

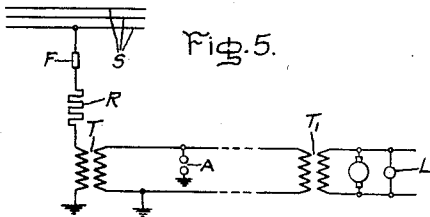
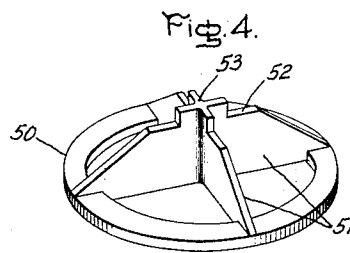
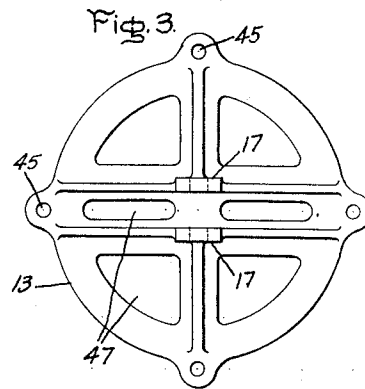
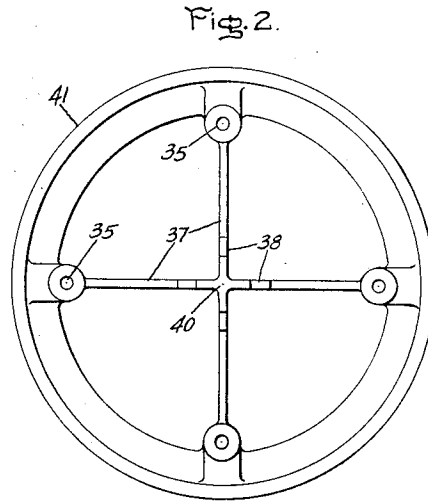
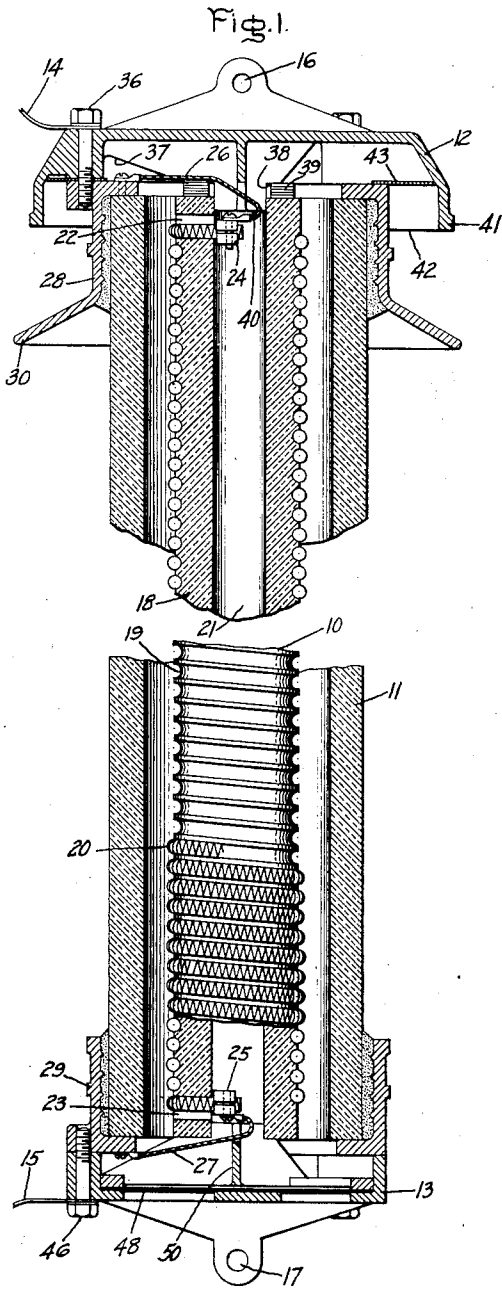
May 26, 1931.

O. R. SCHURIG

1,807,441

RESISTOR

Filed Dec. 28, 1928



Inventor:
Otto R. Schurig,
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UNITED STATES PATENT OFFICE

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RESISTOR

Application filed December 28, 1928 Serial No. 328,970.

My invention relates to resistors, particularly circuit protective resistors, and the principal object is to provide an improved form of air cooled current limiting resistor suitable for high voltage outdoor service.

More specifically the invention provides certain improvements in the resistor insulation and structural arrangement to insure against breakdown due to corona and other conditions encountered in high voltage circuits. Also special provision is made for insuring effective ventilation of the resistor so that it will be capable of carrying continuously high voltage power currents without attaining successive temperatures. At the same time the resistor structure is so proportioned that the sufficient heat storage capacity is obtained to enable the resistor to withstand excessive temporary overload currents such as may occur upon accidental grounding or short circuiting of the high voltage power circuit. In addition, the resistor is enclosed and protected so effectively that it may be installed outdoors and subjected to rain, snow and other conditions without danger of failure. Moreover, the improved resistor is of such construction that it can be manufactured and installed at a moderate cost.

circuit protection, and a resistor is connected in series with the fuse in order to limit the short circuit current imposed on the transmission circuits and also lessen the interrupting duty of the fuse. Thus, the resistor forms an important element of the protective equipment and ordinarily must be installed outdoors. Consequently, it must not only be fully weatherproof but also highly insulated and protected to withstand the high impressed voltage and induced voltages. Likewise, the resistor must carry continuously all the current supplied to the distribution transformer up to the value at which the fuse melts and in addition withstand temporarily the excessive heavy current that may flow until the fuse operates in case of ground faults or short circuits in either the transformer primary or secondary circuits. The improved resistor construction of the present invention meets all of the various requirements in such service at a minimum cost.

A preferred form of the improved resistor construction of the present invention is illustrated in the accompanying drawings, in which Fig. 1 is a view, mostly in section, of the assembled resistor. Fig. 2 is a plan view of the under side of the removable ventilating hood, or end cap, for the resistor; Fig. 3 is a similar view of the removable end cap for the other end of the resistor; Fig. 4 is a perspective view of the spacer used in connection with the end cap shown in Fig. 3 for supporting the end of the resistor; and Fig. 5 is a circuit diagram of a high voltage transformer protective system in which the resistor may be used.

As shown in Fig. 1, the assembled device comprises essentially a tubular resistor unit which is enclosed within the tubular casing 11, having the removable end caps 12 and 13 electrically connected to the ends of the resistor and arranged for connection to the line terminals 14, 15 of the circuit in which the resistor is to be included. The end caps 12 and 13 also serve to support the entire device and for this purpose are provided with suitable supporting eyes 16 and 17 adapted to be mounted on high voltage insulator posts,

While not necessarily limited thereto, the resistor construction of the present invention is particularly adapted for current limiting service in protective equipment for small outdoor transformer substations employed in rural or farm electrification projects such, as described and claimed in the copending application Serial No. 328,184 of Leo H. Perry, filed Dec. 24, 1928, and assigned to the assignee of my present invention.

As set forth in this Perry application, power is supplied directly from high voltage transmission or trunk lines to the adjacent farms or communities of rural customers through separate distribution transformer equipments, preferably of the outdoor type and of as inexpensive construction as possible. The distribution transformer is arranged to be connected directly to the high voltage power line through a protective fuse designed to afford both overload and short-

or other suitable supports, for high voltage service.

The resistor unit 10 preferably is formed of a tube 18 of vitreous insulating material such as an alundum compound adapted to withstand high temperatures without deterioration. The outside of the tube 18 is provided with the spiral grooves 19 in which the coiled resistor element 20 of nickel chromium alloy or other suitable resistance material is wound, as illustrated in the drawing. The central opening 21 in the tube 18 as well as the space between the tubes 10 and 11 serve as ventilating flues to cool the resistor unit. The ends of the resistance element 20 extend through the openings 22 and 23 formed at the ends of the resistor tube 18 and are secured by the clamps 24 and 25 with the coiled resistance element 20 under tension. This insures that the resistance element is maintained in proper position in the grooves of the tube 18 under all operating conditions. The connectors 26 and 27 electrically connect the clamped ends of the resistance element with the end caps 12 and 13 of the enclosing casing, which thus serve as terminals for connecting the resistor to the circuit conductors 14 and 15.

The tubular enclosure 11 for the resistance unit 10 also preferably is formed of vitreous insulating material, such as an alundum compound that will withstand high temperatures. In order to secure the removable end caps 12 and 13 to the ends of the tube 11, the metal collars 28 and 29 are cemented or otherwise suitably secured to the ends of the tube. Since, when used in the transformer protective arrangement described hereinafter, the entire resistor is intended to be mounted outdoors and in a vertical position, as shown in Fig. 1, with the upper end of the resistor connected through a fuse to a high voltage line, the end cap 12 is made in the form of a ventilating hood arranged to completely cover the upper end of the resistor and prevent entrance of rain or snow. Also the hood 12, together with the collar 28, which is provided with a flaring skirt 30, as well as the cap 29 function as corona shields at the ends of the resistor, as they jointly serve to distribute the high electrostatic gradient produced when the resistor is connected in the high voltage circuit.

The detailed construction of the end cap or ventilating hood 12 may be more readily understood from Fig. 2, which shows a bottom view of this member. From this figure it will be seen that four holes 35 are equally spaced around the circumference of the hood 12 to receive the holding down bolts 36, by means of which the hood is fastened to the collar 28 on the end of the insulating enclosure tube 11. Four ribs 37 are formed on the inside of the hood 12 and taper from the edges to a substantial height at the center.

These ribs are provided with the flat faces 38 upon which the upper end of the resistor tube 18 is seated with the washers 39 located therebetween, as indicated in Fig. 1. The central junction of the four ribs 37 forms a frame 40 fitting into the central opening 21 of the resistor tube 18 and thereby supporting the tubular resistor unit in alignment within the tubular enclosure 11. The openings between the ribs 37 provide unobstructed ventilating passages for the space both inside and outside of the tubular resistor unit 21. This insures effective cooling of the resistor.

The depending rim 41 of the hood 12 is of larger diameter than the body of the collar 28 and cooperates therewith to form a downwardly directed circumferential ventilating opening for the cooling air passing over the resistor unit. Thus in outdoor service no appreciable amount of rain or snow can be carried to the interior of the resistor through this ventilating opening. Furthermore, the flaring skirt 30 of the collar 28 functions to divert the heated air issuing from the downwardly directed ventilating opening 42 away from the body of the enclosing tube 11 and thereby facilitates the dissipation of heat from the resistor through the insulating tube 11 directly to the surrounding air. The flaring skirt 30 also serves as a rain shield so as to maintain at least a portion of the outer surface of the insulating enclosure tube 11 dry and thereby reduce the danger of flashover in high voltage service. A screening 43 is clamped between the ventilating hood 12 and the top of the collar 28 and extends across the mouth of the ventilating opening 42 so as to effectively prevent the entrance of birds, bugs, or other undesirable foreign matter into the interior of the resistor enclosure.

The end cap 13 supports the lower end of both the resistor unit 10 and the enclosing tube 11, and at the same time facilitates the entrance of cooling air into the interior of the enclosing casing 11. As shown in Fig. 3, the end cap 13 is provided with four openings 45 for receiving the bolts 46 which fasten the end cap 13 to the collar 29 at the lower end of the enclosure tube 11. The several openings 47 formed in the end cap 13 permit ready entrance of the cooling air, while the ribs therebetween join to form a strong base for the centrally located supporting eyes 17.

The circular protective screen 48 is arranged to cover the several openings 47 in the end cap 13 and is clamped between the end cap 13 and the ribbed supporting spacer ring 50, upon which the lower end of the resistance unit 10 rests, as shown in Fig. 1. The detailed construction of the ribbed spacer ring 50 is shown in Fig. 4. It will be seen that the four ribs 51 extending from the

ring 50 taper to a substantial height at the center and are formed with the flat supporting faces 52 and the central guiding frame 53 for engaging with the interior of the resistor tube 10 in substantially the same manner as described in connection with the ribs on the hood 12. With this construction the ready entrance, as well as exit, of the cooling air both inside and outside of the tubular resistance unit 10 are obtained.

Thus, the heat generated in the resistance element 20 in service is readily transmitted to the air within the tubular enclosing casing 11 and produces a strong chimney action to circulate cooling air over both the inside and outside of the resistor. At the same time, heat is radiated directly from the resistor element 20 to the enclosing tube 11 and the latter is cooled by the natural convection currents on its exterior surface. These exterior convection currents are not materially impeded by the stream of heated air issuing from the interior of the resistor enclosure through the downwardly directed ventilating opening 42 due to the provision of the flaring skirt 30 on the collar 28 which deflects the heated air stream away from the tube 11. These various features combine to promote the most efficient cooling of the resistor unit and thereby permit the unit continuously to carry a relatively heavy load current without attaining a dangerous temperature.

The construction of the insulating portions of the resistor of heat resisting material such as an alundum compound or the like and the formation of the resistance unit itself of a nickel-iron alloy readily permits the resistor to be run continuously at quite high temperatures, for example, at dull red heats of around 500° C. without any appreciable damage.

While the improved ventilated resistor may be used with advantage in other fields of service, it is particularly adapted for use in an outdoor transformer protective arrangement of the type such as described and claimed in the copending Perry application previously mentioned. Fig. 5 diagrammatically shows the resistor embodied in such a system where single-phase alternating current power is supplied from one of the poly-phase high voltage trunk or transmission lines S through an overload and short circuit protective fuse F and the current limiting resistor R to the primary winding of a transformer T. It will be noted that in this arrangement one terminal of the transformer primary and also of the transformer secondary is permanently grounded. The high voltage insulation of the fuse, resistor, and transformer primary is of such break down value that voltage or lightning surges on the transmission lines are taken care of by the high voltage lightning arresters ordinarily provided for this purpose without

danger of failure at any point in the single-phase distribution transformer primary circuit itself. The lower voltage transformer secondary circuit is provided with the lightning arrester A where desired. Furthermore, the voltage at which the power is used, may be still further reduced by means of the transformer T₁ in order to supply ordinary commercial load devices such as lamps, motors, and the like indicated diagrammatically at L.

In such an installation the improved air cooled resistor of the present invention is particularly advantageous for use as the current limiting resistor due to its ability to withstand the high impressed voltage without danger of corona or of breakdown of the insulation. Also the effective ventilating arrangement permits the resistor to carry continuously the full load currents of the transformer T as well as overload currents up to the value at which the fuse melts without overheating. In case of an accidental ground or short-circuit at any point in the transformer primary circuit between the resistor and the ground, the resistor functions to limit the current and thereby prevent operation of the protective circuit breakers of the main transmission line before the fuse melts and clears the fault. As some definite time interval is required for the melting and operation of the fuse F to clear the supply lines of the short circuit or ground, the current limiting resistor necessarily must withstand the excessive current flow during this definite time interval. Due to the ability of the resistor to absorb a considerable amount of heat and to withstand high temperatures, the resistor construction of the present invention is well adapted to successfully withstand the excessive overload current for the brief interval required for operation of the fuse F.

In addition, the simple and efficient resistor construction of the present invention readily lends itself to manufacture and installation at a most reasonable cost and this is an important feature in the transformer protective equipment just described where the underlying idea is to avoid the use of expensive oil circuit breakers, lightning arresters and other usual forms of circuit protective equipment. Moreover, in case of damage or failure of any part of the resistor structure, it is a fairly simple matter to disassemble the resistor for replacement or repair.

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

1. A high voltage current regulating device including an air-cooled resistor, and a tubular ventilating enclosure of insulating material surrounding the resistor and having at one end thereof a metallic collar electrically connected to one end of resistor and extending along the outside of the enclosure with an outwardly flaring portion dis-

posed intermediate the ends of the resistor for shielding the resistor from corona.

2. A high voltage current limiting device including a spirally wound air-cooled metallic resistor, an enclosing tube of insulating material surrounding the resistor and having an external metallic resistor terminal at one end thereof, said terminals being in the form of a corona shielding hood extending along the outside of the enclosure in spaced apart relation with the turns at one end of the resistor and flaring outwardly intermediate the ends of the resistor.

3. A high voltage current limiting device including a spirally wound air-cooled metallic resistor, a tubular enclosure of insulating material surrounding the resistor, a metallic ventilating hood covering one end of the tubular enclosure, and a metallic collar member surrounding the enclosure adjacent to the end of the resistor and having an outwardly flaring portion intermediate the ends of the resistor and in spaced apart relation with the periphery of the ventilating hood, said hood and collar being electrically connected to function as a corona shield for the resistor.

4. In combination a spirally wound air-cooled metallic resistor, a tubular ventilating enclosure of insulating material surrounding the resistor and having metallic end collars permanently secured at the ends thereof for the resistor terminals, metallic end supports for the enclosure provided with ventilating openings and having means for supporting the resistor in alignment within the enclosure, and means for removably securing the end supports to said collars.

5. In combination a hollow tube having a resistor element wound thereon, a tubular enclosure surrounding the resistor tube to form a flue space outside the resistor tube, and end caps engaging with the ends of the tubular enclosure for supporting the resistor tube and having openings therein communicating with the flue space inside and outside of the resistor tube.

6. In combination a resistance unit formed of a hollow tube of insulating material and a resistor wound thereon, a tubular enclosure therefore, supporting members removably secured to the ends of the tubular enclosure and having cross ribs for supporting the resistance unit in alignment therein and providing openings for ventilating the space inside and outside of the resistance unit.

7. In combination a spirally wound, air-cooled metallic resistor, an enclosing tube in spaced relation with the resistor, a hood mounted at the end of the tube to provide a circumferential ventilating opening directed along the outside of the tubular enclosure, and a baffle mounted outside of the tubu-

lar enclosure in spaced apart relation with said opening.

8. In combination a hollow tube having a resistor element wound thereon, an enclosing tube of insulating material, and resistor terminal members at each end of the enclosing tube provided with cross ribs for maintaining the resistor tube in alignment within the enclosing tube and having openings between the ribs forming ventilating flues inside and outside the resistor tube.

9. In combination a resistance unit formed of a spirally grooved tube of insulating material with a coiled metallic resistance element wound thereon, an enclosing tube of insulating material having a metal collar permanently secured at each end thereof and electrically connected to the corresponding end of the resistance element, a hood removably secured to one of said collars and cooperating therewith to ventilate the space inside and outside of said resistance tube and a supporting member for the resistor tube removably secured to the other collar and having openings therein for ventilating the space inside and outside of the resistor tube.

10. In combination, a tube having a resistor element wound thereon, an enclosing tube of insulating material having a metal collar at each end thereof electrically connected to a corresponding end of the resistance element, one of said collars being flared outwardly, a metallic hood secured to one of said collars and cooperating therewith to provide a corona shield for the resistor and to provide a circumferential ventilating opening in communication with the space inside and outside of the resistance unit, and a resistor support secured to the other collar having openings therein for ventilating the space inside and outside of the resistor unit.

In witness whereof, I have hereunto set my hand this 27th day of December, 1928.

OTTO R. SCHURIG.