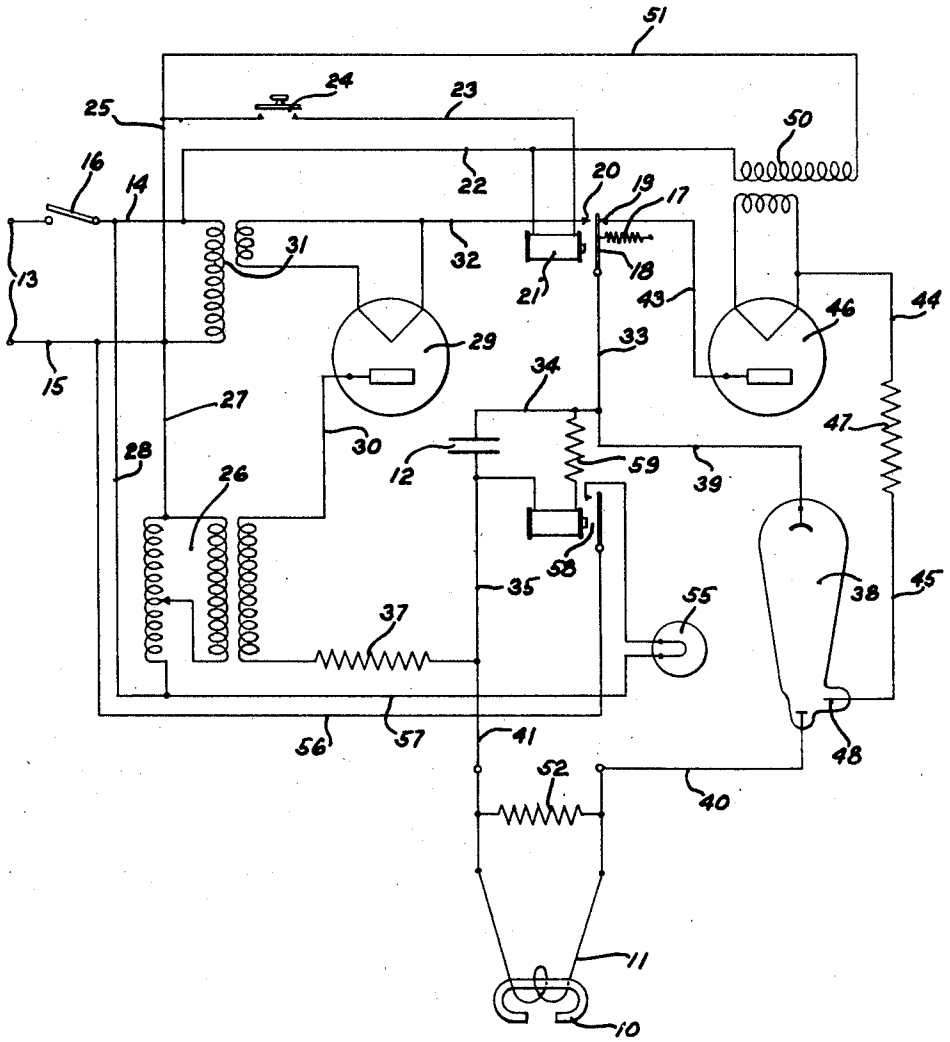
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MAGNETIZER

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MAGNETIZER

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This invention relates to magnetizers, and more particularly to magnetizing apparatus for use in the production of permanent magnets.

An object of this invention is the provision of improved apparatus for subjecting articles to a magnetizing force of suitable characteristics for producing in the articles a high degree of permanent magnetism.

Permanent magnets employed in communication apparatus and in other types of equipment are produced in various shapes and sizes depending upon their intended field of service. Many of these types can be magnetized readily by placing them between the poles of a powerful electromagnet or, in some instances, a strong permanent magnet. However, certain magnet types have a configuration, or possibly a very small air gap, which precludes the possibility of employing another magnet for producing the magnetizing flux.

In such cases it is usually possible to place a temporary winding around the article to produce the desired magnetization. To minimize the cost of this operation, or because of the shape of the magnet, it is often desirable to use as few turns in the temporary winding as possible and to secure the ampere-turns necessary for the degree of magnetization desired by use of a very large current. The duration of the current is not particularly important from a product quality standpoint because magnetization of the article occurs almost instantaneously when the current is applied. However, the duration of the current is highly important from a cost standpoint because of the size and nature of the circuit, switches and other equipment needed to handle currents of this magnitude for any appreciable period of time.

It is, therefore, desirable to produce a very high direct current for a very short period of time in the temporary winding on the magnet. It is difficult to use conventional direct current supply sources, such as a high-voltage battery or a large capacity generator, for this purpose. The circuit and control equipment necessary for handling currents of the desired magnitude from these sources are either not very suitable for large scale production or tend to be costly and somewhat dangerous to operate when adapted to large scale production.

One embodiment of this invention provides an inexpensive apparatus that can be used without hazard for producing and applying a very large and efficient magnetizing current in a coil containing the article. In this apparatus alternating current from a conventional source is rectified and employed to charge a condenser. The condenser is then discharged through a mercury vapor unidirection switch and through a magnetizing coil around the article to induce a magnetic field in the article. To provide for abrupt discharge of the condensers, the mercury switch is actuated through an ignitor circuit which vaporizes the mercury and is fed from the condenser. To prevent oscillation in the condenser discharge circuit, and resultant partial demagnetization of the article, means are provided to permit flow of current only in one direction between the condenser and magnetizing coil. To insure safe operation of the apparatus, the condenser is charged and discharged in separate circuits and a switch common to both circuits prevents the operation of one circuit at any time the other circuit is closed.

Following is a more complete description of the invention taken in conjunction with the appended drawing in which the single figure is a schematic drawing showing a magnetizing apparatus embodying certain features of the invention.

The apparatus shown in the drawing is adapted for magnetizing an article 10 by passing a current of suitable characteristics through a wire 11 looped or wrapped around the article. In some cases a coil into which the article is inserted may be used instead of the wire loop.

The magnetizing current is supplied from a condenser 12, or more conveniently from a plurality of condensers connected in parallel to provide the desired capacity. The condensers are charged and then discharged through the wire loop or coil by means of a condenser charging circuit and a condenser discharging circuit under control of a switch common to both circuits.

Current for the apparatus is conveniently secured from a conventional alternating current supply source 13 to which a pair of power lead wires 14 and 15 are connected, one of the leads having a manually operated control switch 16 therein.

Operation of the condenser charging and discharging circuits is controlled by means of a circuit selecting relay or solenoid having a spring 17 depressed pivoted armature 18 adapted to alternately engage a right hand contact 19 or a left hand contact 20. The coil 21 of the relay is connected with power lead 14 through a wire 22 and with power lead 15 through a wire 23, having a push button switch 24 therein, and a

wire 25. With this arrangement the armature normally engages the right hand relay contact under the spring tension and engages the other contact at times when the push button is closed.

The condenser charging circuit comprises a variable transformer 26 having its primary winding connected with one power lead 15 through a wire 27 and with the other power lead 14 through a wire 28. The transformer secondary is connected to the plate of a rectifier tube 29 by means of a wire 30. The filament of the rectifier tube is heated by means of a transformer 31 connected across the power leads and the filament is connected to the left hand contact 20 in the circuit selecting relay through a wire 32. A wire 33—34 runs from the relay armature to one terminal of the condenser and the other terminal of the condenser is connected to the variable transformer secondary through a wire 35 and a resistance 37. Thus, the condenser charging series circuit includes the transformer secondary, rectifying tube, circuit control relay, condenser and resistance.

As stated above, the condenser is discharged through a loop or coil around the article. Because this combination has both resistance and inductance, the discharge current normally tends to oscillate with a steadily decreasing amplitude. Under these conditions the magnet would be magnetized during the first half current cycle and then partially demagnetized during the next negative half cycle and the final magnetic rating of the article would be inadequate. To avoid this contingency, means are provided to discharge the condenser through the wire loop without any oscillation in the condenser discharge circuit.

The condenser is discharged through an evacuated mercury vapor tube 38 which acts as a mercury vapor rectifier and passes current in only one direction. The tube is normally nonconducting and is actuated or fired to become instantaneously and unidirectionally conducting when mercury contained in the tube is vaporized by the application of current to an electrode 48 in the tube. Thus the tube acts as a unidirectional switch to cause discharge of the condenser. These tubes are available commercially and the "Ignitron" tube is suitable for this purpose.

The anode of the tube is connected to one terminal of the condenser through wires 39 and 34. The cathode of the tube is connected through a wire 40 to one end of the wire loop around the magnet. The other end of the wire loop is connected by means of wires 41 and 35 to the other terminal of the condenser. This arrangement provides a series circuit running from the condenser, through the mercury vapor switch, and through the wire loop around the magnet.

The mercury vapor switch is fired or ignited by current supplied from the condenser. In the firing or ignitor circuit the right hand contact 19 in the circuit selecting relay is connected by wires 43, 44 and 45 through a rectifying tube 46 and resistance 47 to the ignitor electrode 48 in the tube. The rectifying tube, which is heated by a transformer 50 supplied with current from the power leads through wires 51, 25 and 22, prevents any oscillation in the magnetizing circuit through the ignitor circuit by permitting current to flow only in the direction from the condenser to the ignitor electrode.

As a further precaution against oscillation in the magnetizing coil, a resistance 52 is connected across the magnetizing coil or loop to suppress the back E. M. F. developed as the condenser approaches full discharge, to a value below the inverse voltage rating of the tube.

In the operation of the apparatus the magnetizing loop or coil is first placed around the article to be magnetized. At this time the condenser discharge circuit is closed, and the charging circuit is open because the circuit selecting relay armature is normally positioned against the right hand relay contact. After the article is positioned, the push button is closed which shifts the relay armature to the left hand contact. This action first opens the discharge circuit and then closes the charging circuit to charge the condenser.

To facilitate control of the apparatus a signal lamp 55 is provided to indicate the condition of the condenser. This lamp is connected across the power leads through wires 56 and 57—28 through the contacts of a normally open solenoid 58 in a by-pass circuit around the condenser. In the by-pass circuit is a resistance 59 of such rating to cause the solenoid to close and the lamp to glow whenever current is flowing in the charging circuit or a charge of predetermined magnitude is impressed on the condensers.

The condenser charge builds up rapidly when the charging circuit is completed, causing the signal lamp to glow. The push button is then released, which permits the circuit selecting relay armature to move to the right hand contact, thereby first opening the charging circuit and then closing the discharge circuit. When the discharge circuit is closed, the condenser potential is applied to the ignitor electrode, which has a very high resistance, through the ignitor circuit. This vaporizes some of the mercury to make the tube conducting and current then flows to the magnetizing coil. As the current drops to zero the tube ceases to conduct.

In this manner an abrupt surge or impulse of unidirectional current is introduced to the magnetizing coil for a very short period of time. Probably the current duration is less than a thousandth of a second. Due to the short duration of the current, very large current values can be employed without difficulty or hazard. It is possible to use a total condenser capacity as high as 8,000 microfarads, by connecting a number of condensers in parallel, and to charge the condensers to a potential of 500 volts. Current values as high as 25,000 amperes can be employed. By subjecting the article to currents of this magnitude and applying the current in an abrupt impulse without oscillation in the discharge circuit, a magnetic field is induced in the article to establish permanent magnetization therein at maximum values.

Due to the construction of the apparatus, the hazards normally attending the use of heavy currents are eliminated. At the time the operator connects the article to the apparatus, the condenser discharge circuit is closed and the condenser is discharged because of the normal position of the armature in the circuit selecting relay. If the relay should be defective and the armature be deflected from its normal position no current can flow in the discharge circuit because the charging and discharging circuits cannot be operated simultaneously.

It will be apparent that various modifications and adaptations of the above described apparatus are feasible and it is to be understood that

the invention is limited only by the scope of the appended claims.

What is claimed is:

1. In an apparatus for producing an electrical impulse of short duration and magnetizing an article therewith, a condenser, a charging circuit for the condenser, a source of current for said circuit, and a discharge circuit for the condenser, said discharge circuit comprising a coil around the article, and means actuated by the condenser charge for discharging the condenser through the coil in a single unidirectional impulse to induce a magnetic field in the article.

2. In an apparatus for magnetizing an article, a condenser, a circuit for charging the condenser, a source of current for said circuit, a discharge circuit for the condenser, means in the discharge circuit responsive to the charge on the condenser to cause the condenser to discharge into the circuit in an abrupt unidirectional impulse, and means in the discharge circuit for subjecting the article to said impulse to induce a magnetic field in the article and magnetize the article.

3. In an apparatus for magnetizing an article, a condenser, a condenser charging circuit, a condenser discharging circuit, a coil in the discharging circuit positioned to cause the condenser discharge to induce a magnetic field in the article, means in the discharge circuit actuated by the condenser charge to cause discharge of the condenser into the coil in an abrupt unidirectional impulse, and means for operating the condenser charging and discharging circuits independently.

4. In an apparatus for producing an abrupt and unidirectional electrical impulse for inducing a magnetic field in an article and permanently magnetizing the article, a condenser, a condenser charging circuit, a source of current for said condenser charging circuit, a discharge circuit for the condenser, a coil in the discharge circuit surrounding the article, means in said discharge circuit to discharge the condenser through the coil, said means being responsive to the condenser charge, and a control switch for the charging and discharging circuits, said switch being adapted to close the charging circuit only when the discharging circuit between the condensers and coil is open.

5. In an apparatus for magnetizing an article, a coil around the article, a condenser, a circuit for charging the condenser, a circuit for discharging the condenser through said coil, a mercury vapor switch in the discharging circuit, said switch having an electrode therein adapted to vaporize the mercury when energized and make the switch unidirectionally conducting, and means for discharging the condenser by applying current from the condenser to the electrode in the mercury vapor switch.

6. In an apparatus for magnetizing an article, a coil around the article, a condenser, a circuit for charging the condenser, a circuit for discharging the condenser through said coil, said condenser discharging circuit comprising a mercury vapor rectifier connected in series with the condenser and coil and having an ignitor electrode therein to cause vaporizing of the mercury when current is applied thereto, an ignitor circuit connecting the condenser and the electrode, and a rectifier tube in the ignitor circuit to permit the flow of current in the ignitor circuit only in the direction from the condenser to the electrode.

7. In an apparatus for magnetizing an article, a coil around the article, a condenser, a circuit for charging the condenser, a mercury vapor switch connected in series with the condenser and coil and having an ignitor electrode therein for vaporizing the mercury and making the switch unidirectionally conducting when current is applied to the electrode, an ignitor circuit connecting the condenser and electrode for supplying current to the electrode from the condenser, and a manually controlled switch between the condenser charging circuit and the ignitor circuit for selectively operating said circuits to charge the condenser and then discharge the condenser by applying current from the condenser to the ignitor electrode in the mercury vapor switch.

8. In an apparatus for magnetizing an article, a coil around the article, a condenser, a circuit for charging the condenser, a mercury vapor switch connected in series with the condenser and coil and having an ignitor electrode therein for vaporizing the mercury when current is applied to the electrode, an ignitor circuit for conducting current from the condenser to the ignitor electrode, and a second switch for simultaneously controlling both the condenser charging circuit and the ignitor circuit, said second switch being adapted to permit current to flow from the condenser to the ignitor electrode in the mercury vapor switch only when the condenser charging circuit is open.

9. In an apparatus for magnetizing an article, a coil around the article, a condenser, a circuit for charging the condenser, a mercury vapor switch connected in series with the condenser and coil and containing an ignitor electrode for causing the mercury to vaporize when current is applied to the electrode, an ignitor circuit connecting the condenser and electrode for supplying current to the electrode, a rectifying tube in the ignitor circuit to permit the flow of current in said circuit only in the direction from the condenser to the electrode, and a manually operated switch for simultaneously controlling both the condenser charging circuit and the ignitor circuit by permitting current to flow from the condenser to the electrode only when the condenser charging circuit is open.

10. In an apparatus for magnetizing an article, a magnetizing coil around the article, a condenser, a circuit for charging the condenser, a mercury vapor switch connected in series with the condenser and coil, an ignitor electrode in said switch adapted to vaporize the mercury when current is applied to the electrode, an ignitor circuit connecting the condenser and electrode for supplying current to the electrode, a rectifying tube in the ignitor switch to permit the flow of current in said ignitor circuit only in the direction from the condenser to the electrode, a resistance across the magnetizing coil to suppress back E. M. F. in the coil, and a manually operated switch for simultaneously controlling both the condenser charging circuit and the ignitor circuit by permitting current to flow from the condenser to the electrode only when the condenser charging circuit is open.

11. In an apparatus for magnetizing an article, a coil around the article, a condenser, a condenser charging circuit, a circuit for discharging the condenser through the coil around the article, a mercury vapor switch in the discharge circuit having therein an electrode to vaporize the mercury when current is applied to the electrode, an ignitor circuit connecting the condenser and electrode for supplying current to the electrode, a manually controlled relay switch com-

mon to said condenser charging and mercury tube ignitor circuits, a pair of contacts in said relay switch electrically connected respectively in the charging and ignitor circuits, a relay armature electrically connected to the condenser, and means for normally holding the armature against the ignitor circuit contact and permitting the armature to engage the charging circuit contact when the relay is energized.

12. In an apparatus for magnetizing an article, a coil around the article, a condenser, a source of alternating current, a relay switch having a pair of contacts and an armature therein for controlling the apparatus, a variable transformer having its primary winding connected to said power source, a condenser charging circuit comprising the secondary winding of said transformer, a rectifier tube, the condenser, one of the relay contacts and the relay armature in series, a circuit for discharging the condenser through the coil around the article, a mercury vapor switch in the discharge circuit having therein an electrode to vaporize the mercury when current is applied to the electrode, an ignitor circuit connecting the condenser and electrode through the relay armature and the other relay contact for supplying current to the electrode, a spring in the relay adapted to normally hold the armature against the ignitor circuit contact and permit the armature to engage the charging circuit contact when the relay is energized, and means for energizing the relay from said power source.

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