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SAFETY DEVICE FOR RECTIFIERS

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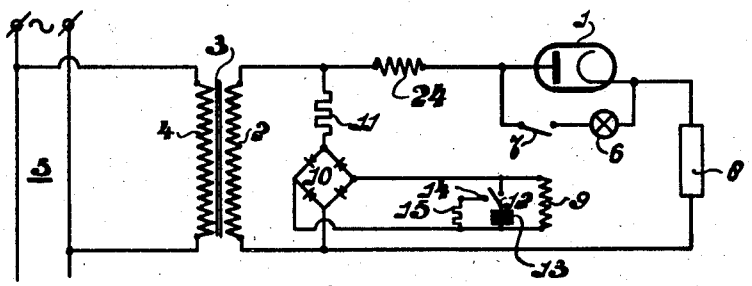


Fig. 1

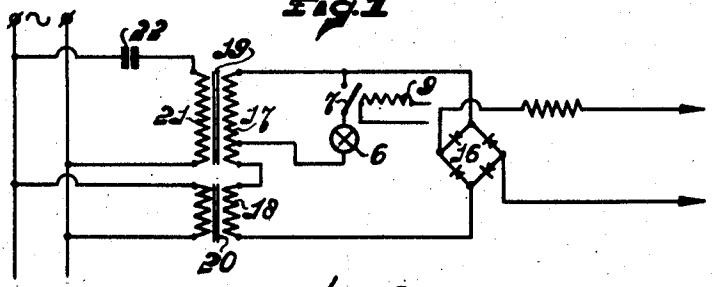


Fig. 2

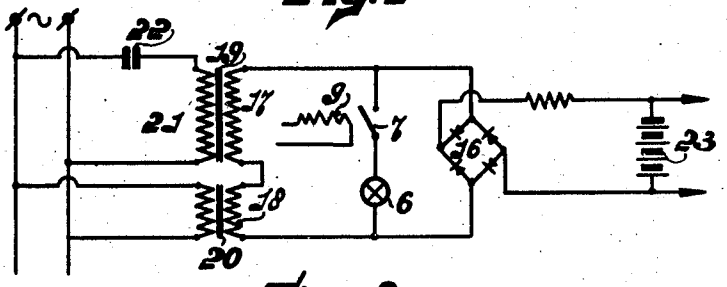


Fig. 3

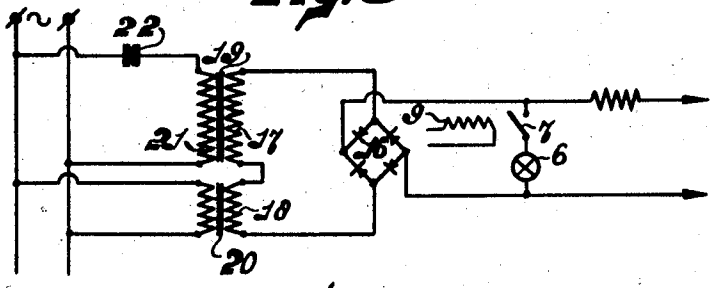


Fig. 4

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SAFETY DEVICE FOR RECTIFIERS

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This invention relates to a safety device safeguarding rectifiers, particularly dry-rectifiers which are supplied from a transformer, against harmful voltages occurring on the network supply being switched on.

In such systems a voltage detrimental to the rectifiers may be constituted by the switching-on pulse itself which occurs on switching-on but in particular cases, which will receive further consideration hereinafter, the said voltage may be of a more or less stationary nature. In order to avoid this disadvantage care may be taken for example that the harmful voltage does not reach the rectifiers by temporarily interrupting the connection of the rectifiers to the supply transformer when the supply voltage is switched on. This interruption may be made into a constrained circuit arrangement by constructing the supply switch for example so as to comprise one pre-position in which the rectifiers are not yet connected up on the transformer being connected into the circuit. In this case, the safety device is, however, not effective if the supply voltage returns after a disturbance. It is more efficient to arrange for the interruption being effected automatically by a magnetic time switch whose coil is connected for example to the input terminal of the device. A disadvantage of this construction consists in that with smaller rectifiers the cost is proportionally comparatively high.

If, however, a much less costly time lag relay is used instead of the magnetic switch, the reliability of service is often insufficient since the entire output has always to be supplied via the relay contact which is constructed so as to be much less sturdy than with a magnetic switch.

The invention provides a more profitable solution for safeguarding the device of the type mentioned in the opening part.

According to the invention, the detrimental voltage is connected to the series combination of an incandescent lamp and switch.

It is known that generally the resistance of an incandescent lamp when hot is a multiple of that when cold. According to the invention, this property is made available for conducting away the occurring detrimental voltage via the closed switch through a cold incandescent lamp which is possessed of a low resistance in such manner that the rectifiers are safeguarded against damage to a satisfactory extent. According as the filament rises in temperature its resistance increases with the result that the voltage is supplied to the rectifiers gradually. It is therefore necessary for the lamp so to be chosen that its cold resistance is low enough to derive the detrimental voltage and that its thermal capacity is

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high enough to ensure a sufficiently long heating-up period and thus a sufficiently gradual passage to the operating condition.

With incandescent lamps normally obtainable commercially the ratio between the hot and the cold resistance is for example about 14, as is largely sufficient for the object aimed at.

After the voltage has thus been supplied gradually to the rectifiers the lamp is switched out by means of the switch. In the first place a continual load of the burning incandescent lamp which is no longer effective is thus avoided and secondly the filament is restored to its cold state of low resistance in order that it may at once act again for example after the rectifier system has been put out of use. In addition to the desideratum that the lamp should take up as little room as possible and its cost should be a minimum preference should be given, in view of the said disconnection, to a lamp whose current which the relay will have to interrupt is so low that a relay of cheap construction may suffice.

Further improving the device according to the invention by means of a zero potential device by which the open switch is closed when the supply voltage falls out in an unexpected manner has in addition the effect of safeguarding against detrimental voltages on the unexpected return of the supply voltage.

According to a further feature of the invention, the disconnection of the lamp after the termination of the heating-up period is brought about as quickly as possible. This ensures various advantages. In the first place, the running time of the lamp is limited to a minimum so that the life is prolonged. In addition, the time over which the lamp acts as a load is reduced as far as possible so that the current losses remain limited to a minimum. Thirdly, the lamp can again act as a safety device within the shortest time possible and this is important if the supply voltage would accidentally again be suppressed a short time after the system has been connected to the circuit to return immediately after that. Thus, the time over which the system is not safeguarded, i. e. during the running time of the lamp, after the termination of the heating-up time, is as short as possible. The short running time of the lamp further permits of using a lamp having such a nominal voltage that it is overloaded for a short time. Thus, the cost is considerably reduced and shortening of the life hardly occurs in pratice.

Preferably, the disconnection is automatically effected by means of a time relay having a time constant of the order of magnitude of say from 0.3 to 0.9 second. Even a cheap direct current

relay having connected in series with it a small blocking layer rectifier and connected to any of the alternating voltages occurring in the circuit arrangement is generally serviceable.

Taking into account the above-mentioned points of view (sufficient low cold resistance, sufficiently high thermal capacity, small volume, low cost, small current) it is possible to be guided by the following considerations when selecting from the available type of incandescent lamps:

(*a*) The intersection of the current-voltage characteristic curve of the rectifier with that of the cold filament should preferably have a voltage of from 15% to 50% of the voltage to which the safety-circuit is connected in normal use.

(*b*) The nominal voltage of the lamp should be a minimum but should not be lower than ⅔ of the voltage to which the safety-circuit is connected in normal use.

The invention is particularly important with transformer circuits in which particularly high voltages occur upon the network being switched on. This may occur for example with transformer circuits whose alternating current part includes a condenser. Such a circuit arrangement is obtained inter alia if use is made of a saturated and an unsaturated transformer whose primaries are connected in parallel with the supply circuit a condenser being connected in series with the primary of the saturated transformer, whereas the secondaries are connected to the rectifier in series connection. The circuit described has been suggested before, particularly with the object of obtaining a voltage-current characteristic curve a part of which is horizontal with comparatively low loads and is comparatively steep with higher loads. Hence, in the case of a lower load an essentially constant voltage and in the case of higher loads a current limitation due to a rapid decrease of the voltage is obtained.

In addition, in this circuit arrangement there may occur with no-load or low-lead rectifier the phenomenon not yet entirely explained that on switching-on a voltage-current characteristic curve quite different from that previously desired makes its appearance either temporarily or more or less stationarily, the voltage being found to have a considerably higher value. These phenomena, which may also give rise to damage of the rectifiers, are also rendered inoffensive by the use of the invention.

In order that the invention may be clearly understood and readily carried into effect it will now be described more fully with reference to the accompanying drawing, in which several schematically represented forms of construction are illustrated.

Fig. 1 shows a rectifier 1 which is supplied from the secondary 2 of a transformer 3, the primary 4 being connected to the supply circuit 5. Interposed between the secondary 2 of transformer 3 and rectifier 1 is a filter choke 24.

According to the invention, the voltages occurring in the supply circuit on the supply part being switched on are conducted away with the interposition of the series combination of an incandescent lamp 6 and a switch 7 so that the rectifier 1 is safeguarded against said voltages, it being premised that the load 8 is capable of withstanding these voltages. If this should not be the case the right hand terminal of the incandescent lamp may be connected to the lowermost terminal of the load so that both the rectifier and the load are shunted by the incandescent lamp with switch.

After the lamp 6 is heated up and as a result thereof the rectifier 1 is gradually connected to the operating voltage the switch 7 is opened by the relay coil 9. For this purpose, a Gratz circuit 10 of small dry-rectifiers with a resistance 11 connected in series therewith is arranged on the secondary side of the transformer. The rectified voltage is connected to the relay coil 9 and to a condenser 13 connected in parallel therewith through a switch 12.

Assuming the switches 7 and 12 to be maintained closed, for example by means of a spring, the condenser 13 will become charged with a certain time lag across the resistance 11 on the network being switched-on. At a given condenser voltage the relay coil 9 will be sufficiently energised to open the switch 7 through which the detrimental voltages have meanwhile escaped. Either by mechanical coupling to the switch 7 or else under direct magnetic influence of the coil 9 the switch 12 is also opened and connected to the resistance 15 via the contact 14, with the result that the condenser 13 discharges rapidly. Thus the de-energisation time of the relay is maintained at a small value so that after a transient interruption of the network the relay is at once again capable of switching on since so long as the supply voltage continues the switches 7 and 12 occupy the position described. As soon, however, as the voltage disappears, for example under the influence of a disturbance, the switch 7 is again closed, whereas the switch 12 brings about the parallel combination of the condenser 13 and the coil 9. The device is thus again ready for use so as, on the return of supply voltage and thus of the voltages that may be detrimental, to conduct them away across the lamp 6.

The following figures in which corresponding parts are provided with similar references still show some few different constructions.

Referring to Fig. 2, the incandescent lamp with the switch are connected to such a part of the secondary of the transformer system that the detrimental voltage can be conducted away to a sufficient extent. The rectifier system is here constituted by a Gratz circuit 16 which is supplied from the two series-connected secondaries 17 and 18 of two transformers 19 and 20. The primary 21 of the transformer 19 which is constructed as a saturated transformer is connected to the supply circuit in series with the condenser 22. The transformer 20 is proportioned to be smaller and unsaturated.

Referring to Fig. 3, the incandescent lamp 6 and the switch 7 are connected in parallel with the secondaries of the supply transformer. The Gratz circuit 16 which is connected to a buffer battery 23 is also safeguarded in this manner.

In those cases in which a battery is not used on the direct current side of the Gratz circuit 16 (Fig. 4) the incandescent lamp with the switch may be connected to the direct current side of the rectifiers. In this case a comparatively large short-circuit current flows temporarily but the latter is essentially in offensive for the rectifiers. The voltages which occur on the supply circuit being switched-on and which are detrimental are, however, prevented.

An additional advantage of the relay construction illustrated in Fig. 1 consists in that the condenser 13 need only be capable of withstanding the attracting voltage of the relay and not the working voltage of the latter since the condenser is only connected to the voltage during the time lag.

Finally, when a battery is not provided on the direct current side of the rectifiers, the supply of the relay may be connected to the said direct current side so that the rectifiers 10 can be omitted.

Although in the forms of construction given by way of example the series combination of incandescent lamp and switch is always used on the secondary side of the transformer, this series combination may be connected to the primary side in parallel with part of the whole of the primary.

What we claim is:

1. In combination with an electrical supply system having rectifier means to which is applied a source of unrectified power, a safety device adapted to apply said power to said rectifier means at a predetermined gradual rate, said safety device comprising an impedance having a non-linear temperature coefficient of impedance connected to said system so as to absorb a portion of said power, the value of said impedance being low in the unheated state relative to the value in the fully heating state, said impedance having a thermal capacity effecting the application of said power to said rectifier means at the desired rate, and switching means interposed between said impedance and said system for disconnecting said impedance after it has attained the fully heated state.

2. In combination with an electrical supply system having rectifier means to which is applied a source of unrectified power, a safety device adapted to apply the power to the rectifier means at a predetermined gradual rate, said safety device comprising a lamp having an incandescent filament connected to said system so as to absorb a portion of said power, the resistance of said filament being low in the unheated state relative to resistance in the fully heated state, said filament having a thermal capacity effecting the application of the power to the rectifier means at the desired rate, a normally closed switch interposed between said lamp and said system, and means responsive to said power for opening said switch after said filament has attained the fully heated state.

3. In combination with an electrical supply system having rectifier means to which is applied a source of unrectified power, a safety device adapted to apply the power to the rectifier means at a predetermined gradual rate, said safety device comprising a lamp having an incandescent filament connected to said system so as to absorb a portion of said power, the resistance of said filament being low in the unheated state relative to the resistance in the fully heated state, said filament having a thermal capacity effecting the application of the power to the rectifier means at the desired rate, a normally closed switch interposed between said lamp and said system, a relay for opening said switch, a rectifier, said relay being connected through said rectifier to said source of power, and a condenser shunted across said relay, said condenser having a value causing said relay to be actuated at a time after said filament has attained the fully heated state.

4. In combination with an electrical supply system having rectifier means to which is applied a source of unrectified power, a safety device adapted to apply the power to the rectifier means at a predetermined gradual rate, said safety device comprising a lamp having an incandescent filament connected to said system so as to absorb a portion of said power, the resistance of said filament being low in the unheated state relative to the resistance in the fully heated state, said filament having a thermal capacity effecting the application of the power to the rectifier means at the desired rate, a first normally closed switch interposed between said lamp and said system, a rectifier, a relay connected through said rectifier to said source of power, a condenser, a discharge path for said condenser, and a second switch for selectively connecting in a first position said condenser across said relay and in a second position said condenser across said discharge path, said second switch being normally maintained in said first position, said relay being arranged upon energization to open said first switch and to operate said second switch to said second position, said condenser having a value causing said relay to be energized at a time after said filament has attained its fully heated value.

5. An electrical supply system comprising a source of unrectified power, rectifying means, a transformer having a primary connected to said source and a secondary connected to said rectifying means, a lamp having an incandescent filament connected across said rectifying means, the resistance of said filament being low in the unheated state relative to the resistance in the fully heated state, said filament having a thermal capacity effecting the application of power to said rectifying means at a predetermined gradual rate, a normally closed switch interposed between said lamp and said rectifying means, a relay for opening said switch, a rectifier, said relay being coupled through said rectifier to the secondary of said transformer, and a condenser connected across said relay and having a value causing said relay to be actuated at a time after said filament has attained its fully heated state.

6. An electrical supply system comprising a source of alternating current, a saturable transformer having a primary and a secondary, a non-saturable transformer having a primary and a secondary, a condenser, said primary of said saturable transformer being coupled to said source through said condenser, said primary of said non-saturable transformer being connected to said source, rectifier means, the secondary of said saturable transformer being connected in series with the secondary of said non-saturable transformer to said rectifier means, a lamp having an incandescent filament connected across a portion of said series-connected secondaries, the resistance of said filament being low in the unheated state relative to the resistance in the fully heated state, said filament having a thermal capacity effecting the application of power to said rectifying means at a predetermined gradual rate, and switching means interposed between said lamp and said secondaries for disconnecting said lamp after said filament has attained the fully heated state.

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