April 2, 1946. M. L. MAGES 2,397,497

METHOD AND MEANS FOR DEMAGNETIZING

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Fig. 1

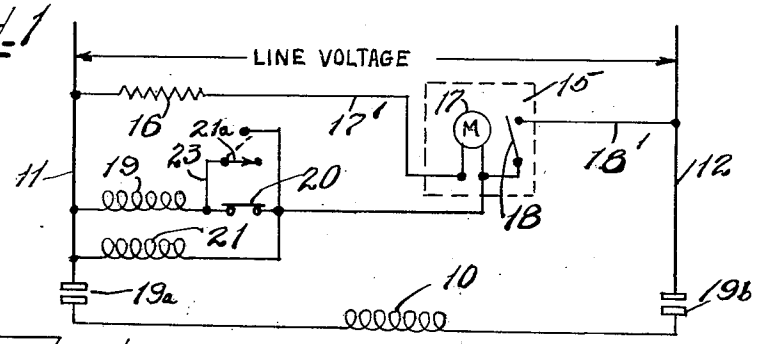


Fig. 2

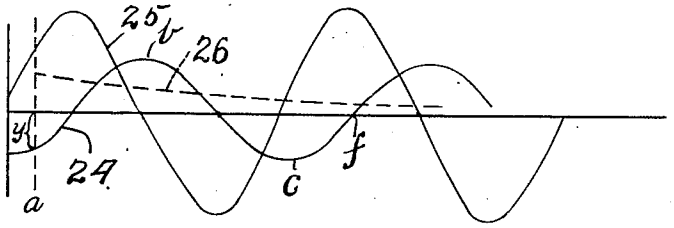


Fig. 3

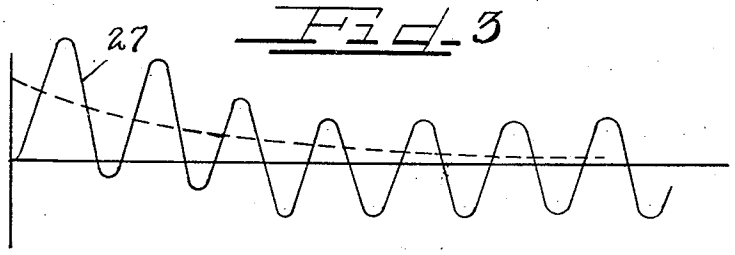
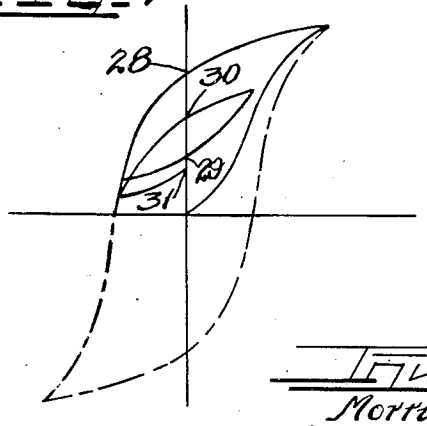


Fig. 4



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Fig. 5

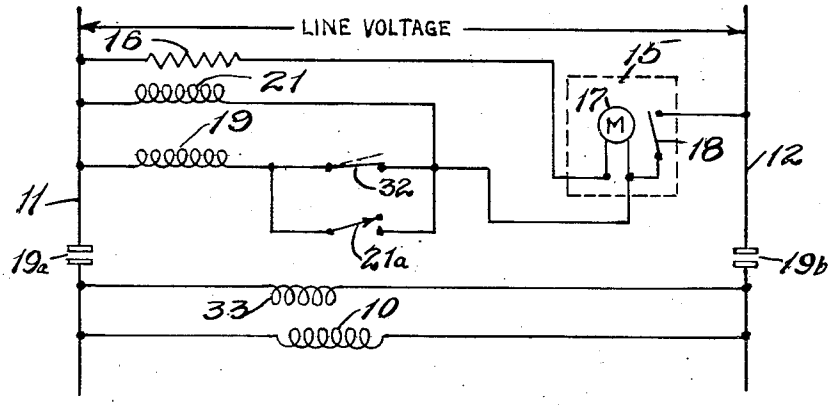
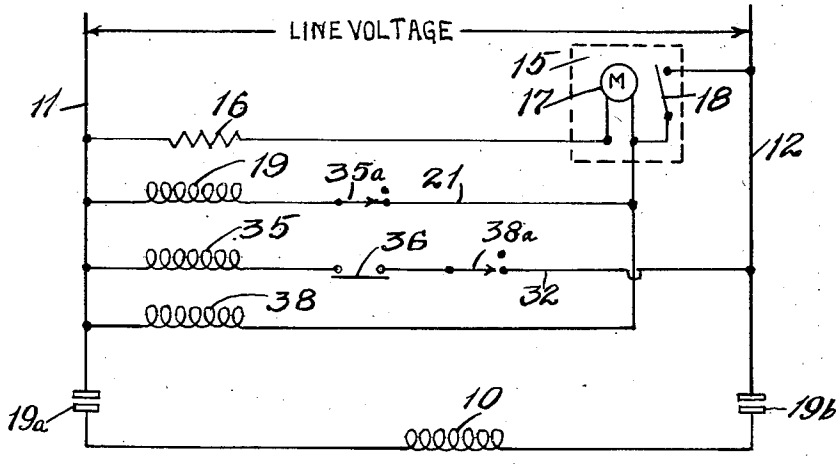


Fig. 6



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Patented Apr. 2, 1946

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UNITED STATES PATENT OFFICE

2,397,497

METHOD AND MEANS FOR DEMAGNETIZING

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Application August 13, 1943, Serial No. 498,524

15 Claims. (Cl. 175—181)

This invention relates to a method and means for demagnetizing and more particularly to a novel method and means for demagnetization with the use of transients.

Some of the troublesome problems encountered in the field are the demagnetization of large parts, in particular, crankshafts, or smaller parts of highly retentive material such as heavy springs. It is quite common today for manufacturers to test metal parts for flaws and other defects by magnetizing the part and then depositing paramagnetic powder on the part for the purpose of observing any special congregation of particles as would be the case if a flaw or other defect were present in the metal. It is usually considered desirable and in many cases it is absolutely necessary that a part which has been tested in such a manner be demagnetized after the test. Where a crankshaft or other large or special part has been magnetized, it is not always possible to obtain satisfactory demagnetization of the part by simply drawing the part through and out of an alternating magnetic field.

I have found that a very satisfactory demagnetization of a part may be obtained by utilizing the starting transient when a demagnetizing coil is first connected to an alternating current power line. More particularly, I have found that if a rapid and successive series of transients is first introduced into the demagnetizing coil prior to to the time when a steady alternating current is caused to flow through the coil so as to enable the part to be gradually withdrawn from the influence of the field, that a much more satisfactory demagnetization will result.

It is an object of the present invention to provide a novel method and means for demagnetizing which includes the use of transients.

Another object of the present invention is to provide a novel demagnetizing apparatus wherein the alternating current energization circuit of the demagnetizer is turned on and off a number of times.

A further object of the present invention is to provide novel apparatus for introducing a series of transients in the demagnetizing coil of a demagnetizer.

Another and further object of the present invention is to provide a novel control circuit for a demagnetizer wherein means is provided for rapidly interrupting the flow of alternating current to the energization circuit of the demagnetizer.

Another and still further object of the present invention is to provide a novel timer control circuit for demagnetizing equipment.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its manner of construction and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description, taken in connection with the accompanying drawings, in which:

Figure 1 is a schematic wiring diagram of the novel control circuit for a demagnetizer embodying the novel principles and teachings of the present invention;

Figure 2 illustrates in full lines the steady state voltage and current flowing in the demagnetizing coil while the transient is shown in dotted lines;

Figure 3 shows the nature of the resulting curve when the transient is combined with the steady current;

Figure 4 is a hysteresis curve showing the effect of the transient on the magnetization of the part being tested;

Figure 5 is a schematic wiring diagram illustrating a modified form of the present invention; and

Figure 6 is a schematic wiring diagram illustrating a third embodiment of the present invention.

One embodiment of the present invention is illustrated in Figure 1 of the drawings wherein a demagnetizing coil 10 is arranged to be connected to alternating current supply conductors 11 and 12 through contactors 19a and 19b. Now the novel method of the present invention includes the placing of a part to be demagnetized (not shown) in the coil 10, turning the current on and off in rapid succession to produce a plurality of starting transients (preferably at least ten or more) and then withdrawing the part from the coil during the time the coil is energized by the steady flow of alternating current from the power supply lines 11 and 12. The control circuit for carrying out such a method includes a synchronous timer 15 which is connected through a dropping resistor 16 to the supply conductors 11 and 12. The synchronous timer includes a motor 17 and a switch 18. The detail nature and construction of the synchronous timer 15 forms no part of the present invention, it being any one of the available types on the market in which the switch 18 is arranged to be closed manually and in which the motor 17 is arranged to cause the switch 18

to be opened after the elapse of a predetermined period of time.

As soon as switch 18 is closed, it will be observed that the motor is energized through conductors 17' and 18'. The contacts 19a and 19b in the main circuit are arranged to be closed upon energization of a contactor coil 19 which is connected through a normally closed contact 20 and switch 18 across conductors 11 and 12. The normally closed contact 20 will hereinafter be referred to as an interlock for this contact 20 is arranged to be opened as the contacts 19a and 19b are closed. It will thus be seen that as soon as the contacts 19a and 19b are closed, the contactor coil 19 becomes deenergized by the opening of the interlock 20 and the contacts 19a and 19b thereupon drop out. But as soon as the contacts 19a and 19b drop out, the interlock 20 is closed and the contactor coil 19 again becomes energized to cause the closing of the contacts 19a and 19b. This results in a rapid opening and closing of the energization circuit to the demagnetizing coil 10.

Connected in shunt with the contactor coil 19 and the interlock 20 is a timer coil 21 which is arranged to cause the movable contact element 21a which is connected to one end of the contactor coil 19 through a conductor 23 to move from its full line position as shown in Figure 1 to its dotted line position as shown in Figure 1. After the timer coil 21 has caused the switch 21a to close, it will be observed that the interlock is shunted out of effective control of the energization of the contactor coil 19 and the contactor coil 19 will remain continuously energized until the synchronous timer 15 has caused the switch 18 to open. During this latter period the part which has been disposed within the demagnetizing coil 10 is gradually withdrawn.

In any circuit, when first making contact, a transient current will nearly always occur because the relationship between the voltage and current in that circuit at the particular instant of contact will not, in general, be the same as for the steady state condition. When considering the demagnetizing coil 10 of Figure 1 by way of example, the steady state condition would be represented by a sine wave 24 of current lagging 90° approximately behind the applied voltage wave 25 (as shown in Figure 2). This 90° lag is of course due to the fact that the resistance of the coil 10 is negligible in comparison with the inductance. Now when the circuit to the demagnetizer coil 10 is closed (by closure of contacts 19a and 19b) at a time "a," the current at the instant of closing is zero, which obviously does not coincide with the finite value of current "y" which would be present at that instant under the steady state condition. As a result, a transient is established which makes up the difference in current and supplies the energy required to establish the field of the coil. The transient in the coil 10 has the shape shown by the dotted curve 26 (an exponential curve) and has a maximum value corresponding to the value "y."

If an oscillogram is now taken of the line current starting at the time "a," the picture would appear as shown by the full line curve 27 in Figure 3. Figure 3 is derived by adding the steady state current to the transient.

The effect can be analyzed by considering a D. C. transient to be present for the first five or six cycles in addition to the normal steady state current. The magnitude of the transient will depend on the instant at which the switch is closed. The maximum transient will occur if contact is made at an instant of time "b" or "c" which corresponds to a closing of the contact at an instant of time when the current wave should be a maximum in a positive direction ("b") or in a negative direction ("c"). If the circuit is closed at a time "f," or in other words at a time when the current wave should be zero, there will of course be no transient at all. It will furthermore be observed from the above consideration that the transient may be either positive or negative, depending on the time of the closing.

Use may be made of this D. C. transient by causing it to oppose the original field in the magnetized part. By energizing the coil a number of times it is believed that a transient will always result of high magnitude which is in the proper direction to neutralize a substantial part of the field in the magnetized part or even to reverse it to some extent. From this point, the usual withdrawal of the part through the coil is sufficient to remove the remaining magnetism. Should another transient in the wrong direction be applied, the beneficial effect of the first transient is not lost to any great extent. This has been conclusively proved in practice. It is believed that an explanation of this effect may be explained by the hysteresis curve shown in Figure 4. The point 29 represents the residual magnetism left in the part after the original magnetization. Point 29 represents the amount left after a favorable transient. Point 30 shows how the residual magnetism is still considerably less than that at 29 in spite of an unfavorable transient being applied after point 29. Point 31 is arrived at by a further favorable transient. Demagnetization from point 30 will not be quite as good as that from point 29, but nevertheless it is still substantially better than what it was at the point 28 where it originally started.

It has furthermore been found in practice that the beneficial effect obtained by rapidly interrupting the energization circuit to the magnetizing coil 10 is due to the starting transient when the circuit is "made" and not due to the condition which exists at the "break." Numerous tests have further shown that a beneficial result is always obtained by a series of openings and closings of the energization circuit of the coil 10.

A modified form of the present invention is shown in Figure 5 of the drawings. In this embodiment the demagnetizing coil 10 is also connected to the power lines 11 and 12 through contactors 19a and 19b as described in connection with Figure 1. The parts are similar to those shown in Figure 1 and they have been given the same reference characters. A synchronous timer 15 having a motor 17 and a timer switch 18 is also connected across the lines 11 and 12 through a dropping resistor 16. The contactor coil 19 in this instance, however, is connected through a normally closed relay contact 32 and through the switch 18 to the lines 11 and 12 rather than through the mechanical interlock previously described. A timer microswitch 21a is provided which is normally open but which is arranged to be closed after a brief interval of time by the timer coil 21 which is connected to the circuit in the same manner as that described in connection with Figure 1. A relay coil 33 is connected across the demagnetizing coil 10 so that it is on the same side of the contactors 19a and 19b as is the demagnetizer coil 10. It will thus be apparent that upon closure of the contacts 19a and 19b by

the contactor coil 19, the demagnetizing coil 10 is energized as is also the relay coil 33. Upon energization of the relay coil 33, the normally closed relay contact 32 is opened causing a deenergization of the contactor coil 19. Upon deenergization of the contactor coil 19, the contacts 19a and 19b drop out and the magnetizing coil 10 as well as the relay coil 33 becomes deenergized. The cycle is rapidly repeated until the timer microswitch 21a has closed thus holding the contactor coil 19 continually energized so long as the synchronous timer switch 18 remains closed. During this period the part is slowly withdrawn from the demagnetizing coil 10. After the elapse of a predetermined interval of time, the synchronous motor 15 opens the switch 18 and prevents further energization of the magnetizing coil 10 until the switch 18 has again been closed.

A third embodiment of the present invention is illustrated in Figure 6 of the drawings, wherein means is provided for obtaining a somewhat slower interruption of the contacts 19a and 19b. In this form of the invention, the contactor coil 19 is connected through a microswitch 34 and the switch 18 of the synchronous timer 15 to the lines 11 and 12. The microswitch 35a is controlled by a timer coil 35 which is connected through a mechanical interlock 36 and a microswitch 38a across the lines 11 and 12. The microswitch 38a is operated by the timer coil 38 which is connected across the lines 11 and 12 through switch 18 of the synchronous timer 15. The synchronous timer 15 is connected across the lines 11 and 12 through a dropping resistor 16 in the same manner as previously described.

When the synchronous timer 15 is turned on by closing its switch 18, the contactor coil 19 and timer coil 38 are energized. The energization of the contactor 19 causes the contacts 19a and 19b to be closed to energize the magnetizing coil 10. The interlock 36 is mechanically connected to the contactors 19a, and 19b in such a manner that upon closure of the latter, the interlock 36 closes. When the interlock 36 closes, the timer coil 35 is energized and after the elapse of a predetermined period of time, such for example as two-tenths of a second, the microswitch 35a opens after opening the energization circuit of the contactor coil 19. Deenergization of the contactor coil 19 causes the contacts 19a and 19b to drop out and results in the deenergization of the demagnetizing coil 10. The opening of the contacts 19a and 19b causes the cycle to repeat itself at two-tenths second intervals. After the elapse of a predetermined period of time, such for example as two seconds (or in other words twenty two-tenths second intervals) the timer 38 causes its microswitch 38a to disconnect timer 35 from the circuit. This stops the intermittent action and causes the demagnetizer coil to remain energized until the synchronous timer shuts off the entire circuit.

It is evident that with this particular embodiment of the present invention, the rate at which the transients are produced, and the number of transients which occur before a steady operation is reached, are both controllable through the timers 35 and 38.

In practice it has been found that a circuit of the general type shown in Figure 6 is more uniform in satisfactory results, for it has been found that if the duration of a transient is very short, it is not as effective in its demagnetizing action as where the duration of the transient is somewhat longer. I have found that under usual operating conditions, the minimum length of time is about six cycles (where sixty cycle alternating current is used) or one-tenth of a second. It has further been found in practice that the effectiveness of the demagnetization increases with the number of transients used but practically the entire benefit of the process is obtained with ten to fifteen transients.

While I have shown and described certain particular embodiments of my invention, it will, of course, be understood that I do not wish to be limited thereto, since many modifications may be made, and I, therefore, contemplate by the appended claims to cover all such modifications as fall within the true spirit and scope of my invention.

I claim as my invention:

1. Demagnetization apparatus comprising a demagnetizing coil in which a magnetized part is placed when it is to be demagnetized, means for energizing said coil with a series of A. C. starting transients for a predetermined period of time, and means for energizing said coil with a steady state A. C. after said predetermined period of energization.

2. Demagnetization apparatus comprising a demagnetizing coil, means for introducing in rapid succession a series of alternating current transients in said coil for a predetermined period of time, and means for causing an alternating current of substantially constant maximum amplitude to flow through said coil after the elapse of said predetermined period of time.

3. Demagnetization apparatus comprising a demagnetizing coil, means for energizing said coil with a plurality of A. C. starting transients in rapid succession, and means for thereafter energizing said coil with alternating current of susbtantially uniform amplitude.

4. Demagnetization apparatus comprising a demagnetizing coil, means for energizing said coil with a series of A. C. starting transients for a predetermined period of time, and means for energizing said coil with alternating current of substantially uniform amplitude for a second predetermined period of time immediately following said first period of time.

5. Demagnetization apparatus comprising a demagnetizing coil, means for energizing said coil with a successively applied group of A. C. starting transients, each transient being applied for a few cycles only, and means for thereafter energizing said coil with alternating current of substantially constant amplitude.

6. Demagnetization apparatus comprising a demagnetizing coil, means for energizing said coil with alternating current of substantial constant amplitude, and means for initially peaking the amplitude of the alternating current wave for a predetermined period of time.

7. A circuit for controlling the energization of a demagnetizer comprising supply conductors arranged to be connected to a source of alternating current, a demagnetizer including a circuit establishing a magnetic field, means for connecting said circuit to said supply conductors including a contactor having a contactor operating coil, and a contact interlock which opens when contactor closes and which closes when the contactor opens, means for connecting said contactor coil and said interlock in series to said supply conductors, and a microtimer switch connected in parallel with said interlock, said microtimer switch having a timer coil connected to said supply conductors for closing said microtimer

switch after the elapse of a predetermined period of time.

8. A circuit for controlling the energization of a demagnetizer comprising supply conductors arranged to be connected to a source of alternating current, a demagnetizer, means for connecting said demagnetizer to said supply conductors including a contactor having a contactor operating coil, and a contact interlock which opens when the contactor closes and which closes when the contactor opens, a synchronous timer connected to said supply conductors and having a synchronous timer switch which opens after the elapse of a predetermined period of time, said contactor coil and said interlock being connected in series with said synchronous timer switch, a microtimer switch connected in parallel with said interlock, said microtimer switch having a timer coil for closing said switch after a predetermined period of time, the predetermined period of time of said microtimer switch being shorter than the predetermined period of time of said synchronous timer.

9. A circuit for controlling the energization of a demagnetizer comprising supply conductors arranged to be connected to a source of alternating current, a demagnetizer, means for connecting said demagnetizer to said supply conductors including a contactor having normally open contacts and a contact operating coil which closes the contacts upon energization thereof, a normally closed relay switch, a relay coil for opening said relay switch upon energization of said relay coil, said relay coil being connected in parallel with said demagnetizer and on the normally open side of said contacts, and means for connecting said contact operating coil and said relay switch in series to said supply conductors.

10. A circuit for controlling the energization of a demagnetizer comprising supply conductors arranged to be connected to a source of alternating current, a demagnetizer, means for connecting said demagnetizer to said supply conductors including a contactor having normally open contacts and a contact operating coil which closes the contacts upon energization thereof, a normally closed relay switch, a relay coil for opening said relay switch upon energization thereof, a microtimer having a normally closed microtimer switch and a timer coil which opens said microtimer switch after the elapse of a predetermined period of energization of said timer coil, said relay coil being connected in parallel with said demagnetizer and on the normally open side of said contactor, said contactor coil and said relay switch being connected in series across said supply conductors, said timer coil being connected across said supply conductors, and said timer microswitch being connected in parallel to said relay switch.

11. A circuit for controlling the energization of a demagnetizer comprising supply conductors arranged to be connected to a source of alternating current, a demagnetizer, means for connecting said demagnetizer to said supply conductors including a contactor having normally open contacts, and a contact operating coil which closes the contacts upon energization thereof, a normally closed relay switch, a relay coil for opening said relay switch upon energization thereof, said relay coil being connected in parallel with said demagnetizer and on the normally open side of said contactor, a microtimer including a normally open microtimer switch and a timer coil for closing said switch a predetermined period of time after the energization of said timer coil, and a synchronous timer having a timer motor and a synchronous timer switch which is opened by said motor after the elapse of a predetermined period of time, said last period of time being greater than the period of time for closing said microtimer switch, said contactor coil and said relay switch being connected in series through said synchronous timer switch, said microtimer switch being connected in parallel with said relay switch and said microtimer coil being connected through said synchronous timer switch to said supply conductors.

12. A circuit for controlling the energization of a demagnetizer comprising supply conductors arranged to be connected to a source of alternating current, a demagnetizer, means for connecting said demagnetizer to said supply conductors including a contactor having normally open contacts, and a contact operating coil which closes the contacts upon energization thereof, a first microtimer having a timer coil and a normally closed microtimer switch, a second microtimer having a timer coil and a normally closed microtimer switch, an interlock switch on said contactor arranged to close when the contacts of said contactor are closed and to open when the contacts of said contactor are open, said contactor coil and said first microswitch being connected in series to said supply conductors, said first microtimer coil, said interlock switch and said second microswitch being connected in series to said supply conductors, said second microtimer coil being connected to said supply conductors, said first microtimer coil being arranged to open its associated microswitch after the elapse of a predetermined period of time, and said second microtimer coil being arranged to open its associated switch after the elapse of a predetermined period of time which is greater than the predetermined period of time for said first microtimer.

13. A circuit for controlling the energization of a demagnetizer comprising supply conductors arranged to be connected to a source of alternating current, a demagnetizer, means for connecting said demagnetizer to said supply conductors including a contactor having normally open contacts, and a contact operating coil which closes the contacts upon energization thereof, a first microtimer having a timer coil and a normally closed microtimer switch, a second microtimer having a timer coil and a normally closed microtimer switch, said first microtimer coil being arranged to open its associated microswitch after the elapse of a predetermined period of time, said second microtimer coil being arranged to open its associated microswitch after the elapse of a predetermined period of time greater than the predetermined period of time of said first microtimer, a synchronous timer having a motor and a closable switch which is arranged to be opened a predetermined period of time after the closure thereof, said last mentioned predetermined period of time being greater than the predetermined period of time of said second microtimer, said contactor coil and said first microswitch being connected through said synchronous timer switch across said supply conductors, an interlock switch arranged to open and close with the contacts of said contactor, said first timer coil, said interlock switch and said second microswitch being connected in series across said supply conductors, and said second timer coil being connected through said synchronous timer switch across said supply conductors.

14. The method of electrically demagnetizing magnetized parts which includes subjecting the part to the magnetic influence of magnetic fields produced by alternating current transients and then slowly withdrawing the part from a steady state alternating magnetic field.

15. The method of demagnetizing a magnetized part which includes subjecting the part to an interrupted series of magnetic fields produced by a series of alternating current starting transients and then slowly withdrawing the part from a magnetic field produced by a steady state alternating current.

MORRIS L. MAGNES.