June 12, 1962 G. N. LEVESQUE 3,039,026

MAGNETIC CHUCK

Filed June 16, 1959

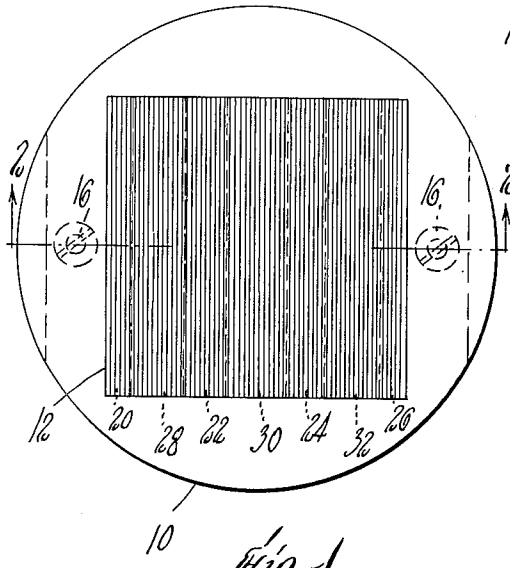


Fig. 1.

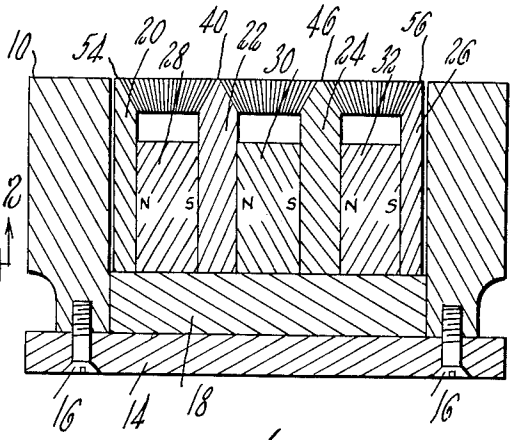


Fig. 2.

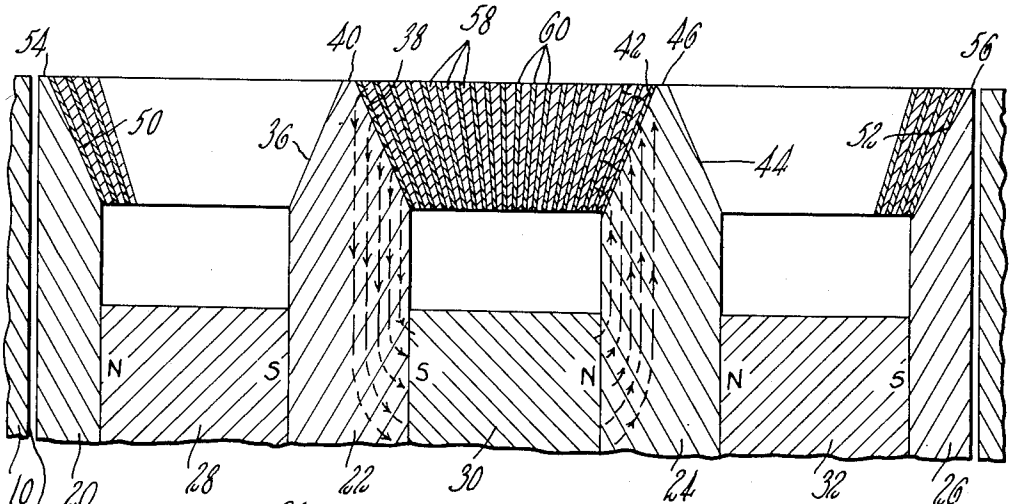


Fig. 3.

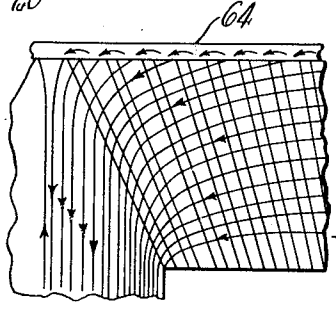


Fig. 4.

Inventor
George N. Levesque
by Maxwell Fish
Atty.

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MAGNETIC CHUCK

George N. Levesque, Warwick, R.I., assignor to Brown & Sharpe Mfg. Co., Providence, R.I., a corporation of Rhode Island

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The present invention relates to magnetic chucks and more particularly to a magnetic chuck having a finely divided work holding surface adapted for the holding of thin stock.

It is a principal object of the invention to provide an improved magnetic chuck in which the magnets and pole pieces together with the magnetic inserts and spacing elements of the chuck work holding plate assembly are so constructed and arranged as to provide a holding surface adapted for holding very thin stock which may be of as little as .001" to .002" in thickness with a greater degree of firmness and tenacity than heretofore considered possible.

It is another object of the invention to provide an improved magnetic chuck of this general type having a finely divided magnetic surface in which the holding power provided by the magnetic flux acting upon thin stock is of a uniformly high strength over the entire work surface of the chuck.

With these and other objects in view, a feature of the invention consists in the improved construction and arrangement of the magnets, pole pieces, magnetic inserts, and spacer elements of a magnetic chuck to provide for a very fine division of the magnetic areas and intervening nonconducting spaces together with an even distribution and maximum flow of the magnetic flux over the entire surface.

More specifically, a feature of the invention consists in the provision of a chuck having at least two magnetic poles of opposite polarity, with work holding pole pieces sharply tapered from a root area of massive cross section at the underside of the work holding plate assembly to a small apex at the work face of the chuck, in combination with a series of downwardly tapered magnetic inserts together with their intervening spacers, said magnetic inserts and the apex portions of said pole pieces being so constructed and shaped as to provide a series of substantially equal work holding magnetic areas over the entire work holding surface of the chuck including specifically those adjacent to and overlying said pole pieces.

With the above and other objects in view as may hereinafter appear the several features of the invention will be readily understood by one skilled in the art from the following description taken in connection with the accompanying drawings in which:

FIG. 1 is a plan view of a magnetic chuck embodying in a preferred form the several features of the invention;

FIG. 2 is a sectional view in side elevation taken on a line 2—2 of FIG. 1;

FIG. 3 is a somewhat fragmentary sectional view similar to FIG. 2 but on an enlarged scale illustrating my improved construction of the magnetic work holding surface of the chuck; and

FIG. 4 is a diagrammatic view on an enlarged scale of a pole piece together with adjacent magnetic inserts and spacers to illustrate particularly the distribution of the flux from the pole piece into the adjacent magnetic spacers and into a workpiece mounted on the work holding surface of the chuck.

The invention is herein disclosed as embodied in a permanent magnet chuck of the general type having a roughly rectangular work surface comprised of a series of pole pieces spaced across the work holding surface,

and a series of magnetic inserts and nonmagnetic spacers interposed between adjacent pole pieces to provide a holding surface having finely divided magnetic holding areas adapted for holding thin stock. Adjacent pole pieces are oppositely polarized by means of magnets which cause a flux to flow between the pole pieces through the interposed magnetic inserts and across the many air gaps provided between the finely divided adjacent magnetic surface holding areas of the chuck.

Referring particularly to the drawings, the illustrated chuck comprises a circular casing **10** which may be of aluminum formed with a square cutout **12** to receive a rectangularly shaped chuck body, and a base plate **14** fastened to the casing **10** by means of machine screws **16**. The chuck body comprises an inner casing of nonmagnetic material generally designated at **18** within which are mounted four rectangularly shaped pole pieces **20**, **22**, **24** and **26** which are separated by three magnets **28**, **30** and **32** which are cross magnetized and are so arranged as to cause the pole pieces **20** and **22** to have a north polarization and the pole pieces **22** and **26** to have a south polarization. In the preferred embodiment of the invention shown, magnets of grain oriented barium ferrite are employed. It will be understood that the invention is not limited to the particular kind or shape of magnets employed and further that electromagnets may be substituted within the spirit and scope of the invention if so desired.

In order to provide for a uniformly fine division of the work holding surface and at the same time to insure an even flow of the magnetic flux from one to another of the finely divided magnetic areas including particularly those disposed directly over the individual pole pieces, the individual pole pieces **20**, **22**, **24**, **26** are each formed with a large root area which comprises the full cross-sectional area of the individual pole piece. As shown in the drawings, the sides of each pole piece, as for example, the pole piece **22** is formed at its upper end with sloping sides **36**, **38** which form a taper starting at the underside of the work holding plate assembly and terminating in an apex **40** of small area at the work holding face of the chuck. The pole piece **24** is similarly provided with a tapered top portion comprising sloping sides **42**, **44** which terminate in an apex **46** of small area at the top face of the work holding surface.

The end pole pieces **20** and **26** of the magnet assembly are formed at their upper ends with outwardly sloping inner faces **50**, **52** respectively which extend from the underside of the work holding plate assembly to an apex **54**, **56** providing a small surface area at the work holding face of the chuck.

The portion of the work holding plate assembly between the two pole pieces **22**, **24** is formed of a series of downwardly tapered magnetic inserts **58** which are separated from one another and from the tapered faces **38** and **42** of the pole pieces **22**, **24** by means of thin nonmagnetic spacers **60** which are of uniform thickness and which provide suitable air gaps between the magnetic areas provided by the tip portions of the pole pieces **22**, **24** and the magnetic inserts **58**.

The portions of the work holding plate assembly extending between the poles **22** and **20** and between the poles **24** and **26** are identical in construction with that portion of the work holding surface above described and fully illustrated in FIG. 3 as extending between the two pole pieces **22** and **24**. It is, therefore, believed unnecessary to illustrate or to describe these similar portions of the work holding surface in further detail. It will be evident from the above description that a work holding surface of uniform appearance across its width is provided having a series of small magnetic areas of oblong shape which are of identical size and are separated from

one another by identical amounts by means of said spacers **60**.

The approximate dimensions of the illustrated chuck are given as follows: The three rectangular cross-magnetized grain oriented barium ferrite magnets **28, 30** and **32** are preferably about .5" thick, the two soft steel pole pieces **22, 24** are approximately .3" thick, and the two side pole pieces **20, 24** will be approximately .2" thick. The magnetic inserts may, for example, have a thickness at the upper or butt end of .019" and a thickness at the bottom tip of the tapered portion thereof of .009". The length of each of the air gaps provided by the nonmagnetic spacing members are each ten thousandths of an inch in thickness. The total air gap between adjacent polarized pole pieces is approximately .21". The dimensions above given while suitable for use in the small fine mesh chuck illustrated utilizing grain oriented barium ferrite magnets, may be varied over wide limits in accordance with the work requirements, and will depend also on the magnetic source employed. It will be understood that the invention is not limited to the construction shown and that substantial variations may be employed both in the pattern and size of the magnets, and in the number and width of the magnetic inserts and spacers employed depending upon the use to which the chuck is to be put. In general, the benefits of my invention will be realized most fully when at least five or more such magnetic inserts are employed between adjacent magnet poles. In a magnetic chuck particularly adapted for the holding of very fine work pieces which may be in the order of .001" to .002" or more in thickness, a very fine division of the chuck work holding surface is to be desired.

My improved chuck work holding plate assembly having as component parts thereof the tapered pole pieces and correspondingly tapered magnetic inserts above described provides for a substantial increase in volume and for a more efficient distribution of the flux channeled through the magnetic work holding surface and through the work pieces to be held thereby, particularly thin stock. It will be understood that for the holding of thin stock such as indicated at **64** in FIG. 4 a substantially uniform distribution of flux over the finely divided magnetic work holding surface is essential since a massive concentration of flux at any particular point on the work holding surface, will result merely in the passage of the flux through the thin work without any substantial holding effect. In particular, my tapered pole piece construction provides a massive root area through which the entire amount of the flux generated by the magnetic source is readily channeled (see FIG. 4) across the magnetic inserts and intervening nonmagnetic spacers to another tapered pole piece which is similarly formed with a massive root area of sufficient extent to channel the entire amount of the flux generated back to the magnetic source. With this arrangement a maximum amount of flux will be channeled through the upper or apex portion of the tapered pole piece **40** and through the intervening magnetic inserts and nonmagnetic spacers to the apex portion **46** of the next adjacent pole piece of opposite polarity, so that each of the magnetic areas including both the magnetic inserts and the apex portions of the individual pole pieces will receive substantially the same volume of magnetic flux and thus will form a very large number of magnetic holding circuits from one magnetic area to another across the intervening nonmagnetic spacers.

The invention having been described what is claimed is:

1. In a magnetic chuck having a magnetic flux generating means, the combination of a work holding assembly which comprises pole pieces of opposite polarity, each of said pole pieces having a root area at the underside of said work holding plate assembly of substantial cross section sufficient for carrying a large proportion of the flux generated by said flux generating means and a tapered portion projecting upwardly from said root portion through the work holding plate assembly terminating in a small apex forming a portion of the work holding surface of said working holding plate assembly, and interposed between said pole pieces a series of downwardly tapered magnetic inserts providing a series of magnetic holding areas in the surface of said work holding plate assembly, and nonmagnetic spacers disposed between and separating each of said magnetic inserts and pole pieces from one another to provide magnetic flux circuits of substantially uniform maximum strength and tenacity between adjacent magnetic holding areas across the width of said work holding assembly.

2. In a magnetic chuck the combination with a magnetic flux generating means of a work holding plate assembly comprising at least two magnetic pole pieces of opposite polarity connected with said flux generating means, each of said pole pieces having a root area at the underside of said work holding plate assembly of substantial cross section sufficient for carrying a large proportion of the flux generated by said flux generating means and a tapered portion projecting from said root portion upwardly through the work holding plate assembly and terminating in a small apex forming a portion of the work holding surface of said work holding plate assembly, and interposed between said pole pieces a series of downwardly tapered magnetic inserts, and nonmagnetic spacers disposed between and separating each of said magnetic inserts and pole pieces from one another, said magnetic inserts and the apex portions of said pole pieces being so constructed and arranged as to provide in said work holding surface a series of holding magnetic areas of substantially equal width whereby lines of flux of substantially equal density are directed from one to another of said magnetic areas comprised by said pole pieces and magnetic inserts.

3. In a magnetic chuck, the combination of work holding plate assembly comprising at least two polarized pole pieces of opposite polarity each having a flux carrying root area at the underside of said work holding plate assembly of substantial cross section tapered upwardly to a small apex forming a surface magnetic holding area in said work holding plate assembly, and interposed between said polarized pole pieces, a series of at least five downwardly tapered magnetic inserts providing intervening magnetic holding areas of said work holding plate assembly, and means providing nonmagnetic gaps of substantially uniform thickness between each of said tapered magnetic inserts and said polarized tapered pole pieces, the surface magnetic holding areas of said polarized pole pieces and magnetic inserts being so constructed and arranged as to provide a series of holding surface magnetic areas of substantially uniform width to provide magnetic flux circuits of substantially uniform strength and tenacity between adjacent magnetized holding areas along lines projected from one to the other of and including the apexes of said polarized pole pieces.

4. In a magnetic chuck the combination wtih magnetic flux generating means, of a work holding plate assembly comprising a plurality of pole pieces of alternating polarity connected with said magnetic flux generating means and spaced from one another across said work holding plate assembly, each of said pole pieces having a root area at the underside of said work holding plate assembly of a substantial cross section sufficient for carrying a maximum flux generated by said magnetic flux generating means, and a tapered portion adjacent to said root area tapered upwardly to a small apex forming a portion of the surface area of said work holding plate assembly, and in each of the spaces provided between adjacent pole pieces a series of downwardly tapered magnetic inserts and nonmagnetic spacers separating each of said magnetic inserts and pole pieces from one another, the butt ends of said tapered magnetic inserts and the apexes of said polarized pole pieces appearing as magnetic holding areas in the surface of said work holding plate assembly

to provide substantially uniform magnetic flux circuits of maximum strength and tenacity between adjacent magnetized holding areas across the width of said work holding assembly.

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