Dec. 22, 1959 C. D. BRIGGS 2,918,610

MAGNETIC CHUCK

Filed Jan. 16, 1956 3 Sheets-Sheet 1

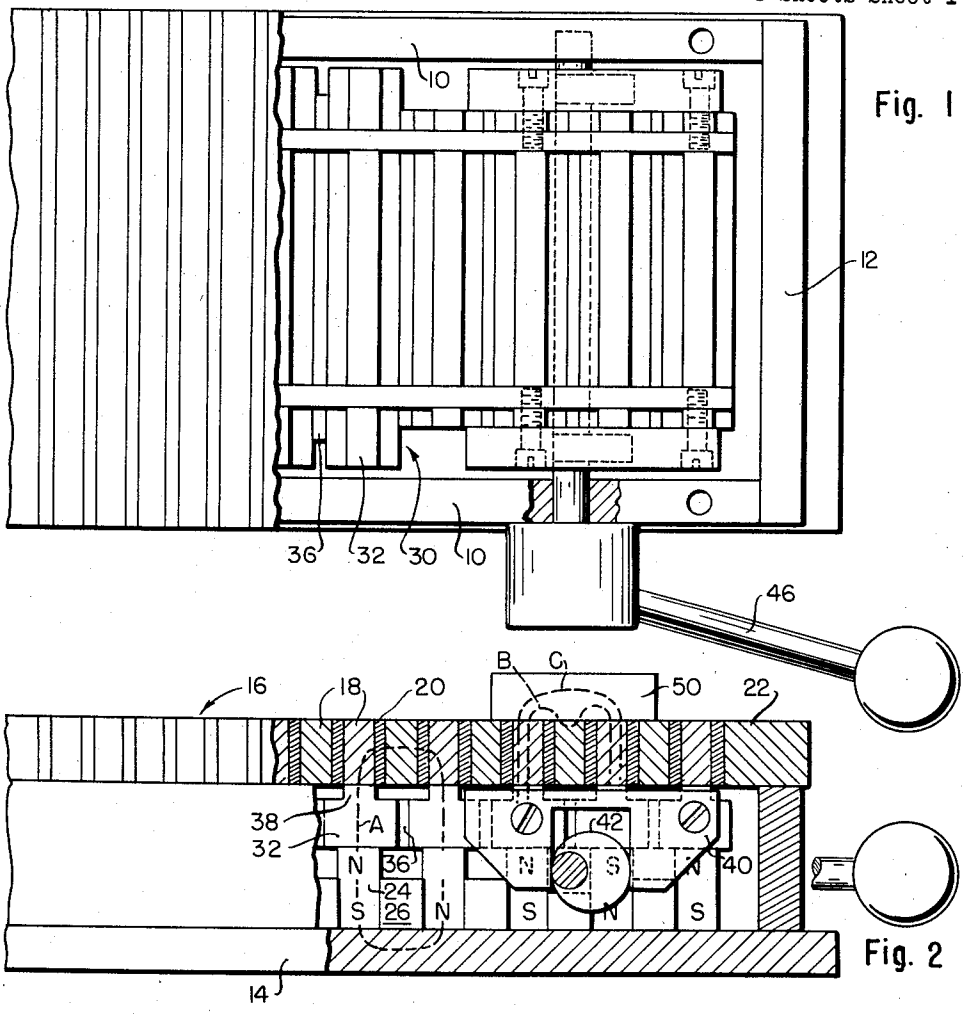


Fig. 1

Fig. 2

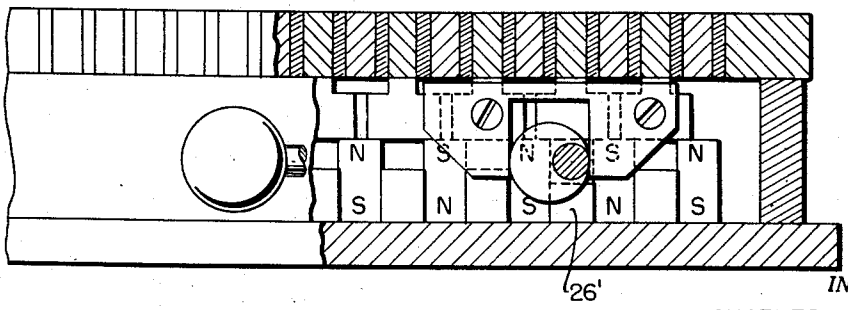


Fig. 3

INVENTOR.
CHARLES D. BRIGGS
BY Kenway Jenney Witter & Hildreth
ATTORNEYS

Dec. 22, 1959 C. D. BRIGGS 2,918,610

MAGNETIC CHUCK

Filed Jan. 16, 1956 3 Sheets-Sheet 2

Fig. 4

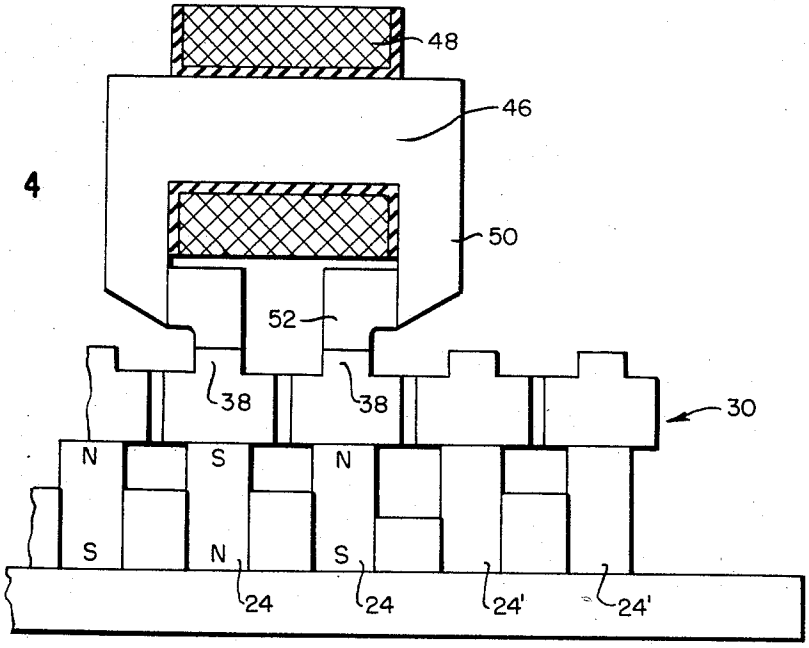
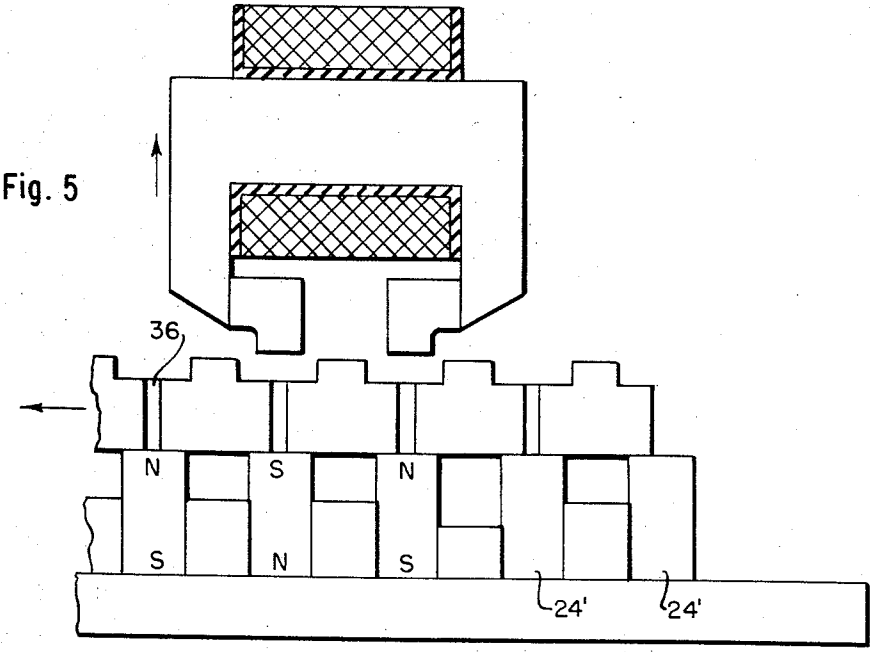


Fig. 5



INVENTOR.

CHARLES D. BRIGGS

BY Kenway Jenney Hilpatrick

ATTORNEYS

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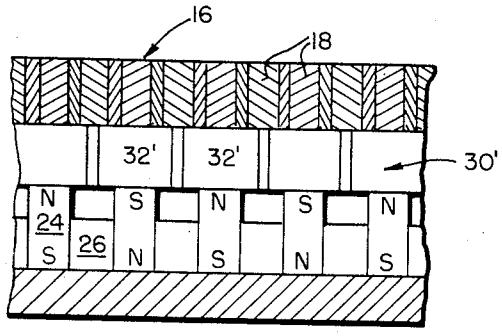


Fig. 6

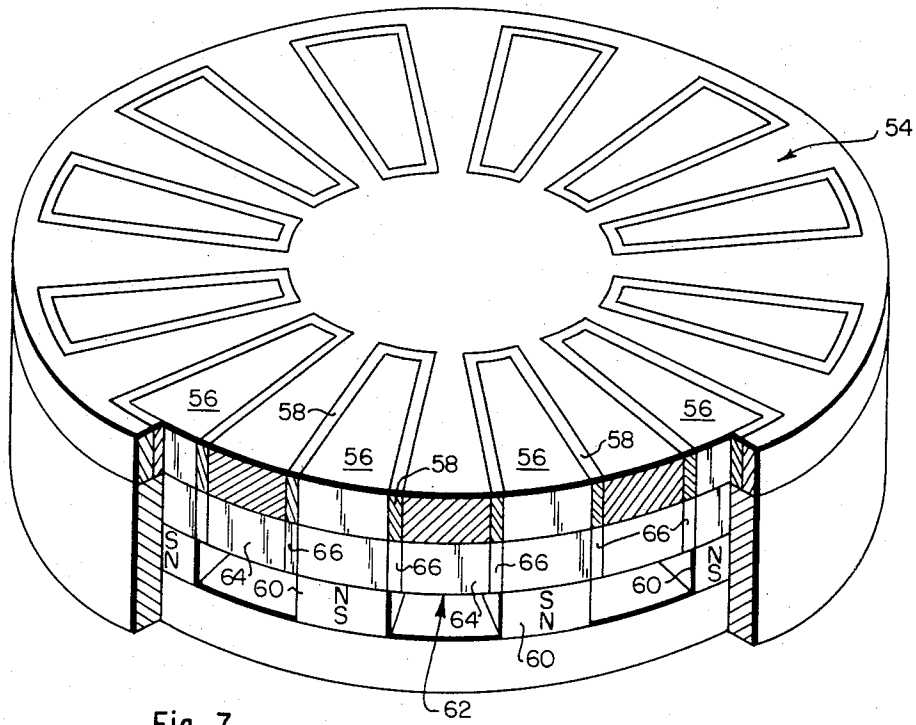


Fig. 7

INVENTOR.
CHARLES D. BRIGGS
BY Kenway Jenney Witter & Hildreth
ATTORNEYS

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MAGNETIC CHUCK

Charles D. Briggs, Worcester, Mass., assignor to O. S. Walker Company, Inc., Worcester, Mass., a corporation of Massachusetts

Application January 16, 1956, Serial No. 559,307

5 Claims. (Cl. 317—159)

The present invention relates to permanent magnet chucks.

In a common type of permanent magnet chuck the magnets are usually alternated with bars of soft iron or other magnetic conducting material. The purpose of this construction is to permit magnetization of the chuck in a single operation with all of the magnets of the same polarity. This requires that the magnetic circuit be completed through inactive bars. An object of the present invention is to provide a permanent magnet chuck in which magnets of opposite polarity are used whereby the magnetic circuit may be completed through magnets in series.

Another object of the present invention is to provide a permanent magnet chuck of the "bar pole" type in which the top surface of the chuck is divided relatively finely by the use of narrow strips or bars of magnetic material. Although so called bar pole arrangements are common in electro-magnetic chucks, such fine divisions have not usually been possible in permanent magnet chucks without the loss of holding force. Since the available magnetic energy in a permanent magnet chuck is necessarily smaller than in an electro-magnetic chuck of the same size, it is important that the flux be directed into useful passage through the work without excessive diversion through the leakage paths that are frequently associated with finely divided constructions.

With the above objects in view, the present invention comprises the permanent magnet chuck hereinafter described and particularly defined in the claims.

In the accompanying drawings Fig. 1 is a plan view, with the top plate partly cut away, of my preferred chuck,

Figs. 2 and 3 are sectional elevations illustrating the parts in work-holding and work-release position, respectively; and

Figs. 4 and 5 are diagrams illustrating the method of magnetizing the magnets of the chuck.

Fig. 6 is a sectional elevation illustrating a chuck similar to that in Figs. 1, 2 and 3 but with a neutralizing plate of different construction,

Fig. 7 is a top plan view of a rotary chuck embodying the features of the present invention.

The chuck shown in Figs. 1, 2 and 3 comprises side walls **10**, end walls **12**, a base **14** and a top plate **16**. The side and end walls are of any suitable material, and the base is of material of high magnetic conductivity. The top plate comprises a series of strips or bars **18** of magnetic conducting material, such as machine steel or soft iron, separated by brass or equivalent spacers **20**. As shown in Fig. 1 the strips **18** and **20** extend completely across the chuck. The top plate is provided with steel end pieces **22** suitably secured to the end walls **12**.

Mounted on the base **14** is a plurality of permanent magnets **24**. As shown in Figs. 2 and 3 the magnets are of alternating or opposite polarities. The provision of magnets with opposite polarities is believed to be new as a practical matter, since it has been customary to utilize magnets of the same polarity alternated with magnetic

conductors, in order that magnetization of the chuck after assembly may be effected. As will be explained later, the present chuck construction lends itself to satisfactory magnetization with magnets of alternating polarities. For the same volume of space taken by the magnetic material, therefore, the present invention has twice the magnetic energy of the conventional chuck.

The magnets **24** are spaced by spacers **26** of nonmagnetic material, and the entire assembly of magnets **24** and spacers **26** is mounted on the base plate **14**. As shown in Fig. 1 the magnet assembly is of somewhat reduced width at one end in order to accommodate the actuating devices to be described later.

Mounted on top of the magnet assembly is a sliding plate which may be termed a neutralizing plate, indicated generally at **30**. The neutralizing plate comprises a plurality of pole pieces, one for each magnet. The pole pieces are shown at **32**; they are of machine steel, soft iron or other magnetic-conducting material.

As shown in Fig. 1 each pole piece **32** extends across the chuck and overlies its corresponding magnet. Each pole piece has a bottom portion considerably wider than the magnet on which it is mounted, so that adjacent bottom portions **34** approach proximity to one another. They are separated by suitable nonmagnetic spacers **36** also extending substantially across the chuck. Above the base **34** each pole piece is formed with a boss **38** adapted to register substantially exactly with the underside of one of the strips **18** of the top plate. As shown in Fig. 2 the bosses **38** engage the under side of every second strip **18**, and intermediate strips **18** are not engaged by the pole pieces. There are thus twice as many bars **18** in the top plate as there are magnets **24** or pole pieces **32**. For purposes of definition, each bar **18** that overlies a magnet will be termed an "active" bar, and the bars alternating therewith will be termed "intermediate" bars.

As shown in Fig. 1 the neutralizer plate **30** is reduced in size at one end in a manner similar to the magnet pack, in order to accommodate the actuating mechanism to be presently described.

The plate **30** is adapted to be moved into neutralizing position shown in Fig. 3 wherein the bottom part of each pole piece **32** spans two magnets. For this setting the magnet flux does not enter the top plate and the work is released.

In order to actuate the plate **30** so that it may be moved between its Fig. 2 and Fig. 3 positions, it is provided at its end with depending yokes or frames **40**, one at each side of the plate and accommodated in the space afforded by the reduced end portion shown in Fig. 1. Received in the jaw of each yoke is an eccentric **42**. A shaft **44** extends across the chuck and has the two eccentrics mounted thereon. The shaft is accommodated by a spacer **26'** of less height than the spacers **26** between the other magnets. The shaft extends through one of the side walls and a handle **46** is secured thereto. Rotation of the handle by about 180° changes the plate **30** from work-holding to work-release position.

When the handle is in work holding position and no work is on the chuck, the flux path is generally as indicated by the dash line A in Fig. 2, namely, from a magnet through the pole piece **32** above it, thence into the "active" strip **18** immediately above the magnet, through the intermediate bar or strip **18**, then into the next active strip **18** and down through the pole piece and the magnet immediately thereunder, and into the base to complete the circuit. (Some leakage also occurs through the spacers **36** of the plate **30**.) When a piece of work **50** is placed on the chuck, the flux paths are as shown diagrammatically at B and C. The path B shows that some of the flux passes through the work at two spaced points and also passes through an intermediate bar **18** of

the top plate; thus the "stitching" effect familiar in electromagnetic chucks is obtained. This effect has been found advantageous, particularly in holding thin or irregular work pieces; for example, iwth a thin work piece, such as a piece of sheet metal, little or none of the flux would follow a path like that shown at C, and fine division of the top plate results in holding the work flat against the chuck. (In order to avoid confusion in the drawing, the return paths through the magnets are not shown for B and C.)

To release the work, the neutralizing plate is simply moved into its position wherein each pole piece **32** spans two magnets, as shown in Fig. 3.

Magnetization of the magnets is preferably carried by the process described in conjunction with Figs. 4 and 5. Although permanent magnet chucks with magnets of alternating polarities have been suggested, the magnetization has presented some difficulty. Previously magnetized magnets cannot be used because they will have been stabilized against air gaps longer than those to which they will be subjected in service. Therefore it has been customary to use magnets alternating with magnet conductors, and the entire chuck has been magnetized at once, with all magnets of the same polarities, thereby reducing by half the volume of magnet material that might be accommodated in the available space.

According to the method shown in Figs. 4 and 5 hereof, the magnets are magnetized one pair at a time. The method is carried out with the base **14**, the magnet pack and the plate **30** in position. The magnetizing apparatus comprises a head having a heavy core **46** energized by a winding **48**. Shoes **50** of magnetic conducting material are connected with pole pieces **52** which are adapted to engage accurately with two of the bosses **38** on the plate **30** above two adjacent magnets **24**. The pole pieces **52** may be made changeable in order to accommodate chucks with top plate bars of different sizes and spacings. The coil is then energized, thereby energizing the magnetic material of the two magnets **24**. The current is then turned off. In order to release the magnetizing head which is now magnetically held to the chuck by the magnets themselves, it is only necessary to slide the plate **30** to a position in which one of the pole pieces **32** spans the two magnets as shown in Fig. 5. The head may then be raised, as indicated in Fig. 5. The neutralizing plate **30** is moved back to its original position over the magnets, and the chuck parts are slid to the left, to bring the next two magnets **24'** under the magnetizing head. By this method magnets are not at any time subjected to air gaps any longer than the leakage gaps represented by the spacers **36**, which are substantially the same as the gaps to which they will be subjected in service.

After magnetization, the top plate **22** and the side and end walls, are fixed to the chuck, and it is then ready for service.

In Fig. 6, I show a modified construction in which a neutralizing plate **30'** is not provided with bosses but is of uniform height; that is, the pole pieces **32'** engage the underside of the top plate and each spans the distance between the approximate centers of two adjacent inactive bars of the top plate, when the chuck is in holding position. Release of the work is effected by moving the top plate **30'** so that the spaces between adjacent pole pieces **32'** overlie the magnets, in the same manner as in Fig. 3. The construction of Fig. 6 is simpler to manufacture than that of Fig. 2 and is especially suitable when the parts are of considerable size. On the other hand, when the conducting strips **18** are narrow and the magnets are correspondingly small, the boss construction of Fig. 2 is preferred because of the smaller amount of leakage flux.

The construction indicated in Fig. 6 is, in principle, adaptable to a rotary chuck of the type shown in Fig. 7, in which the top plate **54** is circular. The top plate is provided with a number of inserts **56** of magnetic material, separated from the top plate proper by non-magnetic spacers **58**. As shown in Fig. 7 there are twelve inserts **56**. The width of each insert **56** with its spacer **58** is approximately the same as the size of the sector of the top plate lying adjacent the spacer members.

Each insert **56** may be termed an "active" pole of the top plate corresponding to the active bars of Fig. 2, in that each pole piece **56** overlies a magnet **60**.

A neutralizing plate **62** is interposed between the magnet **60** and the top plate. The neutralizing plate **62** comprises a rotary plate having sectors **64** each of the same angular width as one of the insert sectors of the top plate. The sectors of the rotary neutralizing plate are separated by non-magnetic spacers **66**. In Fig. 7 the parts are shown in holding position. Angular motion of the neutralizing plate by about one-half the width of each magnet effects neutralization. The work is released by rotating the neutralizing plate **64** by a suitable cam means similar to that shown in Fig. 2 but not repeated in Fig. 7.

The chucks of Figs. 6 and 7 may be magnetized in identical fashion to those previously described by following the steps indicated in Figs. 4 and 5.

Having thus described the invention, I claim:

1. A permanent magnet work-holding device comprising a top plate having a plurality of active pole pieces and spacers of non-magnetic material interposed between the pole pieces, a plurality of permanent magnets disposed below the top plate in spaced relation to each other and to the underside of the top plate with the axes of the magnets substantially perpendicular to the top plate and with the top ends of the magnets in alternately N and S relation, the direction in which the magnets are spaced corresponding to the direction in which the pole pieces of the top plate are spaced, the magnets having a center-to-center spacing corresponding substantially to the center-to-center spacing of every second pole piece of the top plate, and control means for said magnets intermediate the top ends of the magnets and the underside of the top plate, said means comprising an array of spaced magnetically-conductive elements having a center-to-center spacing corresponding to the center-to-center spacing of the magnets, and means for effecting relative movement between the magnets and said array of conductive elements from a work-holding position in which each element of the array is in flux-conductive relation between a single magnet and a pole piece of the top plate to a release position in which each element of the array spans the unlike poles of two adjacent magnets.

2. Apparatus according to claim 1 wherein the magnetically-conductive elements of the array have magnet-contacting faces that are wider than the magnets.

3. Apparatus according to claim 1 wherein the magnetically-conductive elements of the array have magnet contacting faces that are wider than the magnets but have a width less than the center-to-center spacing of adjacent magnets.

4. Apparatus according to claim 1 wherein the top of each magnetically-conductive elements of the array has a surface contacting the underside of the top plate, said surfaces each having a width corresponding approximately to the width of a pole piece of the top plate.

5. Apparatus according to claim 1 wherein the magnets are fixed in position and the array of spaced magnetically-conductive elements is bodily movable relative to the magnets and to the top plate.

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