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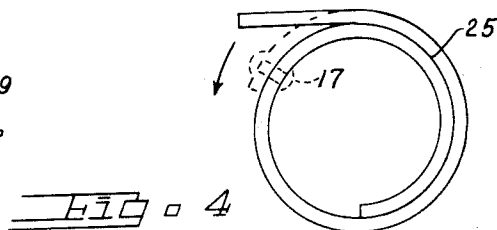
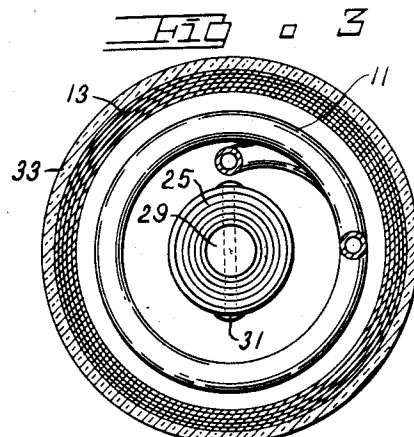
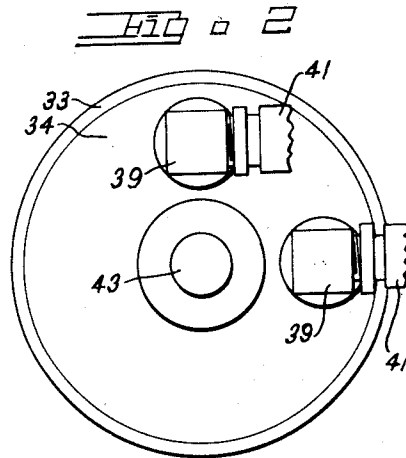
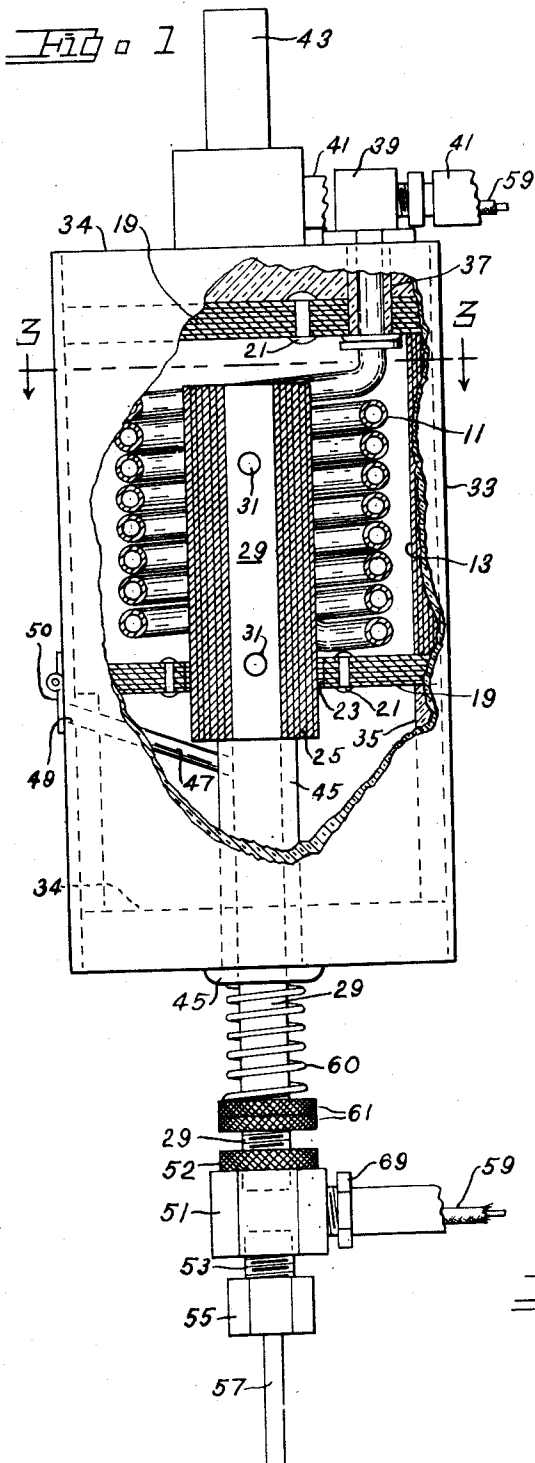
H. V. HARDING

2,383,382

VIBRATORY ELECTROMAGNETIC APPARATUS

Filed July 19, 1943

2 Sheets-Sheet 1



INVENTORS
HENRY V. HARDING

BY *J. D. Hicks*
ATTORNEY

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Fig. 5

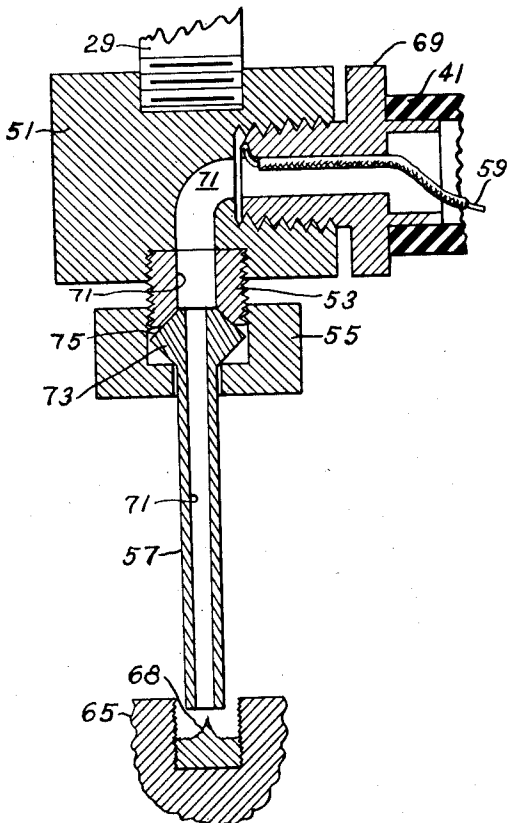


Fig. 7

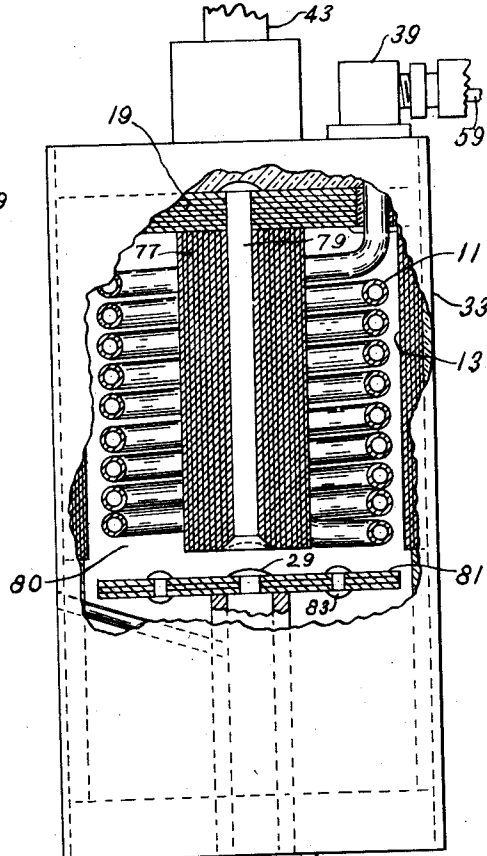
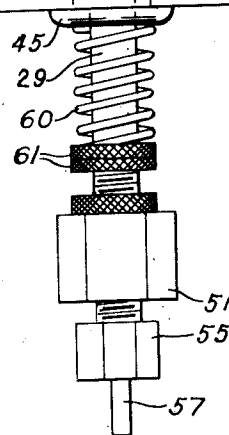
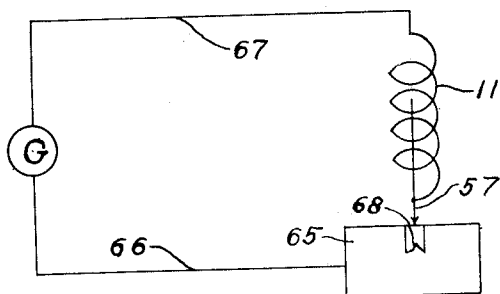


Fig. 6



INVENTORS
HENRY V. HARDING
BY *J. D. Hicks*
ATTORNEY

UNITED STATES PATENT OFFICE

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VIBRATORY ELECTROMAGNETIC
APPARATUSHenry V. Harding, Royal Oak, Mich., assignor to
Elox Corporation, a corporation of Michigan

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2 Claims. (Cl. 219-15)

My invention pertains to improved vibratory electromagnetic devices, and more particularly to such devices for use in vibratory apparatus for working on metals.

It is an object of my invention to provide improved electromagnetic apparatus for use in vibratory devices, tools and the like, and which is compact, sensitive, self-contained and has ample overload capacity.

It is also an object of my invention to provide improved electromagnetic apparatus which will be internally cooled and, requiring no external ventilation, may be made very compact.

It is a further object of my invention to provide an improved electromagnetic device which is especially useful for operating vibratory tools on metals, and wherein the energization may be controlled through the metal.

The invention itself, however, both as to its construction or organization and its use or method of operation, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments, when read in conjunction with the accompanying drawings, in which similar reference characters are applied to corresponding elements throughout, and wherein:

Fig. 1 is a side elevational view partially broken away and sectioned to show structural details;

Fig. 2 is a plan view;

Fig. 3 is a cross-sectional view on line 3-3 of Fig. 1;

Fig. 4 is a diagrammatic view representing the winding of the field structure and the armature core member;

Fig. 5 is an enlarged sectional view showing the self-centering chuck holding and connecting coolant through a hollow electrode adjacent a piece of work;

Fig. 6 is a wiring diagram, schematically representing the connection of the apparatus with the work and a source of electrical energy; and

Fig. 7 is a view similar to Fig. 1, but showing a different embodiment of the field and armature structure which may be utilized in my vibrating apparatus.

Referring more specifically to Figs. 1, 2, and 3 of the drawings, I have shown my apparatus embodying an improved electromagnet, field and armature arrangement which is especially adapted for cool and durable operation on heavy work over long periods of time, and which is especially adapted for vibrating metallic elements, electrodes, or tools, on metals, and which may also control the energizing of the device. My improved

device has a solenoid or winding 11 wound of a conductor of a low resistance metal, such as copper, silver or the like, and of tubular cross-section through which any suitable coolant medium may be circulated for internally cooling the winding while electrical current is passing therethrough in the operation of the device. Although shown open, for clearness, the coils of the winding 11 may be wound quite closely with a minimum space for insulation, such as baked enamel or other material, as hot spots can not develop and injure the insulation and space for ventilating ducts is not required because of being directly cooled.

The field structure provided to reduce the reluctance of flux paths in the magnetic circuit is of an improved construction which greatly reduces the heating and losses caused by eddy currents and hysteresis losses and which is compact and self-contained. The improved field structure comprises an enclosing shell having cylindrical side walls 13 made of high quality ferro-magnetic material. This shell 13 is preferably formed by winding a thin sheet of metal in overlapping spiral fashion, when viewed from the end, and as diagrammatically represented in Fig. 4. The side walls 13 are wound to enclose a space for receiving the solenoid winding and are wound until ample ferro-magnetic metal is provided in the flux paths of the magnetic circuit, the outer end and overlapping layers being then secured by an elongated fastening member or rivet 17, as shown in Figs. 3 and 4.

The cylindrical field structure shell 13 is closed at the ends by end walls 19 which are, as shown in Fig. 1, of flat disc-like conformation formed by stacking thin circular pieces of high grade ferro-magnetic sheet metal of a diameter substantially equal to the outer diameter of the cylindrical side walls. The thin laminations of the end walls of field structure 19 are secured snugly together, as by rivets 21. The lower end wall is provided with a central aperture 23 of a suitable size and shape to closely but freely pass one end of a reciprocable core or armature 25 which is disposed axially in the solenoid winding 11 with one end projecting out through said central aperture.

The reciprocable core or armature 25 is preferably fabricated by winding a strip of thin sheet ferro-magnetic metal in the manner indicated in Fig. 4, on the end of an elongated stem 29 to which it is secured as by transversely disposed rivets 31, shown in Figs. 1 and 3.

An outer enclosing and supporting structure is provided consisting of an outer casing 33 which is of a cylindrical conformation closed by end

walls 34 and adapted to snugly receive and hold the cylindrical field structure with its end discs 19. The casing 33 is substantially longer than the field structure, and a tubular spacer 35 is inserted in the lower end under the field structure to hold these together in a firmly assembled relation with the upper field disc 19 snugly abutting the upper end wall of the outer casing. The casing is made of any suitable plastic composition which may be a phenolic condensation product or any other material sufficiently tough and durable, waterproof and electrically insulating, of which there are a large number. When assembling, the end walls 34 are secured by cement or screws into casing 33. The ends or terminal connections of the solenoid winding 11 pass up through apertures having insulation bushings 37 in the upper field disc 19 and out through the top wall 34 of the outer casing, the exposed ends of the conductor being suitably threaded to receive hose fixtures 39 for hoses 41. One of the hoses 41 may connect to any convenient source of coolant (not shown) such as compressed air, a water tap or other source, and the other hose may discharge the cooling medium for suitable disposal. Electrical connections are made to the winding terminals in any convenient manner, as by solder, clamps or heavy clips (not shown) applied on the hose fixtures 39 for low resistance connection, as will be readily understood. A supporting pin 43 projects axially from the center of the top wall of the outer casing for convenient insertion into any conveniently adjustable chuck, on a drill press spindle or the like, whereby the device may be supported for convenient and accurate positioning and adjustment up or down, and/or from side-to-side, in accordance with the nature of the work.

The armature extension or stem 29 projects downwardly and passes out through a hardened bushing 45 supported in the center of the bottom end wall of the outer casing. This bushing may be lubricated in any suitable manner, as through a tube 47 leading thereinto from an oil hole 49 in the side of the casing closed by a cover 50.

The outer projecting end of the extension 29 is threaded for screwing into a threaded aperture in the upper end of a block 51, to which it may be secured as by a locknut 52. A threaded connector 53 extends into and from the bottom end of said block and supports a chuck or collet 55, wherein various metallic elements, electrodes or tools 57 may be conveniently inserted or replaced. Such an electrode or tool 57 may be connected through any suitable flexible conductor 59 connecting from the block 51 up to one of the fixtures 39 on top of the casing leading from one end of the winding 11 so that the electrode may be controlled by energization of the solenoid.

A compression spring 60 is provided in concentric disposition on the extension 29 where, reacting between the lower end of the bushing 45 and a pair of adjustable locknuts 61, it continuously urges the core armature and extension 29 to its lowest position. The lowest position of the core armature and extension assembly is predetermined by any suitable stop limit means, as by the upper end of the bushing 45 abutting the lower end of the core 25, as shown in Fig. 1.

In operation, one terminal of a suitable electrical source G, as shown in Fig. 6, such as a welding current source, is connected to the work piece 65, through a conductor 66, or the circuit may extend partly by a ground circuit through 75

the frame of a supporting structure, as will be readily understood. The other terminal of the electrical source G is connected through a conductor 67 to the other terminal 39, of winding 11, which is not connected to the tool element. With the work piece 65 and the metallic element, tool or electrode 57 energized to opposite polarities from the current source, the engagement of the element upon the work causes current to flow through the solenoid winding 11 which quickly jerks up the electrode or tool element. This breaks the energizing circuit and deenergizes the solenoid. The element 57 is then quickly thrown down by the spring 59 and reengages the work. This cycle of operation is repeated in rapid succession causing the tool to vibrate on the work.

The tool 57 may be a riveting or peening hammer, a chisel or marking tool for cutting or marking sheet metal, as well as various other types of tools. I have found that by using a hollow or tubular electrode in the chuck and flowing a coolant over the work, it is possible to quickly and conveniently remove a piece of hard metal 68, such as a broken tap. Also a hole may in this manner be formed in hardened metal, as in a die for example. For this purpose a hose connection fixture 69 is provided in the side of the block 51, and is connected to the discharge tube 41, as shown in Fig. 5, for delivering compressed air, water, or other coolant, from any suitable source, so it flows down from the block through an axial passage 71 in the support and through the electrode 57 to the point, where the conduction of the electricity to the metal work piece causes hot spots and the coolant causes these to rapidly chip off, removing the broken tool or forming a new hole in hard metal.

Such electrode tubes 57 are preferably made of the softer metals, such as copper and other non-ferrous metals. For convenience the electrodes, or other metal working tool elements, are preferably provided with an enlarged head 73 having self-centering conical surfaces. The upper conical surfaces 75 of the head enter into the lower end of the aperture in the tubular connector 53 wherein it is clamped by screwing the chuck collar 55 up onto the lower end or the connector tube which, as shown in Fig. 5, centers the tool or element 57. When the element 57 is a tubular electrode, this self-centering arrangement serves to also establish alignment of the apertures 71 for passing a coolant down to the point of the electrode, to chip off metal as the electrode vibrates. In operation the coolant chills the hot spots formed on the hardened metal, and chips are rapidly broken off and are removed by the flow of coolant medium into and out of the hole.

Fig. 7 shows another embodiment of the field and armature arrangement which may be advantageously utilized in my previously described apparatus for work of varying nature and conditions. In this embodiment, a stationary central core member 77 is provided extending axially through the shell 33 and the winding 11 with the upper end snugly abutting the upper field structure disc 19 whereto it is firmly secured, as by an elongated fastening member 79 passing up through an aperture therein and the upper end being secured, as by peening, to prevent its withdrawal. In this structure the lower field disc of the field structure has been removed and the lower end of the shell 13 is open exposing an effective annular air gap 80 extending around between the lower end of the central core member 77 and the lower edges of the cylindrical field

structure 13. Exposed to this annular air gap is an armature 31 of a circular or disc shape. The armature 31 is made of good quality ferro-magnetic material, and may preferably be fabricated by stacking together a large number of thin laminations of the sheet metal and then rigidly securing together, as by a plurality of rivets 33 passing therethrough. The armature 31 is secured on the upper end of the extension or stem 29 which has a reduced end portion passing therethrough and peened over. The extension 29 passes slidably down through the hardened bushing secured in and passing through the lower end wall of the casing, as in the first embodiment, for supporting a connection block 51 and chuck 55 for vibrating metal working elements 57. As in the first embodiment, the extension 29 and the armature are biased by gravity or a spring to a predetermined position from which it is moved when the structure is magnetized by current in a winding 11 disposed around the central core 77 in the cylindrical shell 13. Although the winding 11 could be independently controlled, it is preferably energized and controlled through the metal being worked on, by connecting one end of the winding 11 through the conductor 59 to the sliding extension 29 and the tool or electrode which it vibrates, as in the first embodiment. Also the winding 11 is of tubular conductor for cooling, by flowing coolant therethrough, while carrying the heavy electrical currents which may be applied.

In operation, my second embodiment is utilized by inserting suitable electrodes, tools or other metal working elements in the chuck 55 in the manner, and for the purposes described, with reference to the first embodiment and which will therefore not be repeated. My second embodiment, shown in Fig. 7, has lighter weight in the vibrating parts and it is therefore more sensitive. Also the movements of the armature tend to fan and circulate the air, and the electromotive arrangement has different stroke characteristics useful for operating under various working conditions.

My vibratory electromagnetic metal working device is compact and self-contained, is cool operating and has ample over-load capacity.

I do not wish to be restricted to the specific structural details, arrangement of parts or circuit connections herein set forth, as various modifications thereof may be effected without departing from the spirit and scope of my invention.

I claim:

1. In a vibratory electromagnetic device for working on metals the combination of, a solenoid winding, said winding being wound of tubular metal so that a cooling medium may be circulated therethrough, a core reciprocatably disposed in and extending from said winding, a field structure associated with said winding and core for reducing the reluctance of the magnetic flux paths, conductive means connecting one terminal of said winding to said core and extension, means for guiding reciprocating movements of said core, resilient means tending to urge said core to a predetermined position from which it is attracted when the winding is energized, means limiting the predetermined position to which the core is moved by said resilient means, and a chuck on the extending end of said core, said chuck being constructed to removably mount an elongated, hollow, metallic element therein for engaging metal to be worked upon movement of said core, said chuck having a fluid flow passage therein communicable with said hollow element.

2. Metal working apparatus comprising an electromagnetic winding, said winding including a tubular metallic conductor so that coolant fluid and electric current may flow through the winding simultaneously, an armature structure disposed movably adjacent said winding for movement thereby and having an extension adapted to support a hollow electrode, a fluid flow passage in said extension, and electric and fluid flow conducting means connected to one end of the conductor and connected to said armature structure for movement therewith and communicating with the passage in said extension for conducting coolant fluid therethrough and electrically connecting said conductor and extension, said last named means including a flexible tube for conducting the coolant fluid and an electrical conductor within said tube providing the electrical connection.

HENRY V. HARDING.