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SWITCHING DEVICE

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Fig. 1.

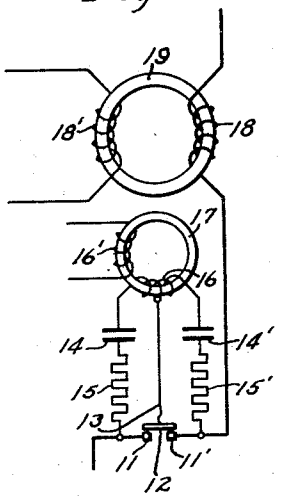



Fig. 2.

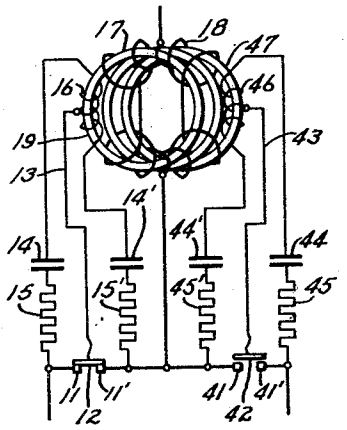
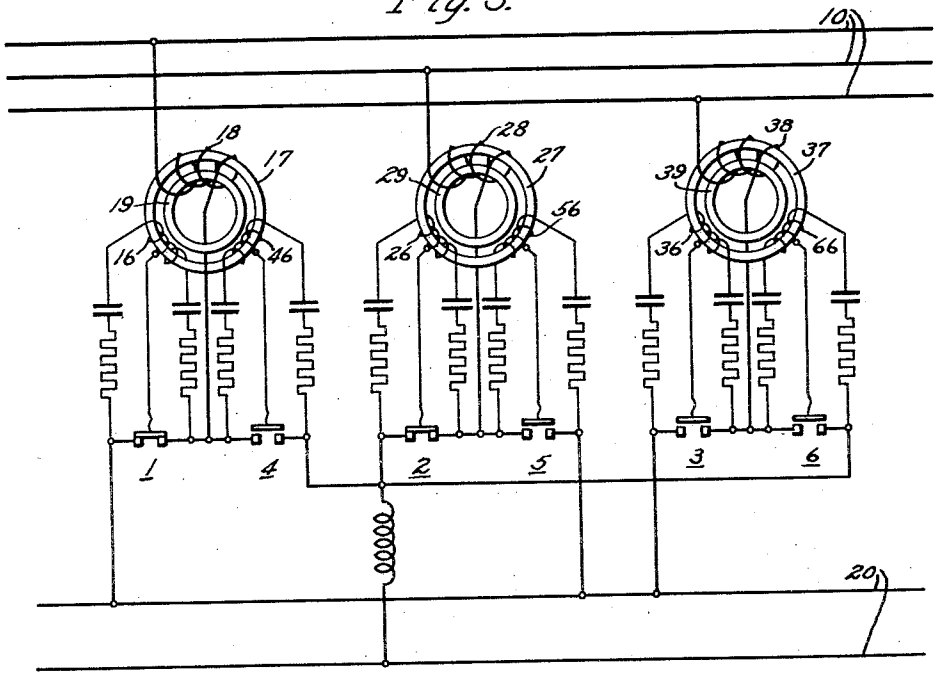



Fig. 3.




WITNESSES:

Leon M. Garman

Nw. C. Groome

INVENTORS

Johannes Wegener, Marcel Zühlke and Floris Koppelmann.

BY

S. A. Strickland

ATTORNEY

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# UNITED STATES PATENT OFFICE

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## SWITCHING DEVICE

Johannes Wegener, Berlin-Johannisthal, Marcel Zühlke, Berlin, and Floris Koppelmann, Berlin-Siemensstadt, Germany, assignors to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

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8 Claims. (Cl. 175—294)

This invention relates to an improvement in a switching device for breaking and making a circuit with a condenser in parallel connection to the breaking point, a choke being series-connected to the condenser in the current path in parallel connection to the breaking point, the magnet core of which choke is saturated when passing a current in predetermined direction and of predetermined intensity and desaturates when the passing current exceeds a certain value in the reverse direction, for instance, for the purpose of passing freely the charging current flowing to the parallel condenser when opening the breaking point, but to oppose temporarily a substantially increased resistance to the condenser current being discharged when closing the breaking point so that the discharging current may not cause any dangerous spark when closing.

In order to increase the switching capacity several simultaneously closing and opening interrupting gaps may, as is well known, be series-connected to which the voltage is distributed uniformly or in a predetermined proportion by the parallel connection of equal impedances. This is, however, impossible if a saturation choke is inserted in the parallel current path. According to the invention the choke is subdivided uniformly or in a certain proportion and the individual parts are distributed uniformly or according to the proportion in common with equal or corresponding parts of the other impedances of the parallel current path to the part circuits arranged parallelly to the individual interrupting gaps.

In the accompanying drawing are shown several embodiments of the invention. Figs. 1 and 2 show single-phase wiring diagrams of the fundamental arrangement as well as of a modification and Fig. 3 the wiring diagram of a multi-phase converter arrangement.

According to Fig. 1 a switching arrangement for breaking a direct or alternating current has two stationary contacts 11, 11' and a movable bridge contact 12 which may be separated when opening. The parallel current path comprises, for instance, two equal condensers 14, 14', two equal ohmic resistances 15, 15' and a saturation choke 16 whose magnet core 17 consists preferably of a high grade iron material. Its magnetization characteristic should be inclined in the unsaturated range as little as possible towards the flux axis, present a sharp bend at the points when passing into the saturated ranges and run nearly parallel to the axis of the magnetic energization at as high as possible a saturation induction in the saturated ranges. The core 17 is, for instance, premagnetized by means of an additional exciting winding 16' in such a manner that the saturation bend has just been exceeded by a slight amount in the same direction in which a charging current flows to the condensers of the parallel current path when opening the interrupting point, so that the charging current may freely flow along the parallel current path to facilitate breaking. The discharging current flowing in opposite direction when closing the interrupting point opposes then the premagnetization causing after having attained a very low value the choke core to be in the unsaturated state, whereby the inductivity of the choke is increased by a multiple as compared to the saturated state. This inductivity prevents for the meantime a further increase of the discharging current. The closing of the interrupting point is therefore facilitated. As it cannot always be prevented even with highest precision of manufacturing that the one of the two breaking points between the contacts 11 and 12 and the contacts 11' and 12 closes a little before the other, the total voltage applied to the switching arrangement will be in any case switched-in by the last contacts closing. This disadvantage will be prevented by connecting the bridge contact 12 to a central tap 13 of the choke 16. Consequently, at equal stress an operating voltage of double the value may be used, i. e., the same arrangement may be made use of with a voltage of double the value as without the connection 13. To facilitate opening a choke 18 with a magnetic core 19 may be provided outside the parallel current path in series-connection with the switch arrangement, which magnetic core also consists of a high-grade iron material and is highly saturated at rated current but desaturates abruptly at each breaking operation near the zero value of the passing current so that a current weak pause occurs during which the breaking may take place under facilitated conditions. On the core 19 a premagnetization winding 18' may be arranged which is supplied with direct or alternating current and may serve for the additional control of the desired magnetization state of the choke as well as for controlling purposes. By means of three arrangements according to Fig. 1 which will be connected to the secondary winding of a three-phase transformer, the movable contacts being operated through cranks, cams, excenters etc. by a synchronous motor connected to the same network, three-phase current may be converted into direct current or vice versa, in which case one pole of the direct-current side is formed by the star point

of the secondary winding of the three-phase transformer, whereas the three switching arrangements at the side away from the transformer form the second direct-current pole.

Fig. 2 shows, for instance, a phase of a multiphase Graetz-system, one main line coming from an alternating-current system being led to two alternately operating switching arrangements of which the one carries the positive and the other the negative half waves. Besides the parts shown in Fig. 1, there are those of Fig. 2 viz. the stationary contacts 41 and 41', the movable bridge contact 42, the condensers 44 and 44', the resistances 45, 45', the choke 46 with the central tap 43 and the core 47. The winding of the switching choke 18 is subdivided in this case in two parallel legs to obtain a good insulation and a small leakage. The cores 17 and 47 are also interlinked with the choke 18. Therefore particular premagnetization devices may under circumstances be dispensed with. The coils 16 and 46 have the same direction of winding and nearly the same number of turns as the coil 18.

When opening a breaking point the current flowing in the switching choke 18 flows also along the parallel current path and therefore through the choke 16 or 46 and counteracts there the excitation of the coil 18 acting upon the core 17 or 47. Care must be taken that the cores 17 and 47 remain in the saturated state during each opening of the corresponding switching arrangement so that the charging current may freely flow into the parallel condensers. If this is not attained by the selection of an iron material whose magnetization characteristic shows its saturation bend of its descending branch below the zero value of the total excitation, it may be obtained by force by a somewhat smaller number of turns of the choke 17, 47 as compared with the coil 18 or by an additional premagnetization. The transition to the unsaturated state is effected during the locking time either by current vibrations forming in the parallel current path owing to a suitable tuning thereof or by an additional premagnetization of the cores 17, 47 which, however, must have now another value than the above-mentioned premagnetization during opening. This may, for instance, be accomplished by supplying the premagnetization winding with an auxiliary alternating voltage of suitable frequency and phase position.

Fig. 3 shows a transformer arrangement for the alternate exchange of energy between a three-phase network 10 and a direct current network 20 with six contact arrangements 1 to 6 arranged in Graetz-connection and which are alternately closed and opened in succession. The contact arrangements 1 and 2 are just being closed. As soon as the contact arrangement 3 has closed the contact arrangement 1 etc. opens.

The chokes 16 and 46, 26 and 56, 36 and 66 are there arranged on one only core 17, 27 or 37 which is also interlinked with the winding of a choke 18, 28, 38 which has besides only one own core 19, 29, 39. The desired magnetization state of the various magnetic cores may be obtained also in this case according to the directions shown in Figs. 1 and 2 by a suitable selection of the number of turns, tuning of the parallel current paths and eventually by an additional premagnetization of the various cores.

As shown by the transformer arrangement of Fig. 3 the parallel chokes of several branching switches connected to the same supply line may in general be arranged on a common magnet core.

The above-described arrangements and characteristics might be to advantage used also in connection with such known switching or transformer arrangements in which an automatically controlled winding or variable impedance is provided in series with the interrupting point for flattening the current characteristic for the purpose of decreasing the switching stresses and whose operation corresponds to that of a switching choke with a premagnetized magnetic core or according to a former proposal with several differently premagnetized magnetic cores, in which case additional means of, for instance, the same type may be employed to shift the current from the interrupting point to a parallel arranged current path or to keep it temporarily away therefrom in the moment of operation.

What is claimed is:

1. A switching device for breaking and making a circuit with a condenser in parallel connection to the breaking point and a choke series-connected to the condenser within the current path parallel connected to the breaking point, which choke has a magnetic core saturated when passing a current in predetermined direction and of predetermined intensity and desaturating when the passing current is in the opposite direction, in which switching device simultaneously closing and opening interrupting gaps are series-connected, to which the voltage is distributed uniformly or in a certain proportion by parallel connecting impedances, characterized in that the choke is subdivided uniformly or in the proportion of the other impedances of the parallel current path and the individual parts are arranged together with the same or the corresponding parts of the impedances in the part circuits arranged parallel to the individual interrupting points.

2. A switching device as set forth in claim 1, particularly for converters, characterized in that the choke core is interlinked with the winding of a choke arranged outside the parallel current path in series connection with the switching device and having a further core highly saturated at rated current and desaturating abruptly at every interrupting operation near the zero value of the passing current for producing a current-weak interval facilitating the current interruption.

3. A switching device as set forth in claim 1, characterized in that the choke arranged in the parallel current path of a switching branch has a common magnetic core with other chokes lying in the parallel current path of other switching branches of the same main line.

4. A switching device comprising a contactor, a protective circuit in shunt with said contactor, said protective circuit including an impedance, a capacitor and a reactor connected in series circuit relation and a saturable core in said reactor, and means for premagnetizing said saturable core whereby current flow in one direction through said reactor tends to saturate said core and current flow in the opposite direction tends to desaturate said core.

5. A switching device comprising a contactor, a protective circuit in shunt with said contactor, said protective circuit including an impedance, a capacitor and a reactor connected in series circuit relation and a saturable core in said reactor, a second reactor in series circuit arrangement

with said contactor, a second saturable core in said second reactor, said second reactor being linked with both said first and second saturable cores.

6. A switching device for periodically making and breaking a circuit comprising a contactor including two stationary contacts and a movable bridge contact, a resistor and a capacitor connected in series with each of said stationary contacts, a reactor winding connecting said resistors and capacitors in shunt with said contactor, a tap in said reactor winding, means for connecting said tap to said movable bridge and a saturable core in said reactor winding.

7. A switching device for periodically making and breaking a circuit comprising a contactor including two stationary contacts and a movable bridge contact, a resistor and a capacitor connected in series with each of said stationary contacts, a reactor winding connecting said resistors and capacitors in shunt with said contactor, a tap in said reactor winding, means for connecting said tap to said movable bridge and a saturable core in said reactor winding, a second reactor winding connected in series circuit relation with said contactor, a saturable core in said second reactor winding, said second reactor winding linking both said saturable cores.

8. A switching device for periodically making and breaking a circuit comprising a contactor including two stationary contacts and a movable bridge contact, a resistor and a capacitor connected in series with each of said stationary contacts, a reactor winding connecting said resistors and capacitors in shunt with said contactor, a tap in said reactor winding, means for connecting said tap to said movable bridge and a saturable core in said reactor winding, a second winding linked with said saturable core for controlling the saturating characteristics thereof.

MARCEL ZÜHLKE.
FLORIS KOPPELMANN.
JOHANNES WEGENER.