

May 30, 1939.

F. R. MALLALIEU
MAGNETIC WORK HOLDER

2,160,405

Filed April 8, 1938

2 Sheets-Sheet 1

Fig. 1.

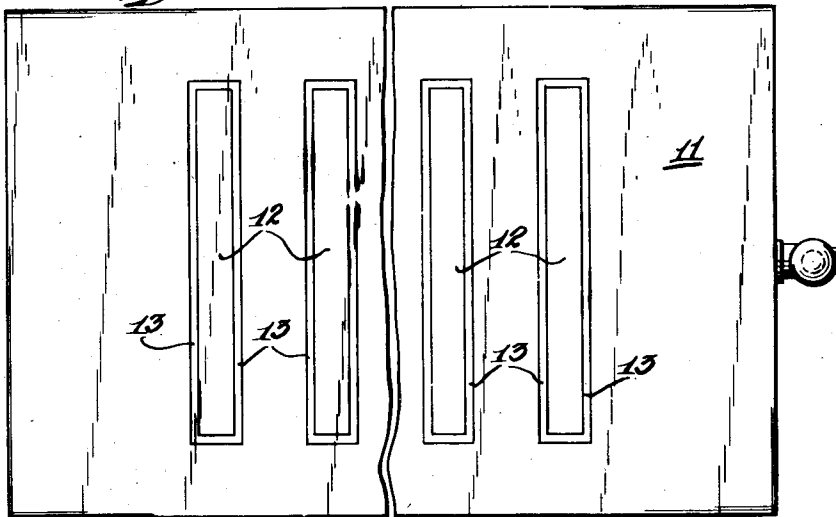


Fig. 2.

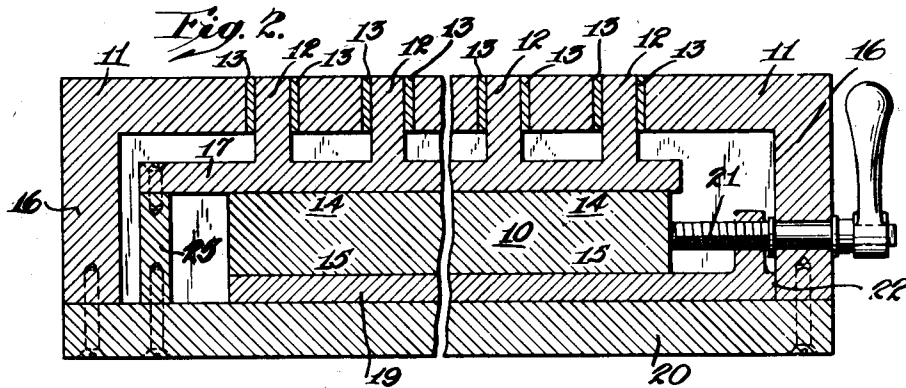
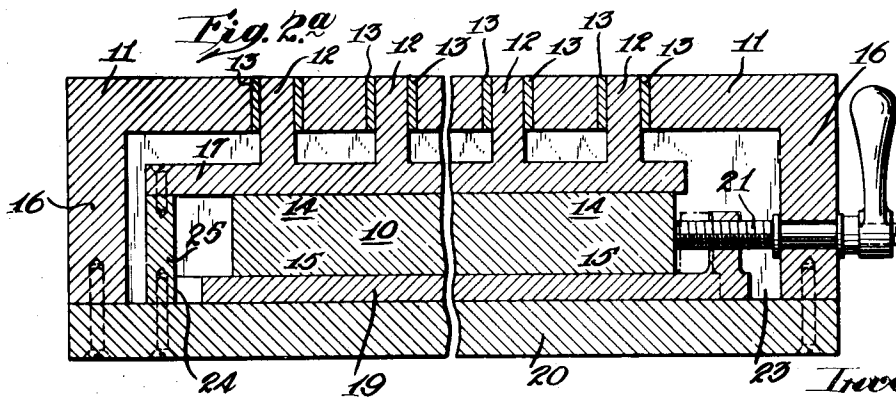


Fig. 2a.



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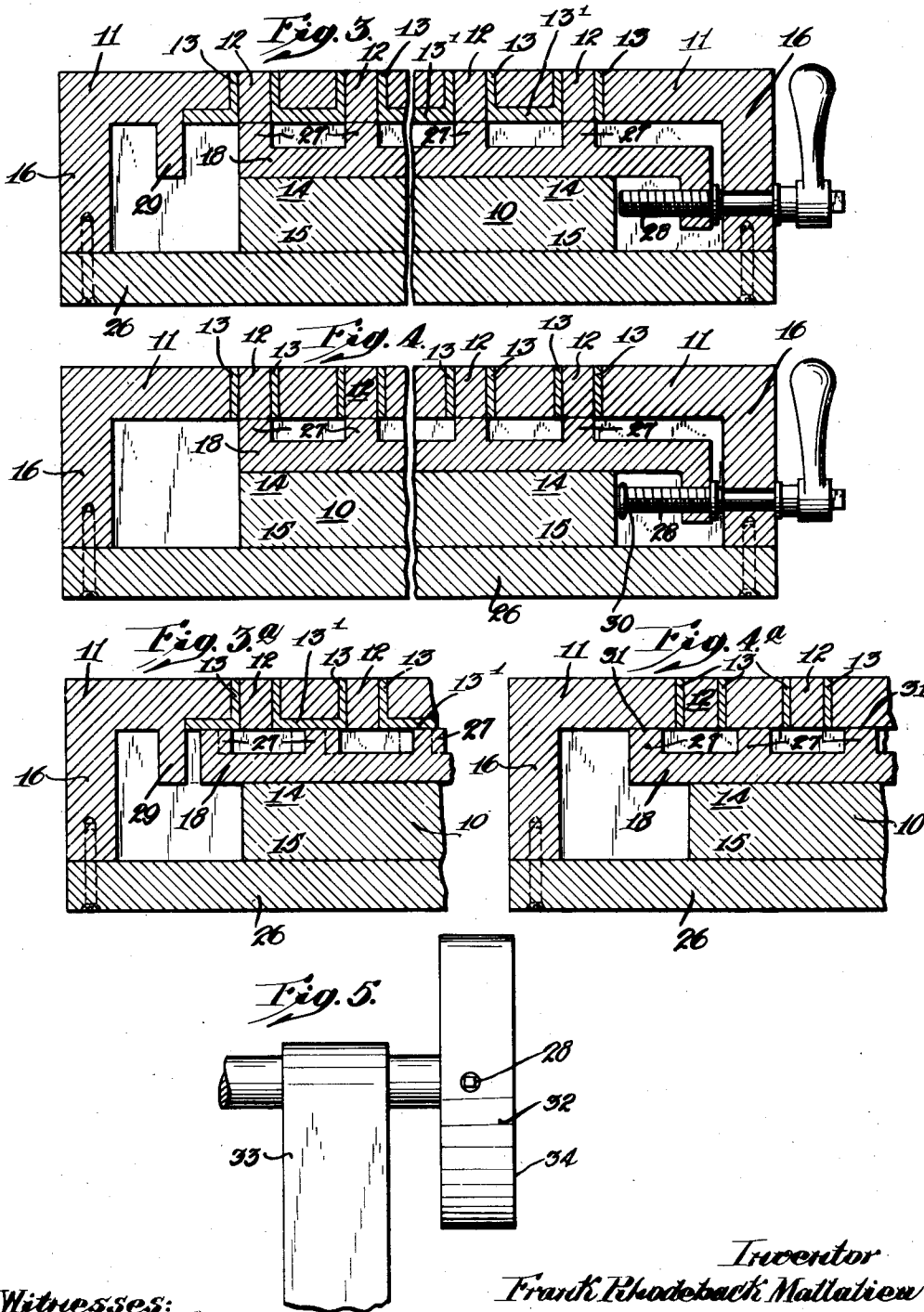
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MAGNETIC WORK HOLDER

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,160,405

MAGNETIC WORK HOLDER

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Application April 8, 1938, Serial No. 200,862

16 Claims. (Cl. 175-367)

The present invention relates to a magnetically energized work holder for articles of magnetic material and in which the magnetic holding members are energized by permanent magnets.

A purpose of the invention is to surround and support multiple pole pieces of a permanent magnet and of one polarity by a common work table of soft iron or the like and of opposite polarity.

A further purpose is to open and close the magnetic circuit of a magnetic work holder without moving a permanent magnet energizing the circuit and at a portion of the circuit intermediate the magnet and the magnetic poles presented to and holding the magnetic work, opening the circuit to release the work without disturbing the work.

A further purpose is to include a soft iron slide in the external magnetic circuit of a permanent magnet energizing a magnetic work holder, locating the slide intermediate the magnet and the work and using the slide as means to release the hold of the magnetic work holder without needing to move the magnet nor one or other of the pole members presented to and holding the work.

A further purpose is to provide a magnetic slide to be in continuous magnetic connection to one pole of a permanent magnet and connecting selectively to either or neither of two magnetic members that magnetically connect respectively to the other pole of the magnet and to a magnetic work table.

A further purpose is to employ the power of magnetic alloys to a fuller extent than has been possible heretofore, while still gaining the advantage of complete release of the work.

A further purpose is to increase the space efficiency of the magnetic cavity.

A further purpose is to hold smaller work on the face of a magnetic chuck.

A further purpose is to increase the force holding work on the face of a permanent magnet work holder, especially when the work does not completely cover the face.

A further purpose is to simplify and cheapen the construction of permanent magnet work holders.

Further purposes will appear in the specification and in the claims.

I have elected to show one main form only of my invention, showing however detail modifications and selecting a main form and modifications thereof that well illustrate the principles

involved and are practical and efficient in operation.

Figure 1 is a fragmentary top plan view intended to illustrate conventionally any of many structures embodying the present invention and specifically corresponding to any of the structures of Figures 2, 3 and 4.

Figures 2, 3 and 4 are fragmentary longitudinal vertical sections of somewhat different forms, each figure however corresponding to a central longitudinal section of Figure 1.

Figure 2a is a view corresponding generally to Figure 2 but with the magnetic control slide in a different position from that of Figure 2. The energizing and release positions are shown respectively in Figures 2 and 2a. Figure 2a also indicates in dot-and-dash line a third position of the slide.

Figures 3a and 4a are fragmentary views corresponding generally to Figures 3 and 4 respectively, with the magnetic circuit-closer, or slide, in different positions, closed in Figures 3 and 4 and open in Figures 3a and 4a. Figure 3a indicates in dot-and-dash line a third position of the slide or circuit-closer.

Figure 5 is a fragmentary elevation showing the chuck of the present invention applied to rotary machinery.

Like numerals refer to like parts in all figures.

Describing in illustration and not in limitation and referring to the drawings:

In previous permanent magnet chucks or work holders, difficulty has in some cases been encountered through failure to provide means for diverting the flux to release the work. In other devices of the kind, whereas release has been provided for, such release is often incomplete and such previous chucks do not develop the full holding forces of the permanent magnets employed.

In the following description, the constructions of certain embodiments of the invention will first be considered, before explaining the special advantages of these constructions.

Throughout the specification and claims the term "soft iron" is intended to mean any suitable magnetic material, soft iron, soft steel or the like, having the property of becoming immediately magnetic when subjected to magnetizing force and of effectively losing its magnetism with removal of the magnetizing force.

In the illustration the magnetic chuck or work holder comprises essentially a permanent magnet 10, a soft iron table 11, multiple pole pieces 12, non-magnetic members 13 that support and magnetically insulate the pole pieces from the

table, and soft iron connections respectively from the pole pieces 12 to one pole of the magnet 10 and from the soft iron table 11 to the other pole of the magnet 10. The work table and pole pieces are preferably substantially flush, although they may be curved to conform to the shape of the work.

The work-holding face of the chuck is the top face presented by the members 11, 12 and 13, the magnetic work being intended to seat on the table 11 across any number of the pole-pieces 12 (here a few only are shown, but by breaking the figures it is intended to indicate that any number of pole pieces may be employed).

Thereby the magnetic flux holding the work to place then passes between the members 11 and 12 through the work and about the remaining portion of the magnetic circuit of the magnet 10.

The magnet 10 is shown conventionally as a bar in the figures, intended to be polarized vertically, that is, parallel to its shorter dimension. Soft iron connection is provided from one magnet pole at the top 14 to the multiple pole-piece inserts 12 and soft iron connection is provided from the other magnet pole 15 at the bottom to the table 11.

In practice the magnet 10 may be made up of any number of smaller magnets or may comprise initially a single magnet. It is however much preferred to use a single magnet.

The soft iron connection between the table 11 and the bottom pole 15 of the magnet is through soft-iron sides 16. The soft iron connection between the multiple pole inserts 12 and the top pole 14 includes a soft iron member that in Figure 2 is a conductor bar 17, stationary and integral with the pole inserts 12, and that in Figures 3 and 4 is a slidable conductor bar 18.

The pole members 11 and 12 presented to the magnetic work are effectively energized only when they are in closed soft-iron connection with the poles 15 and 14 of the magnet and one of the main features of the present invention is to de-energize the pole members 11 and 12 by opening the soft-iron connection of either to the magnet—thereby releasing the magnetic hold of the chuck upon the work without either moving the magnet or disturbing the work.

In Figures 2 and 2a, the magnet pole 14 is continuously in connection with the pole pieces 12 through the conductor bar 17. The soft iron connection between the table 11 and the bottom pole 15 of the magnet includes a soft-iron slide 19. This slide 19 presents its upper face continuously to the downwardly directed pole 15 of the magnet and its lower face slides along a non-magnetic base plate 20 secured to the magnetic side walls 16. It is adapted to be shifted, as by means of a suitable non-magnetic screw connection 21 with the side wall, selectively to occupy settings respectively for energization of the work holder, for work release and for application of a keeper to the magnet.

In the chuck energizing position, Figure 2, the slide, all the way to the right, engages at 22 the soft iron side 16 of the table—thereby securing a continuous soft iron connection between the table 11 and magnet pole 15 through the members 16 and 19.

In the work release position, full-line Figure 2a, the slide 19 has been shifted to a midposition, opening a gap at 23 in the soft-iron connection between the table 11 and the magnet pole. In the magnetic-keeper position the slide has been shifted all the way to the left into en-

gagement at 24 with a soft-iron downward extension 25 from the conductor bar 17.

In Figures 3 and 3a the table 11 and magnet pole 15 are in continuous soft-iron connection through the soft iron sides 16 and soft iron base plate 26. The soft iron connection between the pole pieces 12 and the magnet pole 14 of the magnet includes a soft iron sliding conductor bar 18. This slide 18 is provided with upward polar extensions 27 adapted in one position of the slide, that of Figure 3, to register with the lower ends of the pole-piece inserts 12 of the table. This is the chuck energizing position.

By shifting the slide to the position of Figure 3a, as by means of non-magnetic screw mechanism 28, the polar extensions 27 are intermediate the pole pieces 12 and in contact with the insulation 13', and the resultant gaps in the soft-iron connection between the pole pieces 12 and the magnet pole 14 provide for effectively releasing the magnetic hold of the chuck without moving the magnet or disturbing the work.

In the form of Figures 4 and 4a, the structure is similar to the structure of Figures 3 and 3a except that the table 11 is throughout flush with the bottoms of the pole pieces 12, and no conductor block 29 is needed, as explained below.

It will be understood that when the conductor bar 18 of Figure 3 is moved to the release position shown in full line in Figure 3a, the magnetic circuit to the work is interrupted, but no keeper is applied to the magnet. Further movement to the position shown in dot-and-dash line in Figure 3a forms a closed magnetic circuit from the magnet pole 14, through the conductor bar 18, through the soft iron conductor block 29, the table 11, the side wall 16, the bottom wall 26 and finally to the magnet pole 15.

In the form of Figure 4, when the conductor bar 18 slides to the position of Figure 4a (enlargement 30 on the end of the screw feed may provide a stop), the conductor bar first interrupts the magnetic circuit through the work and then by engagement at 31 with the bottom of the table 11, applies a keeper to the magnet.

In manufacturing the chuck of the present invention, the table 11 and sides 16 may desirably be a casting, produced with the slots in the required positions. The pole pieces may then be inserted in the slots and melted lead poured into the spaces to provide the insulation 13 or 13'.

The table 11 and pole pieces 12 are then surface ground on the upper face in Figure 2 and on both faces in Figures 3 and 4. The magnet is desirably ground on its two pole faces and rigidly held in the construction in any suitable manner as by engaging screws from the end walls, not shown. The operating handle may, if desired, be removable.

An advantage of the present invention is that expensive and relatively weak non-magnetic alloys are reduced to a minimum in the present construction, which can employ chiefly inexpensive steel castings. Machine work is reduced to a minimum. The necessity for grinding a number of magnets together in a set is wholly avoided.

It will be understood that an important advantage of the present invention is the facility with which keeper action may be applied to the magnet when desired without the use of any complicated construction and without the necessity for applying a plate to the working surface of the chuck. In previous permanent magnet chucks, complete breaking of the magnet circuit in the release position has not been accom-

plished or intended. Instead, a partial short-circuiting or shunting of lines of force through an auxiliary circuit has previously been used.

In view of the complete breaking of the magnetic circuit and the ample keeper action, the most powerful of the modern magnet steels may be used, since on the one hand there is no danger of partial holding of the work in the release position as was the case in prior art constructions where complete breaking of the magnetic circuit was not employed, and, on the other hand, the magnet is held at highest efficiency by the keeper.

In accordance with the present invention, a considerably larger proportion of active magnetic material fills the space within the chuck. Almost twice as much magnet area is possible with the present invention as with prior constructions.

The device of the present invention is particularly desirable to hold small work. In the present construction, it is very easy to provide a number of small pole pieces (inserts), as it is only necessary to provide the table 11 with the number and size of pole pieces desired and then to cut the required number of slots in the bar 17 of Figure 2 or the bar 18 of Figures 3 and 4.

No need for re-design of the magnets themselves is caused by this change, as was the case in prior art constructions. Where a piece of work does not cover the entire active face of the chuck, all the flux of the magnet up to the point of saturation of the conductors and of the work is concentrated on the particular pole piece or pole pieces which are active in holding the work. In usual prior art constructions, each pole piece was supplied with flux from one magnet alone of a plurality of magnets, with consequent lowering of the proportional force.

By virtue of the efficiency of the construction from a magnetic standpoint and the possibility of increased magnetic area, the increased holding flux as compared with prior art constructions in which the work is released by shunting of flux, is substantially as follows:

Factor by which the area of the magnet may be increased.....	2
Factor by which the strength of the magnet may be increased.....	1.5
Cumulative sum.....	3

For a given holding area the holding force is proportional to the square of the total flux available. Thus the factor by which the holding force may be increased in the present construction, over prior art chucks, is 9.

This ignores several small disturbing factors, but they are of minor significance. It is thus clearly evident that the invention makes possible a very new and unobvious result in the production of markedly greater holding forces than were previously thought possible.

In designing the chuck of the present invention, it is not, as might be supposed, desirable to isolate conductors of opposite polarities too widely from one another. The spacings of conductors of opposite polarity should be such that there is sufficient leakage flux to prevent great self-demagnetization in the "release" position or in case the device is left in the "on" position with no work on the face.

In other words, a leakage path of substantially the same reluctance in any position of the slider is provided internally between the two poles of the magnet by properly spacing oppositely polarized conductors, and this path serves (and be-

comes important in its service when the main circuit is of high reluctance, as when the device is "on" with no work on the face or "off") to always carry flux from pole to pole of the magnet, at all times providing a relatively low reluctance flux path, preventing partial demagnetization of the magnet. In this way, in effect, a keeper circuit is at all time acting, and thus, except rarely when the work holder is not to be used for a long period of time, it is not necessary to apply the full iron keeper circuit provided in any of the embodiments shown and such circuits are optional and not necessary to the operation of the devices.

As stated above, the reluctance of the leakage path provided is constant irrespective of the position of the slider. Thus, although this path functions in the "on" position of the device also, it does not unduly rob the working face of the holder of useful flux, as the leakage path is made to have a high reluctance relative to the reluctance of the active face when holding work, although it exhibits a relatively low reluctance in respect to the reluctance of the main circuit when opened in the "off" position or when in the "on" position with no work on the face.

The leakage path is thus operative at all times as a "bleeder" circuit, irrespective of the position of the conductor bar. When the iron "keeper" circuit is applied, however, the leakage path is effectively inoperative and wholly negligible.

It will be understood that the chuck or work holder of the present invention may be used for any service where such devices are desired, whether the chuck be stationary or moving, and regardless of the character of the motion. Figure 5 shows a chuck 32 according to the invention, rotatably mounted in a lathe 33 (the live center end only being shown). The active magnetic holding face is shown at 34.

In view of my invention and disclosure variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art to obtain all or part of the benefits of my invention without copying the structure shown and I therefore claim all such in so far as they fall within the reasonable spirit and scope of my invention.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. In a magnetic work holder, a first magnetically conducting member exposed to contact with the work, a plurality of second magnetically conducting members magnetically insulated from the first magnetically conducting member and likewise exposed to contact with the work, a permanent magnet having two poles, a magnetic conductor connecting the first magnetically conducting member to one of the magnet poles, a magnetic conductor connecting all of said second magnetically conducting members to the other magnet pole and means for interrupting the connection between a magnet pole and the corresponding magnetically conducting member or members.

2. In a magnetic work holder, a first magnetically conducting member exposed to contact with the work, a plurality of second magnetically conducting members magnetically insulated from the first magnetically conducting member and likewise exposed to contact with the work, a permanent magnet having two poles, a magnetic conductor connecting the first magnetically conducting member to one of the magnet poles, a magnet-

ic conductor connecting all of said second magnetically conducting members to the other magnet pole and common means for interrupting the connection between a magnet pole and the corresponding magnetically conducting member or members, and for connecting one magnet pole with the other magnet pole.

3. In a magnetic work holder, a first magnetically conducting member exposed to contact with the work, a plurality of second magnetically conducting members magnetically insulated from the first magnetically conducting member and likewise exposed to contact with the work, a permanent magnet having two poles, a magnetic conductor connecting the first magnetically conducting member to one of the magnet poles, a magnetic conductor connecting all of said second magnetically conducting members to the other magnet pole, a sliding conductor bar included in the magnetic circuit between a magnet pole and the corresponding magnetically conducting member or members and means for sliding the conductor bar to interrupt the magnetic circuit and in a further position of sliding, to close a keeper magnetic circuit across the magnet.

4. In a magnetic chuck, a soft iron table having perforations, soft iron pole pieces within the perforations and magnetically insulated from and fastened to the table, a permanent magnet having poles of reverse polarity, a soft iron connection from one of the poles to the table, another soft iron connection from the other of the poles to the pole pieces and means for opening and closing one of the soft iron connections.

5. In a magnetic work holder, a soft iron table having slots, soft iron pole pieces in the slots and magnetically insulated from the table, a permanent magnet having poles, soft iron connections from one pole of the permanent magnet to the table and from the other pole of the permanent magnet to all of said pole pieces and slidable means for interrupting one of the connections and for applying a keeper to the magnet.

6. In a magnetic chuck, a soft iron table having perforations, soft iron pole pieces within the perforations and magnetically insulated from and fastened to the table, a permanent magnet having poles of opposite polarity, a soft iron connection from one of the poles to the table, another soft iron connection from the other of the poles to the pole pieces, one of the said connections including a slide and means for operating the slide selectively to open and close the magnetic circuit.

7. In a magnetic chuck, a soft iron table having perforations, soft iron pole pieces within the perforations and magnetically insulated from and fastened to the table, a permanent magnet having poles of opposite polarity, a soft iron connection from one of the poles to the table, another soft iron connection from the other of the poles to the pole pieces, the soft iron connection from one of the poles to the table including a slide and means for operating the slide selectively to open and close the magnetic circuit.

8. In a magnetic work holder, a table of soft iron having a substantially flat face and having a plurality of slots, soft iron pole pieces in the slots substantially flush with the surface of the table, nonmagnetic metal occupying the space between the pole pieces and the table, serving to position and magnetically insulate the pole pieces, a permanent magnet having poles, a conductor bar in contact with one of the poles and connecting with all of said pole pieces, a movable magnetic circuit breaker in contact with the other pole piece and contacts connecting the magnetic circuit breaker to the table in one position, to the conductor bar in another position and to neither in a third position.

9. In a magnetic chuck, a soft iron table having perforations, soft iron pole pieces within the perforations and magnetically insulated from and fastened to the table, a permanent magnet having poles of opposite polarity, a soft iron connection from one of the magnet poles to the table, another soft iron connection from the other of the magnet poles to the pole pieces, one of said connections including a slide having three positions at which respectively it closes the magnetic work circuit, opens the said magnetic work circuit and at a more widely open position closes a keeper magnetic circuit across the magnet, and means for operating the slide.

10. In a magnetic chuck, a soft iron table having perforations, soft iron pole pieces within the perforations and magnetically insulated from and fastened to the table, a permanent magnet having poles of reverse polarity, a soft iron connection from one of the magnet poles to the table, another soft iron connection from the other of the magnet poles to the pole pieces, the soft iron connection from one of the poles to the table including a slide connecting magnetically continuously to the said one pole and in three selective positions connecting magnetically selectively to either the table, or to the other pole or to neither.

11. In a magnetic work holder, a table of soft iron having a substantially flat face and having a plurality of slots, soft iron pole pieces in the slots substantially flush with the surface of the table, nonmagnetic metal occupying space between the pole pieces and the table, serving to position and magnetically insulate the pole pieces, a permanent magnet having poles, a movable conductor bar continuously in contact with one pole of the magnet and connecting said pole to the pole pieces in one position and to the table in another position and connections from the other pole of the magnet to the table.

12. In a magnetic chuck, a soft iron table having perforations, soft iron pole pieces within the perforations and magnetically insulated from and fastened to the table, a permanent magnet having poles of opposite polarity, a soft iron connection from one of the poles to the table, another soft iron connection from the other of the poles to the pole pieces, the said last connection including a slide and means for operating the slide selectively to open and close the magnetic circuit, the said slide magnetically connecting continuously to the magnet and having multiple slide poles that in one position of the slide register with and are presented to the inner ends of the said pole pieces within the perforations, and the said slide intermediate the slide poles being inwardly recessed to clear the slide in its respective positions respectively from the table and the said pole pieces.

13. In a magnetic work holder, a table of soft iron having a substantially flat face and having a plurality of slots, soft iron pole pieces in the slots substantially flush with the surface of the table, nonmagnetic metal occupying space between the pole pieces and the table, serving to position and magnetically insulate the pole pieces, a permanent magnet having poles, a movable conductor bar continuously in contact with one pole of the magnet and connecting said pole to the pole

pieces in one position and to the table in another position and to neither in a third position and connections from the other pole of the magnet to the table.

- 5 14. In a magnetic chuck, a soft iron table having perforations, soft iron pole pieces within the perforations and magnetically insulated from and fastened to the table, a permanent magnet having poles of opposite polarity, a soft iron connection
10 from one of the poles to the table, another soft iron connection from the other of the poles to the pole pieces, the said last connection including a slide and means for operating the slide selectively to open and close the magnetic circuit, the
15 said slide magnetically connecting continuously to the magnet and having multiple slide poles that in one position of the slide register with and are presented to the inner ends of the said pole pieces within the perforations, and the said slide inter-
20 mediate the slide poles being inwardly recessed to clear the slide in its respective positions respectively from the table and the said pole pieces, and the table being upwardly recessed intermediate the pole pieces to clear the table from the
25 multiple slide poles when the slide is in its work release position.

15. In a magnetic work holder, a soft iron

table, soft iron pole pieces distributed over the table and magnetically insulated from it, a permanent magnet having poles of opposite polarity, a soft iron connection from one of the poles to the table, another soft iron connection from the other
5 of the poles to the pole pieces, means for opening and closing one of the soft iron connections and a leakage flux path from one magnet pole to the other maintained when said one of the soft iron connections is open and also when it is
10 closed.

16. A magnetic chuck having an active face, side walls part at least of which are of magnetic material in magnetic contact with the active
15 face, a permanent magnet occupying the bulk of the space within the side walls, having one pole in magnetic contact with the active face and one pole in magnetic contact with the side walls, whereby the entire magnetic space is engaged in conveying flux to the active face and the return
20 circuit is affected through the side walls, and means for completely interrupting the magnetic circuit and cutting off flow of flux to the active face.

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