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S. HORIKOSHI

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ELECTRIC PROTECTIVE SYSTEM AND APPARATUS

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Fig. 1.

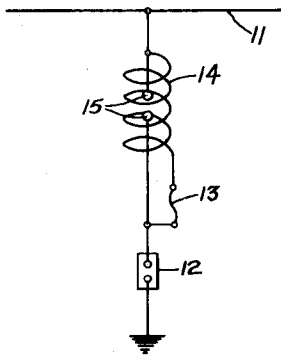
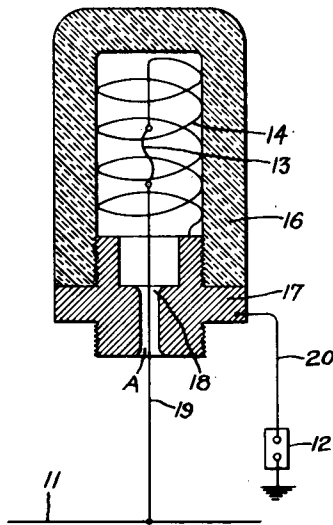


Fig. 2.



Inventor:
Shinichiro Horikoshi,
by *Harry E. Dunham*
His Attorney.

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ELECTRIC PROTECTIVE SYSTEM AND APPARATUS

Shinichiro Horikoshi, Tokyo, Japan, assignor to
General Electric Company, a corporation of
New York

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14 Claims. (Cl. 175—215)

The present invention relates to electric protective systems, and has for an object the provision, in an electric protective system embodying a lightning arrester, of means for protecting the arrester from continuous current of commercial power frequencies without detracting from the operation of the arrester on lightning surges.

In the practice of the invention, a fuse is connected in series with the lightning arrester to protect the arrester against continuous abnormal voltages such, for example, as may occur due to arcing grounds. It is desirable that the fuse remain intact upon subjection of the arrester circuit to a lightning surge current of several thousand amperes for only a few micro-seconds and that the fuse operate, or fuse, upon subjection of the arrester circuit to commercial frequency current, of considerably smaller but abnormal value, which is continuous over a period of approximately 0.1 second or longer. There are some conditions under which such desired operation can not be satisfied by the fuse alone. Hence, in accordance with the present invention, an inductive coil or other suitable device is connected in series with the fuse for producing impedance in the fuse circuit and a special spark gap is connected in parallel with the fuse circuit comprised of the fuse and impedance producing device, the arrangement being such that when the arrester circuit is subjected to a current of steep wave front, such as a lightning surge current, the greater part of the current discharges across the spark gap and passes to the arrester for operation of the latter in its normal manner, while with a continuous abnormal current of ordinary frequency, the current passes through the fuse and impedance device and ruptures the fuse, thus preventing damage to the lightning arrester.

That which I believe to be novel and my invention will be better understood from the following description and the claims appended thereto, taken in conjunction with the accompanying drawing in which Fig. 1 illustrates schematically a protective system embodying the present invention and Fig. 2 illustrates diagrammatically and in section one form of apparatus for carrying out the invention.

Referring to Fig. 1, 11 designates a transmission or feeder line which is connected to ground through a lightning arrester conventionally shown at 12. In series with the arrester there is connected a fuse 13 and an inductive coil 14, and in shunt with the fuse and coil is connected a spark gap having discharge electrodes 15. With this arrangement, relatively continuous abnormal

current of commercial frequency imposed upon the arrester circuit will pass through the fuse and melt the same, the inductive coil offering relatively little impedance to current of commercial frequency. The melting of the fuse clears the lightning arrester and prevents damage thereto. On the other hand, when the arrester circuit is subjected to lightning surge current, the inductive coil offers high impedance thereto and the impedance drop across the inductive coil and fuse will result in arc-over between electrodes 15, thus short-circuiting the fuse and causing passage of the current through the arrester which functions in its normal manner.

It is desirable that some means be provided for drawing the electrodes of the spark gap apart to a circuit interrupting distance upon rupture of the fuse. One method of accomplishing this is illustrated diagrammatically in Fig. 2 wherein the fusible element 13 is shown as being disposed in an expulsion chamber formed by a casing 16 of insulating material, which casing has mounted on the end thereof a metal terminal block 17 provided with a central opening 18 for the outward passage therethrough of the connection lead 19 of the fuse. Lead 19 is connected in any suitable manner to line 11. The series connected inductive coil 14 is illustrated diagrammatically as being mounted within casing 16 in surrounding relation to the fuse, although the coil may if desired be mounted exteriorly of the casing. A discharge gap A, in parallel with the fuse and inductive coil is provided by the connection lead 19 and the inner wall of terminal block 17 which forms opening 18, and the terminal block is connected to lightning arrester 12 through lead 20. With this last described arrangement, the terminal or connection lead 19 is expelled from the opening 18 upon rupture of the fuse, in the well known manner of expulsion fuses. Since lead 19 forms one of the electrodes of gap A, this outward expulsion of the lead results in increasing the gap substantially to infinity so that no current may flow thereafter across the gap and the arrester is effectively removed from the circuit so that no damage may be done to the arrester by continuous abnormal current of commercial power frequency. In case a spring is employed for tensioning the fuse link and effecting rapid separation of the fuse link terminals on fuse operation, as is relatively common practice, the tensioning spring will of course aid in effecting separation of the gap electrodes.

Thus the present invention provides a protective system wherein a discharge gap is so com-

5 bined with a fuse and an inductive coil or other
suitable impedance providing device that tran-
sient currents pass, without damage to the fuse,
through the gap to the arrester which then op-
erates in its intended manner, while the fuse
operates only upon continuous abnormal cur-
rent of commercial power frequency to discon-
nect the arrester and prevent damage thereto.

10 What I claim as new and desire to secure by
Letters Patent of the United States, is:

1. In an electric protective system including a
lightning arrester, protective means for said ar-
rester including a pair of circuits connected in
series with the arrester and in parallel with each
other, one of which circuits includes a fuse and
the other of which circuits includes a discharge
gap, said one circuit having substantial imped-
ance whereby the impedance drop thereacross
upon subjection of the said one circuit to light-
ning impulse current will cause arc-over of said
gap to by-pass the surge current around the fuse
without damage to the latter, said fuse being ar-
ranged to operate upon subjection of said one cir-
cuit to commercial frequency current of prede-
termined abnormal value.

2. In an electric protective system including a
lightning arrester, a fuse connected in series with
said arrester for protecting the latter against
abnormal currents of commercial frequency, and
means for protecting said fuse against lightning
surge currents including an impedance device
connected in series with said fuse and a discharge
gap connected in parallel with said fuse and
impedance device.

3. In an electric protective circuit including a
lightning arrester, a fusible conductor connected
in the circuit in series with the arrester, a surge
gap connected in parallel with a part of the cir-
cuit including said fusible conductor and in series
with the arrester for by-passing lightning impulse
currents around said fusible conductor to the
arrester, means operatively associated with said
part of the circuit for producing thereacross a
voltage drop sufficient to cause arc-over of said
gap upon subjection of the circuit to lightning im-
pulses, and means including said fusible con-
ductor operative to interrupt the circuit to the
arrester in response to flow of abnormal cur-
rent of power frequencies.

4. In combination, an electric protective cir-
cuit including a lightning arrester; a part of said
circuit, connected in series with the arrester, in-
cluding a fusible conductor and having substan-
tial inductance; a surge gap connected in parallel
with said part of the circuit and in series with
the arrester, which said gap is arranged to spark-
over upon subjection of the circuit to lightning
impulses so as to by-pass lightning impulse cur-
rents around said fusible conductor to the ar-
rester, and means including said fusible con-
ductor operative to interrupt the circuit to the
arrester upon subjection of the circuit to abnor-
mal current of power frequencies.

5. In an electric protective system including
a lightning arrester, a pair of circuits connected
in series with said arrester and in parallel with
each other, one of which circuits includes a fuse
and has substantial impedance and the other of
which circuits includes a discharge gap hav-
ing relatively movable electrodes, and means
operative responsively to operation of said fuse
for effecting relative movement apart of said
electrodes to increase said gap.

6. In combination, an electric protective cir-
cuit including a lightning arrester; a part of said

circuit, connected in series with the arrester, in-
cluding a fusible conductor and inductive means
serially connected therewith; a surge gap con-
nected in parallel with said fusible conductor and
inductive means and in series with the arrester,
said gap having relatively movable electrodes and
being arranged normally to by-pass lightning
impulse currents around said fusible conductor
to the arrester, and means operative to effect
relative movement apart of said electrodes to cir-
cuit interrupting distance upon rupture of said
fusible conductor.

7. In an electric protective circuit including a
lightning arrester, circuit interrupting means
connected in the circuit in series with the ar-
rester and operable responsively to abnormal cur-
rent of power frequencies for interrupting the
circuit to the arrester, a gap connected in paral-
lel with a part of the circuit including said inter-
rupting means and in series with the arrester,
said gap including a pair of relatively movable
electrodes and being arranged normally to by-
pass lightning impulse currents around said in-
terrupting means to said arrester, said part of
the circuit including means operative to produce
thereacross a voltage drop sufficient to cause arc-
over of said gap upon subjection of the circuit to
lightning impulses, and means operative to effect
relative movement apart of said gap electrodes to
a circuit interrupting distance upon operation
of said circuit interrupting means.

8. In an electric circuit, the combination of
means to be protected, means providing an in-
ductive current conducting path connected in
series with said means to be protected and includ-
ing a fusible conductor, a surge gap connected in
parallel with said inductive path and in series
with said means to be protected, said gap includ-
ing a pair of relatively movable electrodes and
being arranged normally to by-pass lightning im-
pulse currents around said fusible conductor, and
means operative to effect relative movement apart
of said electrodes to circuit interrupting distance
upon operation of said fusible conductor.

9. In an electric circuit including means to be
protected, circuit interrupting means connected
in the circuit in series with said means to be
protected and operable responsively to abnormal
current for interrupting the circuit to said means
to be protected, a surge gap connected in parallel
with a part of the circuit including said inter-
rupting means and in series with said means
to be protected, said gap including a pair of rela-
tively movable electrodes and being arranged nor-
mally to by-pass lightning impulse currents
around said interrupting means, said part of the
circuit including means operative responsively to
rate of change of current in the circuit for pro-
ducing across said gap a voltage drop sufficient
to cause arc-over of the gap upon subjection of
the circuit to lightning impulses, and means
operative to effect relative movement apart of
said gap electrodes to a circuit interrupting dis-
tance upon operation of said circuit interrupting
means.

10. Electric protective apparatus comprising in
combination, means providing an inductive cur-
rent conducting path including a fusible con-
ductor, a surge gap connected in parallel with
said inductive path and including a pair of rela-
tively movable electrodes, said gap being arranged
normally to protect said fusible conductor by by-
passing lightning impulse currents around the
fusible conductor and the fusible conductor being
arranged to interrupt abnormal current of power

frequencies, and means operative to effect relative movement apart of said electrodes upon operation of said fusible conductor.

11. Electric protective apparatus comprising in combination a fusible conductor, inductive means in series with said fusible conductor, a surge gap connected in shunt directly across said fusible conductor and inductive means for by-passing lightning impulse currents around the fusible conductor, at least one of the electrodes of said gap being movable relative to the other of the electrodes, and means operative to effect relative movement apart of said electrodes upon rupture of the fusible conductor.

12. In an electric protective apparatus, a circuit having substantial impedance and including a fuse, a second circuit connected in parallel with said first circuit and including a discharge gap having a pair of relatively movable electrodes, and means operative responsively to rupture of said fuse for effecting relative movement apart of said electrodes to increase said gap.

13. In an electric protective apparatus, a circuit having substantial impedance and including a fusible element with fuse terminals one of which is supported for movement relative to the other of the terminals, means providing an expulsion

chamber surrounding said fusible element and having a discharge opening for the expulsion therethrough of said one terminal upon fuse operation, and a second circuit connected in shunt with said first circuit and including a discharge gap having a pair of electrodes one of which is supported for movement away from the other of the electrodes to increase said gap in response to expulsion of said one electrode from said opening.

14. An electric protective apparatus including in combination, a conductor having a fusible section, a housing providing an expulsion chamber in surrounding relation to said fusible section, a surge gap connected in parallel with a part of said conductor including said fusible section, said gap including an electrode supported in substantially fixed relation to said housing and a second electrode supported by said conductor in cooperative spaced relation to said first electrode, and inductive means arranged to produce across said gap a voltage drop sufficient to cause arc-over of the gap upon subjection of said conductor to lightning impulse currents, said second electrode being arranged for movement away from said first electrode to increase said gap upon operation of said fusible section.

SHINICHIRO HORIKOSHI.