

Aug. 27, 1940.

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2,213,007

ELECTROMAGNETIC HOLDING DEVICE AND DEMAGNETIZER

Filed Jan. 14, 1937

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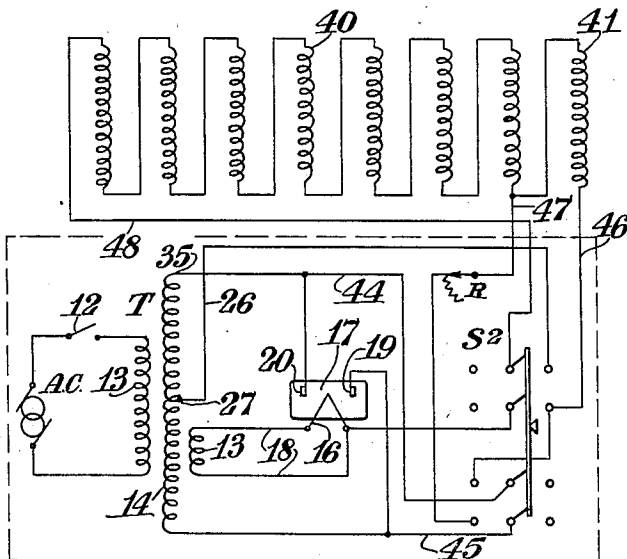
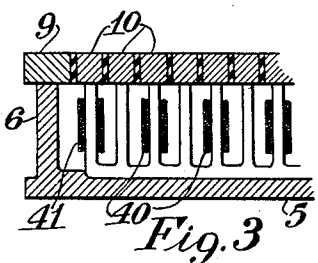
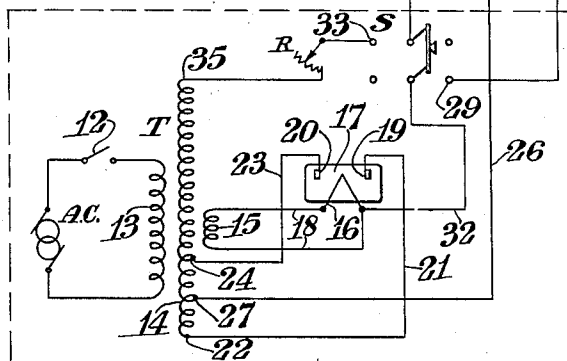
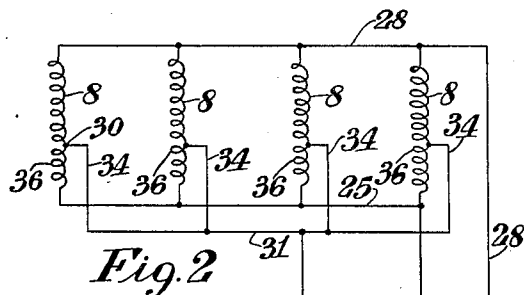
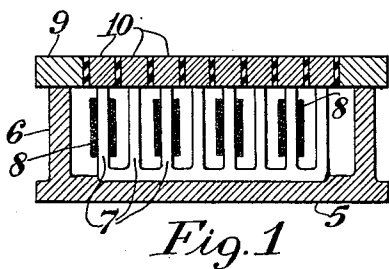


Fig. 4

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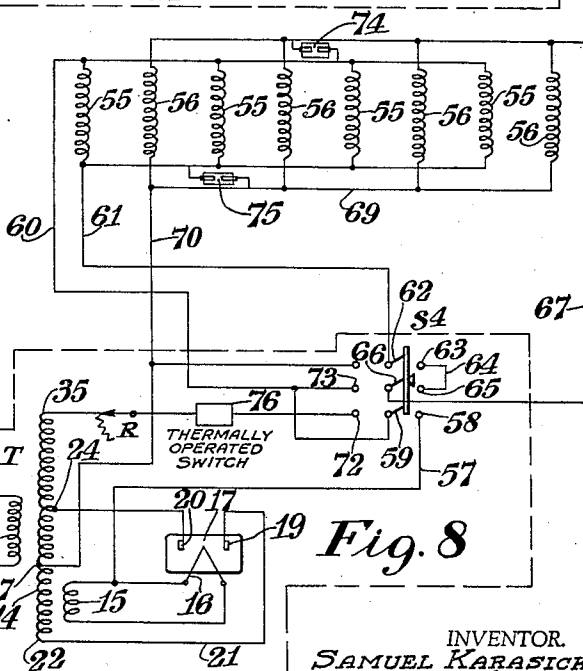
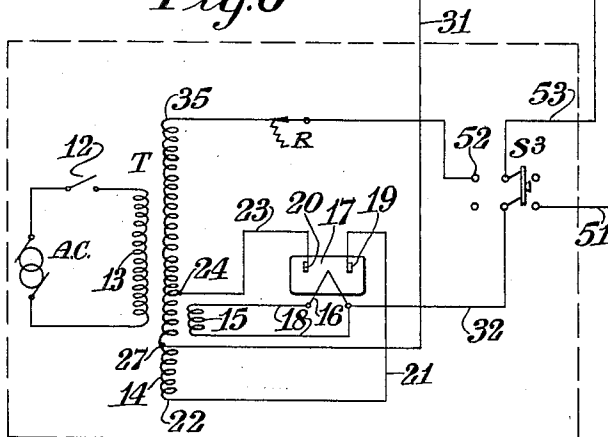
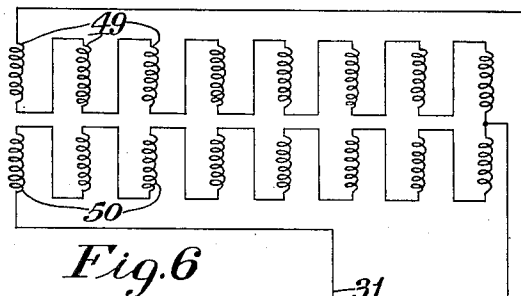
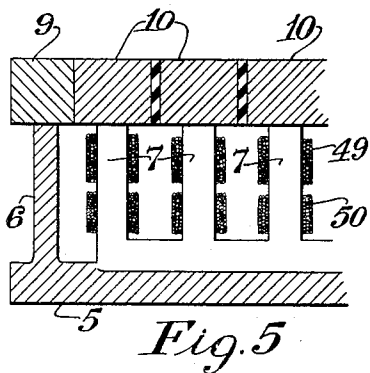
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2 Sheets-Sheet 2



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2,213,007

ELECTROMAGNETIC HOLDING DEVICE AND
DEMAGNETIZER

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Application January 14, 1937, Serial No. 120,606

9 Claims. (CL 175—181)

This invention relates to combined electromagnetic holding devices, and demagnetizers, as well as to the circuits for operating the same.

In applicant's copending application S. N. 691,048, now patent No. 2,138,864, issued December 6, 1938, there is disclosed a combined electromagnetic chuck and demagnetizer which is a marked advance in the art altho it has certain limitations. The purpose of the present invention is to provide improved and more effective circuits for the operation of such a device, and to overcome the limitations on the circuit design imposed by certain features of the circuit described in the said application. As in the case of the previously disclosed chuck, it is essential that the magnetic circuit be adapted to carry alternating flux, at least in those portions thereof used for demagnetization by alternating current. It is however, unnecessary in many cases that the entire chuck surface be capable of use as a demagnetizer, since after the interruption of the holding current, it is comparatively easy to slide work, even of hardened steel, along the surface of the chuck to a demagnetizing zone. The present invention has for a further purpose the provision of a demagnetizing zone at one portion of the work holding surface of a combined chuck and demagnetizer.

In the chuck as described in my previously mentioned application, it is necessary that each pole be provided with an electrical winding, all of which are energized for holding on direct current operation, while only half of these poles are energized by alternating current for demagnetization. However, the use of a coil on every pole piece renders it difficult to provide small poles closely spaced in the work surface whereby numerous small pieces of work, as for example, washers, can be arranged to cover the entire work surface so that a large number of such pieces can be ground simultaneously. This reduction in pole size, is readily accomplished by the use of energizing coils only on alternate poles of the device, but the application of demagnetizing alternating current is then necessary to all coils, as otherwise there would be little or no alternating flux in alternate poles.

It will be further seen that in a magnetic chuck of the type herein described, the work held is subsequently demagnetized, in the identical configuration in which it was initially magnetized. That is to say, the geometrical relation of work and poles on the holding part of the cycle of operations is identical with that existing during the demagnetizing portion of the cycle,

whereby the elimination of the permanent magnetism impressed on the work while held, is greatly facilitated and the resultant demagnetization is more complete. It will, of course, be understood that the amplitude of the alternating flux used for demagnetization must equal or exceed the unidirectional flux utilized for magnetization with the values of uni-directional flux commonly employed in magnetic chucks of the well known direct current type.

For a clearer understanding of the invention reference is made to the following description and appended claims when taken with the drawings in which Fig. 1 is a cross section of an electromagnetic chuck suitable for use in the system of the invention while Fig. 2 is a diagrammatic circuit arrangement suitable for use in the chuck of Fig. 1; Fig. 3 is a cross section of a modified type of chuck suitable for use in a modified type of system of the present invention and Fig. 4 is a diagrammatic showing of a modified circuit arrangement of the invention for use with the chuck of Fig. 3; Fig. 5 illustrates a still further modified type of chuck whereas Fig. 6 discloses a diagrammatic circuit arrangement of the invention suitable for use with this last mentioned chuck; Fig. 7 shows a still further modified type of chuck and Fig. 8 is a schematic showing of the circuit arrangement for energizing the same.

Referring especially to Fig. 1, the chuck there-in disclosed comprises an open top casing having a bottom 5, ends 6 and side walls (not shown). Within the case there is mounted a magnet having a plurality of poles 7 in spaced relation with the poles extending upward toward the open top of the case. Alternate poles of the magnet are encircled by energizing coils 8 thereby permitting the magnet poles to be closely spaced so that numerous small pieces of work such as washers can be held on the chuck simultaneously. The top of the case is closed by a work supporting plate 9 having a series of pole pieces 10 mounted therein preferably by being cast in non-magnetic and/or non-conducting material, the spacing of these poles being such that each of them is brought into contact with a pole of a magnet when the work supporting plate is secured on the top of the casing.

The several coils 8 of this chuck are included in a circuit arrangement disclosed in Fig. 2 which may be selectively operated to energize the several coils 8 by unidirectional current, and subsequently to energize at least a portion of each of the coils by alternating current whereby the

work piece supported on the chuck can be readily demagnetized. The circuit arrangement includes an alternating current source of a commercial power frequency herein designated AC which is connected under the control of a switch 12 to the primary winding 13 of a transformer T. This transformer in addition to the primary winding 13 has a high voltage secondary winding 14 and a tertiary low voltage winding 15. The tertiary winding supplies heating current to the cathode 16 of a rectifier tube 17, over the conductors 18 in series. This rectifier tube is of the full wave type having the anodes 19 and 20 enclosed with the cathode 16 in a glass envelope containing a gaseous medium so that it is of the gaseous conduction type. The anode 19 of this rectifier is connected over the conductor 21 to the terminal 22 of the secondary winding 14 of the transformer while the anode 20 is connected over the conductor 23 to a tap 24 at an intermediate point on the secondary winding. The energizing coils 8 of the chuck have one of their common ends connected in multiple to the conductor 25 which is connected by the conductor 26 to tap 27 of the secondary winding 14 at a point thereon midway between the taps 22 and 24 thereof. The other common ends of the energizing coils 8 are connected in multiple to a conductor 28 terminating at a contact 29 in the double-pole double-throw switch S. A tap 30 on each coil 8 is connected in multiple to a common conductor 31 which terminates in one blade of the mentioned switch S so that a portion 36 of each of these coils can be energized by alternating current to effect the demagnetization of the work supported on the chuck.

When it is desired to hold work on the chuck, the blades of the double pole switch are brought into engagement with the right hand contacts such as 29 thereof and the switch 12 is also closed to connect the alternating current source to the transformer T, to effect its energization. The tertiary winding of this transformer supplies heating current to the cathode 16 of the rectifier tube 17 while the portions of the secondary winding between the taps 24 and 27 and 22 and 27 respectively, apply positive voltage alternately to the anodes 20 and 19 so that tube 17 functions as a full wave rectifier. The output of the rectifier supplies direct current over the conductors 26 and 25 through the entire length of the coils 8, conductor 28, switch contact 29, lower blade of switch S, conductor 32 to the cathode circuit. As long as the switches 12 and S are closed in the position last mentioned, direct current is supplied to the coils 8 to energize them thereby retaining the work pieces against the pole pieces 10 in the work support 9.

When it is desired merely to release work pieces which do not become permanently magnetized by being supported on the chuck, the switch 12 can be opened or else switch S can be moved to an intermediate position so that direct current is no longer supplied to the coils of the chuck. However, if the work material such as hardened steel has been held on the chuck it is necessary to demagnetize it before it can be removed from the chuck. In order to effect demagnetization of such material the movable blades of the switch S are brought into engagement with the lefthand contacts thereof such as 33. With the switch in this position and with the switch 12 closed, alternating current is supplied to the lower portion 36 only of each

of the coils. This alternating current is applied in a circuit traceable from the upper terminal 35 of the secondary winding 14 of the transformer, rheostat R, contact 33 of the switch S, upper blade thereof, conductor 31, branch conductors 34, lower portion 36 of coils 8 in multiple, conductors 25 and 26 to the tap 27 on the secondary winding. Thus alternating current is applied to the lower portion of the coils so that an alternating flux is developed in the poles 7 of the magnet and through the pole pieces 10 to the work on the supporting surface. While the alternating current flux is thus being developed in the work piece, it is preferably moved transversely of the pole pieces 10, in effect applying a decrementally reversing flux to the work piece. The portions 36 of the coils 8 as well as the difference in potential across the terminals 27 and 35 of the secondary winding of the transformer are so proportioned that an alternating magnetomotive force is applied to the poles of the magnet and to the pole pieces 10, equal or greater than the direct magnetomotive force applied thereto. It has been found that for any single coil such as 8, an alternating voltage at least twenty times the direct voltage is required to produce a suitable amplitude of alternating flux because of the inductive reactance of the coils 8. It would of course, be possible to utilize the entire winding of the coils 8 when energized by either direct or alternating current. However, if the entire length of the coils were used, that is, if the taps 30 thereon were omitted and conductor 31 were connected to the upper terminals of the coils 8 while the lower terminals remain connected to the conductor 26, the difference in potential across the conductor 26 and the contact 33 would need to be about twenty times the direct current output of the rectifier, for example, if a direct voltage of fifty volts were used, then the required alternating voltage would be approximately one thousand volts. Such a voltage however, is so high as to be dangerous and would require careful and costly insulation of the windings of the coil 8. If taps 30 are positioned at approximately the midpoints of the windings of the coils 8, then the inductance of the portion of each coil between tap 30 and conductor 25 is one-fourth the inductance of the whole coil 8, and an alternating voltage of two hundred fifty volts would produce the same flux as an alternating voltage of one thousand volts applied to the entire coil 8.

In the present arrangement the alternating current in the lower portions of the coils will be about twice the direct current in the entire winding of these coils. This factor must be taken into consideration in designing the coil. Obviously the taps 30 may be located at various positions along the windings of the coils 8 and the voltage applied thereto adjusted accordingly.

The chuck illustrated in Fig. 3 is substantially identical with the chuck disclosed in Fig. 1 except that the coils 40 and 41 thereof have no intermediate tap such as the tap 30 on the coils 8. The remaining parts of the chuck are designated by the same reference characters as applied to the foregoing chuck.

In the circuit arrangement shown in Fig. 4 the coils 40, 41 of the chuck are all connected in series. This arrangement produces a more efficient rectifier circuit, since it increases the direct voltage applied to the magnets. However, one of these coils, such as 41 can be energized with an alternating voltage induced across the entire

length of the secondary winding of the transformer. When the four pole double throw switch S2 is closed to its lefthand position the coil 41 is energized by the entire secondary voltage induced in the secondary winding of the transformer, while all of the coils are energized in series by direct current when this switch is closed to its righthand position. The rectifier utilized in this arrangement is also of the full wave gaseous conduction type and the circuits of the power device in which it is included, are similar to those disclosed in Fig. 2 and need not be further described.

In the operation of this circuit arrangement, when it is desired to retain the work on the work surface of the chuck, the four-pole, double-throw switch is moved to close its righthand contacts so that the output of the rectifier is applied through the uppermost pair of blades of the switch and conductors 46 and 48 to all the coils 40 and 41 in series. However, when it is desired to demagnetize the work piece on the chuck, the switch is moved to close its lefthand contacts whereby the entire voltage developed in the secondary winding of the transformer is applied over the conductors 44 and 45, the two lowermost blades of the switch and thence through conductors 46 and 47 to the terminals of the coil 41. At the same time the work-piece is moved along the surface of the chuck across the portion thereof energized by the coil 41 which is now carrying alternating current so that the work-piece is demagnetized. In the arrangement illustrated eight coil windings are provided and the entire secondary voltage of the transformer is applied to the coil 41 so that the ratio of the alternating voltage to direct voltage applied to this coil is about twenty to one and hence adequate alternating flux will be developed in its related pole piece.

The modified form of the chuck illustrated in Fig. 5 also includes a casing having a bottom 5 and end walls 6, the casing being open at its top. The magnets 7 which in this instance comprise a plurality of pole extensions are also mounted within the casing with the poles of the magnets extending upward. Each leg of the magnet is encircled by a coil comprising two independent sections 49 and 50. The work supporting top plate 9 closes the top of the casing and has the pole pieces 10 mounted in spaced relation therein in non-magnetic and/or non-conducting material. Each pole piece engages a pole extension of the magnet in this chuck, and the entire surface of the top plate thereof is used for holding the work and for demagnetizing the same.

The circuit arrangement for energizing the coils 49 and 50 in the chuck is illustrated in Fig. 6 and comprises a source of alternating current and a source of rectified or direct current developed by the power device disclosed within the broken lines. The several parts of this power device are identical with those already described and the various parts thereof are designated by the same reference characters as applied to the corresponding power devices already described. This power device is connected to the coils of the chuck by a double-pole double throw switch S3 so that alternating or direct current can be selectively applied to the chuck. When the blades of this switch are moved into engagement with the righthand contacts thereof, rectified current is supplied over the conductor 31 through the windings 50 and 49 in series, conductor 51,

lower blade of the switch, conductor 32 to the cathode of the rectifier tube. When, however, the switch is moved to engage its lefthand contacts, alternating current flows in a circuit from the terminal 35 of the secondary winding of the transformer, rheostat R, contact 52 of the switch, upper blade of the switch, conductor 53 to the windings 50 in series, conductor 31 and tap 27 of the secondary winding. The secondary winding of the transformer is so designed that the difference in potential developed between the upper terminal 35 of this winding and the tap 27 for application to the coils 50, is higher than the voltage of the rectified current.

It will be apparent from the foregoing description that the winding of the coils 49 and 50 and the difference in potential between the tap 27 and the terminal 35 of the secondary winding of the transformer can be so chosen in relation to the direct voltage applied as to produce an alternating flux adequate to demagnetize the work piece supported on the chuck.

The modified type of chuck shown in Fig. 7 is similar to that already disclosed in Fig. 1 and the corresponding parts thereof are designated by the same reference characters. In this chuck each alternate extension only of the magnet is encircled by an energizing coil such as 55 or 56.

A circuit arrangement which is suitable for use with this chuck, is disclosed in Fig. 8 and includes a power device for supplying rectified current to the several coils of the chuck and for applying alternating current to these coils to effect demagnetization of the work supported on the chuck. This power device is identical with the power devices already described. A three-pole double-throw switch S4 is provided to connect either the rectified output of the power device to the coils of the chuck or to connect the alternating output of this device to these coils. With the switch moved to its righthand position to engage its several contacts, rectified current is supplied over the conductor 57 from the rectifier, contact 53 of the switch, blade 59 thereof, conductor 60, coils 55, conductor 61, blade 62 of the switch, contact 63 thereof, conductor 64, contact 55 of the switch, switch blade 56 thereof, conductor 67, coils 56, conductors 69 and 70 to connect the two groups of coils in series across the output of the rectifier. When the switch S4 is closed to the left, the direct current circuit last-described is broken and alternating current flows from the terminal 35 of the secondary winding of the transformer through rheostat R to the contact 72 of the switch thence through blade 59 thereof to conductor 60 and contact 73 of the switch. The current divides, one half thereof flowing over conductor 60 to the coils 55 and the other half of the current flowing through the middle blade 66 of switch to conductor 67 and thence through the coils 56. The current passing through coils 55 returns over conductor 61 while that passing through coils 56 returns over conductor 70. Conductor 61 is connected to the top blade 62 of switch S4 and current therefrom flows to conductor 70 through blade 62 when the switch is in its lefthand position. Thus it will be seen that on alternating current all coils 55 and 56 are connected in parallel. Since there are two poles per coil, and since the two groups of coils 55 and 56 must be equal in number, it follows that in a chuck of this type, the total number of poles must be an integral multiple of four.

Cold cathode gas filled discharge devices 74 75

and 75 are respectively connected between the conductors to which the common ends of the coils 55 and 56 are connected. The switch jaws 63 and 65 are longer than the others on the righthand side of the switch S4 so that when this switch is opened from its righthand contacts, the direct current circuit is broken first at the switch contact 58. Thus the resulting surge voltage induced in the coils 55 and 56 which remain momentarily connected in series through switch contacts 63 and 65, breaks down the discharge devices and the energy stored in the magnetic fields of the coils is dissipated in a momentary discharge through said tubes thereby greatly reducing the surge voltage strains otherwise applied to the insulation of the coils and also reducing arcing in the switch S4. A thermally operated switch 76 of any well known construction is also inserted in a lead which will open the alternating current circuit when the interior of the chuck rises to an objectionably high temperature which might occur if the switch S4 remained closed in its lefthand position inadvertently for a very long period. It will be appreciated that this possibility of overheating may arise from the eddy current losses in the magnetic circuit generally termed iron losses. Such a thermostatic switch is applicable to the alternating circuits of the arrangements of Figs. 2, 4 and 6.

While the group of coils 55 has been shown connected in multiple in Fig. 8 and the group of coils 56 has similarly been connected in multiple, the coils in each of these groups can be connected in series. In such an arrangement the two coil groups are connected in series when direct current is applied thereto for retaining the work on the chuck and are connected in multiple when alternating current is supplied to them for demagnetizing said work.

It should be mentioned that the pole pieces 10 are preferably made of laminated pieces of material having high permeability. The magnets 7 are also preferably made of laminated ferrous material.

It will be noted that a rheostat R is included in one of the leads of the alternating circuit of each chuck and when it is desired to demagnetize the work material, the alternating current applied to the alternating current coils of the several chucks may be gradually decreased by means of this rheostat thereby applying a decrementally reversing flux to the pole pieces of the several chucks.

What I claim is:

1. In a holding device for pieces of magnetizable material on which work is to be done, a work support, a plurality of pole pieces of magnetizable material terminating in a surface of said support in a given pattern, means unidirectionally to magnetize said pole pieces to grip a piece of material against said surface, and means including a source of alternating current for reversing repeatedly at a commercial power frequency the magnetization of said same pole pieces for demagnetizing said piece of material in the same flux pattern that magnetized it, said unidirectional magnetizing means comprising a coil placed upon each alternate pole piece, and said means for reversingly magnetizing said pole pieces comprising all of the coils aforesaid, said coils being further connected in two groups, the alternate coils being connected together in one coil group and the other coils in a second coil group and means for connecting said groups in

series for unidirectional magnetization and means for connecting said groups in multiple with said alternating current source for demagnetization.

2. In a work holding device, spaced magnetizable pole pieces arranged in a given pattern, a work support having a surface in which said pole pieces terminate, magnets having poles, each pole engaging a pole piece, a pair of coils about each of certain of said poles, means including a source of unidirectional current to energize said coils for magnetizing said magnets and pole pieces to retain a work piece of magnetic material on said surface, a source of alternating current and means including said alternating current source and a single coil of each pair energized therefrom for reversingly magnetizing said pole pieces whereby said work piece is demagnetized.

3. In a work holding device, spaced magnetizable pole pieces arranged in a given pattern, a work support having a surface in which said pole pieces terminate, magnets having poles, each pole engaging a pole piece, a pair of coils about each of certain of said poles, means including a source of unidirectional current to energize said coils in series for magnetizing said magnets and pole pieces to retain a work piece of magnetic material on said surface, a source of alternating current and means including said alternating current source and a single coil of each pair energized in series for reversingly magnetizing said pole pieces whereby said work piece is demagnetized.

4. In a work holding device and demagnetizer, spaced magnetizable pole pieces, a work support having a surface in which said pole pieces terminate, magnets having poles, each pole engaging a pole piece, a coil about each of certain of said poles, each alternate coil being connected together in one coil group and each of the other alternate coils being connected together in a second coil group, means including a source of unidirectional current supplied to said groups of coils in series for magnetizing said magnets and pole pieces to retain a work piece on said device, a source of alternating current, and means including said alternating current source applied to said groups of coils connected in multiple for reversingly magnetizing said magnets and said pole pieces whereby said work piece is demagnetized.

5. In a work holding device and demagnetizer, spaced magnetizable pole pieces, a work support having a surface in which said pole pieces terminate, magnets having poles, each pole engaging a pole piece, a coil about each of certain of said poles, each alternate coil being connected into one of two groups of coils, means including a source of unidirectional current supplied to said groups of coils in series for magnetizing said magnets and pole pieces to retain a work piece on said device, a source of alternating current, means including said alternating current source applied to said groups of coils connected in multiple for reversingly magnetizing said magnets and said pole pieces whereby said work piece is demagnetized, and surge voltage discharge means connected across the terminals of said coils.

6. In an arrangement of the class described, a combined magnetic holding and demagnetizing device, a commercial alternating current source for operating said device, said device comprising a core having core elements, at least a portion

of said elements being each provided with an energizing coil, the impedance of each coil at the frequency of said source being several times as great as the direct current resistance thereof, 5 said coils being arranged into a plurality of coil groups, means for rectifying said alternating current, means for connecting said coil groups in series to said rectifying means, a transformer connectible to said alternating current source, 10 means for connecting said coil groups in parallel to said transformer, said transformer having such a transformation ratio that the total electromotive force per coil group is materially greater than when said coil groups are connected 15 to said rectifying means, and means effective at will for connecting said coil groups either to said rectifying means or to said transformer.

7. In an arrangement of the class described, a combined magnetic holding and demagnetizing device, a commercial alternating current source 20 for operating said device, said device comprising a core having core elements, each alternate element only of at least a portion of said elements being provided with an energizing coil, 25 the impedance of each coil at the frequency of said source being several times as great as the direct current resistance thereof, said coils being arranged into a plurality of coil groups, means for rectifying said alternating current, 30 means for connecting said coil groups in series to said rectifying means, a transformer connectible to said alternating current source, means for connecting said coil groups in parallel to said transformer, said transformer having such a 35 transformation ratio that the total electromotive force per coil group is materially greater than when said coil groups are connected to said rectifying means, and means effective at will for connecting said coil groups either to said rectifying means or to said transformer.

8. In an arrangement of the class described, a combined magnetic holding and demagnetizing device, a commercial alternating current source

for operating said device, said device comprising a core having core elements, each alternate element only of at least a portion of said elements being provided with an energizing coil, the impedance of each coil at the frequency of said 5 source being several times as great as the direct current resistance thereof, said coils being arranged into a plurality of coil groups, means for rectifying said alternating current, means for 10 connecting said coil groups in series to said rectifying means, a transformer connectible to said alternating current source, means for connecting said coil groups in parallel to said transformer, the inductance of the coil groups connected 15 in series being materially greater than the inductance of the coil groups connected in parallel, said transformer having such a transformation ratio that the total electromotive force per coil group is materially greater than when 20 said coil groups are connected to said rectifying means, and means effective at will for connecting said coil groups either to said rectifying means or to said transformer.

9. In a work holding device and demagnetizer, spaced magnetizable pole pieces, a work support 25 having a surface in which said pole pieces terminate, magnets having poles, each pole engaging a pole piece, a coil about each of certain of said poles, the alternate coils being connected in multiple into two groups of coils, means in- 30 cluding a source of unidirectional current for supplying direct current to said groups of coils in series for magnetizing said magnets and pole pieces to retain a work piece on said device, a source of alternating current, and means includ- 35 ing said alternating current source for supplying alternating current to all of the coils of said groups connected in multiple with each other as a second group for reversingly magnetizing said magnets and said pole pieces whereby said work 40 piece is demagnetized.

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