Nov. 2, 1943. J. T. BEECHLYN 2,333,230

MAGNETIC CHUCK

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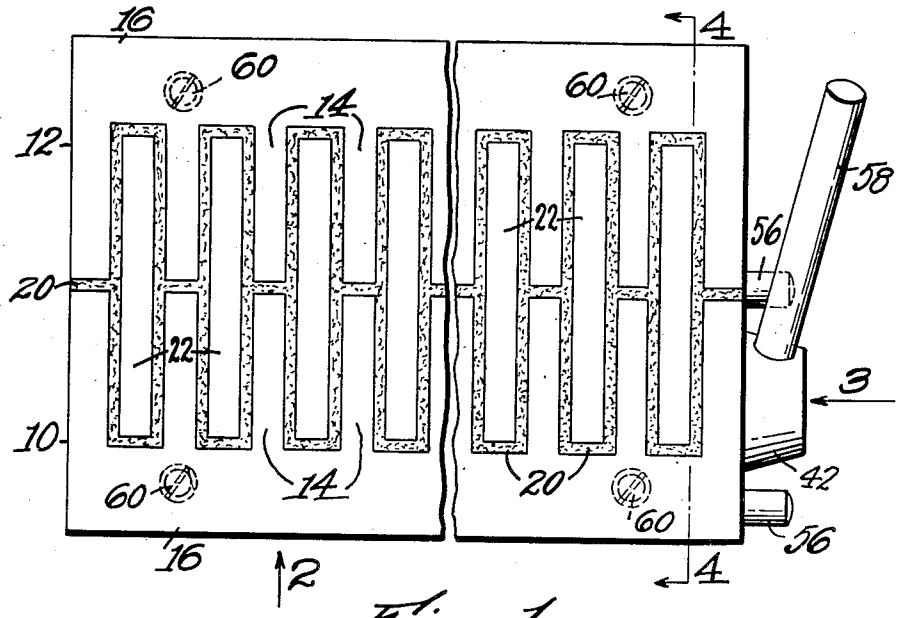


Fig. 1

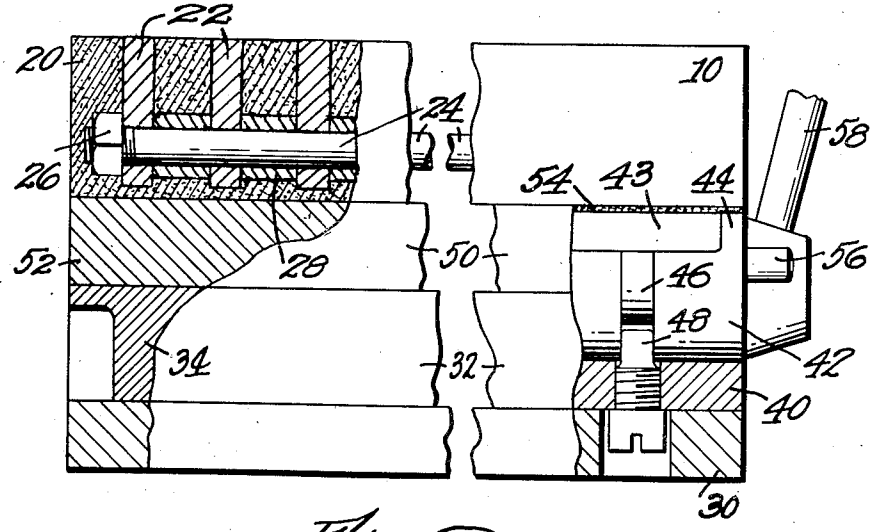


Fig. 2

Inventor
John T. Beechlyn
By attorney
Charles R. Fay

C. F. Jones

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MAGNETIC CHUCK

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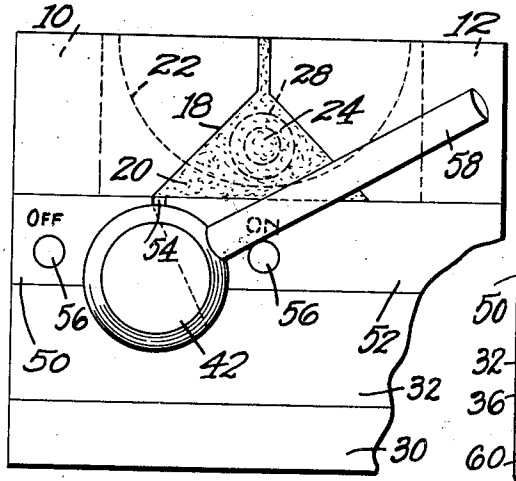


Fig. 3.

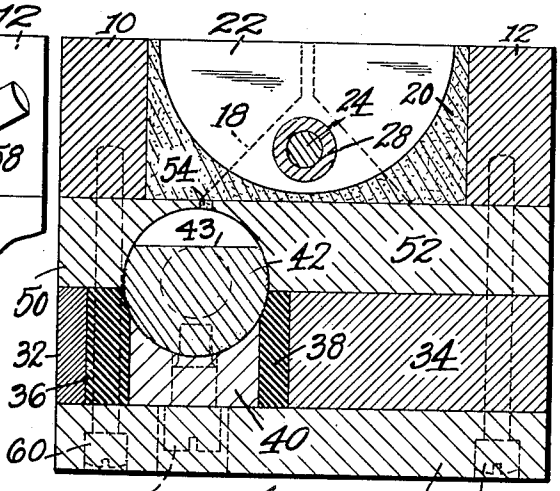


Fig. 4.

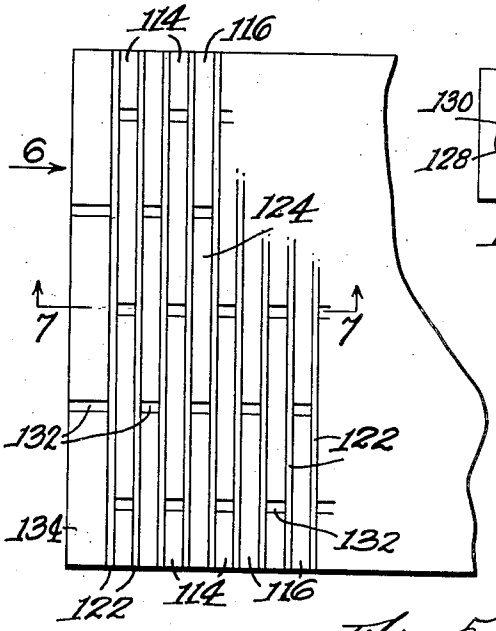


Fig 5.

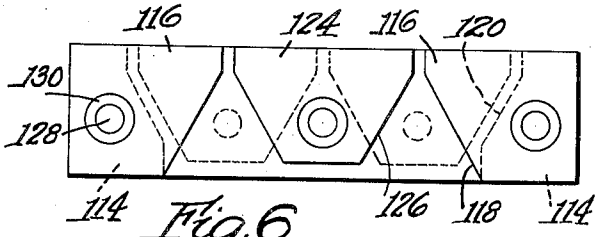


Fig. 6.

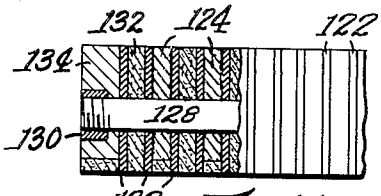


Fig. 7.

Inventor
John T. Beechlyn
By attorney
Charles R. Fay

Wilkinson Crowell

Nov. 2, 1943. J. T. BEECHLYN 2,333,230

MAGNETIC CHUCK

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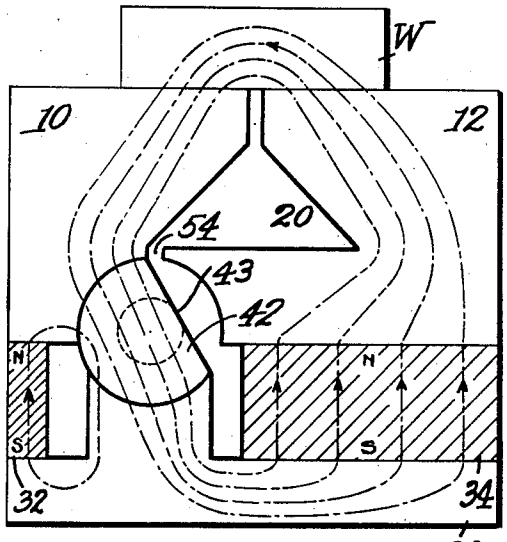


Fig. 8.

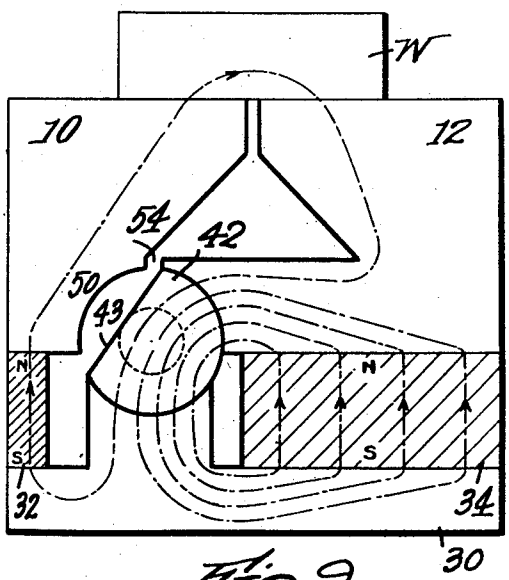


Fig. 9.

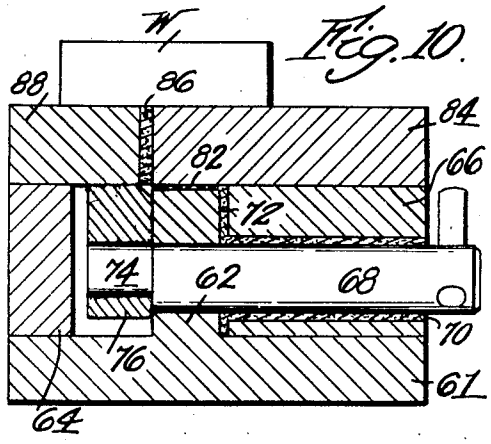


Fig. 10.

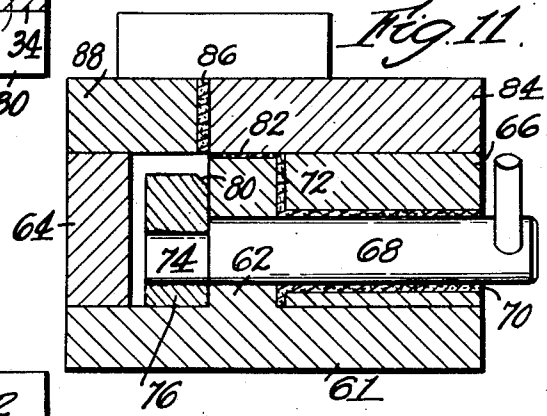


Fig. 11.

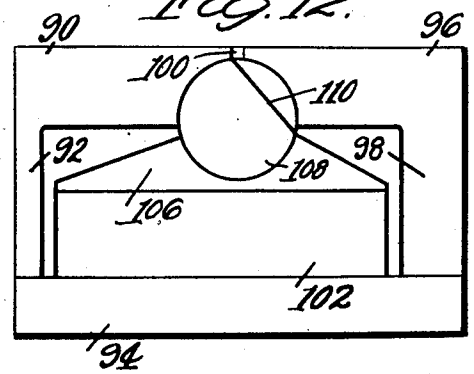


Fig. 12.

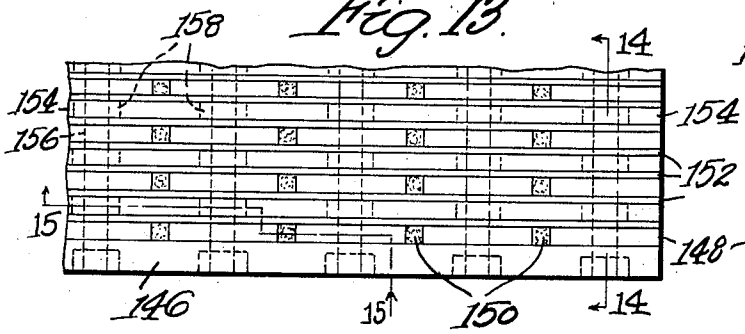
Inventor
John T. Beechlyn
By attorney
Charles R. Ray

Nov. 2, 1943. J. T. BEECHLYN 2,333,230

MAGNETIC CHUCK

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Fig. 13.



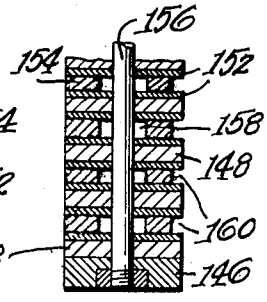


Fig. 14.

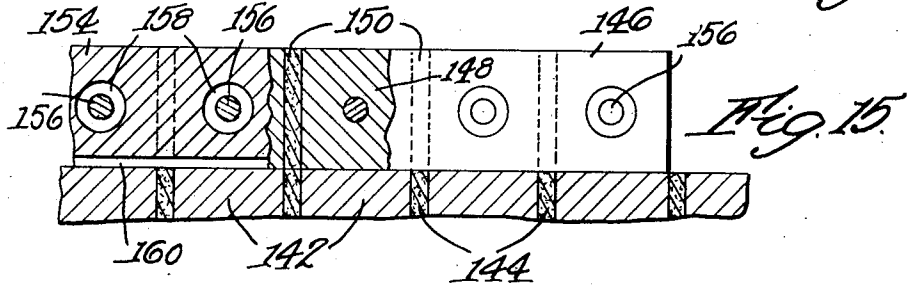


Fig. 15.

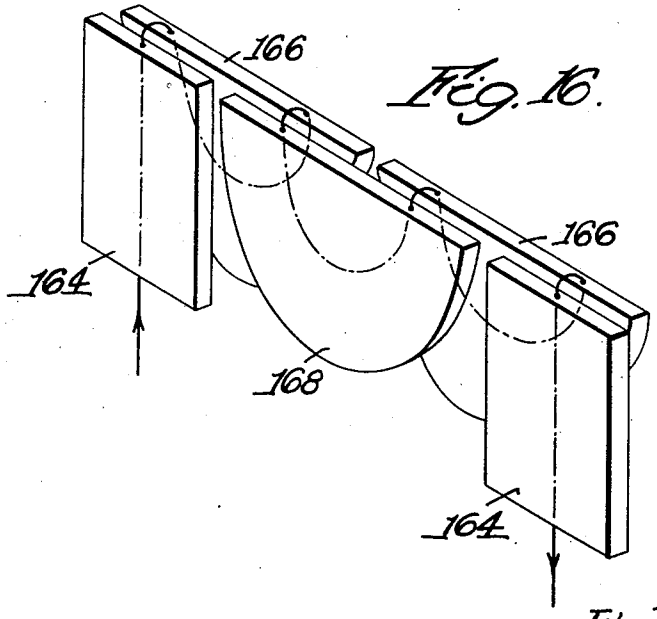


Fig. 16.

Inventor
John T. Beechlyn
By attorney
Charles R. Fay

Patented Nov. 2, 1943

2,333,230

UNITED STATES PATENT OFFICE

2,333,230

MAGNETIC CHUCK

John T. Beechlyn, Worcester, Mass., assignor to O. S. Walker Co. Inc., Worcester, Mass., a corporation of Massachusetts

Application December 24, 1940, Serial No. 371,518

11 Claims. (Cl. 175—367)

This invention relates to magnetic holding devices and embraces features rendering it particularly adaptable to chucks of the permanent magnet type, but the invention also contemplates features capable of utilization in chucks of either the permanent magnet type or of the electro-magnet type.

Objects of the invention include the provision of a holding device wherein the coercive material supplying the magnetic force is always stationary and in fixed relation to the work holding members or working surface, and provides dual magnetic circuits in the working surface, in combination with a movable means, preferably of high permeability but not coercive per se, to control the magnetic circuits so as to enable the device to hold or release the work; and the provision of a device as just described wherein the movable member is in reality a flux valve and is centered at a single point in the device, and in which the dual circuits merge, with the advantage that flux control is effected with a relatively small conduit section.

Further objects of the invention include the provision of a novel series-parallel arrangement of the pole pattern in the work surface of the chuck, wherein economic use of the available flux volume is effected by repeated use of the same lines of force, without encountering the limitations of the prior art sequence arranged poles; the provision of a novel pole arrangement wherein a wider span of effective holding surface is obtained between basic points of energization in the top plate, and which enables the proper holding of small pieces and pieces of slight thickness, the holding of which has always been unsatisfactory in the prior art; and the provision of novel pole pattern arrangements as above specified, which are usable and effective in chucks of both the permanent magnet and electro-magnet types.

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 top plan view of a device embodying the invention;

Fig. 2 is a side elevation with parts in section of the device as seen along arrow 2 in Fig. 1;

Fig. 3 is a front elevation as seen along arrow 3 in Fig. 1;

Fig. 4 is a section on line 4—4 of Fig. 1;

Fig. 5 is a top plan view of a modified top plate structure, with parts broken away;

Fig. 6 is a front elevation looking along arrow 6 in Fig. 5;

Fig. 7 is a section on line 7—7 of Fig. 5;

Fig. 8 is a diagrammatic view of the flux distribution of a device as constructed in Figs. 1 to 7, in "on" position;

Fig. 9 is a view similar to Fig. 8, but showing the flux distribution in "off" position;

Figs. 10 and 11 illustrate the "on" and "off" positions, respectively, of a modified form of the invention;

Fig. 12 shows a still further modification, with the valve in "on" position.

Fig. 13 is a partial plan view of an adapter plate;

Fig. 14 is a section on line 14—14 of Fig. 13;

Fig. 15 is a section on line 15—15 of Fig. 13 and showing the adapter plate in position on a chuck top plate; and

Fig. 16 is a diagrammatic view of elements of a top or adapter plate showing the flux paths when a work piece is in position thereon.

Turning first to the top plate of the chuck disclosed in Figs. 1 to 4, it will be seen that there are two complementary ferric or other permeable based pole piece sections 10, 12. These elements are alike and are constructed with comb-like teeth or fingers 14 and backs 16, the teeth being undercut as shown at 18 in Figs. 3 and 4, and aligned as shown in Fig. 1. The ends of the teeth 14 are adapted to be separated by a gap 20 of non-magnetic material which extends from end to end of the top plate and surrounds unbased or floating pole pieces 22 magnetically insulating the latter and the elements 10, 12 each from the others.

Pole pieces 22 are made in the form of semi-circular elements, as here illustrated, and are spaced to evenly fit between corresponding teeth 14 of the sections 10, 12. A ferric rod 24 having a nut 26 at each end may be used to clamp the pieces 22 in desired relation, there being ferric collars 28 spacing the pieces the correct distances to lie in the spaces between teeth 14. The pole pieces 22 may be assembled as a unit and lead or other non-magnetic material may then be cast in the gap 20 to complete the entire top plate as a single unit. It will be noted that the gap forms a triangular pattern between the undercut portions of the teeth 14, which provides a space for rod 24 while leaving a sufficient flux section for the top plate. As will be clear to those skilled in the art, the top plate unit just described will be useful in electro-magnetic chucks as well as in permanent magnet chucks.

The operation of the top plate will be discussed below in conjunction with the description of the form shown in Figs. 5 to 7.

Referring to Figs. 2 and 4, there is shown a bottom plate 30 of ferric material which extends throughout the area of the top plate. A permanent magnet 32 of small section is located at and rests on one longitudinal edge of the bottom plate coextensively therewith, and a second magnet 34 of larger section is located at the opposite edge and is spaced from magnet 32. Obviously, the space between the magnets is located to one side of the longitudinal axis of the chuck, and this space is utilized to allow for a unit comprising a thick brass or other non-magnetic bar 36 adjacent magnet 32, a thinner like bar 38, and a central ferric block 40. These bars and the block extend throughout the length of the chuck and are recessed at their tops in the form of a semi-circle to provide a partial bearing for a generally cylindrical ferric or other permeable rotatable bar 42.

Bar 42 is truncated at one side as at 43, but has a round bearing element 44 at each end thereof, and the bar is thus rotatably mounted. A peripheral groove 46 is provided for reception of a pin 48 screwed into block 40, the bottom plate 30 having a bore for accommodating this pin, which prevents longitudinal motion of the bar 42 while allowing rotary motion thereof.

Completing the energizing portion of the chuck, there are a pair of ferric members 50, 52, the former lying over the magnet 32 and brass plate 36, the latter lying over the magnet 34 and brass plate 38. These members are recessed to form the upper part of the bearing for the rotary bar 42, and are separated by a gap 54. The members 50, 52 carry projections 56 forming stops for a handle 58 for bar 42, and the projection on member 50 is labeled "Off," while the other projection indicates the "On" position of the chuck. Members 50, 52 form continuations of the sections 10, 12, respectively, and the parts are held in assembled relation by bolts 60.

Figs. 8 and 9 illustrate the operation of the chuck above described, it being noted that the magnets, or coercive elements, are rigidly held in fixed relation at all times, and that with the bar 42 in "On" position, as in Fig. 8, a large flux volume from magnet 34 passes up thru section 12, work W, down thru section 10, and thru the bar, to complete the circuit in the bottom plate. In this position, a large gap is apparent between the bar and member 52, forming part of section 12. Also, the flux emanating from magnet 32 is provided with a return path thru the bar at the same time the latter carries the work holding flux.

In Fig. 9, the bar 42 is shown in "Off" position and a large gap now appears between member 50 and the bar. This gap has the effect of placing a relatively great reluctance in the path of the flux of magnet 34 thru section 10, so that it does not now follow this path, but follows a path of lesser reluctance, which in this case, does not include the work. A gap also now appears between member 50 and the bottom plate and the flux from magnet 32, seeking its path of least reluctance passes thru the work in a direction opposite to the former flux therethru, and passing thru the bar 42 returns thru the bottom plate. This last flux provides for at least a partial demagnetization and consequent easy removal of the work piece.

It will be noted that the magnets are fixed and cannot be moved relatively to the chuck body, the whole work holding and releasing effect depending on the ferric but non-coercive bar 42, which may be referred to as a magnetic or flux valve. This bar is here illustrated as rotary, and may be moved easily from either "On" or "Off" position to the other as selected. It will be clear that dual circuits are provided, both circuits always merging in the bar or valve 42, which, merely by being correctly re-positioned, will cause either circuit to pass thru the work piece to the exclusion of the other circuit, and that the fluxes of these circuits, although unidirectional in the bar or valve, will be of opposite direction in the work piece. By having one magnet of large volume and one small, holding and demagnetizing effects are produced.

A modified chuck is illustrated in Figs. 10, 11, this form of the invention utilizing substantially the same mode of operation as that above described. A ferric base plate 61 having a longitudinal centrally offset flange 62 is provided and a solid magnet 64 of small section is located to one side of but parallel to and spaced from the flange. A magnet 66 of larger section is located in parallel relation at the other side of the flange and this magnet is apertured to allow for a ferric rotary rod 68 which may be surrounded in the aperture by a non-magnetic material such as lead, this construction thus providing a gap 70 completely surrounding rod 68 and separating flange 62 from the magnet as at 72.

Rod 68 is provided with an eccentric 74 for the vertical adjustment of a ferric block 76 which may assume extreme positions as shown in Figs. 10, 11, depending on the angular position of rod 68. Block 76 is beveled at 80 to continue gap 82 between flange 62 and one section 84 of the top plate and gap 86 between top plate sections 88 and 84. It will be noted that the gap between block 76 and section 88 is greater than gap 82 when the block is in position as shown in Fig. 11.

Fig. 10 illustrates the chuck in "On" position, flux from magnet 66 passing thru section 84, the work W, section 88, block 76, and base plate 61, while the flux from magnet 64 passes thru section 88, block 76 and the base plate without affecting the work. In Fig. 11, flux from magnet 66 will tend to pass over gap 82 which is less than the gap between block 76 and section 88, thus not affecting the work, and flux from magnet 64 now passes thru the work and also over gap 82, in the opposite direction to tend to demagnetize the work. It will be seen that dual circuits merging in block (or valve) 76 are produced, and that these circuits perform the same functions as those of the first described chuck.

Fig. 12 illustrates a further modification, wherein top plate section 90 has a ferric leg or connection 92 of small section abutting base plate 94, while top plate section 96 has a corresponding but larger sectioned leg 98. A gap 100 separates sections 90 and 96, and a single large magnet 102 rests on the base plate. An iron bearing plate 106 rotatably mounts an iron bar or rod 108 which may be similar to bar 42, and is truncated at 110 to provide a gap or selectively a flux path between sections 90 and 96 and the magnet. In this case, the chuck is illustrated in "On" position, such that flux from the magnet will pass up thru the bar 108, the major portion of the flux passing into the work (bridging the gap, but not shown) and a lesser portion will take the path thru member 92, of relatively

greater reluctance. In "Off" position, the greater portion of the flux will pass directly from bar **108** into section **96** and thru member **98**, of relatively smaller reluctance, while a lesser portion of the flux will pass thru the work in a direction opposite to the previous holding flux, tending to demagnetize the work. This portion of the flux will then pass thru the member **92**. It is to be noted that a slight gap could be used to obtain the same reluctance as now shown effected by the small section in member **92**. In any case, the direction of the flux in members **92**, **98** will always be the same, but the direction of the flux in the work piece may be changed by actuation of the bar **108**. Hence, dual circuits merging in bar (or valve) **108**, similar to the circuits previously described, are produced, but in this case a single magnet only is necessary to produce them.

In all of the chucks illustrated, the top plate of Figs. 1 and 2 may be used, and although the magnets tend to impart similar polarities in the based pole sections, diversion of one of the circuits will produce opposite polarities in the sections at the work holding surface.

Also, in all cases, the two circuits are always present in the sections and are affected to perform their functions merely by the re-positioning of the ferric valves.

A different form of top plate is illustrated in Figs. 5, 6 and 7, wherein small oblong iron pieces **114** alternate along opposite sides of the top plate with longer iron pieces **116**. The longer pieces are undercut as at **118**, the shorter pieces extending forwardly as at **120** below the surface of the plate to substantially align with the longer pieces at the bottom of the plate whereby all the pieces **114** and **116** have the same flux feed section. Each short piece is opposite a short piece at the other edge of the chuck and the long pieces are also opposite. Pieces **114** and **116** are separated by long brass or other non-magnetic strips **122** which extend from side to side of the plate.

Between the pieces **114**, **116**, which are, in effect, based pole elements similar in function to the sections **10**, **12** of Fig. 1, there are three sets of unbased or floating pole elements. Each set is similar to the others, but is offset, and each set comprises a series of spaced oblong iron pieces **124** undercut as shown at **126**. A long iron rod **128** extends thru and connects the pieces in each set, this rod passing thru strips **122**. Similar rods are used to assemble the pieces **114**, **116**, there being nuts **130** to secure the outer and central rods in place.

It will be seen that the pieces **124** are positioned to overlap corresponding pieces in the other sets and the pieces **116**, and that the whole assembly is sealed by means of lead or other non-magnetic material **132**, which underlies the lowermost points of the pieces **124**, but not the pieces **114**, **116** which extend below the others to form flux bases for the entrance of the flux from the chuck energizing members. All pieces **114**, **116**, and **124** are separated as shown, and this applies also to the outermost elements **134**.

In the practical use of magnetic chucks, a large variety of top plate forms is involved in regard to size, shape, and fineness of pole spacing. But, in general, all such forms may be divided into two distinct types, determined by the nature of the flux distribution in the holding surface. Of these types, the one in most common use involves the familiar arrangement of two pole bases of opposite polarity each of which carries a group of pole elements. The two groups are intermeshed, often in the form of grid, to provide a pole pattern of alternating polarity, the arrangement being thus similar to that of the plates in a storage battery cell, where the plates are connected in parallel.

Since substantially the full M. M. F. of the magnetic source is present between adjacent poles throughout the pattern, this type provides an optimum of holding power. However, this power cannot be obtained over the entire area of the working surface if the latter is made equal to the maximum plane section of the chuck, for the reason that the flux volume supplied to the pole bases is restricted by space required by an energizing winding in the electromagnetic chuck, and by the low flux density in the magnet alloy of a permanent magnet chuck.

A holding surface of optimum power can therefore not be extended indefinitely by adding reproductions of the primary chuck unit. This is particularly true if a fine pole pattern is used, because the small pole separation and large leaking area in such pattern entails a heavy flux loss beneath the working surface, and renders unavoidable in the top surface a marginal inactive zone of considerable area. Furthermore, in such a chuck the span of the grid bars must be kept relatively short on account of the small section available to conduct flux laterally. Thus a chuck designed for holding small work pieces, when built to this type, must necessarily be quite small.

The second type in common use is characterized by the condition that the two pole bases each present only a single pole element in the work-holding surface and that these are not situated adjacently but are designed to cooperate through a series of intervening unbased pole elements held in spaced relation.

The M. M. F. between adjacent poles in an unloaded surface will therefore be only a fraction of that obtaining between the two based elements and this naturally limits the number of intervening poles that may be judiciously employed.

When a number of work pieces are placed across such a surface, each of which contacts two adjacent poles, a satisfactory holding power is obtained and this is brought about with a very economic use of the flux since each line of force is used repeatedly in entering and leaving successive poles and work pieces.

For this reason, there is no difficulty in obtaining a total holding area equal to the maximum plane section of the chuck unit, and this area may be extended indefinitely by merely incorporating in the chuck a necessary number of primary chuck units.

This type is, however, not so well suited for holding single large pieces covering the entire span of a single unit, because the flux after entering the piece at one based pole will traverse the piece and enter the other based pole without interchanging much flux with the intermediate poles. If a thin plate is to be held, this shortcoming becomes very apparent, because not only will the effective holding area be restricted to a fraction of the occupied space, but the flux density of the flux transmitting pole area is apt to be quite low, because this area is likely to greatly exceed the cross sectional area of the plate which by saturation limits the flux volume.

This condition cannot be improved beyond a

certain limit by reducing the scale of the primary chuck unit, on account of required winding space in an electro-chuck, and, in the case of a permo-chuck, an unpractical multiplication of flux controlling means.

From the foregoing, it will be apparent that neither of the two types described is well suited for holding thin plates of considerable extent. The type first described provides indeed a high specific holding power, but since for best effect the pole width of chucks wherein, as in the chucks here disclosed, each pole carries the entire holding flux should be no greater than the thickness of the plate to be held, the fineness of the pattern will be such that the total width available as a continuous holding surface will be greatly restricted; while the second type, although not thus limited, has a relatively feeble holding power in such applications.

It is indeed an accepted fact that the prior art has not afforded provision for the satisfactory holding of thin plates of considerable extent, but this is now brought about by combining the parallel pole connections of the first described type with the series pole arrangement of the second type into a new series-parallel grouping of pole elements, as above described.

Referring to Figs. 5, 6 and 7, it will be seen that each of the pole groups joined by a rod **128** represents a member corresponding to a single pole in the second type discussed, the several members being arranged in magnetic series. However, coaction between any two adjacent members in the series takes place in the same manner as in the type first discussed, namely by the inter-nesting of two groups of pole elements in parallel connection.

It will now be evident that with a given span between the based members and a given fineness of pole pattern, the number of stages in the series will be greatly reduced from that required in the ordinary series type chuck, with the result that a correspondingly higher M. M. F. is obtained between adjacent poles and thereby improved holding power for small parts. Conversely, of course, if the number of stages be the same in both cases, the span between the basic points of energization can be made much greater with the new pole arrangement, although, ordinarily, this will not be an object.

It will be evident that a holding surface of this type can be extended indefinitely by added chuck units and symmetrical reproduction of the top plate. Such an extended surface also offers advantages over the ordinary series type for holding large work pieces entirely spanning one or several chuck units, because with the use of relatively few stages the based elements will represent a considerable portion of the total surface and thus provide a greater effective holding area. If the cross section of the piece is such that it will carry the flux across the unit without saturation, there will be practically no flux exchange with the intermediate areas. However, if a thin plate covering an entire unit span be placed in contact with the surface the flux transmitted will not be limited by the normal cross section in the plate, but rather by a developed section following the contour of the gap that separates the elements of adjoining members in the series. Since this section greatly exceeds the normal cross section of the plate a relatively large flux volume, which has entered the plate from a based member, will be able to traverse the work piece across the gap and then immediately enter the pole elements of the next adjoining member in the span. The flux will then traverse these elements for some distance across the span and then re-enter and again leave the work piece in order to reach the next succeeding member, this action being repeated until the final member in the series is entered.

This re-entrant course of the flux path with respect to a thin plate has been shown diagrammatically in Fig. 16, but the plate being held has been omitted in order to avoid obscuration of the flux path.

In the figure, the based pole elements are numbered **164**, and the flux is seen traversing these elements, as influenced by any of the magnets shown in this case. Unbased or floating pole elements **166** are longitudinally aligned and overlap the based poles and also the central floating pole element **168**. Obviously, the flux circuit will pass thru a based pole, cross the gap between the latter and element **166** next adjacent, traverse this element, and return across the gap to traverse element **168**, and so forth, thus providing a plurality of attraction points for the work piece.

It will be noted that a plate of this character affords a greater total holding power than a much thicker plate of the same area, because the latter provides no re-entrance of the flux and can convey no more than is transmitted to it through the saturated based pole elements, which volume is substantially the same in both cases.

This condition is in entire contrast with prior experience. It should be noted, however, that only a difference of forces is involved in this phenomenon, the energy involved being substantially the same in both cases. Thus the range of attraction at some distance from the holding surface will be greater for the heavy work piece plate, whereas the thin work piece plate depends upon intimate contact to cause re-entrance of flux.

In the foregoing three kinds of work pieces have been considered, which may be said to broadly cover the field of ordinary practical applications, and it has been shown that in each instance the new pole arrangement provides a better holding power than the series type chuck of prior art. Whereas, when comparison is made with chucks having parallel pole connection, the gain consists in the unlimited extension that can be given a surface having high holding power.

In Figs. 5, 6 and 7, the individual pole elements in each stage have been shown as being in ferric inter-connection by means of the rods **128**. This not only provides a convenient means of assembly and alignment, but is magnetically of importance, particularly when an isolated work piece is to be held by pole elements of two adjacent intermediate stages. In such case extra flux will reach the engaged pole elements by leakage between the remaining stages and since this is distributed along the entire length of the chuck the reluctance will be lower than if the engaged elements were isolated from other elements in the same stage. If the elements are evenly loaded by a flat plate, the rods do not perform any function and could be omitted. Also, if a particular construction wherein the rods were impractical were designed, the top plate would work without the rods.

The above discussion will illustrate the advantages and operation of the adapter plate shown in Figs. 13 to 15, wherein a conventional chuck top plate having poles **142** and gaps **144** is shown, in combination with which the adapter

plate is to be used. This plate comprises lateral iron side bars **146** (only one of which is shown) having next adjacent thereto a row of short oblong iron elements **148** spaced longitudinally by gaps **150**. Next to these elements there is a brass or other non-magnetic strip **152**, and then a continuous iron bar **154**. This construction is multiplied across the adapter to its opposite side. The parts are held assembled by rods **156**, which, as shown in Fig. 14, pass thru each series of elements **148** in intimate contact therewith, but the rods are gapped as at **158** with respect to bars **154**, and the latter are also gapped at **160** to avoid contact with the top plate.

By placing the adapter with gaps **150** aligned with top plate gaps **144**, it will be seen that in effect a top plate having the useful functions of the plate shown in Figs. 5 to 7 is formed, and that by this means the same chuck may be used to hold heavy or thin plates under optimum conditions for either.

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 magnetic holding device comprising a pair of spaced soft iron members forming a work surface, a soft iron base plate, a magnet having one pole directly and fixedly connected to one of said members and its other pole directly and fixedly connected to said base, and non-coercive high permeability soft iron means for magnetically connecting said base and the other of said members, said means being selectively movable to a position wherein it directly connects said base and said one member and disconnects said base and said other member.

2. In a magnetic holding device, a pair of magnetically insulated members forming a work holding surface, a base plate, fixed magnets spacing and directly communicating with each member and said base plate, said magnets each having like poles adjacent said base plate, and their opposite poles adjacent said members, and non-coercive ferric means effective to selectively magnetically connect and disconnect either one of said members with said base plate.

3. In a magnetic holding device, a pair of magnetically insulated soft iron members forming a work holding surface, a soft iron base plate, a soft iron element movably mounted to directly connect either of said members and said base plate while disconnecting the other member from said base plate, and spaced magnets directly and fixedly connected between each member and said base, said soft iron element being spaced from said magnets and located between them.

4. A magnetic holding device comprising two soft iron members in fixed noncontiguous relation, elements of each of said members jointly forming a work holding surface, a third soft iron member situated in spaced relation to said two members, a two pole permanent magnet having one of its poles in fixed magnetic connection with one of said first named members and its opposite pole in fixed connection with said third member, a second magnet having one of its poles in fixed connection with the other of said first named members and its opposite pole in fixed connection with said third member, and non-coercive high permeability soft iron means adapted to magnetically directly connect said third member and either of said first named members.

5. A magnetic holding device comprising a pair of ferric members magnetically separated to form a holding surface, a ferric base element, magnets forming a connection between each member and said element at spaced points thereon, means forming with these members, element, and magnets at least two distinct magnetic circuits, one circuit including both ferrric members and a work piece to be applied to said holding surface, and another circuit being contained entirely within the device and limited to one only of said ferric members, said magnets simultaneously supplying magnetic flux to said circuits, said circuit-forming means including non-coercive high permeability soft iron means to selectively and at least partially interchange the paths of the fluxes of said circuits with respect to said ferric members so that the flux of said one circuit is wholly contained within the device and the flux of the other circuit includes said work piece.

6. A magnetic holding device comprising a pair of ferric members forming a work holding surface, a gap between said members, a ferric base element, fixed magnetic connections from each member to spaced points on said base element, said magnetic connections including a source of magnetic flux adapted to impress a flux through said base element and both said members across said gap, a non-coercive high permeability soft iron connection between said base element and said members, said soft iron connection being movable to selectively connect either member singly to said base element to provide a closed circuit through the base element, the soft iron connection, and the one of the members connected to the base element, said soft iron connection forming a part of both circuits, and said magnetic source being effective to supply flux to both circuits simultaneously.

7. A magnetic holding device comprising a pair of ferric members forming a work holding surface, a gap between said members, an iron base element, a magnetic connection between each member and said base at spaced points on the latter, a movable non-coercive high permeability soft iron connection adapted to connect either member with said base, said magnetic connections both including a magnet, said magnets providing two separate simultaneous flux circuits one of which includes a magnet, the base, the soft iron connection, connected member, any ferric work piece spanning the gap, and the unconnected member; and the other circuit including the other magnet, base, soft iron connection, and the connected member only.

8. A magnetic holding device as recited in claim 5 wherein said non-coercive soft iron means comprises an element adapted to selectively magnetically connect either member to said base element intermediate of said magnets whereby the directions of the fluxes in said circuits are opposite when passing through the work piece.

9. A magnetic holding device comprising a pair of magnetically separated ferric members jointly forming a work holding surface having a gap, a ferric element spaced from said surface and forming a base for the device, fixed direct magnetic connections between each member and said base at spaced points on the latter, a non-coercive high permeability ferric connection between said base and said members, said non-coercive ferric connection being located intermediate of said first named connections and being selectively movable to connect either ferric member with said base to form a closed circuit within the device, said magnetic connections in-

cluding a source of magnetic flux adapted to impress flux through a circuit including the base, the member unconnected to the base at the non-coercive ferric connection, a work piece spanning the gap, the connected member, and said non-coercive ferric connection, said circuits being selectively interchangeable at least in part.

10. A magnetic holding device as recited in claim 9 wherein said fixed connections have markedly unequal flux sections.

11. A magnetic holding device as recited in claim 2 wherein said magnets are of markedly unequal flux volume.

JOHN T. BEECHLYN.