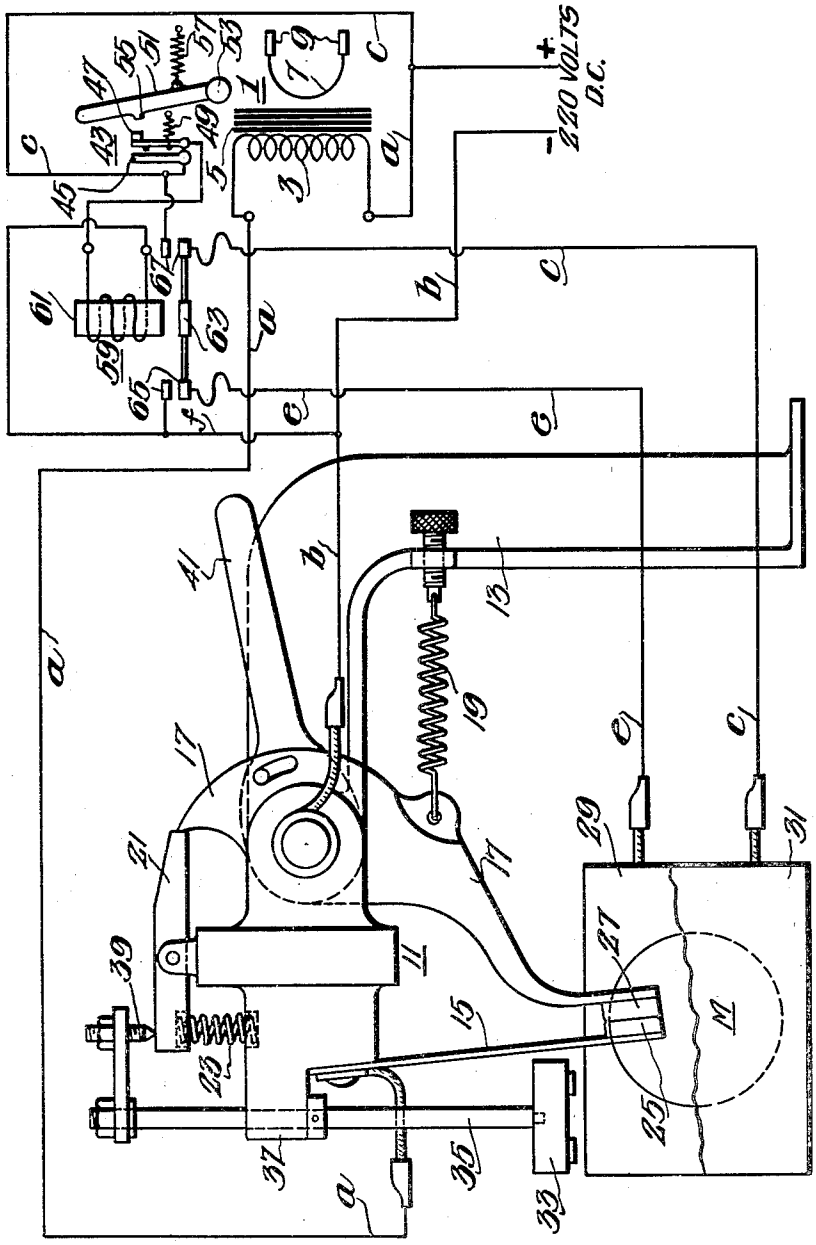
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CURRENT IMPULSE TRANSFORMER

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CURRENT IMPULSE TRANSFORMER

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5 Claims. (Cl. 171—97)

This application is a division of application Serial No. 133,965, filed March 31, 1937.

This invention relates to transformers, particularly to so-called "current impulse transformers" and to circuits and apparatus for energizing and controlling the same.

Current impulse transformers capable of generating relatively high momentary values of direct current find useful application, for example, in the art of magnetizing permanent magnets.

A current impulse transformer may comprise a primary winding of many turns, a secondary of few turns (usually one), and an intermediate iron core. Direct current is fed to the primary winding in an amount sufficient substantially to saturate the iron core. If the circuit to the primary winding now be opened, the energy stored in the core will be suddenly released. A portion of this energy will appear in the secondary circuit (if it is closed) as a direct current impulse, and the balance will appear in the form of an arc between the opened terminals of the primary circuit. Since only the direct current impulse in the secondary circuit is usefully employed, it follows that the efficiency of the device is proportional to the quantity of energy dissipated in the form of an arc between the open terminals of the primary circuit, that is to say, the less energy dissipated in the primary circuit, the more is the useful energy appearing in the secondary circuit. It is apparent from the foregoing that the more rapidly the primary circuit is opened, and the more rapidly and completely the resulting arc is quenched, the greater is the energy available in the form of a direct current impulse on the secondary side of the transformer.

In order to ensure a rapid break and adequate quenching of the developed arc, resort has heretofore been had to circuit breakers of the type comprising a fast acting switch having contacts immersed in an arc-quenching magnetic field. The usual practice has been to provide a multiple contact switch and to so arrange the connections thereto that upon opening of the primary circuit the current from the line is switched to the coils which then, and not until then, generate the arc-quenching magnetic field. Regardless of the advantages claimed for the described conventional type of circuit breaker, it may be said generally that such arrangement is unsuited for breaking a circuit subjected to large inductive loads, for the reason that arcing will occur between the opened primary contacts before the flux of the magnetic field has been built up to the density required to ensure proper quenching.

Accordingly, an object of the present invention is to provide a circuit for use in connection with iron core transformers and including means for preventing the actuation of said device until the energy in said core is built up to the value required to accomplish a given task, whereby wasteful dissipation of energy is obviated.

Another object of the invention is to provide a circuit for a current impulse transformer system of the type wherein direct current flowing in the primary circuit gives rise to energy in the core of said transformer, said system including means adapted to open the primary circuit quickly and cleanly, whereby the energy released upon the collapse of the magnetic forces stored in the core may be efficiently transformed into current of optimum value in the secondary of said transformer.

Other objects and advantages, together with certain details of construction, will be apparent and the invention itself will be best understood by reference to the following specification and to the accompanying partly diagrammatic, partly elevational view of a current impulse transformer system embodying the invention.

In this drawing, 1 designates generally a current impulse transformer comprising a primary winding 3, an iron core 5 and a secondary winding 7. Winding 7 terminates in a pair of bus bars 9. By way of example, the primary winding 3 may comprise twenty-five hundred turns and the secondary 7 but one turn. The energy applied to the primary 3 of transformer 1 may be obtained from a 220-volt 24-ampere source of direct current. Such source is indicated in the drawing by the conventional plus (+) and minus (—) symbols.

The application of direct current to the primary 3 stores up magnetic energy in the iron core 5. When this core becomes saturated, or substantially so, and the circuit supplying current to the primary is then broken, a momentary direct current surge or impulse will appear in the secondary 7, provided its terminals 9 are closed. This impulse may reach a value of, say, fifty-five thousand (55,000) amperes provided only that too much of the magnetic energy stored in core 5 is not dissipated in the form of an arc between the points at which the primary circuit is broken. Current of the order or value mentioned may be utilized, for example, to permanently magnetize metal objects, in which case

the object to be magnetized (not shown) may be removably clamped to bus bars 9.

A switch, indicated generally at 11, is provided for opening the circuit carrying current to the primary winding 3 of transformer 1. Switch 11 comprises a frame 13 which supports a fixed switch arm 15 and a movable switch arm 17. Arm 17 is biased to open as by means of a spring 19 and may be held in the closed position as by means of a pawl 21, which is urged into engagement with arm 17 by means of a spring 23.

Switch arms 15 and 17 are provided with contacts 25 and 27, respectively. In order to quench or "blow-out" the arc incident to the opening of the switch, contacts 25 and 27 are immersed in a magnetic field which bridges the pole pieces 29 and 31 of an electro-magnet M. The arrangement of these pole pieces may, if desired, be similar in all respects to that described in connection with the modified form of switch shown in Fig. 2 of the previously-identified parent application Serial No. 133,965.

In order to prevent the opening of contacts 25 and 27 until the flux density of the magnetic field reaches a value sufficient to insure prompt and adequate quenching of the arc between these contacts, a magnetically actuated mechanism is provided for releasing the pawl 21 which holds the movable switch arm in its illustrated closed position. Such mechanism may be constituted essentially of an armature 33 composed of a magnetically permeable material secured to a plunger 35 which is slidable in an extension 37 in frame 13 and connected to pawl 21 by an adjusting screw 39. As illustrated, the armature 33 and plunger 35 are in that position whereat pawl 21 holds switch arm 17 closed against the tension of spring 19. It will be understood that spring 23 of the release mechanism is so adjusted that when the flux density of the magnetic field in which contacts 25 and 27 are immersed reaches a value sufficient to adequately quench the arc developed upon opening of these contacts then armature 33 will be pulled down against the tension of spring 23 causing pawl 21 to pivot out of engagement with the end of switch arm 17 and permitting it to be instantly and forcibly pulled outwardly by spring 19. A switch handle 41 is provided for returning switch arm 17 to its illustrated closed position with respect to arm 15.

As previously set forth, the surge of current across terminals 9 of the secondary 7 of transformer 1 when the magnetic energy stored in core 5 is released must be of a certain high value to perform its task. If the circuit to primary 3 were to be opened before core 5 stored up enough energy to provide secondary 7 with current of a value less than that required, much energy, as well as the operator's time, would be wasted. To obviate such waste, an auxiliary control is provided in conjunction with the release mechanism of switch 11 whereby premature opening of the circuit to the primary winding 3 of the transformer 1 is prevented.

The illustrated "auxiliary control" comprises a pair of switches 43 and 59 connected in series in the circuit which provide energy for generating the arc-quenching magnetic field. Switch 43 may comprise a stationary arm 45 and a pivoted arm 47 shown biased to the open position by a spring 49. A separate pivoted arm 51 supports an armature 53 of magnetically permeable material adjacent and within the influence of the magnetic field generated about core 5. Arm 51 is provided with a snubber 55 and is normally held by a spring 57 in a position such that its armature 53 is out of the region of maximum intensity of the field adjacent core 5.

As the energy transferred to core 5 from primary 1 is built up, armature 53 is gradually attracted thereto and pushes arm 47 over (to the left as viewed in Fig. 1) against the tension of spring 49. This brings arm 47 in contact with arm 45 and thereby completes the circuit to switch 59. Switch 59 may be of conventional design and comprises a solenoid 61 which when energized attracts an armature 63 closing contacts 65 and 67.

In operating the device of Fig. 1, the switch arms 15 and 17 of switch 11 are first closed by means of the switch handle 41. Arm 17 carrying contact 27 is thus "locked" in its closed position by pawl 21, and armature 33, which controls the release of pawl 21, and hence of arm 17, is in its idle or "raised" position. The circuit to this switch 11 may now be traced from the positive (+) side of the 220-volt line through lead *a*, primary winding 3, arm 15, contacts 25 and 27 to movable switch arm 17 and through lead *b* to the negative (—) side of the current source.

Current flowing through the primary winding 3 stores magnetic energy in core 5. When core 5 is saturated, or substantially so, it attracts the armature 53 of switch 43, and moves pivoted arm 51 which in turn moves contact 47 against the tension of spring 49 into contact with arm 45. Contacts 45, 47 being thus closed, the solenoid 61 of switch 59 is energized and its contacts 65 and 67 are closed. Current now flows through branch line *c* through contact 67 to the electromagnet M, and through lead *e* to contacts 65 from whence it flows through wire *f* back to the return lead *b* to the negative (—) side of the direct current source.

Contacts 25 and 27 are maintained closed by pawl 21 until armature 33, on plunger 35, is pulled down. Armature 33 can be pulled down to release the pawl 21 and the spring biased switch arm 17 only when the flux density of the magnetic field in which contacts 25 and 27 are immersed reaches a value sufficient to quench the arc incident to the opening of these contacts. As previously set forth, prompt and adequate quenching of the arc between contact 25 and 27, such as is provided by the improved mechanism of the present invention, ensures that energy released upon the collapse of the magnetic forces stored in the iron core 5 will be converted into current of optimum value in the secondary or output 3 of the current impulse transformer 1.

Various modifications of the invention will suggest themselves to those skilled in the art. It is to be understood therefore that the scope of the invention is not to be limited except as required by the prior art and by the spirit of the appended claims.

What is claimed is:

1. In a device of the character described, a source of current, a transformer connected to said source, a switch connected between said source and said transformer, means for generating a magnetic field within which the contacts of said switch are immersed, means for actuating said switch, and means for delaying the operation of said switch actuating means until the electrical energy in said transformer and the flux density of said magnetic field reach predetermined values.

2. In apparatus of the character described, a source of direct current, a current impulse transformer connected to said source, a switch con-

nected between said source and said transformer, means responsive to an electrical condition of said transformer for generating an arc quenching magnetic field adjacent the contacts of said switch, and means responsive to the intensity of said magnetic field for controlling the actuation of said switch.

3. In apparatus of the character described, an iron core transformer, a source of direct current connected to the primary winding of said transformer, a switch between said source and said winding, means responsive to an electrical condition of said iron core for generating an arc quenching magnetic field adjacent the contacts of said switch, and means for opening said switch when said arc quenching magnetic field reaches a predetermined intensity.

4. In apparatus of the character described, a controlling and a controlled circuit, a switch arm in said controlling circuit, means biasing said switch arm to its open position, means for holding said arm closed against the force of its bias, means connected to said controlling circuit for deriving current from said controlled circuit and for producing an arc quenching magnetic field adjacent said switch arm, and means responsive to a predetermined flux density of said magnetic field for releasing said holding means.

5. In apparatus for magnetizing objects, a source of direct current, an iron core transformer having a primary terminal connected to said source and a secondary terminal to which a magnetizable object may be attached, a switch connected between said source and the primary of said transformer, a pair of pole pieces adjacent the contacts of said switch, a second switch having an actuating member mounted adjacent said transformer and adapted to close when the electrical energy in the said core of said transformer reaches a value calculated to be sufficient to magnetize said object, means responsive to the closing of said second switch for producing an arc quenching magnetic field between said pole pieces, and means for delaying the opening of said first-mentioned switch until said magnetic field reaches a value sufficient to extinguish the arc developed between its contacts incident to the opening of the circuit between said source and the primary of said transformer.

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