Aug. 24, 1943. C. O. SMITH 2,327,748

UNIVERSAL WORK-HOLDING PLATE FOR MAGNETIC CHUCKS

Filed April 24, 1941 2 Sheets-Sheet 1

Fig. 1.
Prior Art.

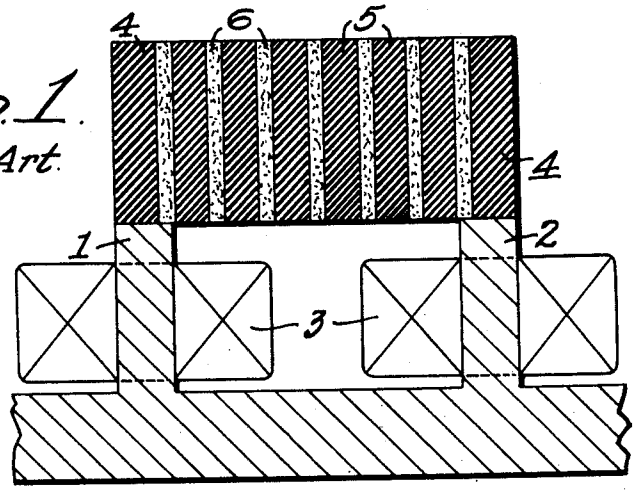


Fig. 2.
Prior Art.

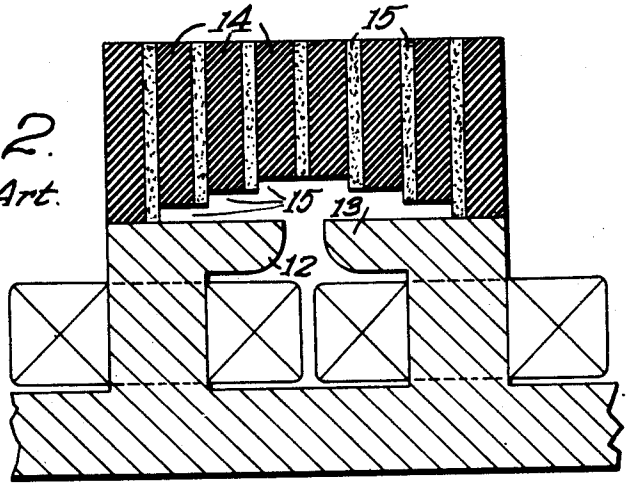
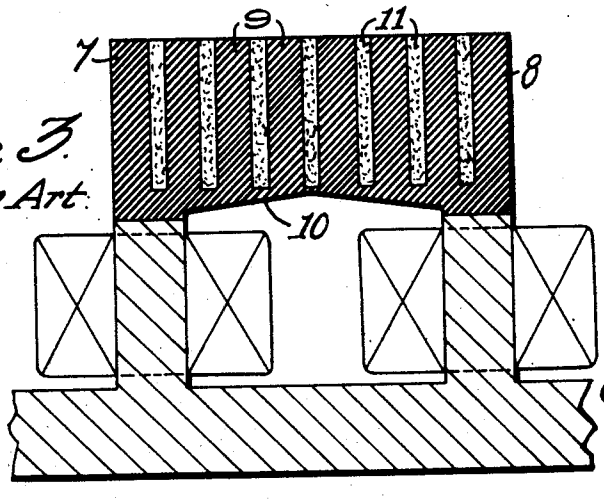


Fig. 3.
Prior Art.



Inventor:
C. O. Smith
By attorney
Charles R. Fay

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Fig. 4.

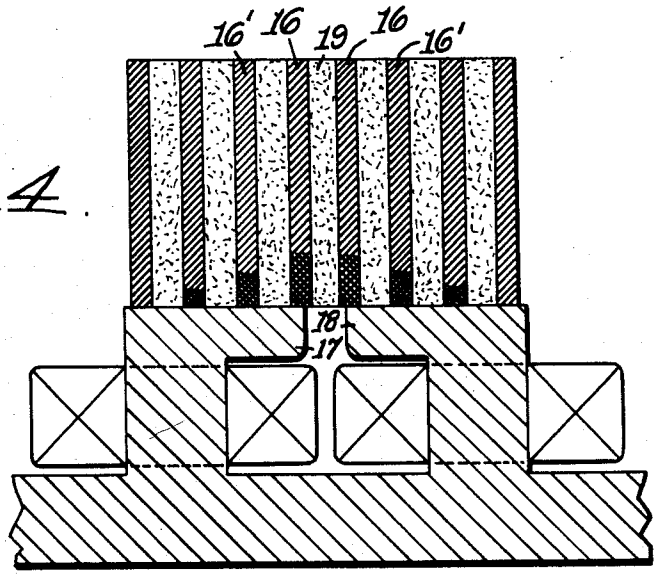
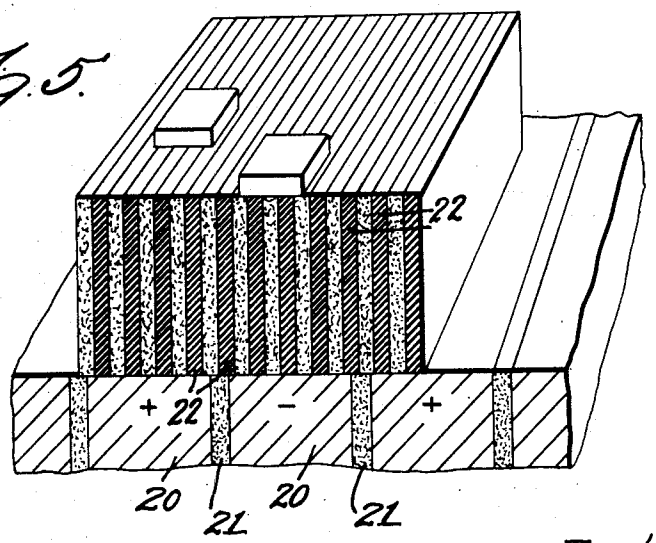


Fig. 5.



Inventor
Clayton O. Smith
By attorney
Charles R. Fay

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UNITED STATES PATENT OFFICE

2,327,748

UNIVERSAL WORK-HOLDING PLATE FOR MAGNETIC CHUCKS

Clayton O. Smith, Worcester, Mass., assignor to O. S. Walker Co. Inc., Worcester, Mass., a corporation of Massachusetts

Application April 24, 1941, Serial No. 390,154

1 Claim. (Cl. 175—367)

This invention relates to work-holding plates for magnetic chucks, being principally in the nature of auxiliary means for extending the use of chucks of conventional type, to the holding of certain classes of work, not contemplated by the original chuck design.

A large variety of such plates has been used in the past and may be roughly divided into two classes, namely those designed to engage special contours or position the work at a predetermined angle, and those designed to provide a flat surface having a greater fineness of pole spacing than the underlying chuck surface, whereby small or thin workpieces may be held with greater security and continuity.

The first mentioned class is often furnished by the trade in the form of rectangular plates, the upper surface of which may be machined by the user to fit his particular purpose. Most often such plates consist of a series of vertically disposed iron elements separated by non-magnetic inserts and adapted to register with the pole-pattern of a chuck having similar spacing. Such plates may, however, also be used with chucks having a different pole spacing, although this ordinarily involves a certain sacrifice of holding power, since an optimum holding power occurs only at intervals corresponding with the degree of registration. Under these conditions it is evident that a more pronounced difference in spacing between plate and chuck poles tends to increase the occurrence of magnetic nodes and thereby to promote some degree of continuity of holding power. Examples of registering and non-registering plates of this nature are disclosed respectively in Patent No. 1,312,546 to Karasick, and in Patents 1,343,751 to Simmons and 1,301,135 to Karasick.

In regard to the second class of plates discussed, namely such as are designed for the holding of small work pieces, the prior art involves a type requiring definite registry with a corresponding pole pattern in the chuck surface. Such a plate has been shown in Patent No. 2,209,558, Bing et al. It will be evident that the configurations of the ferric contact areas respectively in the bottom surface and in the top surface of the plate must be distinctly different to provide the desired result and further, that the use of any one plate of this type must be confined to chucks having a corresponding pole spacing.

It is a general object of this invention to combine in a single type of plate, as far as possible, all of the functional capacities now provided by the two types that have been discussed in the foregoing, and thus to provide a universal holding means for many applications not contemplated by a conventional chuck.

Other objects include provision for a plate that will not require registration with the chuck pole pattern, beyond the need of keeping the plate in square alignment, and that will have practically continuous holding power over its entire area and will securely hold extremely small pieces.

It is also an object to provide a plate which can be inexpensively manufactured, and lends itself to profiling or machining to fit particular applications, but which may also be used as a top-plate for a chuck. In fulfilling these and other objects, the invention makes use of a structure essentially similar to the type first discussed in the foregoing, but differing from the prior type in certain respects, namely, by the relative proportions of the elements composing the plate and their proportions with respect to the average width of pole elements likely to be encountered in practice. However, the properties thus bestowed on the plate are not merely a change in degree of already existing properties, but are new in character, due to utilization of the principle of saturation in ferric induction which occurs with relative abruptness, and can bring about very definite changes of flux distribution in a compounded magnet circuit.

Other objects and advantages of the invention will appear hereinafter.

In the drawings,

Figs. 1 to 3 illustrate various types of work-holding plates or blocks as utilized in the prior art; and

Figs. 4 and 5 illustrate the improved work-holding plate or block as contemplated in the present invention.

Although the present adapter plate is designed for use with a conventional pole pattern, i. e., one in which two pole groups are intermeshed to form a succession of alternating polarity with poles of each sign respectively connected in parallel to a common pole base, the work-holding surface of the plate itself has the characteristics of a bar pole chuck, this being a name used in the trade to designate a chuck in which a limited group of pole elements are arranged in magnetic series. For this reason, it is desirable to discuss the present device with relation to the prior art in this class to more clearly describe the invention.

Fig. 1 shows a bar pole chuck having base poles 1 and 2 of opposite sign, and adapted to be ener-

gized by windings 3. A work-holding plate having a series of spaced pole elements is provided in an attempt to distribute the flux over the entire holding surface in a uniform manner. It will be noted that the end pole elements 4 are based on poles 1 or 2, and that the intermediate elements 5 are unbased, so that in unloaded condition the M. M. F. drop between any two adjacent poles will be but a fraction of that obtained between the based pole elements 4. It has been found in practice that the drop between pole elements is not uniform throughout the series, but is greatest between a based element 4 and its next adjacent unbased element 5, and the drop decreases toward the center of the span of the plate, where it becomes a minimum. This inequality in the potential drop is due to air leakage both above and below the plate, which occurs even between relatively remote pole elements, and this causes a progressive diminution of the flux transmitted directly over the gaps or spaces 6 between the pole elements as the center of the span is approached. If the gaps are uniform in width, the potential drop will vary directly as the flux density in the gaps.

It is evident that this condition could be corrected by using gaps of different widths at different points in the span, but in practice, it is customary to seek the same result by providing an auxiliary flux channel extending at least part way across the span, this being designed to lower the potential drop over gaps near the ends of the span, and thus to conserve a larger proportion of the total drop for gaps near the middle. One much used method for achieving this is shown in Fig. 3, where numerals 7 and 8 represent the two based end pole elements. The latter and the intermediate poles 9 are all joined by a ferric bridge 10, the cross-section of which is progressively reduced toward the center of the span. Flux transmission over this bridge is naturally limited by saturation in the bridge, but the local reduction of reluctance, which is greatest toward the ends of the span, tends to equalize the flux density in the several gaps 11.

Another much used construction is shown in Fig. 2. In this case there is no bridge but the two pole bases 12, 13 have each been extended to within a short distance of the middle of the chuck span. The intermediate poles 14 are of varying height causing them to be progressively spaced a greater distance from each of the extended bases. The auxiliary flux paths provided by the bases and the increasing gaps 15 separating them from the pole elements operate in an obvious way to produce the same results as in the first described method.

Referring now to Fig. 4, it will be seen that the general arrangement is very similar to that shown in Fig. 2 except that the gaps separating the intermediate plate pole elements 16, 16' from the pole bases 17 and 18 have been reduced to zero. Ordinarily this would constitute an overcorrection of the condition remedied in Figs. 2 and 3. In other words, the potential drop between the pole elements over each base would be practically reduced to zero and the entire drop would occur between the two poles in the middle of the span with a correspondingly high density in the gap 19 at this point. Such would indeed be the case except for the fact that the pole element sections have been greatly narrowed, and the gaps have been correspondingly widened, so that the expected flux volume across the central gap 19 cannot be conveyed from the base by the horizontal ferric section of the pair of pole elements adjacent to the central gap. This will produce saturation in these pole elements over a considerable distance from the bases 17 and 18 upwardly, and this in turn will establish a potential between these pole elements and the next adjacent elements 16', 16' on each side of the center, thus causing flux transmission over the intervening gaps. If the potential between the bases 17, 18 be sufficiently high, the flux volume will be such as to also cause saturation near the bases of these last named pole elements, although for a shorter distance than in the first named pair, and this condition will be repeated with diminishing saturation in successive pairs toward the opposite ends of the span.

It will be evident that the saturated sections, approximately as indicated by shading in Fig. 4, act in a very similar way as the gaps 15 adjacent to the pole bases in Fig. 2 and serve to produce a certain degree of uniformity in the potential drop between successive elements in the top surface of the plate.

It is apparent that this result is dependent on the relative value of a number of quantities, that must be considered when the principle is applied to an adapter suited for universal application. These quantities include: the applied M. M. F., the ferric section in the poles, and the width and vertical cross-sectional area of the gaps. However, in practice it is found that the applied M. M. F. of commercial chucks does not vary sufficiently to render it necessary to provide a set of various work-holding blocks, and but one design will accommodate all except special purpose chucks, and the action will be as above described.

The effect just above described with respect to Fig. 4 also obtains in the condition illustrated in Fig. 5, wherein chuck poles 20 of alternate sign are separated by narrow gaps 21, and the adapter plate is constructed with the spaced pole elements of Fig. 4. In this case, the saturation will be present in all the pole elements, being greatest in those adjacent a gap 21, as for instance those marked 22. The intermediate pole elements will have a less degree of saturation, and therefore the potential drops across all the plate gaps will be rendered practically uniform.

It will at once be apparent that the plates of Figs. 4 and 5 do not require any particular registration of their pole elements with the chuck poles, as is required in the prior art constructions of Figs. 2–3. Hence, plates forming the subject matter of this invention may be placed on the chuck surfaces in any relation thereto, so long as their pole elements are located in general parallel relation to the poles and gaps in the chuck surface. Incidentally, the plates in Figs. 1–3 must be mechanically held on the chuck poles, thus insuring the necessary registration, but the present device renders such holding unnecessary, and therefore provides an easily portable and removable chuck top or adapter plate.

In Fig. 5, gaps 21 might be made much narrower than shown, so that a plate pole element could span a gap 21 and become short circuited. However, the flux section of any pole 20 is so much in excess of the combined sections of all plate pole elements in magnetic contact therewith, that the potential drops and magnetic circuits in the upper or work holding surface of the plate are unaffected by the short circuit, which would act merely as a leak across or thru a gap 21.

From the foregoing, it will be seen that this invention provides an adapter plate having plane sides which accomplishes the desired results in a simpler and more efficient manner than plates of the prior art. The number of active gaps in the top surface of the plate is greatly increased over the gaps in the underlying chuck surface and therefore the iron and non-magnetic strips will provide for holding small pieces regardless of different chuck pole patterns, so that but one plate design is necessary. This result allows adapter plates to be more cheaply and quickly, in large sizes capable of being cut to any desired smaller sizes, without detriment, and with better functional results as well as obviating the necessity of registering contact areas with the chuck poles, which of course wastes time in setting up the work.

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 claim, but what I claim is:

The combination with a magnetic chuck having at least two parallel and relatively wide poles separated by a relatively narrow non-magnetic space, of an adapter plate comprising a plurality of ferro-magnetic strips fixed together and spaced by alternate non-magnetic strips, said strips being parallel with said space and all being of smaller width, said width being slightly smaller than the width of the non-magnetic space in the chuck, all said strips having their edges aligned to form continuous plane top and bottom surfaces for the plate, the widths of the strips being such, relative to the width of the chuck poles, that four or more of the ferro-magnetic strips contact each chuck pole, and the thickness of the plate in a vertical direction being at least seven times greater than the width of any of the strips.

CLAYTON O. SMITH.