July 31, 1928. 1,678,979

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ELECTRIC PERCUSSIVE TOOL

Filed Nov. 21, 1923

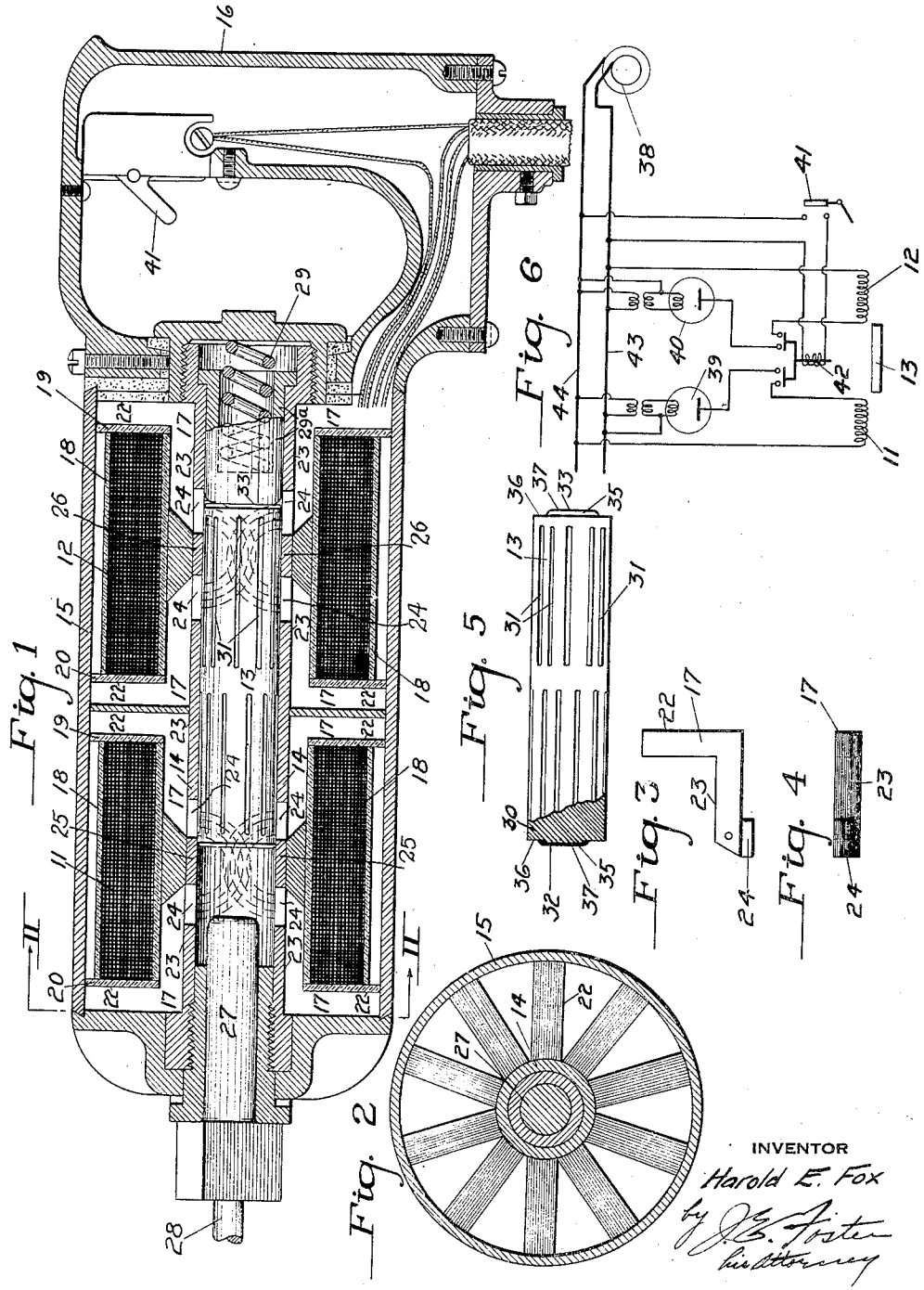


Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

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Patented July 31, 1928. 1,678,979

UNITED STATES PATENT OFFICE.

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ELECTRIC PERCUSSIVE TOOL.

Application filed November 21, 1923. Serial No. 676,043.

My invention relates to electric tools and particularly to those of the percussive type.

One object of my invention is to provide an electric hammer comprising a striking element that shall have a body portion of relatively high magnetic permeability and an impact surface or portion of relatively low magnetic permeability to obviate sticking between the striking element and a tool member acted upon thereby in a magnetic field.

Another object of my invention is to provide an electric hammer of the above indicated character comprising a core member embodying a relatively soft body portion and a relatively hard impact portion to obviate the necessity of heat-treating and hardening the core member and thereby to permit the use of a relatively soft and highly magnetic striking element and consequently increase the efficiency of the hammer.

Another object of my invention is to provide a striking element with an impact portion that shall not reduce the effective cross-sectional area of the element as a magnetic flux-conducting path.

Another object of my invention is to provide a novel striking element as an article of manufacture and a method of producing the same that shall be simple and inexpensive.

In practicing my invention I employ a reciprocating electric motor embodying two solenoids, and rectifying devices, such as asymmetric valves of the electronic type, to alternately energize the solenoids in synchronism with the alternations of an impressed alternating current, or at some other desired rate. A stock or chuck is disposed adjacent the end of one solenoid and serves to receive and support or guide the shank of a tool such as a drill or the like by which useful work is to be done.

The tool is actuated to do work by a core or striking element which is reciprocated by the solenoids in synchronism with the applied current.

The tool and the stock, or chuck are usually made of iron or steel to secure hardness and durability. Heretofore it has been necessary to heat treat the core or striking element to secure sufficient hardness to withstand the constantly recurring impact blows during operation. Such treatment of the core, to harden it, has decreased the permeability of the core and reduced the efficiency of the hammer.

In order to obtain the results desired and at the same time simplify and reduce the cost of manufacture by obviating the necessity and expense of heat-treating the core or striking element, I employ a core or striking element of relatively soft and highly magnetic iron of low retentivity and dispose an impact surface or tip of relatively hard, non-magnetic metal, such as stellite, on the respective ends of the striking element.

The employment of a core having a relatively soft body portion and a hard impact portion of stellite, in addition to eliminating the expense of heat-treating the core, eliminates the tendency of the core and the tool to stick, since the tip of stellite is relatively non-magnetic, having a permeability characteristic similar to that of air. Moreover, the employment of a soft core having high permeability increases the efficiency of the hammer by increasing the effective attraction and consequently the force of each blow struck upon the operating tool. The increased effective attraction is obtained by reason of the decreased reluctance of the highly permeable core and the resulting increased magnetic flux.

In securing the impact portion to the body portion of the striking element, it is essential to retain the entire cross-sectional area of the body portion of the element as a flux-conducting path, since the gain in increased attraction by reason of employing a soft and highly permeable body portion to permit an increased flux would otherwise be offset by increasing the reluctance of the body portion to the actuating flux.

In the accompanying drawings Figure 1 is a cross-sectional view of the hammer embodying my invention.

Fig. 2 is end view illustrating the disposition of the magnetic circuit elements;

Fig. 3 is a side elevational view of a lamination for the magnetic circuit;

Fig. 4 is a view of the laminations showing the arrangement of a set to constitute a magnetic pole;

Fig. 5 is a side elevational view of the core or striking element used with the hammer in Fig. 1; and

Fig. 6 is a diagrammatic view of the circuit connections for the operating coils or solenoids of the hammer that is illustrated in Fig. 1.

As illustrated in Fig. 1, the hammer comprises in general two operating coils or solenoids 11 and 12, a core or piston 13 movable in and between the coils, a cylindrical guide or barrel 14 for the movable core 13, an enclosing shell 15 and a handle 16.

The coils 11 and 12 are disposed on and surround the barrel 14 which is composed of a non-magnetic material such as bronze. Between the coils and the barrel are disposed a plurality of iron laminations 17 of substantially L-shape and insulating material 18 to preclude grounding of the coil conductors on the structure of the hammer, and to present a smooth winding surface for the coil conductors. Fiber washers 19 and 20 are disposed at the respective ends of the coils to insulate the coil conductors from the upright portion 22 of the iron laminations 17.

Each lamination comprises in addition to the upright portion 22, a base portion 23 which is disposed between the associated coil and the barrel 14.

The laminations are arranged in sets with the upright portions extending radially from the barrel as illustrated in Fig. 2. A plurality of the intermediate laminations of each set are provided with tips 24 that extend through openings in the side of the barrel to within a few thousandths of an inch from the inner surface of the barrel.

The enclosing shell 15 is composed of a magnetic material preferably silicon steel, and together with the laminations 17 constitutes two magnetic circuits for the coils 11 and 12 that are substantially closed except at the air gaps occupied in part by the portions 25 and 26 of barrel 14 between the tips 24 of the laminations associated with the respective windings 11 and 12.

By reason of the reduced area of the tips 24 constituting magnetic poles of the magnetic circuits, as illustrated in Figs. 3 and 4, a concentrated flux distribution is obtained at the tips to produce a greater attraction on the movable core 13.

As the two coils 11 and 12 are energized in sequence, the core 13 is moved to and fro in synchronism with the intervals of energization of the coils. In its forward stroke the core strikes a tool socket 27, in which is disposed a tool such as a drill or rivet set 28, and causes the tool to do useful work. In its backward stroke the core engages the buffer 29^a in which is disposed a resilient tempered spring 29 which stores energy which is returned to the core when the forward coil 11 again impels the core forward toward the tool socket 27.

Since the core is constantly operating in a highly concentrated magnetic field it is desirable to reduce to a minimum eddy current and hysteresis losses.

Since the tool socket 27 is in a field of magnetic influence of the coil 11, some means must be provided to diminish or to preclude the tendency of the core magnetically to stick to the end of the socket.

Moreover, the nature of the work imposed on the core as a striking element requires that the core have a characteristic of hardness to preclude any tendency of the ends of the core to become burred or upset, since such a result would interfere with the proper operation of the hammer.

In order to reduce to a minimum the eddy current and hysteresis losses, the core is formed of a body portion 30 of low carbon silicon steel having a high electrical resistance to eddy currents, high magnetic permeability characteristic and relatively low magnetic retentivity and is provided with a plurality of longitudinal slots 31, as illustrated in Fig. 5.

In order to bear up under the continuous impact during operation, the core is, in addition, provided with end portions or tips 32 and 33 of extremely hard metal, such as stellite, having relatively low magnetic permeability. The low magnetic permeability characteristic of the tips, which approximates that of air, precludes any tendency of the core 13 to be magnetically attracted or held to the tool socket 27.

The metal stellite is a commercial alloy of cobalt with one or more metals as chromium, tungsten, etc.

The percentages of the various elements composing the alloy are not necessary for an understanding of the present invention and are accordingly omitted.

By providing hard impact-sustaining tips or surfaces for the core, the body portion is relieved of the stresses to which it would otherwise be subjected and the necessity for an expensive heat-treatment is obviated. Moreover, the softer body portion of the core which may be used presents less reluctance to the magnetic flux to which it is subjected and the consequent increased flux produces an increased attraction of the core.

It will be readily realized that by decreasing the losses incident to the operation of such a hammer and by increasing the effective attraction on the core, the efficiency of the hammer is considerably increased.

The stellite tips are secured to the body portion by welding. The following method has been found advantageous in obtaining a homogeneous mass by fusing the stellite tips and the core. Advantage is taken of the relatively greater density of stellite as compared with that of the low carbon silicon steel in the body portion of the core. The stellite is flowed on the ends of the core from

a rod of the metal, by an oxidizing flame to the desired thickness. The oxidizing flame removes the carbon film tending to separate the stellite from the silicon steel and permits the stellite to fuse together with the silicon steel. As the silicon steel is heated, the stellite gradually works into and fuses into a homogeneous mass with the metal in the body portion as the end thereof is softened by the flame and by heat conducted from the stellite tip.

The stellite tips may thus be easily secured by welding to the core, to any desired depth. The depth required will depend upon the thickness of the core to which the stellite is to be applied and upon the impact forces to which the striking elements may be subjected during operation.

By reference to Fig. 1 of the drawings, it will be seen that where the core 13 is in its rear position against the member 29ª, the front end of the core is adjacent the air gap 25 of the coil 11. When the coil 11 is energized, the flux between the pole tips 24, at the air gap 25, enters the end surface of the core and by the attractive force on the core, actuates it to strike the tool.

Since the end portion of the core is traversed by the actuating flux, it is essential to avoid any increase in the reluctance of the core in that portion. For this reason the impact portion or tip must not be secured to the core in any manner that would increase the reluctance in the end portion of the core.

In experiments conducted with cores of different types for an electric hammer, it has been found that a core provided with an impact portion plugged or threaded thereinto, in such manner as substantially to reduce the effective flux-conducting area of the end portion, has materially reduced the efficiency of the hammer.

By applying the impact portions in the manner herein described, the entire conducting area of each end portion of the core is retained as an effective flux-conducting path.

Because of the extreme hardness of stellite, the whole end surface of the core is not covered since some of the stellite might flow over the edge and necessitate a grinding and finishing operation to regain a true circular contour on the core. Instead, a slightly raised portion 35 of the end surface of the core is covered with the stellite which then flows over the edge to the base surface 36 and forms a round hard impact surface 37 having about the same area as the impact surface of the tool socket 27. Thus the surface of the core which receives the direct impact stress is protected by the stellite.

The hammer is operated by alternately energizing the coils 11 and 12. A preferred method of controlling such energization is illustrated in Fig. 6 in which the coils 11 and 12 are shown as energized from an alternating current circuit 38 through asymmetric valves 39 and 40 to subject the respective coils to the alternate current waves. A trigger switch 41 is disposed on the handle 16 of the hammer and is subject to the control of the operator to energize a relay switch 42 to connect the coils to the valves 39 and 40.

The valves 39 and 40 are of the two electrode electronic type and transmit current in one direction only. When the conductor 43 of the circuit 38 is negative, the coil 11 is energized but the coil 12 is not. When the polarity changes and the conductor 44 becomes negative, the coil 12 is energized but the coil 11 is not. The core is thus actuated in synchronism with the applied current.

Although I have illustrated the application of a hard tipped core or striking element in an electromagnetic tool, it will be obvious that it may just as well be used in a percussive tool of any other type, such as, for example, a pneumatic or fluid-operated.

Similarly, although I have specified silicon steel with low carbon content as desirable for the body of the core, and stellite for the tips, other metals or alloys having similar electrical and physical characteristics may be employed and may be applied under different temperature conditions without departing from the spirit and scope of the invention as set forth in the appended claims.

I claim as my invention:—

1. In a percussive tool, a striker element comprising an impact portion of stellite.

2. An electric percussive tool comprising means for producing a magnetic field, a magnetic striking element movable in said field, and a hard impact-resisting material fused to the striking face of said element and consisting of an alloy comprising cobalt with at least one metal of the chromium group.

3. A striking element of magnetizable metal having a hard impact-resisting non-magnetic material fused to the ends thereof, said material consisting of an alloy of cobalt with at least one metal of the chromium group including mixtures or admixtures of elements not substantially changing the characteristics thereof.

4. An electric percussive tool comprising means for producing a magnetic field, a magnetizable striking element movable in said field, and an impact-resisting material of considerably lower magnetic permeability and of a much greater degree of hardness than the respective qualities of said striking element, having a homogeneons union with the ends of said striking element and not affecting the reluctance of the magnetic circuit through the striking element.

5. A magnetic striking element comprising a member of good magnetic characteris-

tics having a non-magnetic impact-resisting material much harder than said member fused to the striking surfaces thereof, said material having a melting point similar to the material of said member and adapted to alloy therewith forming a strong and permanent union between said materials.

6. A magnetic striking element comprising a magnetizable member having fused to the striking surface thereof a thin layer of material different from that of said member, said material being less magnetic and more impact-resisting than that of said member.

In testimony whereof, I have hereunto subscribed my name this 17th day of November, 1923.

HAROLD E. FOX