

Jan. 14, 1958

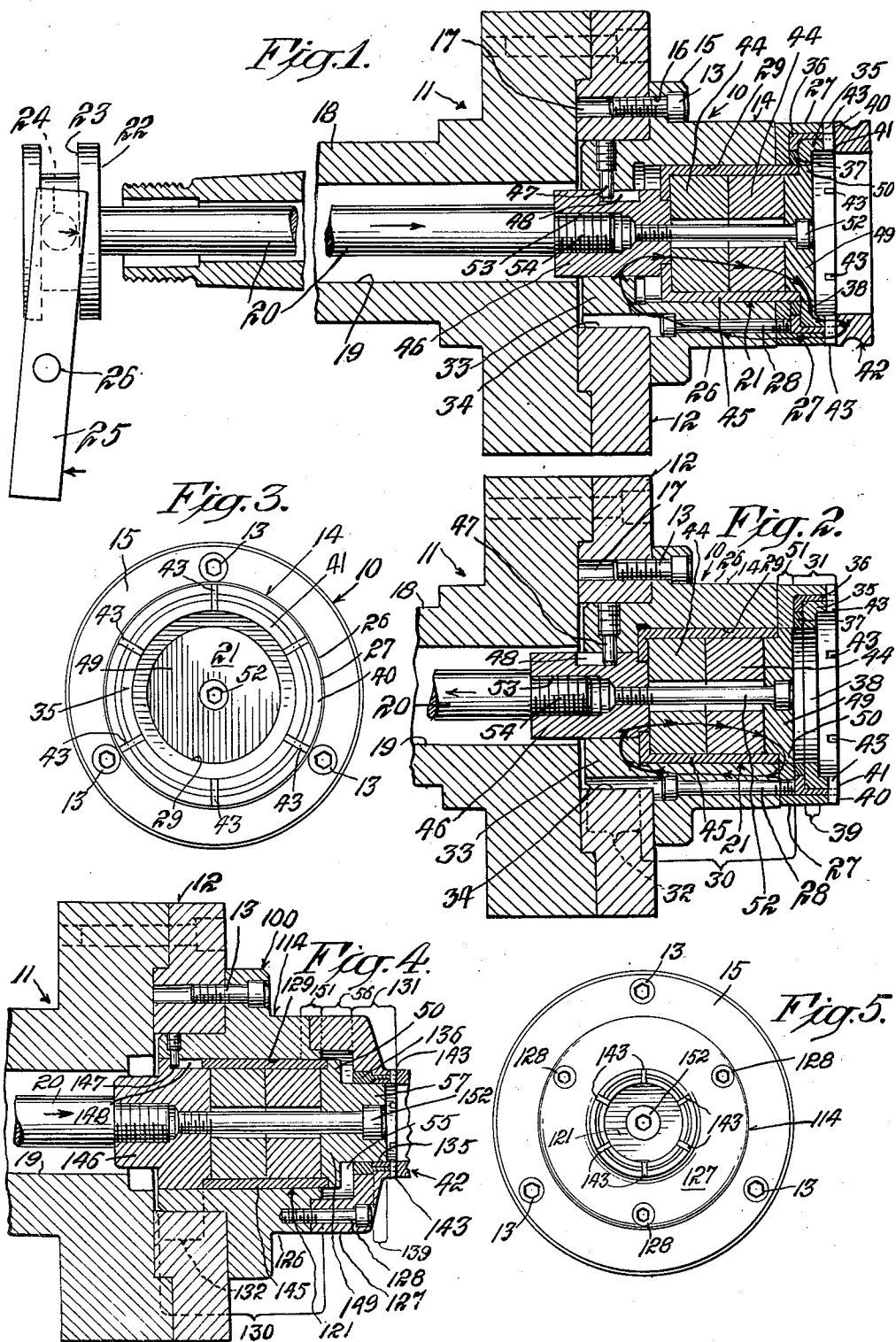
C. STEAD

2,819,905

ROTARY MAGNETIC WORK HOLDERS

Filed July 30, 1956

2 Sheets-Sheet 1



Jan. 14, 1958

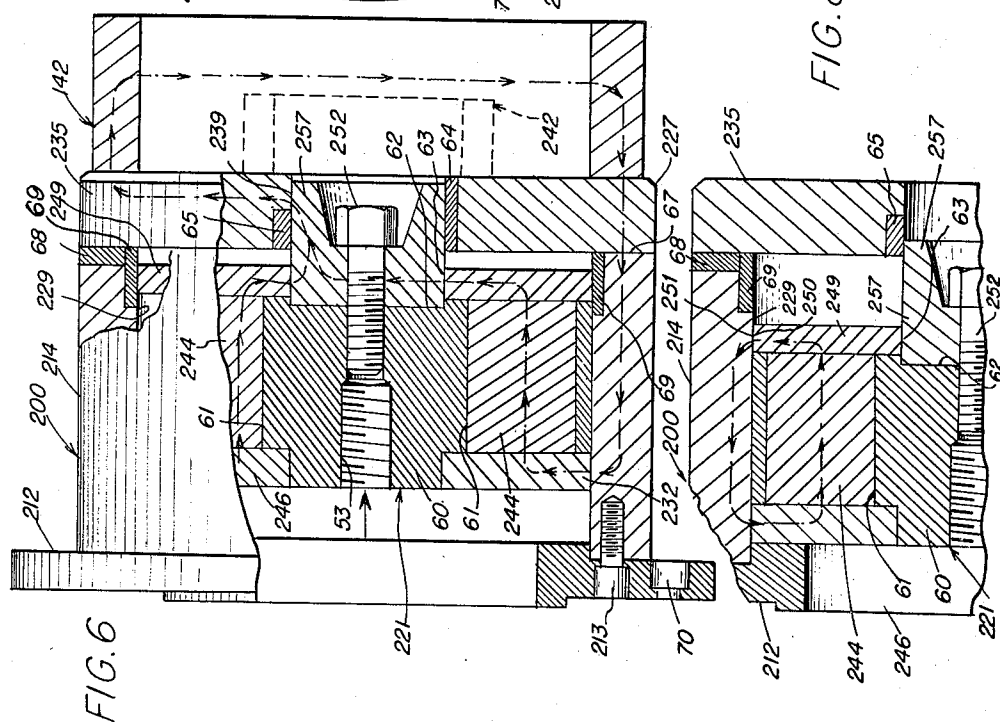
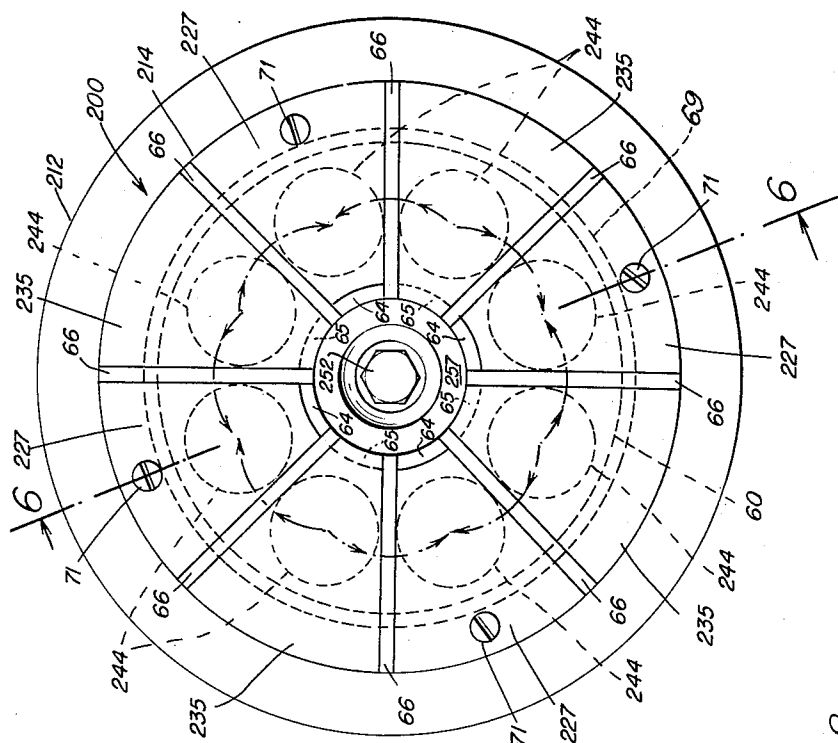
C. STEAD

2,819,905

ROTARY MAGNETIC WORK HOLDERS

Filed July 30, 1956

2 Sheets-Sheet 2



1

2,819,905

ROTARY MAGNETIC WORK HOLDERS

Clifford Stead, North Smithfield, R. I., assignor to The Taft-Peirce Manufacturing Company, Woonsocket, R. I., a corporation of Rhode Island

Application July 30, 1956, Serial No. 600,843

15 Claims. (Cl. 279—1)

The present invention relates to rotary magnetic work holders of the type adapted to be used on driven spindles of machine tools for the purpose of holding work pieces of magnetic material, and which are commonly termed "magnetic chucks."

A general object of the present invention is to provide such a magnetic work holder which has a magnetic core assembly that may be readily shifted between two positions and which in one position of the core assembly will effectively hold against the free end thereof a work piece of magnetic material and efficiently release the work piece when the core assembly is shifted to the other position, such shifting being readily performed during rotary motion of the chuck.

A more specific object of the present invention is to provide such a magnetic work holder in a form efficiently to serve as a magnetic driver of work pieces in performing cylindrical grinding, especially centerless grindings with the driver having an annular end surface against which the work piece is securely held by magnetic force when a magnetic core assembly thereof is shifted axially to one position with completion of a flux path through the work piece, while permitting the work piece readily to be released by shunting the flux away from traverse of the work piece accomplished simply by moving the core assembly to another position.

Another object of the present invention is to provide such a magnetic work driver which efficiently simplifies setups by eliminating need for complex tail stock arrangements while permitting rapid automatic or manual loading and unloading, which can be used effectively to hold an unusually large range of work sizes and is of such simple and sturdy construction as to minimize trouble and need for repair while requiring little or no maintenance.

A further object of the present invention is to provide structural embodiments of the device which may be readily constructed and which permit efficient use and operation thereof.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combination of elements, and arrangement of parts, which will be exemplified in the construction hereinafter set forth, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention reference should be had to the following detailed description taken in connection with the accompanying drawing, in which:

Fig. 1 is an axial section, with parts broken away, of a mounted embodiment of the magnetic work holder of the present invention, showing in elevation means to shift the magnetic core assembly thereof to the work holding position and with a work piece illustrated as being held thereby;

Fig. 2 is an axial section, with parts broken away, of the structure shown in Fig. 1, illustrating shift of the

2

magnetic core assembly to the position which releases the work piece;

Fig. 3 is an end elevational view of the rotary magnetic work holder illustrated in Figs. 1 and 2;

Fig. 4 is an axial section similar to Fig. 1, with parts broken away and omitted, illustrating another embodiment of the present invention with a portion of a work piece being shown held thereto;

Fig. 5 is an end elevational view of the embodiment of the work holder illustrated in Fig. 4;

Fig. 6 is a sectional view similar to the right side portion of Fig. 1 or Fig. 4, with parts broken away, showing a further embodiment of the present invention featuring circumferentially-spaced pole members as distinguished from the radially-spaced pole members in the Figs. 1 and 4 embodiment, with the parts thereof in work piece holding positions;

Fig. 7 is an end view of the device shown in Fig. 6 but with the work piece omitted therefrom for clarity of the showing of structural parts of the device; and

Fig. 8 is a sectional view of the structure shown in Figs. 6 and 7, similar to Fig. 2, with parts broken away, illustrating the location of the core assembly when in flux shunting position.

Referring to the drawings in which like numerals identify similar parts throughout, it will be seen from Figs. 1, 2 and 3 that an embodiment of the rotary magnetic work holder or driver of the present invention may comprise a device 10 mounted to a driven machine spindle 11 in any suitable and simple manner, such as by means of a face plate 12 and a plurality of socket head cap screws 13—13. For this purpose, a main body 14 of the magnetic work holder 10 has a radial flange 15 through which a plurality of holes 16—16 are formed to align with internally threaded holes 17—17 to receive the threaded shanks of the cap screws 13—13, so as to be drivable or rotatable by the machine spindle 11. The machine spindle 11 has a hollow shank or stem 18 provided with a through bore 19 through which extends an operator or shift rod 20 to perform shifting operation of a core assembly 21, more fully explained later. The operator or shift rod 20 may carry a shifting spool or collar 22 having an annular groove 23 in which rides a pin 24 carried by a shift lever 25 pivotally mounted on a pin 26, so that when the lever is swung the operator rod 20 may be shifted axially and without interfering with the rotary motion of the machine spindle 11. The shift lever 25 may be swung by any suitable means, such as by means of a solenoid or an air cylinder, or shift rod 20 may be directly connected to such an operator.

Main body 14 is formed of magnetic material, such as steel and preferably is in the form of a hollow body which is generally tubular. Although not necessary to practice of the invention, main body 14 preferably is made in two parts with the rear part 26 thereof carrying the mounting flange 15 and the other front end part 27 constituting a stepped ring or tube secured in abutting relation to the former by any suitable means, such as a plurality of socket head cap screws 28. The main body 14, comprising the parts 26 and 27, has a through bore 29 which preferably is stepped, as shown, and as will be seen from Fig. 2 this stepping of the bore provides an elongated cylindrical bore section 30 with an enlarged front zone 31 of the bore forming an annular recess. A reduced rear zone 32 of the bore preferably is provided in an axial extension 33 of the body part 26, which is received in a central bore 34 in the face plate 12 with this reduced section providing a flux transfer or contact zone or land, as will be explained later.

Another or supplemental body 35, constituting a circular member, preferably is in the form of an annulus or counterbored ring of magnetic material, such as steel,

3

The ring or annulus 35 is fixedly mounted to or on the main body 14 for driven rotation therewith and for this purpose is telescoped into the annular recess 31 of main body part 27. Since flux is not to pass directly between these two concentric tubular bodies 14 and 35, the latter is axially and radially spaced appreciably from the inner walls of the recess 31 by means of relatively high reluctance and, although an air gap might serve this purpose, the spacing and the fixed mounting can readily be accomplished by interposing a counterbored cylindrical brass spacer ring or sleeve 36, with the parts suitably secured together by braze filling 37. It will be noted from Figs. 1 and 2 that the smaller bore section of the supplemental body 35 is of a diameter substantially equal to bore section 30 of the main body bore 29 to provide an annular land 38 which defines an annular shunting zone 39 for a purpose to be explained later.

The end ring or tubular part 27 of the main body 14 has a transverse end face 40 preferably disposed in a transverse plane to form a circumambient work-engagable face. The supplemental body 35 also has a circumambient transverse end face 41 located in the vicinity of end face 40 of the drivable main body 14 and preferably aligned therewith in the same transverse plane for simultaneous engagement of or abutment to a work piece, such as that illustrated at 42 in Fig. 1, for bridging the latter across the radially-spaced end faces of the bodies, such as in the manner illustrated in Fig. 1. Preferably the transverse work-engagable end faces 40 and 41 of the main and supplemental bodies 14 and 35 are provided with means for resisting wear thereof. In cases where the work is located by support shoes at an off-set position to the center of the driving machine spindle, the work piece may be caused by the machining operation continually to slip back and forth so as to skive or wear the transverse work-engagable faces 40 and 41 of the magnetic work holder 10, such as in shoe type centerless grinding. Such skiving or wear is readily avoided or minimized by providing a plurality of radially disposed hard inserts 43—43, which are formed of non-magnetic material, such as tungsten carbide, seated in radial slots aligned across the end faces 40 and 41 and the intervening outer edge of the interposed brass spacer 36.

In the Figs. 1, 2 and 3 embodiment, the core assembly 21 may consist of a source of magnetic lines of force, preferably in the form of a permanent magnet, which may be provided by a stacked pair of cylindrical magnets 44, 44 coaxially arranged within the bore 29 and preferably the cylindrical section 30 thereof. The permanent magnet, comprising the stacked magnets 44, 44, has the sides thereof spaced appreciably radially inward of the wall of this bore section 30, so as to interpose a relatively high reluctance path, and for this purpose a brass sleeve 45 may be employed to house these magnets with the brass sleeve being axially slidable in this bore section.

The permanent magnet is provided at opposite ends with a pair of end poles spaced along the bore axis. The end pole behind the magnet preferably is in the form of a rear pole member 46 slidably mounted in the reduced bore zone 42 for continual sliding contact therewith as dictated by a travel-limiting pin 47 extending through the main body extension 33 and with its nose received within an elongated longitudinally-extending slot 48 in the rear pole member. As shown in Figs. 1 and 2 the front end of rear pole member 46 abuts an end face of the rear permanent magnet 44. The other end pole in front of the permanent magnet is provided by a front pole member 49 having an annular land 50 extending beyond the front end of the spacer sleeve 45 at relatively close juxtaposition to the bore wall section 30 at its front end. For this purpose the diameter of the land 50 preferably is only slightly less than the internal diameter of the bore section 30, and the latter includes the bore in

4

that portion of the main body front part 27 which is of smaller diameter, so that as will be explained later, it will constitute an annular shunting zone 51 of the main body 14, indicated in Fig. 2. The back end of the front pole member 49 is abutted against the front end face of the front magnet 44 and a socket head cap screw 52 of nonmagnetic material, such as brass, preferably extends successively through the front pole member 49, the two permanent magnets 44, 44 and into an internally threaded hole in the rear pole member 46, to hold these core parts together.

The rear pole member 46 preferably has an internally threaded socket 53 in the back end thereof which threadably receives a reduced externally-threaded front end 54 of the operator or shift rod 20. Thus when the operator rod 20 is shifted axially, the permanent magnet comprising magnets 44, 44, its shielding sleeve 45, front pole member 49 and rear pole member 46 are moved together as a core assembly in the bore 29 of the main body 14. This core assembly, identified by the numeral 21, is shown in its forward holding position in Fig. 1 and in its rearward released position in Fig. 2.

In use and operation of the embodiment illustrated in Figs. 1, 2 and 3, it will be seen from Fig. 2 that when the operator rod 20 is retracted the core assembly 21 is pulled to the rearward position dictated by abutment of the travel-limiting pin 47 against the forward end of the longitudinal slot 48 in the rear pole member 46. In this position, the annular land 50 of the front pole member is juxtaposed to and in sliding contact with the shunting zone 51 provided by the rear portion of the front body part 27. Consequently, flux will flow through the stacked permanent magnets 44, 44 to the front pole member 49 and then via the land 50 of the latter to the shunting zone 51 of the main body part 27, thereafter back through the other main body part 26, the rear body extension 33 and finally across to the juxtaposed portion of the rear pole member 46 in the circular zone of sliding contact 32, as is indicated by the path of arrows in the lower part of Fig. 2. As a result, the flux of the permanent magnet is shunted to pass around the permanent magnet directly through the main body 14, i. e., directed through a closed circuit through the latter.

As will be understood from Fig. 1 when the operator or shift rod 20 is advanced, the core assembly 21 is slid forward in the main body bore 29 to the forward position illustrated therein, as dictated by engagement of the travel-limiting pin 47 in the back end of the longitudinal slot 48 in the rear pole member 46. In this forward motion of the core assembly 21, the land 50 of the front pole member 49 is moved forward out of alignment with the shunting zone 51 of the main body 14 to interpose between the magnet and the bore wall of the main body the front end of the spacing sleeve 45 of relatively high reluctance, and simultaneously to align this pole land with the rear portion of reduced diameter of supplemental body annulus or ring 35 in the flux transfer zone 39. As a result flux flows from the stacked permanent magnets 44, 44 through the front pole member 49, the annular land 50 of the latter, the supplemental body or annulus 35, across the end face 41 of the latter into the work piece 42 and back across the end face 40 of the main body part 27, thence via main body part 26 to the rear extension 33, and finally in the circular zone of sliding contact 32 across to the rear pole member 46, as is indicated by the path of arrows in Fig. 1. Location of the work piece 42 against the end faces 40 and 41 intervenes the bodies of magnetic material 14 and 35 with a bridge of magnetic material.

It will thus be seen that both in the rearward position of the permanent magnet or the core assembly 21, illustrated in Fig. 2, and in the forward position thereof, illustrated in Fig. 1, the rear pole member 46 is always in juxtaposition to or in sliding contact with a portion of the bore wall of the main body 14 to provide there-

5

between a flux transfer path of relatively high permeability. In the rearward position illustrated in Fig. 2, the front pole member 49 is spaced rearwardly from the supplemental body ring or annulus 35 so as to interpose therebetween relatively high reluctance. In this rearward position, the front pole member land 50 is juxtaposed to a portion of the bore wall of the main body part 27 so that a shunt path is provided immediately about the permanent magnet to prevent flux from flowing through the work piece 42 across the end faces of the two bodies 14 and 35. The passage of flux between the concentric telescoped bodies 14 and 35 through the work piece 42, as illustrated in Fig. 1, causes the latter to be held magnetically against or abutted to the work-engageable end faces 40 and 41 of these bodies of magnetic material; and by shunting the flux immediately about the permanent magnet through only the main body, as illustrated in Fig. 2, releases such work piece. Although the supplemental body 35 is shown to be in the form of a ring, it will be understood that it may be a circular member of other form, such as a plate telescoped into and suitably spaced in the front end recess 31, with its rear face adapted to be juxtaposed to the front pole member 49 as the latter is pushed forward to the forward position of the permanent magnet or core assembly 21.

Although in the Figs. 1, 2 and 3 embodiment, the continual sliding contact between the rear pole member 46 of the magnet and the main body is provided by a stepping of the main body bore 29 to form a circular land of contact in the main body rear extension 33 in which the rear pole member 46 is slidable and in continual contact therewith, the bore of the supplemental body 35 being of a diameter equal to that of the main section 30 of the main body bore so that both may slidably receive alternately therein the front pole member land 50, such structures may be in a sense reversed. Such a so-called reversal or rearrangements of parts is proposed in Figs. 4 and 5. In the Figs. 1, 2 and 3 embodiment, the relatively highly permeable means interposed between the rear pole member and the main body for continual sliding contact and flux transfer is provided by the annular internal land of rear extension 33 in the main body bore 29, while in the shunting zone 51 the diameter of the main body bore is the same as it is in the main section 30 with the bore in the supplemental body 35 in the flux transfer zone 39 also being the same. Thus in this first embodiment, the relatively highly permeable means, which is interposed between the front pole member 49 and the main body 14, is by way of land 50 on the front pole member in the shunting or rearward position of the core assembly 21 and via this front pole member land to the supplemental body in the forward flux transfer or holding position. As contrasted therewith, in the embodiment of Figs. 4 and 5, the rear portion of the main body bore is not provided with an internal land and the relatively highly permeable means interposed there between the main body and the rear pole member is by way of an annular external land on the latter while a land on the front pole member serves as a shunting means with an axial extension of the front pole member serving as the flux transfer means for the supplemental body, as will appear hereinafter.

In the Figs. 4 and 5 embodiment, the rotary magnetic work holder 100 is mounted to the face plate 12 of the machine spindle 11 in a manner similar to the mounting of the embodiment of Figs. 1, 2 and 3, and the main body 114 thereof has a uniform cylindrical bore 129 which constitutes a rear cylindrical bore zone 130 of the main body bore. The front part 127 of the main body 114 is provided in the form of an end cap or cover affixed to the main body part 126 by socket head cap screws 128—128, with a bore of reduced diameter extending axially through the cover providing a front bore zone 131 of reduced diameter. The interior of the end cap or cover 149 provides an internal chamber 55 which

6

defines an intermediate enlarged chamber zone 56, with the front end of the bore section 130 adjacent thereto constituting the shunt zone 151. The bore of the end cap or cover 127 has seated therein a spacing ring 136 of relatively high reluctance, preferably of brass, which has a reduced forward extension intervening the cover and the supplemental body, the latter being in the form of a cylindrical ring or annulus 135. The front pole member 149 is provided with an axial extension 57 which is mounted for close sliding contact through the spacer ring 136 and in the forward position into the supplemental body ring 135, as shown in Fig. 4. The front pole member 149 also carries annular land 50, like that in the other embodiment, which in the rearward position is brought to sliding contact of or juxtaposed to the shunting zone 151 of the bore zone 130.

In the Figs. 4 and 5 embodiment, the two magnets which are like those of the other embodiment, stacked end-to-end, are housed in an annular sleeve 145 of relatively high reluctance, preferably of brass, to interpose between the magnet and the bore wall of the main body 114 appreciable reluctance. Brass sleeve 129 is cylindrical throughout its entire extent and thus the rear end thereof is rabbeted into the front face of rear pole member 146 which has a circumferential contact surface or external annular land in the circular zone 132 of continual sliding contact with the bore wall of the main body within the main section 130 thereof. A longitudinal slot 148 in the rear pole member 146 is defined, preferably but not necessarily, at the front end thereof by the rear edge of the spacer sleeve 145. The socket head set screw 152 is similar to that employed in the other embodiment, being of nonmagnetic material, such as brass, and designed to hold the parts of the core assembly together, being only appreciably longer as required by the axial extension 57 of the front pole member 149.

It will be understood from Figs. 4 and 5 that, in use and operation of this embodiment of the rotary magnetic work holder, when the core assembly 121 is pushed to the forward position by operator rod 29, the rear pole member 146 remains in sliding contact in the flux transfer zone 132 of the main body bore 129. However, the shunting land 50 of the front pole member 149 is pushed forward out of alignment with the shunting zone 151 into the chamber 55 there to be appreciably spaced from the cover part 127 of the main body 114. At the same time, the axial extension 57 of the front pole member 149 is slid forward into the cylindrical supplemental body or annulus 135 for transfer of flux therebetween. Thus in the forward position, illustrated in Fig. 4, flux flows through the stacked magnets and the front pole member 149 to the axial extension 57 of the latter and thence across to the supplemental body 135 for traversing through a portion of the work piece 42 intervening the end faces of the supplemental body and the cover 127 of the main body; thereafter the flux flows back through this cover, the main body part 126 and then at flux transfer zone 132 across to the rear pole member 146. In the retracted or rearward position of the core assembly 121 the front pole member land 50 becomes aligned in the shunting zone 151 with the bore wall of the main body part 126 while at the same time the front pole member extension 57 is pulled back out of the supplemental body annulus 135 so that the flux is shunted to pass immediately around the permanent magnet through the main body structure.

The rotary magnetic work holder or drive of the present invention may be embodied in a form to provide on the transverse work-engageable end face at least a pair or a plurality of alternately arranged radially-extending work-engageable members of magnetic material to serve as the pole members, as contrasted with the pair of radially-spaced annular or concentric pole members of the embodiments of Figs. 1 to 5 inclusive. Such a modified form of the device is illustrated in Figs. 6, 7 and 8 and, as will be seen therefrom, such construction pro-

vides relatively wide work-engageable end faces to permit abutment of and holding thereto of work piece rings which differ widely in diameter. As illustrated in Figs. 6, 7 and 8 by way of example, such modified form of the device 200 may have a cylindrical main body 214 provided with a mounting flange 212 which may be in the form of a ring fastened to the body in any suitable manner, such as by a plurality of socket head cap screws 213. The cylindrical main body has a through bore 229 in which the core means or assembly 221 is slidably mounted. Axial translation of the core assembly 221 between a retracted or inward released position and a forward holding position may be accomplished in a manner similar to that proposed in connection with the embodiments of Figs. 1 to 5 inclusive, such as by means of a push and pull rod (not shown in this embodiment).

The core assembly 221 preferably comprises a spider or cylindrical body 60 having a plurality of bores 61—61 extending longitudinally therethrough at angularly-spaced and radially-located points, and the inner end of said body or spider is preferably provided with an internally-threaded socket 53 in which a push and pull rod, such as that illustrated at 20 in Figs. 1, 2 and 4, may be threadably anchored. The spider 60 is made from non-magnetic material, such as aluminum, brass or the like, and it is slidably mounted in the main body bore 229. In each of the spider bores 61—61 is mounted a cylindrical permanent magnet 244 and the rear pole ends of like polarity of these permanent magnets are juxtaposed to or abutted by a circular pole means or plates 246 of magnetic material carried by the spider and secured thereto by any suitable means (not shown). The front end of the spider 60 is provided with a socket 62, preferably concentric with the axis of the spider, in which a cylindrical pole extension 257 of magnetic material is seated and fixed by any suitable means, such as a stud bolt 252 of non-magnetic material, preferably brass. The front pole ends of the plurality of permanent magnets 244—244 are juxtaposed to or abutted by another pole means, preferably in the form of another circular plate 249 of magnetic material having an axial hole 63 which snugly receives a flux transfer structure, preferably in the form of pole extension 257, for flux transfer therebetween.

A plurality of angularly-spaced, radially-extending, work-engageable pole members 227—227 and 235—235 of steel or other magnetic material are provided to form the work-engageable, transverse end face. These pole members preferably are sector-shaped, as is best seen in Fig. 7, but different in details for the purpose of introducing certain reluctance between them and adjacent structure. For example, each pole member 227 is provided on its radially-inner end with an arcuate plate or strip 64 of non-magnetic material, such as brass, Babbitt metal, aluminum, etc., to prevent flux transfer between such pole member and the core pole extension 257. As contrasted therewith the radially-inner end of each of the sector-shaped pole members 235 has a portion at 239 which is defined by a circular arc of a diameter about equal to or only slightly larger than the diameter of the core pole extension 257, for close juxtaposition in the forward position of the core assembly 221 and consequent flux transfer. However, the rear side of the radially-inner end of each of the pole members 235 is arcuately rabbeted for reception therein of an arcuate strip 65 of non-magnetic material, such as brass, Babbitt metal, aluminum, etc., to define a retracted, flux non-transfer zone. The pole members 227 and 235 are alternately arranged as will be seen from Fig. 7 and are angularly separated by means having appreciable reluctance, such as by radially-extending strips 66—66 of non-magnetic material, such as brass, aluminum or the like. If arcuate strips 64 and 65 are of suitable non-magnetic material, such as brass, and radial strips 66—66 are also of such material the former may be secured to the latter by brazing for anchorage thereof.

Further, while each of the pole members 227 is in flux transfer relation to the main body 214 with the latter being of magnetic material, such as steel, such as by abutment at the end face 67 of the latter, as indicated in Fig. 6, each of the pole members 235 is spaced from this main body by means having appreciable reluctance, such as an arcuate plate 68 of non-magnetic material, e. g. brass or aluminum, and for this purpose the end face 67 of the main body is cut back behind each of the pole members 235 to accommodate each such arcuate plate. The angularly-spaced, arcuate isolating plates 68—68 may be mounted in position in any suitable manner, such as by being brazed to a cylindrical non-magnetic ring or annulus 69 when these plates and ring are of brass. Ring or annulus 69 is telescoped into an outer counterbored section of the main body bore 229, and with this non-magnetic annulus serving a dual purpose. The inner diameter of the non-magnetic annulus 69 is preferably the same as the inner diameter of the main body bore 229 so that in one position (the forward position) of the core assembly 221 the circumferential edge of front pole plate 249 is juxtaposed thereto.

In operation and use of the embodiment of the invention illustrated in Figs. 6, 7 and 8 let it be assumed that the device is mounted by its mounting flange 212 to a suitable driven machine spindle, such as that proposed at 11 in Figs. 1, 2 and 4, by any suitable means, such as a plurality of bolts or screws for which purpose the mounting flange may be provided with a plurality of bolt or screw holes. One such counterbored hole for a socket head cap screw is shown at 70 in the Fig. 6. With the slidable core assembly 221 suitably mounted upon a push and pull rod, such as that indicated at 20 in Figs. 1, 2 and 4 by threadable engagement of the rod in the internally-threaded socket 53 of brass spider 60, the core assembly may be pushed outward or forward to the forward position, illustrated in Fig. 6. In such position, the rear pole plate 246 has its circumferential edge surface juxtaposed to the wall of the main body bore 229 for flux transfer, but the circumferential edge surface of the front pole plate 249 is positioned with or opposite to the brass annulus 69 so as to interpose between this front pole plate and the main body appreciable reluctance, preventing flux transfer therebetween. The core pole extension 257, which is in flux transfer relation to the front pole plate 249, is telescoped forward into the cylindrical hole defined by the arcuate plates 64—64 and 65—65, and the arcuate radially-inner end at 239 of each of the pole members 235, and with its nose juxtaposed to these radially-inner ends of the latter pole members, as illustrated in Fig. 6, for flux transfer.

As a result, when a work piece, such as ring 142 (or a smaller ring indicated in dotted lines at 242) is placed against the transverse work-engageable end face, provided by the alternately-arranged, sector-shaped pole members 227—227 and 235—235, it will, if of magnetic material, such as steel, be held magnetically in such position. Flux will flow, for example, from the like front end poles of the permanent magnets 244—244 to the front pole plate 249 and thence to the core pole extension 257, and then transfer at 239 to each of the pole members 235. The flux then flows from the pole members 235—235 into the juxtaposed magnetic work piece 142 and then from the latter to the alternately-arranged pole members 227—227, finally to pass from the latter to the juxtaposed main body 214 and, at 232, transfer to the rear pole plate 246 for completing the magnetic circuit to the rear pole ends of the magnets 244—244. Such flow of flux is graphically illustrated by dot-dash lines in Fig. 6, and it will be seen from similar dot-dash lines in Fig. 7 how such flux passes from each pole member 235 to the two adjacent pole members 227, 227 of opposite polarity via the work piece (omitted from Fig. 7 for clarity).

Whenever it is desired to release the work piece 142

from the rotary magnetic work driver illustrated in Figs. 6, 7 and 8, the core assembly 221 is retracted by the pull rod to the retracted position illustrated in Fig. 8. As there indicated, in the retracted position of the core assembly 221, the circumferential edge 250 of the front pole member 249 is withdrawn from the isolating brass annulus 69 to juxtaposition of the wall of the main body bore 229 at 251 for flux transfer at that point. Consequently, since the circumferential edge of the rear pole plate 246 remains juxtaposed to the wall of the bore 229 of the main body 214 of magnetic material, the flux will be shunted from the pole members 227—227 and 235—235 to flow from the front pole ends of the permanent magnets 244—244 to the front pole plate 249, thence at 251 to the main body 214, and finally from the latter to the rear pole plate 246 for return to the permanent magnets at their rear pole ends, as indicated by the dot-dash line in Fig. 8. In this retracted position of the core assembly 221, the core pole extension 257 is isolated from the pole members 235—235 by their arcuate brass plates 65—65 which interpose appreciable reluctance therebetween. As a result any work piece abutted to the pole members 227—227 and 235—235 will drop away.

In a device of a construction similar to that proposed in Figs. 6, 7 and 8, the sector-shaped pole members and their intervening radial isolating strips and arcuate plates and strips may be mounted to the main body in any suitable manner. For example, the parts may be undercut or provided with dovetails so that, when fitted together, or if of suitable material such as brass to be connected together by brazing, anchorage of certain of the pole members to the main body by any suitable means will hold the parts in their relative positions. As indicated in Fig. 7, each of the pole members 227 may be so anchored by means of a socket head cap screw 71 (omitted from the lower portion of Fig. 6 to avoid confusion in the showing). It is to be understood that other ways of providing the isolating bodies or elements of non-magnetic material and mounting them with the parts of magnetic material, such as the work-engageable pole members, may be practiced within the scope of the present invention. Thus, the elements or parts of non-magnetic material may be molded from suitable plastic material, such as an epoxy resin composition, and such may be employed for forming some or all of the non-magnetic elements of the illustrated embodiments or others within the scope of the claims. For example, in the Figs. 6, 7 and 8 embodiment some or all of such parts, i. e. the spider 60, ring 69, sector-shaped strips 68—68, arcuate strips 64—64 and 65—65 and radial separator strips 66—66 may be so molded; and the related magnetic parts could be properly placed in molds and the plastic elements molded there against or about portions of the magnetic parts to serve the additional purpose of holding such parts in proper positions, e. g. spider 60 could be cast about the permanent magnets 244—244 and strips 64—64, 65—65 and 66—66 could be cast against and between the pole members 227—227 and 235—235. Further, radial separator strips 66—66 could be formed of non-magnetic wear-resistant carbide material to minimize wear and damage of the work-engageable end faces of the pole members 227—227 and 235—235.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above construction without departing from the scope of the invention, it is intended that all matters contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific

features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

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

1. A rotary magnetic work holder comprising, in combination, a rotatable body of magnetic material having a transverse work-engageable face and providing a portion of a flux path, another body of magnetic material rotatable with said first-mentioned body and having a transverse work-engageable face located in the vicinity of said first-mentioned face while being spaced therefrom with interposed appreciable reluctance, said second body providing another portion of the flux path to be closed at said faces by an intervening work piece of magnetic material abutted thereto, a source of magnetic lines of force intervening said bodies in a flux transfer respect to cause flux to flow along said path, and movable shunt means of magnetic material associated with said magnetic source which in one position shunts flow of flux from the latter directly through one of said bodies without passage through the other body and in another position completes the flux path through both of said bodies and the intervening work piece.

2. A rotary magnetic work holder comprising, in combination, a drivable rotary body of magnetic material having a transverse work-engageable face and an axial bore, said work-engageable face having at least a pair of members of magnetic material appreciably spaced from each other by means having appreciable reluctance, one of said work-engageable members being juxtaposed to said drivable body for flux transfer therebetween, a source of magnetic lines of force mounted in said bore and having opposite poles, relatively highly permeable means interposed between one of the magnetic poles and said body providing a low reluctance path therebetween at all times, and shunt means of magnetic material mounted for axial motion in said bore and associated with the other magnetic pole, said shunt means in one axial position providing a relatively highly permeable path between said body and the second-mentioned pole, said shunt means when in another axial position being appreciably spaced from said body to introduce appreciable reluctance therebetween while being connected in the latter position by relatively highly permeable means to the other of said work-engageable members.

3. A rotary magnetic work holder comprising, in combination, a drivable rotary body of magnetic material having an annular work-engageable face substantially located in a transverse plane and an axial bore extending therethrough, an annulus of magnetic material carried by said body and telescoped into the outer end of said bore, said annulus having a transverse work-engageable face substantially located in the transverse plane, means of relatively high reluctance interposed between and appreciably spacing said annulus radially inward of said body; and a core assembly slidably mounted in said bore and comprising a permanent magnet having its opposite poles concentrically arranged with and axially spaced along the bore axis and with the sides thereof spaced appreciably radially of the bore wall, means to slide said permanent magnet in said bore in radially spaced relation between a rearward position and a forward position, a rear pole member of magnetic material slidably mounted in said bore behind said magnet juxtaposed relatively closely to said body and providing a flux path of relatively high permeability between said body and the rear pole member of said magnet in both positions of the latter, and a front pole member of magnetic material slidably mounted in said bore ahead of said magnet with the wall of said bore having an annular zone juxtaposed relatively closely to said front pole member in the rearward position of said magnet to provide a shunt path, said front pole member being axially spaced forward

of said zone an appreciable distance and radially spaced appreciably from said body in the forward position of said magnet with said front pole member juxtaposed relatively closely to said annulus in the latter position.

4. A rotary magnetic work holder comprising, in combination, a drivable rotary hollow body of magnetic material having a stepped bore extending therethrough with an enlarged zone thereof providing an annular recess at its outer end, an annulus of magnetic material fixed in said recess, means of relatively high reluctance interposed between said annulus and said body, the outer end of said body and said annulus having radially-spaced annular faces arranged substantially in a common transverse plane for simultaneous abutment to a work piece of magnetic material, a substantially cylindrical permanent magnet slidably mounted concentrically in said bore rearward of said recess with its opposite poles spaced axially of said bore and adapted to be slid axially between a rearward position and a forward position, a sleeve of relatively high reluctance carried about the sides of said magnet and interposed between it and the wall of said bore, a rear magnetic pole member carried by said magnet to the rear of the back end of said sleeve and closely juxtaposed to a cylindrical zone of said bore wall in all positions of said magnet, and a front magnetic pole member carried by said magnet juxtaposed relatively closely to said cylindrical bore wall zone in the rearward position of said magnet to provide a magnetic shunt path, said front magnetic pole member in the forward position of said magnet being appreciably spaced axially forward of said cylindrical bore wall zone and radially inward from said bore wall while being juxtaposed relatively closely to said annulus for flow of flux between said body and annulus through a work piece abutted to their annular faces.

5. A rotary magnetic work holder comprising, in combination, a drivable rotary hollow body of magnetic material having an outer end and a bore extending therethrough, said bore having a rear cylindrical zone and a front zone of reduced diameter adjacent the outer end of said body with said zones intervened by an intermediate enlarged chamber zone, an annulus of magnetic material fixed in said front reduced zone of said bore, means of relatively high reluctance interposed between said annulus and said body, the outer end of said body and said annulus having radially-spaced annular faces arranged substantially in a common transverse plane for simultaneous abutment to a work piece of magnetic material, a substantially cylindrical permanent magnet slidably mounted concentrically in said rear cylindrical bore zone with its opposite poles spaced axially in said bore and adapted to be slid axially between a rearward position and a forward position, a sleeve of relatively high reluctance carried about the sides of said magnet and interposed between it and the wall of said rear cylindrical bore zone, a rear magnetic pole member carried by said magnet to the rear of the back end of said sleeve and closely juxtaposed to the wall of said rear cylindrical bore zone in all positions of said magnet, and a front magnetic pole member carried by said magnet and having a circumferential land closely juxtaposed to said wall of said rear cylindrical bore zone in the rearward position of said magnet, said land being slid forward with said magnet into said chamber zone for radial spacing from said body when said magnet is slid to its forward position, said front magnetic pole member having an axial front extension spaced rearwardly from said annulus in the rearward position of said magnet and receivable in said annulus in close juxtaposition thereto when said magnet is slid to its forward position.

6. A rotary magnetic work holder comprising a rotatable tubular body of magnetic material having an outer work piece-engaging transverse end face surrounding its bore, a circular member of magnetic material fixed in the outer end of the body bore in radially and axially spaced

relation to said body for interposing appreciable reluctance with said member having a transverse work piece-engaging face substantially aligned with that of said body, a permanent magnet axially slidable in the body bore between rearward and forward positions in radially spaced relation to said body, and a pair of front and rear pole members fixed to opposite ends of said magnet for slide therewith and relatively closely fitted in the body bore for juxtaposition of both to said body in the rearward position of said magnet providing a shunt flux path in such position, said front pole member and the outer end of the bore of said body being shaped relative to each other appreciably to space them apart in the forward position of said magnet with said front pole member in the latter magnet position being juxtaposed relatively close to said circular member.

7. A rotary magnetic work holder comprising a rotatable tubular body of magnetic material having a central cylindrical bore and a transverse work piece-engaging outer end surface, a ring of magnetic material fixed in the outer end of said bore spaced appreciably at all points from said body and having a transverse work piece-engaging end surface substantially aligned with that of said body, the cylindrical body bore having an elongated wall section spaced axially rearward from said ring, a cylindrical permanent magnet arranged coaxially in said bore wall section and slidable therein between a rearward position and a forward position, a sleeve of relatively high reluctance encasing the sides of said magnet and slidable therewith in said bore wall section, a rear pole member fixed to the rearward end of said magnet, said rear pole member and bore wall section having a cooperating pair of circular zones rearward of the inner end of said sleeve which are in sliding contact with each other in both the rearward and forward positions of said magnet, and a front pole member fixed to the forward end of said magnet which is circumferentially juxtaposed to another circular zone of said bore wall section and spaced rearwardly of said ring in the rearward position of said magnet and is spaced from said body and forwardly of said bore wall section and is juxtaposed to said ring in the forward position of said magnet.

8. A rotary magnetic work holder comprising a rotatable tubular main body of magnetic material having a cylindrical bore section and an axially-extending circular rim forwardly of said bore section, a cylindrical permanent magnet slidably mounted in said bore section for axial motion between rearward and forward positions, a rear pole member carried by said magnet in slidable contact with the wall of said bore section in all positions of said magnet, a supplemental body of magnetic material fixedly mounted in said rim in radially-spaced relation thereto with forward end faces of both adapted simultaneously to engage a work piece of magnetic material, and a front pole member carried by said magnet in slidable contact with the wall of said bore section and spaced rearwardly of said supplemental body in the rearward position of said magnet, said front pole member being slidable forward out of said bore section and spaced therefrom and to juxtaposition of said supplemental body when said magnet is slid to its forward position.

9. A rotary magnetic work holder comprising a pair of rotatable, axially and radially spaced, concentric tubular bodies of magnetic material telescoped one within the other in relatively fixed relation and having aligned concentric end faces for abutment to and bridging thereof by a work piece of magnetic material, one of said bodies having an axial bore the wall of which is provided with axially-spaced first and second circular contact zones, a cylindrical magnet slidably mounted coaxially in said bore with the sides thereof spaced appreciably from the bore wall for axial movement between a pair of axially-spaced positions, and pole means carried by said magnet at opposite ends thereof with one in sliding contact with the first contact zone of said

bore wall in both magnet positions and the other juxtaposed only alternately to the second contact zone of said bore wall for shunting operation and the other of said bodies for magnetic chuck operation as said magnet is shifted axially from one of said positions to the other.

10. A rotary magnetic work holder comprising a pair of rotatable concentric circular bodies of magnetic material with one having a through bore into which the second body is telescoped and fixed in axially and radially spaced relation thereto, said bodies having aligned radially-spaced work piece-engageable faces, the wall of said bore having axially-spaced first and second circumambient contact zones, an elongated magnet slidably mounted coaxially in said bore and spaced radially inward appreciably from the bore wall for axial movement between a pair of axially-spaced positions, and pole means carried by opposite ends of said magnet with one having sliding contact with the first bore wall contact zone in both magnet positions, the pole means at the other end of said magnet being juxtaposed only to the second bore wall contact zone when said magnet is in one of said positions and juxtaposed only to the second body when said magnet is in the other position.

11. A rotary magnetic work holder comprising, in combination, a drivable rotary body of magnetic material having a transverse work-engageable face and an axial bore, at least a pair of radially-extending work-engageable members of magnetic material located in said work-engageable face and spaced angularly from each other by means having appreciable reluctance, one of said pair of work-engageable members being carried by said body in flux transfer relation thereto with said members being bridgeable at the work-engageable face by a juxtaposed work piece of magnetic material, a source of magnetic lines of force mounted in said bore and having opposite poles, relatively highly permeable means interposed between one of the magnetic poles and said body providing a low reluctance path therebetween at all times, and shunt means of magnetic material mounted for axial motion in said bore and associated with the other magnetic pole, said shunt means in one axial position providing a relatively highly permeable path between said body and the second-mentioned pole, said shunt means when in another axial position being appreciably spaced from said body to introduce appreciable reluctance therebetween while being in the latter position in flux transfer relation to the other of said pair of work-engageable members.

12. The rotary magnetic work holder as defined in claim 11 characterized by said work-engageable face being circular and made up of a plurality of said work-engageable members in the form of sector-shaped, radially-extending, angularly-spaced pole members arranged as to polarity in alternate fashion about the bore, a set of the alternate pole members of like polarity being mounted permanently in flux transfer relation on said body with the set of intermediate pole members of opposite polarity being carried by said body with appreciable reluctance intervening said body and said second set, said source of magnetic lines of force being permanent magnet means axially slidable in said bore with said shunt means carried thereby together to constitute at least parts

of axially-translatable core means, said core means having flux transfer structure juxtaposed to said second set of pole members when appreciable reluctance is interposed between said shunt means and said body.

13. The rotary magnetic work holder as defined in claim 12 characterized by means of non-magnetic material interposed between said core flux transfer structure and each of said second set of pole members when said core means is retracted to the inward of the two positions, said shunt means providing a flux flow path directly between the second-mentioned pole of said magnet and said body in said retracted position for shunted flux flow immediately about said magnet means, and means of non-magnetic material interposed between said shunt means and said body when said core means is advanced to the forward of the two positions to interpose therebetween the appreciable reluctance.

14. The rotary magnetic work holder as defined in claim 13 characterized by said core means as comprising a cylindrical spider of non-magnetic material having a plurality of bores extending longitudinally therethrough at radial points about the axis of said core means, said permanent magnet means comprising a plurality of cylindrical magnets with each mounted in one of said spider bores and having the like poles thereof arranged at one end of said spider, circular pole means of magnetic material mounted to the inner end of said spider and in flux transfer relation to one set of like poles of said permanent magnets and juxtaposed to said body in flux transfer relation with respect to the latter in both of said inward retracted and forward advanced positions of said core means, said circular pole means constituting the relatively highly permeable means which provides a low reluctance path between said body and said permanent magnet means at all times, and other circular pole means of magnetic material mounted to the other end of said spider and in flux transfer relation to the other set of like poles of said permanent magnets and alternately constituting the flux transfer structure and shunt means.

15. A rotary magnetic work driver comprising, in combination; a rotatable body structure having an axial bore and an outer free end provided with a transverse work-engageable face; at least a pair of appreciably-spaced pole members mounted in said face with interposed appreciable reluctance for bridging transfer of flux from one to the other through a work piece of magnetic material when juxtaposed thereto; core means slidably mounted in said bore for movement to and from a pair of positions, said core means having a permanent magnet with the opposite poles thereof in flux transfer relation to said pole members through said body structure when said core means is in one of said positions; and means providing a shunt flux path across said pole members when said core means is in its other position to pass flux directly about said magnet through said body structure.

References Cited in the file of this patent

UNITED STATES PATENTS

2,741,481 Ortegren ----- Apr. 10, 1956