Dec. 30, 1941. J. T. BEECHLYN 2,268,011

PERMANENT MAGNETIC CHUCK

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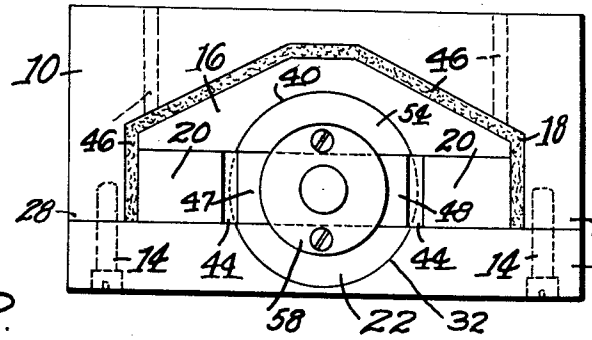
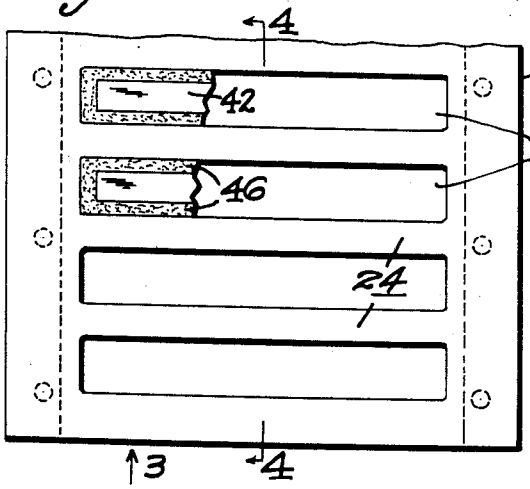


Fig. 1

Fig. 2.



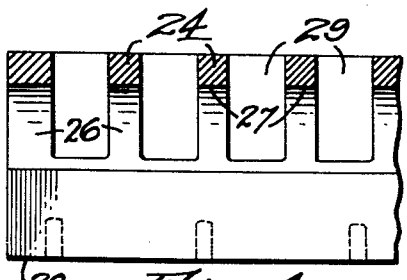


Fig. 4

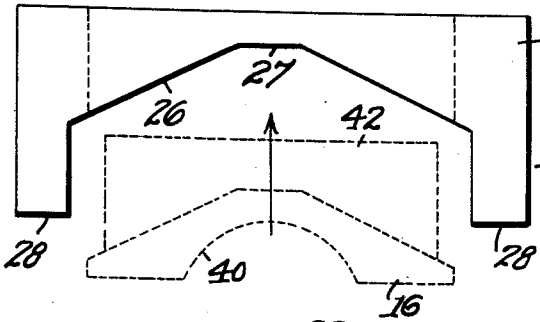


Fig. 3.

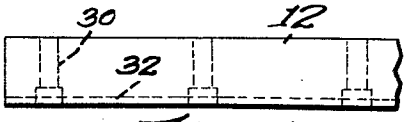


Fig. 7.

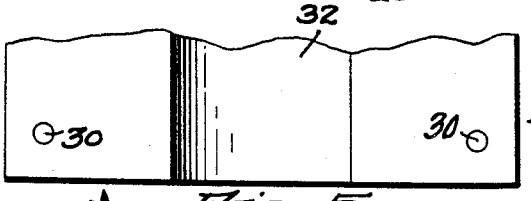


Fig. 5.

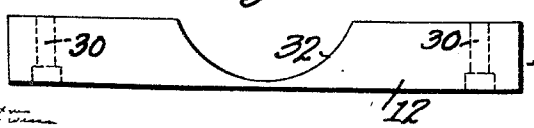


Fig. 6.

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PERMANENT MAGNETIC CHUCK

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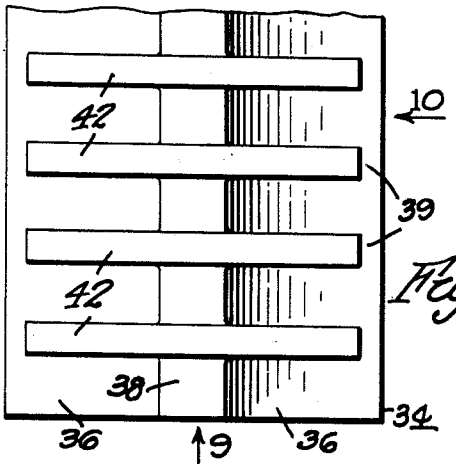


Fig. 8.

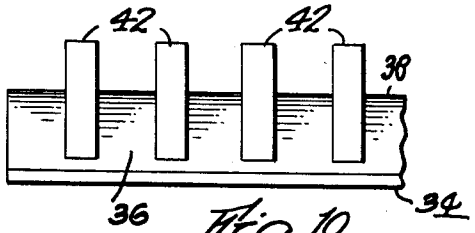


Fig. 10.

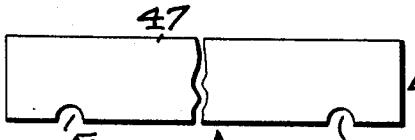


Fig. 11.

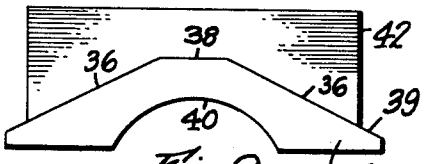


Fig. 9.

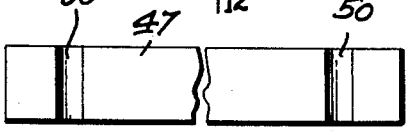


Fig. 12.

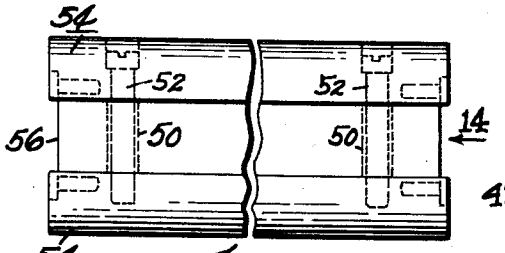


Fig. 13.

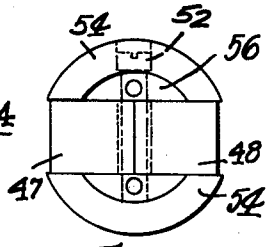


Fig. 14.

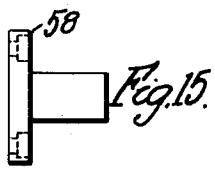
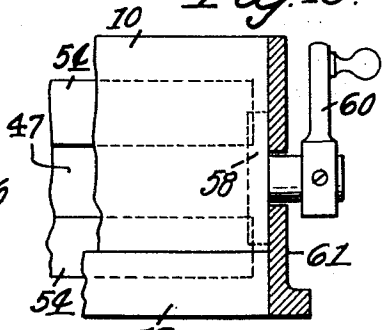


Fig. 15.

Fig. 16.



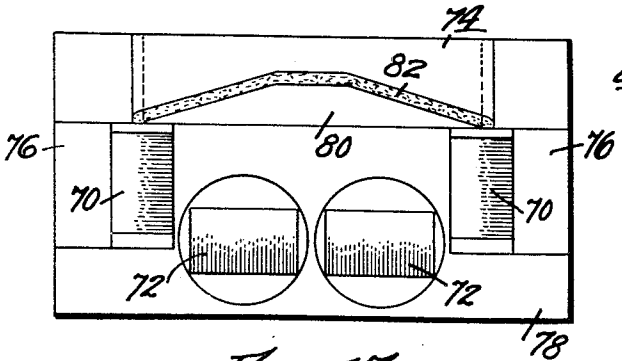


Fig. 17.

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2,268,011

UNITED STATES PATENT OFFICE

2,268,011

PERMANENT MAGNETIC CHUCK

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Application August 6, 1940, Serial No. 351,564

10 Claims. (Cl. 175—367)

This invention relates to magnetic chucks, which are holding devices for magnetically securing ferric articles, while undergoing manufacturing operations such as machining, grinding or polishing. More particularly the invention involves a type of chuck in which, instead of the usually employed electrically energized winding, a permanent magnetic source is relied upon to furnish the needed magnetic force, such type having been rendered practical by recent discoveries of alloys having exceptional coercive force.

Applied to holding devices the permanent magnet has several inherent advantages over the electromagnet. However, when subject to the full requirements of the developed art in connection with standardized machinery, the permanent magnet chuck has thus far failed to equal, in several respects, the performance obtained from electro-magnetic devices. This refers both to the holding power or, at least, to that percentage of the total working surface in which an optimum of attractive force can be obtained, and also to the degree of facility with which work may be released and removed from the chuck. In addition, it has been a characteristic of such chucks, as hitherto commercially employed, that the rim of the top plate framing the holding surface, differs in magnetic polarity from the bottom of the chuck and the machine to which it is attached. This produces an undesirable zone of attraction around the chuck, tending to cause accumulation of chips or sludge, and eventually a reduction of holding power, a condition that does not occur with the ordinary electrochuck, in which the top frame and its entire external support have identical polarity. Also, the permanent magnet chuck of the prior art tends to deteriorate with age and use.

It is the general object of the invention to overcome these shortcomings and to produce a permanent magnetic chuck that in all important respects will be the equal of the electrochuck, while still retaining the special advantages incidental to the permanent magnet.

Another object of the invention is the provision of a permanent magnetic chuck in which the holding power is greatly increased over prior art chucks of this type, and will even equal that of an electrochuck of similar size.

Another object is the provision of a permanent magnetic chuck which will not deteriorate with age and use, such deterioration in prior chucks being due to displacement of a magnet with respect to a flux transmitting surface with which it is in discontinuous contact. In the present structure this is avoided by keeping the magnets in fixed contact with the next contiguous flux transmitting members at all times.

A further object is the provision of a permanent magnetic chuck in which the top and bottom plates are of the same polarity, and in which such plates are located in abutting relation, so that the side walls of the chuck serve as a return path in the magnetic circuit.

A still further object is the provision of a permanent magnet chuck having a stationary magnet and a reversible magnet, the latter being capable of parallel or series connection with the former, and the reversible magnet being equal to or greater in magnitude than the stationary magnet, so that when in series connection, the polarities of the work-holding members will be reversed, and work release and even partial demagnetization of the work will occur; and, when in parallel connection, the flux of both magnets will be additive and thus both will contribute to the flux in the work holding circuit.

Other objects and advantages of the invention will appear hereinafter.

Reference is to be had to the accompanying drawings, in which

Fig. 1 is a front elevation of a chuck embodying the invention;

Fig. 2 is a top plan of the same;

Fig. 3 is a front elevation of the top of the chuck, showing the pole section separated in broken lines;

Fig. 4 is a section on line 4—4 of Fig. 2;

Fig. 5 is a broken away top plan of the bottom plate;

Fig. 6 is a front elevation of the bottom plate looking in the direction of arrow 6 in Fig. 5;

Fig. 7 is a side elevation of the bottom plate, looking in the direction of arrow 7 in Fig. 5;

Fig. 8 is a top plan of the pole section;

Fig. 9 is a front elevation of the pole section looking in the direction of arrow 9 in Fig. 8;

Fig. 10 is a side elevation of the pole section looking in the direction of arrow 10 in Fig. 8;

Fig. 11 is a top plan of a part of the rotary magnet;

Fig. 12 is a side elevation of the same looking in the direction of arrow 12 in Fig. 11;

Fig. 13 is a side elevation of the complete rotary magnet;

Fig. 14 is a front elevation of the same looking in the direction of arrow 14 in Fig. 13;

Fig. 15 is a detail view of an end plate for the rotary magnet;

Fig. 16 is a partial side elevation of the assembled chuck, showing an end plate in section; and

Fig. 17 is a diagrammatic view of a modified form of the chuck.

Referring to Fig. 1, the main parts of the chuck are shown as the top plate 10, bottom plate 12, secured directly to the top plate as by bolts 14, pole section 16, soft nonmagnetic metal spacing 18, stationary permanent magnets 20, and rotary or reversible magnet assembly 22.

The top plate 10 comprises an integral body in the shape of a flanged grill, the latter having any desired or required number of cross bars 24 which extend between the flanges or sides 25. These bars are relatively great in height near the flanges, but approach the top of the plate on their lower edges as at 26, and at 27, these edges meet at the flat area as shown in Fig. 3. Continuous legs 28 extend downward from adjacent the flanges or sides 25 and in effect are continuations of the same, and form a support for the top plate. The top plate is cast as one piece of soft iron, or other magnet flux carrying material, and this is also true of the pole section and bottom plate, although clearly any or all of these parts could be machined from iron blocks. The bars 24 form slots 29 which extend across the body from points just short of the inner faces of the legs 28.

The base plate 12 is bored and counter-sunk at 30 to provide for bolts 14, and on its top surface it has a circular depression 32 bored or otherwise machined out. The pole section 16 is shown in detail in Figs. 8–10, and comprises a base 34 having a top surface which extends upwardly from both longitudinal edges as at 36, these edges merging into a flat top surface 38. The bottom of the pole section is bored out at 40 complementary to the depression 32 in the bottom plate.

A row of parallel pole pieces 42 having flat tops, project from the sides 36, and each pole piece continues across the flat top 38 to the other side thereof. The pole pieces are not as long as the base 34 is wide, and as shown in Fig. 9, they are evenly recessed or inset from the edges of the base, as at 39.

Fig. 3 shows how the pole section 16 is assembled with relation to the top plate 10, the former being moved in the direction of the arrow, so that each pole piece will be inserted in a slot between cross-bars in the top plate. The tops of the pole pieces are adapted to lie flush with the top surface of the top plate. The bottom plate 12 is then bolted to the top plate, and the legs 28 rest directly on the bottom plate, as will be clear from Fig. 1.

Permanent magnets 20 of Alnico or some other permanent magnet alloy are placed between the bottom plate and the pole section, as shown in Fig. 1, and the latter rests directly on the magnets which in turn rest on the bottom plate. The magnets 20 will be of a length to extend the length of the chuck.

With the parts as described, soft metal 46, as Babbitt metal or lead, is poured into the insulating spaces between the pole pieces and the bars 24, thus sealing the assembly against entrance of foreign matter and securing the members in fixed relation. This of course leaves a generally cylindrical opening caused by surfaces 32, 40, thru the chuck. The magnets 20 are of such a width that they stop short of the opening, leaving air gaps 44.

The rotary, or reversible magnet pieces 47, 48, are correspondingly apertured as at 50 for the reception of bolts 52. Soft iron top and bottom pieces 54 are drilled for the bolts 52 and these pieces clamp the magnets together to form a single magnet. This magnet is designed to have an equal or slightly greater magnitude than that of magnets 20 combined.

The end faces of pieces 54 are counterbored as at 56 for the reception of end plates 58, one or both of which may be provided with a handle 60 for turning the magnet assembly 22, and the latter is journaled directly in the cavity formed by surfaces 32, 40, for turning movement about its axis. The handle extends thru an end plate 61 as shown in Fig. 16. There is another end plate at the other end of the chuck similar to plate 61.

The construction as above described, and which embodies a preferred form of the invention, provides a return path for the flux emanating from the magnets 20, 47, 48, thru the sides 25 and legs 28, to the bottom plate 12, so that the entire exterior of the chuck body except for pole pieces 42 will always have the same polarity, thus avoiding the collection of chips, sludge, and other particles on the rim of the top plate, and which has been unavoidable heretofore in chucks of the permanent magnet type. At the same time, the chuck body affords interior space for an adequate total section of permanent magnetic material, a result not heretofore obtainable. Hence, a holding power is achieved, in the relatively small space commercially required of a chuck, at least as great as in an electrochuck of the same or similar outside dimensions. Factors contributing to this result will be described below.

The reversible magnet assembly 22 provides a novel arrangement for arbitrarily causing complete release of the work from the chuck. Thus, when magnet 22 is located with the pole uppermost which is similar in sign to the top poles of magnets 20, the fluxes of all three magnets are in parallel, and a powerful flux flows thru the pole pieces, into the work, thru the top plate and the side walls to the bottom plate, thus closing the circuit. However, if magnet assembly 22 be given a 180° turn, the flux thereof will be in series with that of magnets 20, and the total flux volume will be reduced by nearly one-half. The flux excess from magnet 22 will now cause a reversal of polarities in the work-holding members, and thereby release of the work. Since the flux volume in the magnet 22 may be designed to exceed in any degree that of magnets 20 combined, a partial demagnetization of the residual magnetism of the work piece may also be effected.

The invention thus involves the division of the total magnetic source into two slightly differing quantities, each of these sources being normally magnetically connected with the work-holding chuck members so that flux in the circuit traverses the two sources in parallel to hold the work, means being provided for reversing connections for the larger source, whereby the total flux volume will be reduced by nearly one-half, and the major portion of this flux will traverse the two sources in series, resulting in a reversal of polarities in the work-holding members, and release of the work.

In the described form the source having fixed connections has been shown as consisting of two separate magnets respectively situated on each side of the reversible magnet. While this ar-

rangement is desirable, it will be apparent that the operating principle in no way depends on such separation, and that a single larger magnet can be employed as the fixed source and disposed in any position within the chuck so long as it is properly connected with the basic ferric members.

However, the present symmetrical arrangement offers the advantage particularly where subject to the limits of chuck height encountered in practice, that a large diameter of the reversible magnet is rendered possible through its central disposition without involving any encroachment on the flux conducting ferric sections of the chuck. Also the division and disposition of the fixed magnet, which is of relatively low height compared with the height of a well proportioned coil in an electrochuck, permits the use of a relatively large section in the grid bars 24 where they join the sides 25 of the top plate 10. The section at this juncture ordinarily constitutes a "bottle neck" in the flux conduit in chuck design, and the gain afforded by the present arrangement accounts in a measure for the high degree of holding power that has been attained even with the work surface fully loaded.

It will be noted that iron pieces 54 overlap the magnets 47, 48, see Fig. 14, and therefore the magnet is never movable with respect to a contacting flux transmitting member. Hence the lines of force in the magnet are never disturbed, and partial demagnetization is avoided. By this structure the chuck is insured against deterioration due to use and age, such deterioration being a fault of all prior art permanent chucks in which a magnet is in movable contact with a flux transmitting surface.

A modification of the invention is shown in Fig. 17, wherein stationary magnets 70 are arranged to transmit the flux laterally.

This arrangement has some advantage in connection with certain grades of magnet alloy having high coercive force but a relatively low remanence, since it allows the use of a total magnet section greater than could be deployed across a single plane within the side walls of the chuck, as in the priorly described design. The reversible magnet in this case has been divided into two separate magnets 72, 72, and any desired linkage or gearing may be applied to cause both magnets 72 to turn together.

The top plate 74 is substantially the same as plate 10, but the feeding section may be slightly smaller. Flanges or sides 76 provide the return flux path to bottom plate 78, which is bored to receive the magnet assemblies 72. Pole section 80 is somewhat different in shape from pole section 16, the pole pieces extending laterally beyond the section itself. Soft metal 82 insulates the pole section from the top plate at the working area, but the magnets 70 are directly connected between these two members. However, the operation of this device is generally the same as that shown in Fig. 1, and it is not thought necessary to repeat it.

In the foregoing reference has been made to different magnitudes of the stationary and reversible magnets. This does not necessarily refer to physical dimensions but rather to the magnetic magnitudes involved. Although the dimensions of the magnets will in some measure influence their magnetic magnitudes, the insertion of a high reluctance in any magnetic circuit will affect the magnetism of the circuit. Hence a thin non-magnetic plate may be placed to transect the circuit of one of the magnets, as the stationary magnet, and thus cause a differential in the power of the circuits of the stationary and reversible magnets.

Having thus described my invention and the advantages thereof, I do not wish to be limited to the details herein disclosed, otherwise than as set forth in the claims, but what I claim is:

1. A permanent magnet chuck comprising a plurality of magnetic members having a magnetic interconnection at one area and a magnetic insulation at a separated area, said interconnection including a pair of magnets, said magnets being adapted to be relatively reversible with relation to their poles one magnet being fixed in said chuck and the other being rotatable.

2. A permanent magnet chuck comprising a base, a top plate, said top plate having integral depending sides connected to said base to form a flux path, said top plate sides providing a space therebetween, a fixed magnet and a pole section in said space, a pole piece on said pole section extending into said top plate and insulated therefrom to form a work-holding surface, a second magnet in said space, said second magnet being mounted for rotary movement about an axis intermediate of its poles whereby it may be positioned selectively in parallel or series flux circuit with said first magnet, said base, top plate, and pole section being of ferro-magnetic material.

3. A permanent magnet chuck comprising a combined bottom plate and top plate, the former being generally plane and the latter being in the form of an inverted U, with its legs connected to said bottom plate, slots in said top plate, a fixed magnet and a pole section within the space formed by said bottom and top plates, said magnet being located between said bottom plate and said pole section, pole pieces on said pole section extending into said slots, said pole section and said bottom plate being complementarily recessed to provide a bore, and a reversible magnet journaled in said bore.

4. A permanent magnetic chuck comprising a work holding surface, a magnet fixed with relation to said surface, and a second magnet adapted for rotation, said magnets being in parallel circuit when said second magnet is in one position of rotation and in series circuit when said second magnet is in another position of rotation.

5. A permanent magnetic chuck having a fixed magnet and a rotary magnet, whereby said magnets may be situated in series or parallel flux circuits, said rotary magnet being of greater flux magnitude than said fixed magnet, whereby when in parallel, both magnets pass flux in a single direction through a work-holding circuit, and when in series a small portion of the flux from the rotary magnet is oppositely directed through the work-holding circuit.

6. In a device of the class described, a housing of ferro-magnetic material comprising a top, side walls, and a base, a flux transmitting member in said housing and projecting into relation with the top to form a work surface therewith, said housing and member being magnetically separated at said surface, a permanently fixed magnet having two poles and resting on said base with a fixed magnetic connection from one pole to said base, said member resting on and rigidly supported by said magnet in fixed magnetic connection with the other pole of said magnet, a second magnet, and magnetic connections between the individual poles of said second magnet and the member and base, said last named connections being selectively reversible with relation

to said member and base, whereby the flux of said second magnet may be directed in parallel with the flux of said first named magnet or in opposition thereto.

7. A device as recited in claim 6 wherein said second magnet has a flux magnitude sufficiently greater than that of said fixed magnet to cause a reversal flux through said member and housing, said reversal flux being large enough to overcome any substantial holding effect due to residual magnetism in a work piece on said surface, thereby permitting easy removal of the work piece from the device.

8. A permanent magnetic holding device comprising a pair of soft iron members magnetically separated to form a work-holding surface, a fixed magnet adapted to form a magnetic circuit with said members and a work piece held on said device, and a second magnet capable of having its poles reversibly connected with respect to said work surface and said fixed magnet, said second magnet having a flux magnitude sufficiently greater than that of said fixed magnet to cause a reverse flux through said members, said reverse flux being large enough to overcome any substantial holding effect due to residual magnetism in said work piece, thereby permitting easy removal of the work from the device.

9. In a work-holding device of the class described, the combination of two ferric members jointly forming a magnetic work-holding surface, a ferric base, one of said members being fixedly seated on said base, a two pole magnet also fixedly seated on said base with one of its poles connected thereto, the other of said members being fixedly seated on the opposite pole of said magnet, whereby a magnetic circuit including said members, magnet, base, and a work piece adapted to be held to said surface is provided; with a second magnet, and magnetic connections between the poles of said second magnet and the other of said members and said base. said magnetic connections being selectively reversible, whereby the flux of said second magnet may be selectively directed in parallel with the flux of said fixedly seated magnet or in opposition thereto.

10. A device as recited in claim 9 wherein said second named magnet has a flux magnitude sufficiently greater than the flux of said fixedly seated magnet to cause a reversal flux through said ferric members and work piece, when said fluxes are directed oppositely, said reversal flux being large enough to overcome any substantial holding effect due to residual magnetism in the work piece, thereby permitting easy removal of the latter from the device.

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