Sept. 12, 1939. R. D. NELSON 2,172,640

ELECTRICAL PROTECTING DEVICE

Filed July 30, 1937 2 Sheets-Sheet 1

Fig. 1

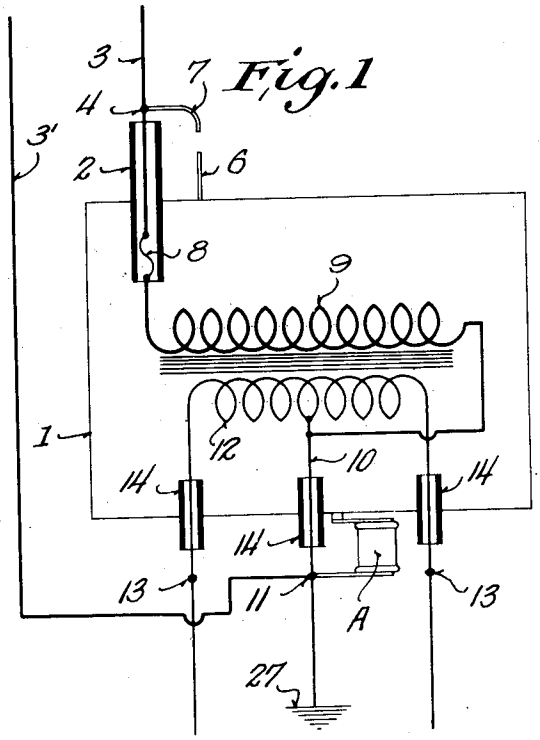


Fig. 3

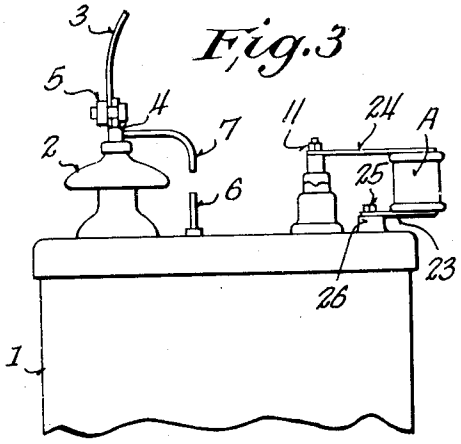


Fig. 4

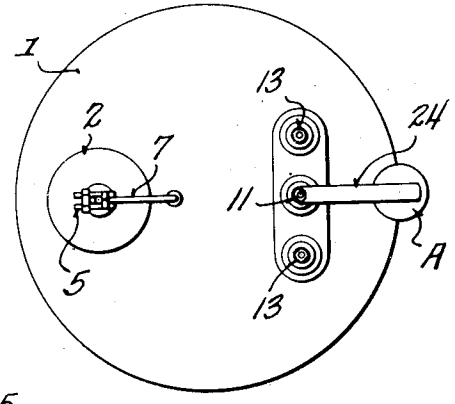
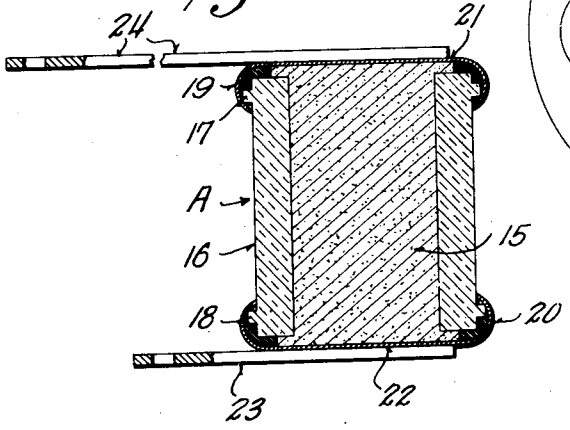


Fig. 2



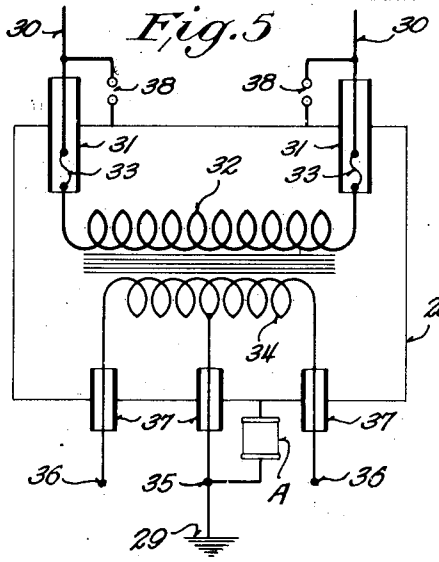
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Fig. 5



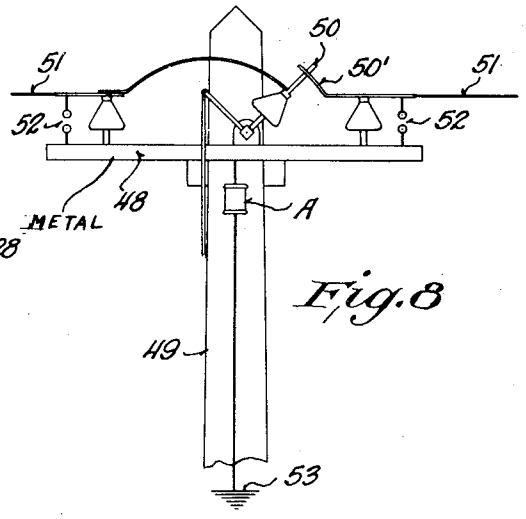


Fig. 8

Fig. 6

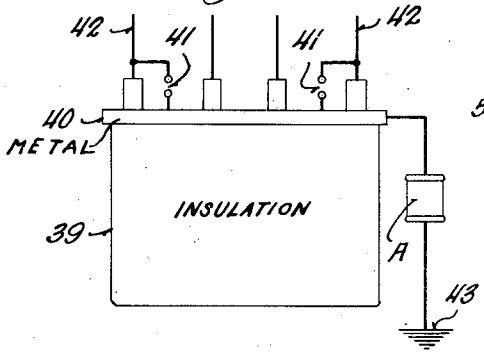
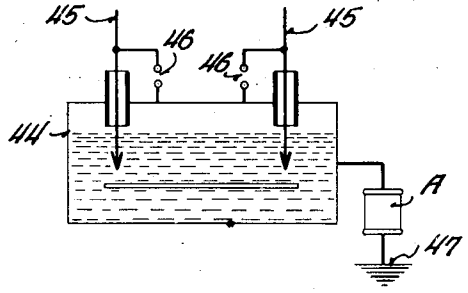


Fig. 7



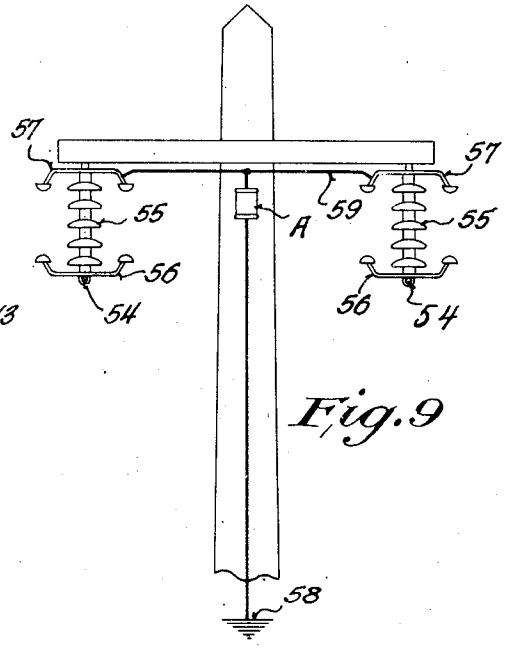


Fig. 9

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2,172,640

ELECTRICAL PROTECTING DEVICE

Rolland D. Nelson, Milwaukee, Wis., assignor to Line Material Company, South Milwaukee, Wis., a corporation of Delaware

Application July 30, 1937, Serial No. 156,539

15 Claims. (Cl. 175—294)

This invention relates to electrical protecting devices.

Objects of this invention are to provide a protecting device which is adapted to protect a transformer, electrical switch and transmission line, or any other electrical instrumentality, and the invention is particularly directed to means which protect against a sudden surge on the line while still preventing the follow-through current after the surge has passed without requiring the use of any auxiliary apparatus.

Additionally, in devices of this type difficulty has been encountered due to the fact that birds frequently bridge or short-circuit the gap and thus start an arc which if not interrupted, will cause damage. It is, therefore, a further object of this invention to provide a construction which overcomes this defect due to the bridging of the gaps by birds so that although a bird may alight on the apparatus and temporarily bridge the gap, the fault is immediately burned out and follow-through current is prevented, as in the case of a lightning surge.

Further objects are to provide a construction which may be applied to an electrical instrumentality equipped either with one or more spark gaps, the apparatus being so constructed that cooperative action between either gap and the valve material or negative resistance material is obtained, the construction permitting the use of a single member provided with the valve material for either one or a plurality of spark gaps.

Further objects are to provide a construction in which where a conducting case or conducting portion or member is employed and separated from the high voltage line by means of spark gaps, the conducting portion itself may form a part of the ground discharge circuit, valve material being provided between such conducting portion and the ground and the construction further insuring protection even under the extremely adverse condition where a portion of the high tension line becomes grounded to the conducting portion of the apparatus, the valve material quickly failing and causing a fuse or other device to open the circuit and thus protect the system. This feature, however, avoids any chance of dangerous potential being permanently built up between the ground and the conducting portion of the apparatus.

Embodiments of the invention are shown in the accompanying drawings, in which:

Figure 1 is a diagrammatic view showing the invention applied to a single bushing transformer construction.

Figure 2 is an enlarged sectional view through the protective unit or follow-through current interrupting member.

Figure 3 is a fragmentary view of the upper portion of the transformer with parts broken away.

Figure 4 is a plan view of the top of the transformer.

Figure 5 shows the invention as applied to a double bushing transformer having two spark gaps.

Figure 6 shows the invention as applied to a transformer or other electrical device in which a portion only of the casing is conducting.

Figure 7 shows the invention as applied to an oil switch.

Figure 8 shows the invention applied to a disconnecting switch.

Figure 9 shows the invention applied to a transmission line.

Referring to Figures 1 to 4 of the drawings, it will be seen that a rural type single bushing transformer has been shown as provided with a casing 1 formed of conducting material, which obviously may be of any suitable shape and may be provided with a cover portion, as shown in Figure 3. The casing is provided with an insulating bushing 2 through which the live high tension lead 3 is carried. For example, the insulator 2 may carry an upper terminal member 4 which, by means of the connector 5, joins the high tension lead 3.

A spark gap is provided between the casing 1 and the high tension lead 3 and may consist of an upwardly projecting rod 6 positioned directly below the downwardly turned rod or spark gap finger 7 supported from the terminal 4.

A fuse link 8 is interposed between the live side of the primary 9 of the transformer and the high tension lead 3, as shown diagrammatically in Figure 1, the other side of the primary 9 being connected to the grounded neutral 10 which extends to the grounded or neutral terminal 11 of the secondary 12. The outer ends of the secondary are connected to the terminals 13. Suitable insulating bushings 14 are interposed between the neutral and the outer sides of the secondary 12 and the casing 1. It is customary to connect the grounded side of the high tension line indicated at 3' to the neutral terminal 11.

It will be seen, therefore, that the neutral is not directly grounded to the casing. However, a

valve member indicated generally at A, is interposed between the neutral and the transformer casing. This valve member may employ valve material, such as silicon carbide, which is commonly known as granulon, or any other suitable material. The material has a negative resistance characteristic and is indicated by the reference character 15 in Figure 2. It may be carried within an insulating cylinder 16 provided with upper and lower annular flanges 17 and 18 about which the inwardly turned flanges 19 and 20 of the upper cap 21 and the lower cap 22 may be spun, preferably rubber or other sealing material being interposed between the caps and the ends of the cylinder, as indicated in Figure 2.

A lower supporting member and conductor 23 is brazed, soldered, or otherwise secured to the lower cap 22 and an upper conductor and supporting member 24 is similarly brazed, soldered, or otherwise secured to the upper cap 21. The members 23 and 24 may be relatively rigid bars. The lower combined conductor and support 23 is bolted, as indicated at 25 in Figure 3, to a metal lug 26 cast integrally with the cover of the casing. The upper conductor or support 24 is similarly secured to the neutral terminal 11, as shown in Figures 3 and 4. Thus the valve member is supported in a very simple and practical manner and is readily accessible and may be easily removed and replaced.

It is to be understood that in all forms that the invention may take the parts, such, for instance, as the casings or other conducting portions, are properly insulated from the ground. The wooden poles, upon which the apparatus is frequently mounted, generally offer a sufficient margin of insulation to give adequate protection and insure proper operation of the apparatus.

In the event a surge occurs, such for example as lightning, the arc will strike across the spark gap 6 and 7 to the transformer casing and the current will pass through the valve material A to the ground indicated at 27 in Figure 1. In view of the fact that the valve material has a negative resistance characteristic, it is apparent that free discharge is afforded in this manner but nevertheless as soon as the surge ceases, the follow through current is prevented from flowing as a high resistance is interposed in this grounded circuit. Consequently the arc is stopped and the device resumes its normal functioning.

With regard to the bird trouble, it is apparent that there is much less likelihood of a bird shorting across between the fingers 6 and 7 or between the finger 7 and the casing, due to the high resistance valve member A. However, if shortage should occur, it is obvious that the fault is immediately burned out and follow-through current is prevented, as in the case of a lightning surge.

If for any reason the live side of the transformer, that is to say, the high voltage primary, should become grounded on the casing, the valve material would have sufficient current to cause rapid heating and when this material gets hot, it becomes a good conductor and clinkers within a short time, thereby forming a conducting path and minimizing any possible hazard due to the transformer casing being connected to the high tension line and a difference of potential existing between the transformer case and the neutral conductor or ground. Continuous overload, if the live side were grounded to the casing inside of the fuse 8, would result in rupture of the fuse 8 and if the grounding of the live side to the casing occurred on the outer side of the fuse 8, the next line protecting device, for example that at the substation, would open.

It will be seen, therefore, that this transformer can be used in a manner such that it does not require automatic auxiliary apparatus for its normal functioning but instead is self-contained and a complete and automatically actuating unit in itself.

The invention is equally applicable to a construction in which a plurality of gaps are employed.

For example, in Figure 5 a double bushing transformer has been shown, the case 28 being connected through the valve member A to the ground as indicated at 29. The high tension lines 30 pass through the insulating bushings 31 and connect to the primary 32 of the transformer, fuses 33 being provided.

Although the fuses have been shown as in Figure 1, it is obvious that they may be positioned at any point desired both in the construction shown in Figure 5 and in Figure 1 between the transformer terminal or terminals and the high tension line or lines. The spark gaps 38 are provided between each high tension line 30 and the casing 28.

The secondary 34 has its neutral connected to the grounded neutral terminal 35 and the outer ends of the secondary are connected to the terminals 36. Suitable insulating bushings 37 are provided for the neutral and for the outer terminal conductors so that the secondary is insulated from the transformer casing 28.

In the form of the invention shown in Figure 6, the electrical instrumentality, such as a transformer, may have a portion of its casing formed of insulating material as indicated at 39 and may have a metal top or other metal portion indicated at 40. The spark gaps 41 are positioned between the high tension lines 42 and the conducting portion 40 of the apparatus. The valve member A is connected between the ground 43 and the conducting portion 40 of the apparatus.

The invention is not limited to transformers as obviously, as shown in Figure 7, it could be applied to a switch oil immersed or otherwise. In this form of the invention the casing may be either made partly of insulating material and partly of conducting material as in Figure 6 or wholly of conducting material as shown in Figure 7, the casing being indicated at 44. The high tension lines 45 extend into the casing and spark gaps 46 are positioned between such high tension lines and the casing. The casing is connected through the valve member to the ground 47.

Disconnect switches such as shown in Figure 8 are frequently mounted upon steel channel or other shaped supports 48 carried upon a pole 49. The disconnecting switch may be of any type, such, for instance, as one having the movable portion 50 and the stationary contact member 50' and being pivotally or otherwise supported from the conducting support 48. The live parts are insulated from the conducting portion 48 in accordance with the conventional practice. The line wires are indicated at 51 and spark gaps 52 are interposed between such line wires and the conducting portion 48. This conducting portion 48 is connected to the ground 53 through the valve member A.

The principle of this invention may be applied to the protection of high tension lines. For ex-

ample, the high tension lines 54 as shown in Figure 9 may be supported by strings of insulating members 55 and arcing horns 56 and 57 may be provided for each line. The arcing horns 56 are connected together and are connected through the valve member A to the ground 58. In this form of the invention the conducting portion may be regarded as the arcing horns 57 and their common conductor 59 and this conducting member or portion is connected, as stated, through the valve member A to the ground.

It will be seen that this invention provides a novel means of protecting electrical instrumentalities in such a way that adequate and full protection is provided against lightning or other surges and that in the case of an instrumentality provided with a conducting portion dangerous voltages cannot build up between the instrumentality and the conducting portion, but when such a condition tends to occur, there is a relief across the spark gap and the surge is conducted to the ground, the valve member, however, preventing follow-through current.

It is to be noted that in the event a bird shorts across a spark gap, the fault is immediately burned out and follow-through current is prevented, as in the case of a lightning surge.

It is also to be noted that in the case of transformers whether of the single or double bushing type, it is impossible for high voltages to pass to the low voltage distribution system fed from the transformer.

It is also to be noted that the constructions whereby these results are obtained are very simple and are cheap and easily produced and do not require elaborate or extensive parts.

Although this invention has been described in considerable detail, it is to be understood that such description is intended as illustrative rather than limiting, as the invention may be variously embodied and is to be interpreted as claimed.

I claim:

1. In an apparatus of the class described, an electrical device, a support therefor having a conducting portion, line wires leading to said device, spark gap means between at least one of said line wires and said conducting portion, and a valve member having one side connected to said conducting portion and having the other side grounded and forming a direct resistance path between said conducting portion and the ground, whereby the conducting portion is normally maintained at ground potential and resistance to follow-through current is offered when an arc is established across said spark gap means.

2. In an apparatus of the class described, an electrical device, a support therefor having a conducting portion, line wires leading to said device, spark gap means between each of said line wires and said conducting portion, and a valve member having one side connected to said conducting portion and having the other side grounded and forming a direct resistance path between said conducting portion and the ground, whereby the conducting portion is normally maintained at ground potential and resistance to follow-through current is offered when an arc is established across said spark gap means.

3. In an apparatus of the class described, an electrical device, a housing for said device, said housing having a conducting portion, line wires leading to said device, spark gap means between at least one line wire and said conducting portion, and a valve member having one side connected to said conducting portion and having the other side grounded and forming a direct resistance path between said conducting portion and the ground, whereby the conducting portion is normally maintained at ground potential and resistance to follow-through current is offered when an arc is established across said spark gap means.

4. In an apparatus of the class described, an electrical device, a housing for said device, said housing having a conducting portion, line wires leading to said device, spark gap means between at least one line wire and said conducting portion, said apparatus having a grounded terminal, and a valve member connected between said grounded terminal and said conducting portion.

5. In an apparatus of the class described, an electrical device, a casing for said device having a conducting portion, line wires leading to said device, overload responsive, circuit interrupting means connected in series with said line wires for protecting said device, spark gap means interposed between at least one of said line wires and said conducting portion, and valve means having one side connected to said conducting portion and having the other side grounded, and forming a direct resistance path between said conducting portion and the ground, whereby the conducting portion is normally maintained at ground potential and resistance to follow-through current is offered when an arc is established across said spark gap means.

6. In an apparatus of the class described, an electrical device, a casing for said device having a conducting portion, said apparatus having a grounded terminal, line wires leading to said device, overload responsive, circuit interrupting means connected in series with said line wires for protecting said device, spark gap means interposed between at least one of said line wires and said conducting portion, and valve means having one side connected to said conducting portion and having the other side connected to said grounded terminal.

7. In an apparatus of the class described, an electrical device, a casing for said device having a conducting portion, line wires leading to said device, one of said line wires being grounded, spark gap means interposed between the other line wire and the said conducting portion, and a valve member having one side grounded and having the other side connected to said conducting portion and forming a direct resistance path between said conducting portion and the ground, whereby the conducting portion is normally maintained at ground potential and resistance to follow-through current is offered when an arc is established across said spark gap means.

8. In an apparatus of the class described, an electrical device, a casing for said device having a conducting portion, line wires leading to said device, overload responsive, circuit interrupting means for protecting said device, spark gap means interposed between said conducting portion and each of said line wires, and a valve member having one side connected to said conducting portion and having the other side grounded and forming a direct resistance path between said conducting portion and the ground, whereby the conducting portion is normally maintained at ground potential and resistance to follow-through current is offered when an arc is established across said spark gap means.

9. In an apparatus of the class described, a transformer having a primary and a secondary, one side of said primary being grounded and the other side being alive, a casing for said trans-

former having a conducting portion, valve means interposed between said portion and the grounded side of said primary, and a spark gap between the live side of said primary and said casing.

10. In an apparatus of the class described, a casing having a conducting portion, a transformer housed by said casing and having a live primary terminal and a grounded terminal, a secondary having a part thereof connected to said grounded terminal, and valve means interposed between said portion and said grounded terminal.

11. In an apparatus of the class described, a casing having a conducting portion, a live primary terminal and a grounded terminal, a transformer having a primary and a secondary, said primary having one side connected to said live primary terminal and the other side connected to said grounded terminal, a valve member connected between said portion and said grounded terminal, spark gap means between said casing and said live primary terminal, and overload responsive, circuit interrupting means connected in circuit with the live primary terminal.

12. In an apparatus of the class described, a casing having a conducting portion, a live primary terminal and a grounded terminal both carried by and insulated from said casing, a transformer housed by said casing and having a primary connected between the live primary terminal and the grounded terminal, a secondary having a grounded neutral, a spark gap interposed between the live side of said primary and said casing, and valve means interposed between said portion and said grounded terminal.

13. In an apparatus of the class described, a casing having a conducting portion, a grounded terminal carried by and insulated from the conducting portion of said casing, an electrical device housed within said casing, line wires leading to said electrical device, a spark gap interposed between at least one of said line wires and the conducting portion of said casing, and valve means interposed between the conducting portion of said casing and the grounded terminal, said valve means being removably held in place with reference to said casing.

14. In a device of the class described, a casing having a conducting portion, a transformer housed within said casing and having a primary and a secondary, line wires leading to said primary, spark gap means interposed between each of said line wires and the conducting portion of said casing, the secondary of said transformer having a grounded portion, and a valve member removably carried by said casing and having one side grounded and the other side connected to said conducting portion.

15. In an apparatus of the class described, a support having a conducting portion, an electric switch carried by said support, line wires leading to said electric switch, spark gap means interposed between at least one of said line wires and said conducting portion, and a valve member having one side grounded and the other side connected to said conducting portion and forming a direct resistance path between said conducting portion and the ground, whereby the conducting portion is normally maintained at ground potential and resistance to follow-through current is offered when an arc is established across said spark gap means.

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