the cross members in the work table.

Each valve element 22 is made from bar stock of ferromagnetic material to have generally tapered sides and has formed thereon cylindrical surfaces 22*a* and 22*b* (Fig. 5) to make a close fit with the arcuate surface of the pole top 15 of the magnet and the arcuate surfaces of the lower ends of the pole pieces 12, all as indicated in Fig. 4. The respective ends of the valve element 22 are turned down to provide cylindrical extensions 23 and 24 (Fig. 3) on which there are forced bronze washers 25 which guide the valve element in its rotary movement. Retaining plates 26 and 27 fixed by screws to the respective ends of the magnets 14 (Fig. 3), prevent longitudinal movement of the valve member 22. The end portion of the rear extension 24 is milled to provide flat parallel surfaces thereon to enable this portion of this extension to be inserted in a correspondingly-shaped opening in a crank arm 28 where it is retained by any suitable means. The lower ends of each pair of adjacent cranks are connected by links 29 and 30, there being two links on each crank except the first and last in the series, thereby forming a locomotive drive for simultaneous rotation of all the valve elements. The means for actuating this locomotive drive comprises a shaft 31 extending crosswise of one end of the case in parallel relation to the valve elements. One end of this shaft projects through the case where it is provided with a handle 32 by which it can be rocked. A crank 25 is secured on the shaft while a link 33 connects this crank to the series of links. The arrangement of these parts is such that when the handle is rotated to one of its limiting positions, the valve elements 22 will be in the position illustrated in Fig. 4 whereas when the handle 32 is swung to its alternate extreme position, the valve elements are moved to the position illustrated in Fig. 5, wherein the work pieces on the work table can be removed therefrom.

In the work-holding position, illustrated in Fig. 4, flux from a given magnet 14 passes through the flux concentrating pole 15 thereon, valve element 22 and to the related pole pieces 12, thence through the work piece, not shown, to return through the cross members 9 and through the bottom plate 19 to the other pole of the magnet

14. It will be appreciated that flux from the upper pole of the magnet will also pass between the cross member 10 and the pole pieces 12 when a ferromagnetic work piece (not shown) bridges these parts, to return through the side rails 8 and cross member 9, and through bottom plate 19 to the other pole of magnet. In order to open the magnetic circuit and thereby release the work pieces from the work table, the handle 32 is swung so that all the valve members 12 are simultaneously rotated through 90 degrees to the position indicated in Fig. 5. In this position of the valve members 22, there are gaps of high reluctance between each flux concentrating pole 15 and its related valve members, as well as a gap of high reluctance between the valve member and the pole pieces 12. When the parts are in this off position, the leakage reluctance from the edges of the concentrating pole top 15, as well as from the sides of the magnet 14 to the adjacent lower portions of the cross members 9 should be less than the reluctance of the flux paths including the pole pieces 12. However, when the valves are in their holding position, as shown in Fig. 4, the reluctance of the path through the work piece is materially less than that through the leakage paths just referred to. The rotation of the valve member 22 toward its position, shown in Fig. 5 can increase the reluctance of the path through the work-holding table to such an extent that no appreciable holding power can be detected thereat or the rotation of this member to the position shown in Fig. 4 can reduce this reluctance to such a degree that the work piece is firmly held on the work table. The valve member 22 therefore operates in one instance to increase the reluctance of the work-holding path above that of a predetermined fixed reluctance leakage path to release the work and in another instance decreases the reluctance of the flux path through the work to a given value below that of the leakage path when the work piece is to be held on the work-supporting table.

The chuck just described is of relatively large size but it will be understood that a single magnet 14 together with the cross members 9, 10 and pole pieces 12, as well as the related valve member 22 constitutes a chuck unit. Thus, a chuck of any desired size may be made by assembling a plurality of these chuck units in a case of appropriate size.

While the valve elements in the preferred form of the invention have been disclosed as being rotatable, it will be understood that these elements may be operated in a different manner. For example, in the modified form of the invention, shown in Fig. 6, the valve element 22 is in the form of a truncated cone adapted for longitudinal movement. Of course, it will be understood in this arrangement that the shape of the top pieces 15′ of each magnet 14′ and the shape of the ends of the related pole pieces 12′ will conform to the outer surface of the valve member so that when this valve member is in its extreme inner position, as shown in Fig. 6, the flux paths through the chuck will be completed in the same manner, as illustrated in Fig. 4. However, when the valve member is moved outward to the left, as illustrated in dotted lines, a substantial air gap will be introduced in the magnetic paths. When several units are incorporated in one case, the valve elements 22′ will be simultaneously actuated by a single means.

In Fig. 7, there is illustrated a further modified form of the invention which differs from that

shown in Figs. 1 to 5 inclusive by having the several chuck units radiate from a common center to provide a circular rotary chuck which is rotationally balanced. The parts of this modified chuck which correspond with similar parts in the construction illustrated in the last-mentioned figures, are identified with the same reference characters with a double prime added. The several parts comprising the cross members, the pole pieces, the magnets and the valve elements are preferably somewhat sector-shaped. Otherwise, the construction and function of these parts is the same as that above. Any suitable means may be provided for simultaneously rotating the several valve elements between their closed and open positions corresponding to the positions illustrated in Figs. 4 and 5.

The present disclosure is given merely by way of example and it will therefore be understood that the chuck of this invention can have various embodiments within the limits of the present claims, without departing from the principle of the invention.

What I claim is:

1. In a magnetic holding device, a work-holding support comprising at least two parts of ferromagnetic material mounted in spaced relation with non-magnetic material therebetween to be bridged by a work piece to be held thereon, a permanent magnet mounted with one of its poles in spaced relation to one of said parts, said last-mentioned pole and an adjacent portion of said last-mentioned part being provided with curved opposing surfaces, ferromagnetic means connecting the other pole of said magnet to the other of said parts, said work support and said magnet being secured in immovable relation with respect to each other, and a valve element having curved surfaces complementary to said first-mentioned curved surfaces, said element being rotatable at will to place only said complementary surfaces into contact or out of contact whereby the reluctance of the space between said magnet and said first-mentioned part may be changed to control the holding or releasing of the work piece on the support.

2. In a magnetic holding device, a work-holding support comprising at least two parts of ferromagnetic material mounted in spaced relation with non-magnetic material therebetween to be bridged by a work piece to be held thereon, a permanent magnet mounted with one of its poles in spaced relation to one of said parts, said last-mentioned pole and an adjacent portion of said last-mentioned part being provided with concave opposing surfaces, ferromagnetic means connecting the other pole of said magnet to the other of said parts, said work support and said magnet being secured in immovable relation with respect to each other, and a valve element of ferromagnetic material having convex surfaces complementary to said first-mentioned curved surfaces, said element being rotatable at will to place only said complementary surfaces into contact or out of contact whereby the reluctance of the space between said magnet and said first-mentioned part may be changed to control the holding or releasing of the work piece on the support.

3. In a magnetic holding device, a work-holding support comprising at least two parts of ferromagnetic material mounted in spaced relation with non-magnetic material therebetween to be bridged by a work piece to be held thereon, a permanent magnet mounted with one of its poles in spaced relation to one of said parts, said last-mentioned pole and an adjacent portion of said last-mentioned part being provided with cylindrical opposing surfaces, ferromagnetic means connecting the other pole of said magnet to the other of said parts, said work support and said magnet being secured in immovable relation with respect to each other, and a valve element of ferromagnetic material having cylindrical surfaces complementary to said first-mentioned curved surfaces, said element being rotatable at will to place only said complementary surfaces into contact or out of contact whereby the reluctance of the space between said magnet and said first-mentioned part may be changed to control the holding or releasing of the work piece on the support.

4. In a magnetic work-holding device, a work support comprising at least a first pair and a second pair of elongated parts of ferromagnetic material mounted in spaced parallel relation with non-magnetic material therebetween and with a part of said first pair interposed between the parts of the second pair, an elongated permanent magnet mounted with one of its poles in spaced parallel relation to said first pair of parts, ferromagnetic means connecting the other pole of said magnet to the second pair of parts, the thickness of said magnet being approximately equal to the thickness of the first pair of parts together with the non-magnetic material therebetween, the adjacent surface portions of said magnet and of said first pair of parts being concavely curved to define a cylinder, and a ferromagnetic rotatable valve element transversely tapered with its edges curved convexly to define surface portions of said cylinder, said valve element being rotatable only from a position in which it bridges the space between said magnet and said first-mentioned pair of parts to close the portion of magnetic circuit therebetween and being movable into a second position wherein it opens the mentioned portion of the magnetic circuit.

5. In a magnetic work holding device, a work support comprising a first series and a second series of elongated parts of ferromagnetic material mounted in spaced intermingled parallel relation with non-magnetic material therebetween, an elongated permanent magnet mounted with one of its poles in spaced parallel relation to said first series of parts, ferromagnetic means connecting the other pole of said magnet to the second series of parts, the thickness of said magnet being approximately equal to the thickness of at least a pair of parts of the first series together with non-magnetic material therebetween, the first mentioned pole of said permanent magnet being provided with a flux-concentrating member with its sides converging in the direction of the work support, the adjacent portions of said member and of said pair of parts being curved to define portions of the surface of a cylinder, and an elongated ferromagnetic element generally cylindrical in shape with at least one slabbed side, the diameter of said element being approximately equal to that of said cylinder and being rotatable about the axis of the cylinder from a position in which it is in contact with said member and with said pair of parts to close a portion of a magnetic circuit therebetween and being rotatable into a second position wherein it opens the mentioned portion of the magnetic circuit.

SAMUEL KARASICK.