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PROTECTIVE DEVICE FOR HIGH TENSION CIRCUITS

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Fig. 1.

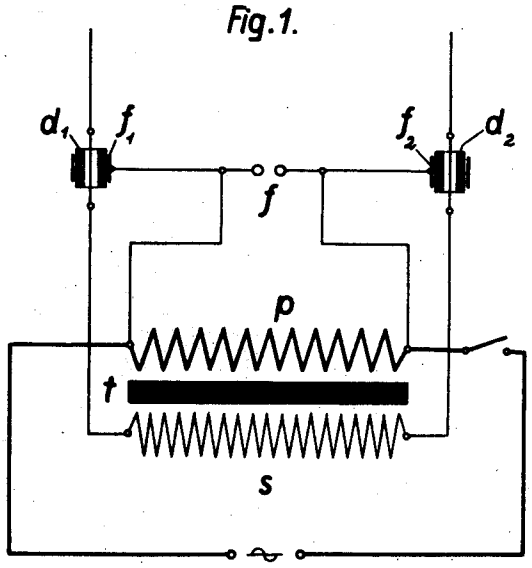
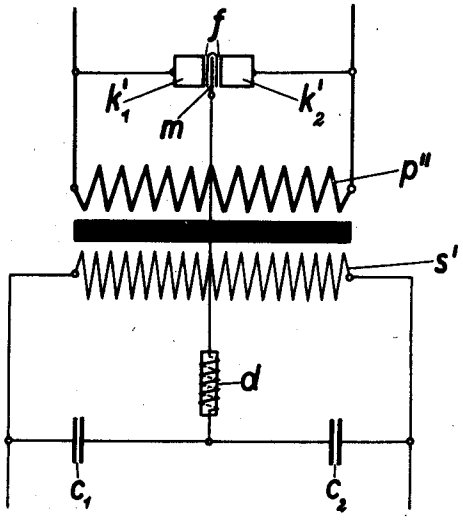


Fig. 2.



INVENTOR
KARL NIEMANN
BY Richards & Geier
ATTORNEYS

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KARL NIEMANN, OF BERLIN-SIEMENSSTADT, GERMANY

PROTECTIVE DEVICE FOR HIGH-TENSION CIRCUITS

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This invention relates to improvements in high tension circuits especially used in connection with X-ray apparatus, and has particular reference to a protective device therefor.

It is known to protect operators of X-ray apparatus and patients being treated therewith against injuries which may be caused by touching wires under high tension, by providing circuit breakers within the circuit of the high tension transformers which are actuated by phenomena caused within the circuits under high tension by the touching thereof. Such arrangements, however, are often too late in their operation, since all of these breakers operate with a certain retardation.

An object of the present invention is to avoid the great disadvantage of the above mentioned arrangement.

In its preferred embodiment the discharge gap or the primary winding of a transformer, in the secondary winding of which the discharge gap is mounted, is bridged over the primary winding of the high tension transformer in such a way that the current is disconnected from the latter through the operation of the discharge gap. This causes the disappearance of the high tension. In the operation of this system the dangerous high tension is eliminated at the same moment that there is a disturbance of the potential equilibrium caused by touching the wires of a high tension system, or which is better yet, the high tension is suppressed through the operation of this system caused by the electric spark which occurs immediately before the touching of such a system. The short circuit which is thus caused breaks the circuit immediately afterwards, but this feature is only for the purpose of protecting the power circuit.

In the drawings—

Figures 1 and 2 diagrammatically represent different circuits for carrying out the present invention.

In Figure 1, s is the high tension winding of the transformer t as applied, for instance, to X-ray apparatus. High tension conductors lead from the terminals of the winding s into the operating room and pass through insulating tubes d^1 and d^2 in the wall of such room. Each of these tubes d^1 and d^2 is provided with a metallic coating f^1 or f^2, so that condensers are formed each of whose dielectrics is composed of the respective insulating tube and the air space between the latter and the high tension conductor, the plates of the condensers being formed, on the one hand, of the high tension conduits, and on the other, of the associated metal coating f^1 or f^2. A conductor leads from each of the plates f^1 and f^2 to the discharge gap f. Each flange is connected to one end of the discharging gap f which may be of any suitable type wherein the electrodes of the discharging gap are constituted by material such that the electrical discharges occurring upon excessive potentials cause a short circuit, or an arc discharge. The two electrodes are also connected to the ends of the primary winding p of the high tension transformer t so that, in comparison with the parts of the X-ray apparatus which carry high tension current, said electrodes are at a potential that is practically equal to the earth potential.

If, through inadvertence or any other unforeseen cause occurring during the operation of the apparatus, a grounding of one of the two high tension lines should take place (across an ohmic resistance or by means of a spark occurring between the earth and the line) or if the high tension line, during the operation of the apparatus, should come in contact with a body of considerable capacity which is insulated from the earth, the distribution of potential in the high tension circuit changes materially with the result that considerable potentials occur at points of the high tension circuit, and at the discharge gap f, between which no potential or only a low potential previously existed, so that the discharge gap f is actuated. This discharge, however, short circuits the primary winding p of transformer t. Consequently the line potential is cut off and therefore the high tension winding s is currentless; or, at least, the potential falls to such a value that it is no longer

dangerous. It is thus seen that by the employment of a discharge gap as a short circuiting means, the operation is an instantaneous one, in contrast with mechanical circuit breakers whose operation is retarded because of the inertia of the parts and requires an appreciable period of time to be effected.

The discharging circuit may also be arranged within another line circuit such as an auxiliary winding, the short circuiting of which causes the discontinuance of the high tension. Instead of a single discharge gap, several may be employed. In any case, however, they are to be so inserted that they are able to indicate potential differences which are effective during defective operation of the installation.

In contra-distinction to the known arrangements, the present invention is effective when the circuits under high tension are touched, even before these lines or wires or parts are subjected to high tension and this touching still exists at the moment of the high tension connection.

It has proved to be advantageous not to employ the discharge gap or line to operate as short circuit-breaker as indicating means for the shift of potential, but to assign this function to a special discharge circuit causing the discharge in the short circuiting discharge line. In thus disencumbering the main discharge line, it may be so designed that its short circuiting effect is as efficient and as nearly perfect as possible at the inception of the discharge.

The discharge circuit which is sensitive to potential shifts is suitably connected with one terminal to a point of the high tension circuit which during normal operation has a certain earth potential, such as, for instance, the center of the high tension winding or any other artificial zero point such as the center of an ohmic resistance bridged over the high tension terminals, whereas the other terminal may be connected to the ground or to a point of the transformer low tension winding; in other words, to a point the potential of which is not materially altered during disturbances of the potential equilibrium in the high tension circuit.

The problem to operate the short circuiting discharge circuit when and only when the auxiliary or indicating discharge circuit is operated, may be solved in such a way that the auxiliary discharge circuit is provided with a certain capacity which discharges itself upon over-bridging of the indicating circuit into the short-circuiting discharge circuit.

It is essential for the satisfactory functioning of the present device that, in accordance with the above mentioned features, the short-circuiting discharge circuit is connected to the high tension circuit in such a manner that it operates only with potential shifts occurring in the high tension circuit.

This requirement is essential because if, for instance, it were possible to also energize the discharge circuit by means of high frequency oscillations generated by the spark caused immediately before the touching of parts of an oscillatory circuit connected to the discharge circuit, the device would operate continuously, inasmuch as it were coupled to X-ray apparatus with rotating high tension rectifier or with any other device or arrangement containing a spark circuit.

In such cases in which there is danger of influencing the discharge circuit by means of eventually generated sparks, it is advantageous to take other special precautions in order to avoid harmful electrical oscillations or to prevent their impression upon the discharge circuit. This is best effected by means of a choke coil inserted immediately in front of the discharge gap. Also, apparatus may be connected with the choke coil which affords the conductors a convenient equalization path in front of said coil.

Figure 2 represents such an arrangement. The terminals of high tension winding s' are bridged over by any kind of device adapted to create an artificial zero point, as for example, by means of two or more series-connected condensers c^1, c^2. The low tension winding p'' is connected to the spark circuit f^3, the electrodes of which are formed by the two copper blocks $k^{1'}$, $k^{2'}$. A thin metal foil m is placed between these blocks and is covered on the one side with a thin insulating layer such as paper, for instance. The metal foil m is connected over a choke coil d with a midpoint of condensers c^1, c^2, in other words, with a point of earth potential. The drawing does not show special condensers parallel to the two spark gaps which are formed by the metal foils and the copper blocks, since the capacity of the electrodes is sufficient to the attainment of the desired results.

If now, through any possible cause a potential shift occurs in the high tension circuit, the center of the condenser battery takes a corresponding potential with respect to the ground. One of the two spark circuits formed by the metal foil and copper block k^1, or $k^{2'}$, respectively, is put into operation, the metal foil fuses or evaporates and thus causes an arc discharge between the copper blocks $k^{1'}$ and $k^{2'}$, thereby short circuiting the primary winding of the high tension transformer. Any other spark occurring in the high tension circuit or between parts included in the high tension circuit does not suffice to operate the discharge circuit $k^{1'}$, $k^{2'}$, even if it is capable of generating strong electric oscillation for these oscillations would take the line of least resistance for them which leads over the con-

denser battery, and they would not take the detour leading to the discharge circuit which is obstructed for them by the choke coil *d*.

If the capacity of c^1 and c^2 is suitably dimensioned, the choke coil *c* may, in many cases, be dispensed with. It is also possible to use discharge circuits or spaces containing easily ionizable gases.

What is claimed is:

1. A protective device for X-ray apparatus comprising a transformer having a primary and a secondary winding, electrodes connected to the terminals of the primary winding and forming a spark gap across such winding, leads connected to the terminals of the secondary winding, and capacitive couplings between said leads and the spark gap circuit of said primary winding.

2. A protective device for X-ray apparatus comprising a transformer having a primary and a secondary winding, electrodes connected to the terminals of the primary winding and forming a spark gap across such winding, two condensers connected to the terminals of the secondary winding, a thin foil terminal located in said spark gap, and a choke coil connected in series through one terminal to said thin foil terminal, the other terminal of said coil being connected midway between said condensers.

3. A safety device for high tension systems comprising a transformer the primary winding of which is connected through regulating devices to the main supply circuit and the secondary of which is connected to the high tension system, a spark gap comprising three electrodes, a connection from one electrode to one line of the main supply circuit, a connection from another electrode to the other line of the main supply circuit, and a connection from the third electrode to the secondary winding of the transformer, said electrodes so spaced with relation to each other that an arc travelling from said last mentioned electrode to either of the other two electrodes, due to a partial or complete ground in the high tension system, will cause an arc to be created between said first two mentioned electrodes to short circuit the incoming supply lines.

KARL NIEMANN.