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R. T. REARDON

2,260,055

MAGNETIC TOOL

Filed Sept. 19, 1939

Fig. 1.

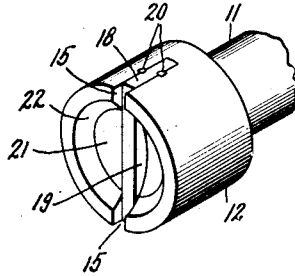


Fig. 2.

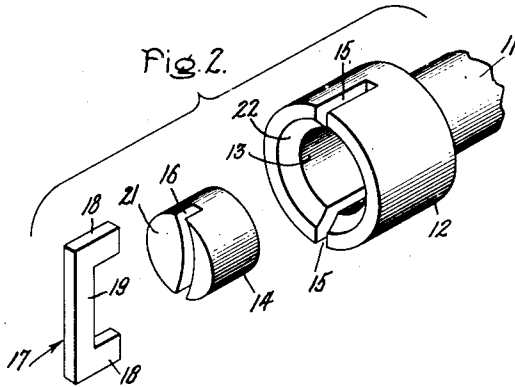


Fig. 4.

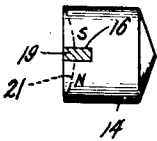


Fig. 3.

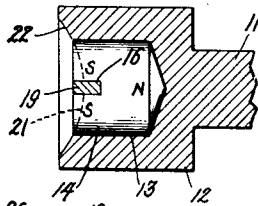


Fig. 5.

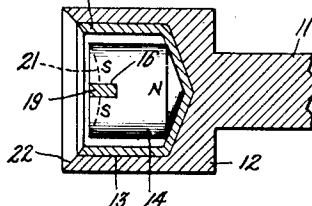


Fig. 8.

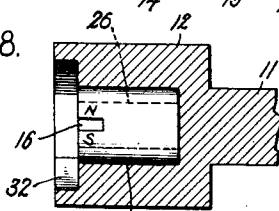


Fig. 9.

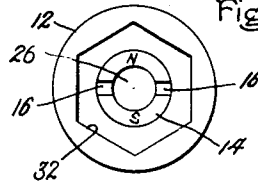


Fig. 6.

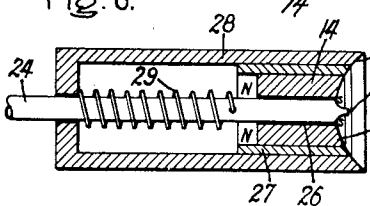
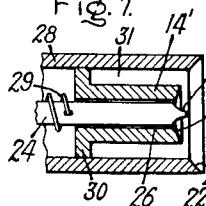


Fig. 7.



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UNITED STATES PATENT OFFICE

2,260,055

MAGNETIC TOOL

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Application September 19, 1939, Serial No. 295,599

2 Claims. (Cl. 145—50)

This invention relates to improvements in magnetic tools and more particularly to screw drivers, socket wrenches, and the like, wherein a permanent magnet is employed to temporarily maintain articles such as screws and nuts in engagement with the driving portion of the tool preparatory to rotation of the tool for securing the articles to or removing them from an object.

Heretofore, many attempts have been made to provide tools such as screw drivers and socket wrenches with permanent magnets for holding the articles which are driven or operated by the tools in order that the articles may be guided into position with the threaded objects with which they are to be engaged. It has been customary to produce these magnets from relatively low coercive force materials and they have usually been of the horseshoe shape to obtain the length and shielding necessary to prevent excessive loss of magnetism caused by the self-demagnetizing force exerted on the magnet. Consequently, the magnets customarily used have necessarily had a large dimensional ratio. By this I mean a large ratio of length to cross-sectional area. This required size and shape of the prior art devices has resulted in a bulky tool which renders the tool useless for many assembly operations, particularly in those situations where it is desired to place a screw or nut in position for tightening in deep recesses or narrow passages. The same difficulty is present when it is desired to remove the screw or nut from its engaged position.

Moreover, in the prior art arrangements the magnet employed has been quite susceptible to demagnetization caused by subjecting it to elevated temperatures, mechanical shocks, and stray magnetic fields. These deleterious influences contribute to bring about a gradual loss of magnetism in the magnet, with the result that the efficiency of the tool soon becomes so greatly impaired that it is necessary either to replace or remagnetize the magnet or otherwise employ a completely new tool. Such failure of the tool is not only costly from the standpoint of repair or replacement but dropping of screws or nuts during group assembly operations may mean either a reduction in speed or a complete stoppage of the assembly line. Another disadvantage in the use of magnetic tools of the prior art is the necessity of carefully packing the tools for shipment and when not in use to avoid the demagnetizing effect of adjacent tools.

As a result of the aforesaid influences and disadvantages, magnetic tools have not found widespread use.

The use of high coercive force materials in the construction of the permanent magnets employed with such tools would obviate many of the aforesaid disadvantages inherent in the prior art devices but unfortunately, while the magnetic characteristics of such materials favor their adoption for such applications, certain other qualities render them unfit for employment as an element in the magnetic tool structures of the prior art. Principal among these deterrent factors is the brittle character of certain of these high coercive force materials and their inability to withstand the torsional forces necessary to drive the screw or nut into or from its engaged position.

I have provided a novel structural arrangement which permits me to take advantage of the aforesaid highly desirable magnetic characteristics of these high coercive force materials and which at the same time overcomes the objections to their use because of their less favorable mechanical properties.

It is therefore an important object of my invention to provide a magnetic tool having a novel structural arrangement which makes possible the employment of magnet alloys of high coercive force.

Another object of my invention is to provide an improved magnetic tool adapted for either manual or machine operation wherein the mounting for the permanent magnet permits the flux of the magnet to be utilized in the most effective manner.

A more specific object of my invention is to provide an improved magnetic tool wherein the permanent magnet is protected from the deleterious effects of dropping the tool on hard surfaces, and to provide means which prevents the transmission through the magnet of the torsional force required for driving the screw or nut into or out of its engaged position.

Another object of my invention is to provide magnetic tools which shall be compact, of simple and rugged construction, of long life, and which may be manufactured and assembled in an economical manner.

Other objects and advantages of the invention will become apparent as the description proceeds.

According to a preferred embodiment of the invention the shaft or shank of the tool is provided with a non-magnetic recessed end portion, and the permanent magnet, which is in the form of an insert, is mounted in this recess. I provide means for maintaining the magnet in position and for transmitting independently of the

magnet a torsional force to articles such as screws and nuts to rotate the articles to or from their engaged position. By the use of a construction which provides the maximum amount of flux in the air gap of the magnet, the holding power does not depend on the tip of the screw driver, thus insuring that the article will be firmly held in place against the tool and in engagement with the driving element.

The novel features which I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof will best be understood from reference to the following specification when considered in connection with the accompanying drawing. In the drawing Fig. 1 is a perspective view of an improved screw driver made in accordance with my invention; Fig. 2 is an exploded view of the apparatus of Fig. 1, showing the manner in which the constituent parts are assembled; Figs. 3, 4, and 5 represent cross sectional views showing different types of permanent magnet arrangements for use in the screw driver head of Figs. 1 and 2; Figs. 6 and 7 are cross sectional views of modified forms of machine-operated screw drivers employing the principles of my invention; and Figs. 8 and 9 are respectively cross sectional and end views showing a modified form of my invention employed in a socket wrench.

Like reference characters refer to corresponding parts throughout the several views.

Referring to Figs. 1 and 2 of the drawing, I have shown assembled and exploded views, respectively, of a magnetic screw driver made in accordance with the principles of my invention. The numeral 11 designates the shaft or shank of the tool which may be provided with a handle at one end or it may be properly shaped to fit into the kind of stock with which it is to be used for either manual or automatic operation. The opposite end of the shank is provided with a head portion 12 preferably of increased diameter and which is constructed from a suitable non-magnetic material such as stainless or other chrome nickel steels. Such materials have considerable mechanical strength, they are practically non-corrosive and when polished the surface presents a pleasing appearance. A central bore or recess 13 is formed in the head or end portion 12 of the shank 11 and provides a chamber of sufficient size to receive the permanent magnet insert 14. The head 12 is thus made generally in the form of a shell and is provided with two longitudinally extending diametrically opposed slots 15. The permanent magnet insert is provided at its outer polar face or end surface with a transverse slot 16 which is of substantially the same width as the slots 15 in the head or shell 12.

I provide means for maintaining the permanent magnet insert 14 in position in the chamber 13 and for transmitting the necessary torsional force through the head 12 for rotating a screw to or from its engaged position. In the arrangement illustrated, this comprises a generally U-shaped member 17 which is constructed from a non-magnetic material such as brass, stainless steel or, in certain cases, it may be made of a highly permeable material, as will be later explained. The member 17 is formed with end portions or legs 18 which are joined by an intermediate portion 19. The intermediate portion 19 has a portion protruding from the face of the

magnet which serves as the bit or blade for the screw driver. The blade 19 and the legs 18 are made of sufficient thickness to snugly engage the transverse slot 16 and the longitudinal slots 15, the thickness of the blade 19 and the width of the transverse slot 16 being dictated largely by the width of the transverse slot or channel commonly formed in the screw head which is to be engaged by the tool.

A material which I have used with highly satisfactory results for the permanent magnet insert 14 is an alloy containing iron, nickel, and aluminum as the basic or essential ingredients and prepared as described in United States patents to Michima, 2,027,994 to 2,028,000, inclusive and 1,947,274 and 1,968,569 to William E. Ruder; or if it is desired to form the magnet by a sintering process I may employ the method described in a copending application Serial No. 164,354, filed September 17, 1939, to Goodwin H. Howe, now Patent No. 2,192,741, entitled "Method of making a sintered alloy," and assigned to the same assignee as the present invention. Such magnetic material after being magnetized to saturation and then removed from the influence of the magnetizing force, exhibits a residual induction of approximately 7500 gauss and a coercive force of approximately 440 oersteds. While this residual induction—which is generally lower than that of the low coercive force steels but higher than for any of the other commercially feasible high coercive force materials—necessitates a slightly greater cross sectional area than with the other magnetic materials, the increase in this dimension is considerably overbalanced by the decrease in length made possible because of the high coercive force. As a result, for the most efficient operating condition, considerably more magnetic energy per unit volume is obtainable than from the other commercially available materials.

The fact that a smaller volume of magnetic material may be used to produce the same flux conditions is obviously a distinct advantage in a tool of this character, where the working space is often quite limited. The use of these materials is also particularly advantageous in that magnets may be produced of most any size and shape desired. Furthermore, the high coercive force renders the material so slightly susceptible to stray fields that it maintains its magnetism almost indefinitely. Such materials are also highly resistant to the demagnetizing influence due to use at elevated temperatures and jarring or impact shocks such as might be produced by dropping the tool on hard surfaces.

There is still another important advantage in using a magnetic material of the above character. Due to the fairly high residual induction the magnetic tools will operate with a varying air gap all the way from zero to one of appreciable value. The combination of good residual induction or remanence with a high coercive force provides a material that is most suitable for both conditions. A good holding magnet with a closed air gap might require a magnet having relatively high residual induction whereas one operating with an appreciable gap would require a high coercive force.

In assembling the apparatus, the permanent magnet insert 14 is positioned in the chamber 13 with the transverse slot 16 in alignment with the longitudinal slots 15. The U-shaped member 17 is then positioned over the end of the insert 14 with the blade 19 engaging the transverse slot 16

and the legs 18 in engagement with the longitudinal slots 15. By peening the edges of the slots 15 and the legs 18 as indicated at 20, the parts are securely fastened together.

While I have shown the slots 15 connecting the exterior of the head 12 with the recess 13, it is obvious that my invention is not limited to such a construction but obviously includes arrangements wherein the slots do not pass completely through the head of the tool, particularly since these slots merely provide means for positioning the bit or blade 19 in order that the torsional force may be transmitted to it from the head 12.

The face of the magnet may be concaved as shown at 21 to provide an enlarged surface or seat to receive the convex head of a screw. A portion of the end face of the head 12 may also be concaved as shown at 22. If desired the radius of the concave face of the magnet in relation to the end face 22 may be such that a variety of different sizes of screws having approximately the same size head slot or channel can be used with a standardized tool, or if desired the tool may have a straight cross face making it particularly adaptable for use with flat head screws.

In operation, the bit or blade 19 which projects from the face of the magnet extends into the slot or channel commonly formed in the head of screws and bolts and the magnetic force exerted by the permanent magnet maintains the screw head in firm engagement with the seat 21 in order that the screw may be guided for insertion into the threaded object which it is to engage. Upon rotation of the shaft or shank 11 a strong torsional force may be applied for driving the screw until it is securely in position. The reverse movement of the shank removes the screw from its engaged position.

By virtue of the above described novel construction, the torsional force required to rotate the screw is not transmitted through the permanent magnet insert but is transmitted through the shell or head 12 directly to the bit or blade 19, thereby making it possible to take advantage of the desirable magnetic and dimensional characteristics of high coercive force materials. The non-magnetic shell or head 12 in addition serves as a backing to protect the magnet from breakage, avoids shunting useful flux from the magnet, and prevents the adherence of magnetic articles to the side of the tool head.

In Fig. 3 I have shown an arrangement wherein the cylindrical insert 14 is polarized in the longitudinal direction in such a manner that its north and south poles are located respectively at opposite ends of the magnet. Each side of the transverse slot 16 thus forms a common pole of the magnet. In such a construction, the U-shaped member 17 is preferably constructed of a highly permeable magnetic material such as soft iron. With this arrangement the soft iron tends to concentrate the flux from the magnet at the head of the screw, the latter when in position forming the armature or keeper for the magnet. By virtue of this concentration of flux in the screw head, including the bottom and side surfaces of the slot 16, the screw is held in firm engagement with the tool.

In the modified arrangement shown in Figure 4 the permanent magnet 14 is polarized across its external end face in such a manner that the end surface on one side of the transverse slot 16 forms the positive pole while that on the opposite side of the slot forms the negative pole of the magnet. The bit or blade 19 in this instance is

made of non-magnetic material such as brass so that it has no effect on the polarization of the magnet. Furthermore, by employing a non-magnetic blade the flux from the magnet is most effectively employed since the holding power does not take place through the blade but it depends upon the air gap of the magnet wherein the screw head itself forms the armature or keeper for the magnet.

In Fig. 5 I have shown another modification employing a magnet similar to that of Fig. 3 in which the magnet 14 is positioned within a highly permeable magnetic shell 23 such as soft iron, which is in turn positioned in the recess 13 of the head or shell 12. In order to prevent short circuiting of the magnet, shell 23 is arranged to engage only one pole thereof, it being spaced from the side walls thereof as shown. The blade or bit 19 which is positioned in the transverse slot 16 of the magnet is preferably made of non-magnetic material to permit utilization of the available flux in the most effective manner. With this construction the flux of the magnet finds a return path of low reluctance through the magnetic shell and the magnetic circuit is completed through the head of the screw.

In Fig. 6 I have shown a modification which is particularly suitable for use in connection with a screw driver machine of the automatic or power driven type. Referring now more in detail to Fig. 6 of the drawing, the numeral 24 represents a rotatable shaft which may be driven through a ratchet, gear, belt or the like by a suitable source of power. The end of the shaft is provided with a screw driver bit or blade 25 which as illustrated is made integral with the shaft. It will be obvious, however, that the bit may be formed separately, if desired, and within my invention. Positioned in concentric relation with the shaft 24 is a magnetic insert 14 having a central longitudinal bore 26 and a concave face or screw seat 21. In this arrangement I may magnetize the insert 14 in the longitudinal direction. I have provided a non-magnetic spacer or collar 27 which is positioned about the outer cylindrical surface of the magnet 14 and in contact with the inner surface of the outer shell or head 28 which is formed from a relatively permeable material. The collar 27 is constructed of sufficient thickness to avoid flux leaking to the outer shell and it serves to locate the magnet in the shell. When the magnet is polarized longitudinally, I prefer to form the bit proper of permeable material, utilizing it as a return path for the flux. As an alternative arrangement I may form the hollow magnet with a transverse slot 16 and polarize it as shown in Fig. 4. In this case I prefer to make the bit proper of non-magnetic material. A spring 29, formed of a suitable material such as bronze, is connected at one end to the shell 28 and at the other end to the shaft 24, and serves to yieldingly bias the magnet and the shaft to a given relative position. The method of operation of the device should be obvious in view of the foregoing description of the operation of the other modifications.

Fig. 7 represents a modification of Fig. 6. In this arrangement the tip or blade 25 is formed of non-magnetic material and the magnet 14' is provided with a flanged or increased diameter portion 30 which engages the inner surface of the permeable shell or head 28. With this construction an air gap 31 displaces the non-magnetic collar 27 of Fig. 6. The permeable outer

shell in this case serves as a return path for the flux.

While in most instances of use it is advantageous to construct the outer shell of Figs. 6 and 7 of permeable material to aid in carrying the flux to a definite air gap, namely, that which is closed by the screw head, in some applications it may be found desirable to make the outer shell of non-magnetic or corrosion-resistant material to avoid rusting or deleterious effects caused by using the tool in acid conditions.

In Figs. 8 and 9 I have shown my invention applied to a socket wrench. In this construction the permanent magnet insert 14 may be formed with a circular bore or axial opening 26 in the form of a shell as in Fig. 6 or the insert may be made solid as desired. By making the insert hollow as at 26, the bolt or screw is permitted to run through the nut beyond the outer face of the nut. This is particularly desirable when it is desired to place more than one nut on the bolt. The magnet 14 is polarized as indicated with the transverse slot 16 forming an air gap between the poles N and S. A recess or chamber 32 of appropriate size is located in the outer end portion of the non-magnetic head 12 of the wrench, and is adapted to receive the usual polygon-shaped bolt head or nut. With this construction the bolt head or nut acts as a keeper for the magnet and the torsional force required to turn the nut is transmitted through the non-magnetic head or shell 12 of the tool independently of the magnet by rotation of the shank 11.

As explained heretofore alloys of iron, nickel, and aluminum are quite brittle, which makes them susceptible to breakage caused by dropping on hard surfaces and they are unadaptable for resisting torsional strains such as those encountered in apparatus of this nature. It is here pointed out that as between the two materials, the sintered product is superior to the cast product from the standpoint of being able to withstand these influences. With the construction shown, however, the torsional stress is not transmitted through the magnet but this force is taken up directly through the driving member without any force being transmitted through the magnet. I have thus provided magnetic tools in which the magnetism of the magnet is maintained almost indefinitely and which is not subject to any appreciable demagnetization caused by severe shocks incident to dropping the tool. Also, the tools may be used in stray fields and at elevated temperatures. A considerable advantage is gained too in making possible a very small, highly compact, tool heretofore not possible because of the dimensions required to satisfy the other conditions.

The apparatus of my invention is adaptable to either manual operation or to machines of the automatic type and therefore finds a wide field of usefulness in manufacturing operations in which assembly calls for the continuous operations of inserting bolts, screws and nuts such as in the assembly of starter switches for electric motors, switchboards, radio apparatus and the like.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention together with the apparatus which I now consider to represent the best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In a magnetic tool, a head portion having a recess therein, a short permanent magnet insert positioned in said recess and having at least one of its polar faces extending toward the open end of said recess and forming a seat for magnetically holding a driven member, said magnet being further provided with a transverse slot in said seat, a bit member positioned in said transverse slot and having a portion protruding from said seat for engaging a slot in the driven member, means for securing said bit to said head portion, and means independent of said permanent magnet through which a torsional force may be applied by said head portion to said bit for rotatably driving said driven member.

2. In a magnetic screw driver, a shank including a head portion composed of non-magnetic material and having a recess therein, a short permanent magnet insert positioned in said recess, said magnet having a shallow transverse slot formed in the end thereof which extends toward the open end of said recess and said magnet being magnetized to form polar faces of opposite polarity on opposite sides of said slot, said polar faces being shaped to form a seat for magnetically holding a screwhead, a bit member of non-magnetic material positioned in said transverse slot and having a portion protruding from said seat for engaging the slot in the screwhead, said head portion having means to engage said bit at opposite ends thereof whereby upon applying a torsional force to said shank, said torsional force is applied to said bit without exerting torsional stress on said magnet.

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