J. J. NIELSEN.

CIRCUIT BREAKER.

APPLICATION FILED MAY 24, 1915.

**1,212,146.**

Patented Jan. 9, 1917.

3 SHEETS—SHEET 1.

FIG. 1

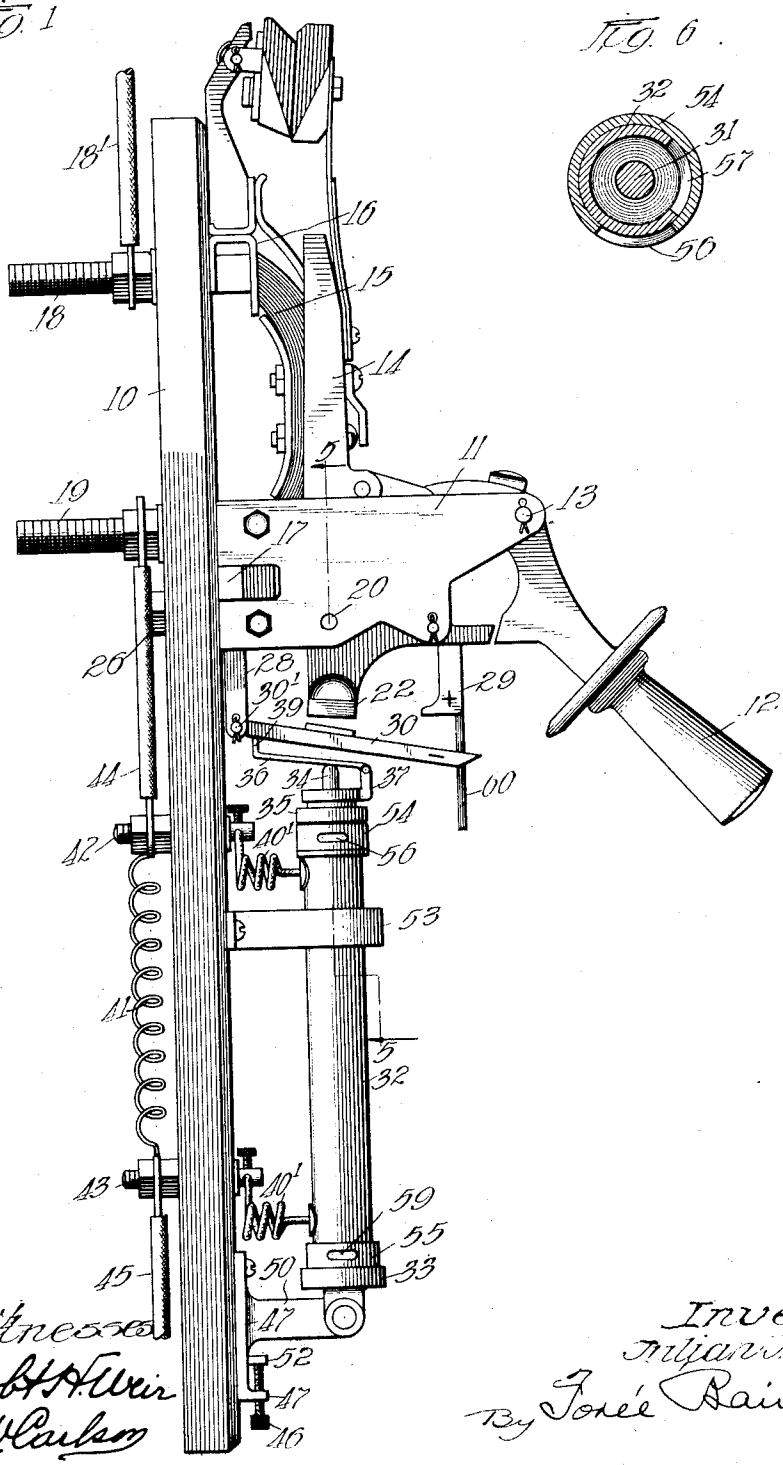



FIG. 6.




Witnesses
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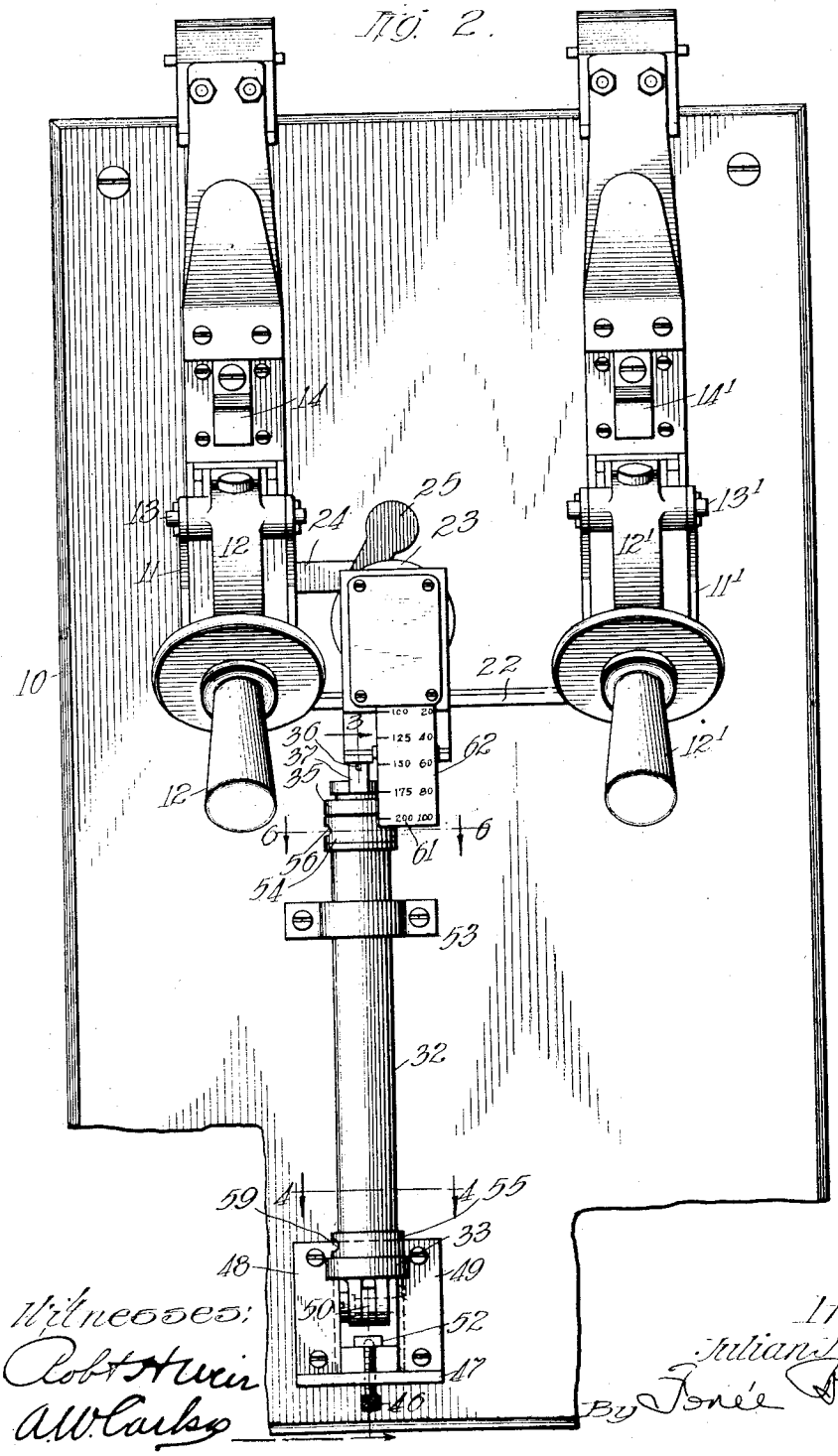
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3 SHEETS—SHEET 2.

FIG. 2.




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3 SHEETS—SHEET 3.

FIG. 3

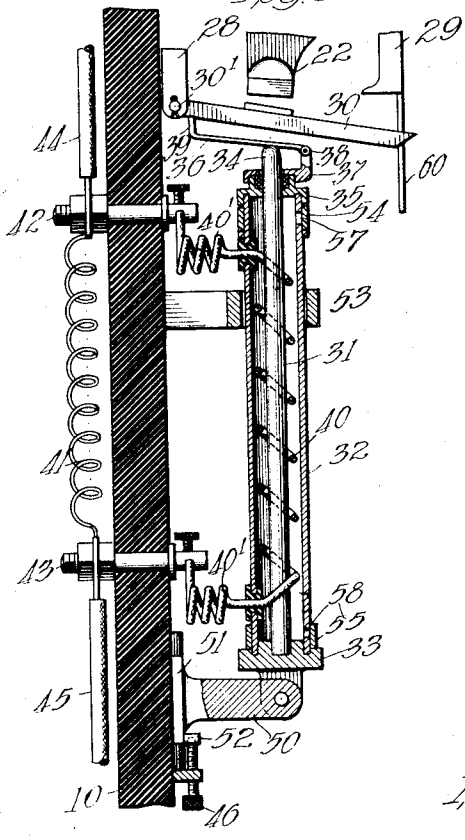



FIG. 4

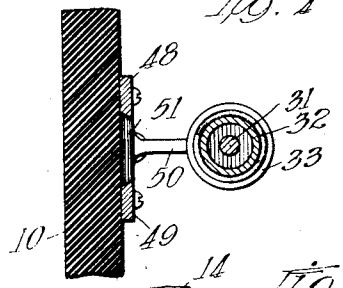



FIG. 5.

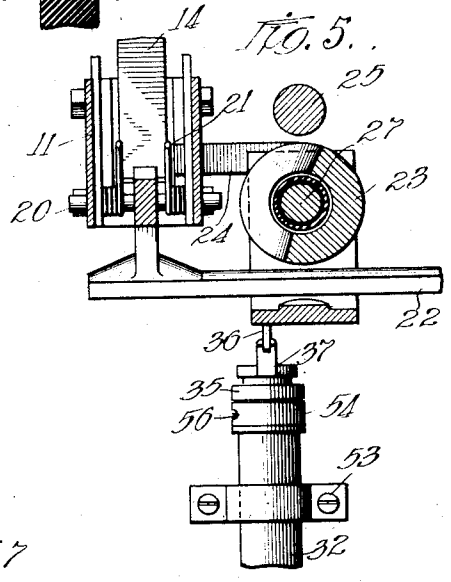
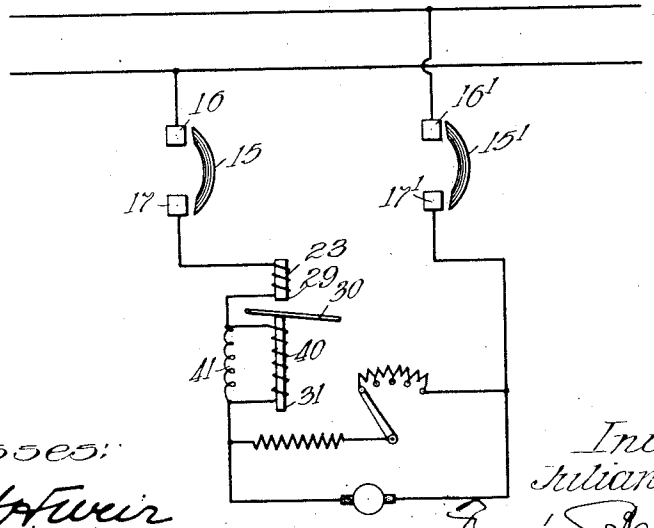



FIG. 7




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# UNITED STATES PATENT OFFICE.

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## CIRCUIT-BREAKER.

1,212,146. Specification of Letters Patent. Patented Jan. 9, 1917.

Application filed May 24, 1915. Serial No. 29,990.

*To all whom it may concern:*

Be it known that I, JULIAN J. NIELSEN, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Circuit-Breakers, of which the following is a specification.

One of the objects of my invention is to provide means for automatically adjusting a circuit opening switch, or circuit breaker, operable by the current flowing in the circuit which it is designed to protect, and whereby the switch will not respond to limited, sudden, abnormal rises of current, of short duration, but will become effective to automatically open said circuit when the current rise persists and is more gradual and sufficiently above normal, although the maximum increase of current value may be less in the latter than in the first example.

Another object of my invention is to provide means to automatically change the adjustment or calibration of the switch or time limit of operation, whereby it will operate to open the circuit upon a persistent small rise of current, above normal, in substantial harmony with a given rise of temperature of the armature of a dynamo electric machine, or other such translating device, with which it is associated.

Other and further objects of my invention will become readily apparent, to persons skilled in the art, from a consideration of the following description when taken in conjunction with the drawings wherein—

Figure 1 is a side elevation of an automatic circuit breaker, of a well known type, showing my attachment in connection therewith. Fig. 2 is a front elevation of the same. Fig. 3 is a section of one exemplification of my thermo-electric switch adjusting mechanism, taken on line 3—3 of Fig. 2. Fig. 4 is a section taken on line 4—4 of Fig. 2. Fig. 5 is a section taken on line 5—5 of Fig. 1. Fig. 6 is an enlarged section taken on line 6—6 of Fig. 2. Fig. 7 is a diagram of circuits.

In all the views the same reference characters are employed to indicate similar parts.

I have shown my invention in connection with an automatic circuit breaker, or switch, of a well known type. The structure consists of the base 10, such as slate or the like, upon which is mounted a housing 11 in which is pivoted a switch setting member or lever 12, as at 13, which lever depresses the switch lever 14 and latches it in place, so that the laminated bridge 15, carried thereby, is caused to bear firmly upon the terminal blocks 16 and 17. The lever 14 is pivoted to the housing, as at 20, and is held in closed position by a toggle latch against a spring 21. The latch is opened and lever 14 released when the latch tripping lever 22 is raised to break the toggle, whereupon the lever 14 will be outwardly moved, on its pivot 20, by the spring 21 and the switch thereby opened.

An electro-magnet 23 has one of its ends 24, connected to the terminal 17 and the other end 25 to the terminal 26. The core 27, of the magnet, terminates in the magnetic pole pieces 28 and 29. A toggle-breaking or latch-tripping armature 30, is hinged to the pole piece 28 and when attracted serves as a magnetic bridge between the poles 28 and 29. When it is lifted against the force of gravity, by the magnetism developed by the coil 23, it strikes the trigger 22 and trips the latch or breaks the toggle which holds the switch lever 14 depressed.

The length of the air gap between the free end of the armature 30 and the magnetic pole 29 determines the strength of current that shall flow in the magnet 23, necessary to attract the armature.

In carrying my invention into effect I may substitute the device shown in the drawings or its equivalent, for the usual adjusting screw, in a switch of the type shown, to vary the length of air gap between the armature 30 and the magnetic pole 29. A thermo-expansible rod 31 such as copper, or the like, is mounted in a tube 32, its lower end being fixed in a head 33 and its upper end 34 projecting freely through a closure cap 35. A lever 36 is pivoted to a bracket 37, as at 38, which is supported upon the tube 32, the free end of the lever 36 is upturned, as at 39, and rests under the armature 30, near the fulcrum 30′. By this arrangement a slight expansion of the rod 31 will raise the outer end of the armature a considerable relative distance and a current of less value will then attract the armature than that required for the purpose before the armature was so lifted by the expansion rod.

One form of my device includes a coil 40, within the tube 32, surrounding the expansion rod 31. This coil is designed to be connected in series with an armature of a dynamo electric machine or other translating de-

vice that is to be protected by the circuit breaker. It is not necessary, however, that all of the current from or to the armature of the dynamo or other device shall pass through the coil 40. A definite portion thereof may be used for this purpose and to this end I may provide a shunt 41. The terminals of the shunt 41, and of the heat coil 40 being connected to the binding screws 42 and 43 to which wires 44 and 45 are connected, respectively. The shunt 41 may be of a material, such as iron wire, or the like, in which the resistance coefficient, due to heating effect of the current, is greater than that of the material of which the coil 40 is composed so that as the temperature of the shunt 41 rises, due to current, a larger current will flow through the branch coil 40, by this means contributing in varying the time element of operation of the switch.

The tube 32, with the expansion rod 31 and lever 36 are bodily movable, and vertically adjustable by means of a screw 46, which is threaded in a base 47 provided with guides 48 and 49. A standard 50 carries the head 33, the lower end providing a base 51 which is freely slidable between the guides 48 and 49. The screw 46 turns freely in a projection 52 from the base 51 so that when the screw 46 is turned the rod 31 and connecting parts are thereby raised or lowered, thus changing the relative positions of the armature 30 and the magnetic pole 29, increasing or decreasing the air gap between these parts to vary the current necessary to flow through the coil 23 to lift the armature 30 and to trip the switch. A guide 53 vertically supports the upper end of the tube 32 and permits its axial movement.

Over each end of the tube 32 is a rotatable ring 54 and 55, respectively. The ring 54 is perforated, as at 56, which perforation may be made to register with a perforation 57 through the tube 32. The perforations may be closed, to a greater or less extent, by rotation of the ring 54. The lower end of the tube 32 is provided with a similar perforation 58 with which the perforation 59 of the ring 55 may be made to register, to a greater or less degree, by rotation of the ring 55. When both perforations are open, there is induced a draft of air through the tube 32 by the heat of the coil 40, thus carrying away some of the heat, and requiring a larger current for a longer time to be circulated in the heating coil to cause expansion of the rod to a given extent. When either, or both of the openings in the tube 32 are closed, or partly closed, a smaller current for a relatively short time, in the heating coil will expand the rod to a greater extent than when they are fully open.

A dial plate 60 depends from the pole 29 substantially parallel with the path of the free end of the armature 30, and on its front face is a scale 61 reading in amperes. When the end of the armature is in a horizontal plane corresponding with 200—apperes—the air gap is greatest and it will require approximately 200 amperes to pass through the coil 23 before the armature 30 is attracted, and the switch thereby is tripped. When the armature is supported so that its free end is in a horizontal plane with 100—amperes—only 100 amperes will be required to trip the switch. Another scale 62 on the plate 60, is the temperature scale, the object and use of which will hereinafter be more fully explained.

An automatic circuit breaker, substantially such as illustrated, is used to safeguard electric motors and in this connection I will describe the use and operation of my invention.

When a motor is being started, the initial or starting current that will flow through the motor and the switch, is usually from 50 to 60 per cent. greater than the normal full running load current. If the circuit breaker is to be used to protect the motor while starting, it must be set to respond to current higher than the initial current and much greater than necessary to take care of the slight irregularities of normal operation, which is in excess of any setting of the circuit breaker which would afford this necessary protection.

In my improved device the coil 40 is designed to be heated, to a greater or less extent, by the normal current load of the motor armature, the effect of which is to slightly expand the rod 31. Assume, for example, that the normal running current of a motor is 125 amperes and it is required that the circuit breaker shall operate to open the circuit thereof when the current has increased to 150 amperes that will endure for a predetermined period of time. The screw 46 is turned until the end of the armature 30 is opposite a point somewhere between 190 and 200 while the expansion rod 31 is at atmospheric temperature. When current is initially turned on the armature of the motor, as in starting, it will begin to heat the conductor of the coil 40 substantially in accordance with the rise of temperature of the motor armature. There will be very little rise of temperature therein, however, for the short period of time required to start the motor, or while the abnormal current of 190 amperes, say, at the instant of closing the circuit, is flowing in the armature circuit and through the heating coil 40. Gradually, after the enduring current load comes on the motor, the permissible accumulated heat from the coil 40 will cause expansion of the rod 31, which in turn will lift the armature 30, through the agency of the compound lever 36, until the free end of the armature

is about opposite 175 on the scale 61. Any sudden rise of temperature or corresponding impulse of current of short duration, of less value than 175 amperes, thereafter, will not cause any automatic movement of the armature 30 to open the switch, because the rod 31 will not sufficiently respond to a limited rise of current of short duration. If, however the current rise be continued for a greater time, predetermined by opening or closing the vents in the tube 32, the accumulated heat in the tube 32 will cause further expansion of the rod 31 until the armature 30 is raised sufficiently, by said expansion rod, for the pole 29, of the magnet 23, to lift it against the force of gravity until it strikes the trigger 22 breaking the toggle and operating the switch to open the circuit.

The accumulation of heat within the tube 32 may be varied by changing the sizes of the air vents or orifices 56 and 58, by rotation of the respective rings covering them. A full opening will carry away the heat faster and require a larger current for a longer time to operate the device, a more restricted flow of air will have the opposite effect. The device may be thus calibrated by empirical observations.

The current-temperature responsive device does not directly operate the switch but conditions or controls the mechanism thereof whereby the switch may be operated at a critical time in response to the rise of current and consequent temperature in a selected part of the circuit containing the device to be protected.

Sudden rise of current of abnormal value, within bounds, for a short period of time, rarely if ever injures the armature of a motor. It is the slow rise of current, even of less current value, that endures for a protracted period of time that causes accumulation of heat in the coils of the dynamo armature that tends to burn it out by the effect of the persistence of heat.

The temperature scale on the right hand side of the plate 60 is more or less approximate but indicates that when a given armature, with which the switch is adapted to be connected is operated at 200 amperes the rise above normal will be 100 degrees centigrade. When it is operated at 175 amperes the temperature rise will be 80 degrees cnt. above normal. 150 amperes the rise of temperature will be 60 degrees. 125 amperes the rise of temperature will be 40 degrees and 100 amperes the rise of temperatures will be 20 degrees. In the illustration referred to, with the armature operating at 125 amperes, full load, the permissible rise of temperature is 40 degrees centigrade, the switch being so adjusted that when the rise of temperature reaches 60 degrees centigrade, with a current of 150 amperes, the armature 30 will be automatically moved by the expansion rod, from a position below that indication up to the mark indicating 150 amperes and the magnetism of the magnet 23, due to the current flowing therein, will attract the armature and trip the switch.

It will be seen, from the foregoing description, that the device is substantially self calibrating and that the calibration is effected by the increase or decrease of heat due to increase or decrease of current in a selected part of the circuit controlled by the switch.

While I have herein shown and described a single embodiment of my invention for the purpose of clear disclosure and while I have described its use in connection with an electric motor, it is manifest that there are many changes in the form and arrangement of the parts and many other uses to which it may be applied permissible within the scope of the appended claims.

Having described my invention, what I claim is:

1. The combination with a switch releasing trip, an armature adapted to actuate said trip, and an electro-magnet associated with said armature; of means expansible in response to increase in temperature, a connection between said means and armature, a heat producing means responsive to current passing through the switch and associated with said expansible means, and means for controlling the amount of heat communicated to the expansible means by the heating means.

2. The combination with a switch releasing trip, an armature adapted to actuate said trip, and an electro-magnet associated with said armature; of means expansible in response to increase in temperature, a connection between said means and armature, a heat producing means responsive to current passing through the switch and associated with said expansible means, a casing inclosing said expansible means and heat producing means, said casing having openings formed therein, and means for varying the area of said openings.

3. The combination with a switch releasing trip, an armature adapted to actuate said trip, and an electro-magnet associated with said armature; of a rod expansible in response to increase in temperature, a connection between one end of said rod and the armature, an abutment for the other end of the rod, means for varying the position of said abutment with respect to the armature, a heat producing means responsive to the current passing through the switch and associated with the rod, and means for controlling the amount of heat communicated to the expansible rod by said heat producing means.

4. The combination with a switch releasing trip, an armature adapted to actuate said trip, and an electro-magnet associated

with said armature; of means expansible in response to increase in temperature, a connection between said means and armature, a heat producing means associated with said expansible means and responsive to current variation, and means for controlling the amount of heat communicated to the expansible means by the heating means.

5. The combination with a switch releasing trip, an armature adapted to actuate said trip, and an electro-magnet associated with said armature; of means expansible in response to increase in temperature, a connection between said means and armature, a heat producing means associated with the expansible means and responsive to current variations, and a casing inclosing and supporting said expansible means and heat producing means, said casing having openings formed therein at the upper and lower ends thereof.

6. The combination with a switch releasing trip, an armature adapted to actuate said trip, and an electro-magnet associated with the armature; of a rod expansible in response to increase in temperature, a connection between one end of said rod and the armature, an abutment for the other end of the rod, means for varying the position of said abutment with respect to the armature, a heat producing means responsive to current variations associated with the rod, a tube surrounding said heat producing means and expansible rod and carried by the abutment, and means for controlling the movement of air through said tube.

In testimony whereof I hereunto set my hand in the presence of two subscribing witnesses.

JULIAN J. NIELSEN.

In the presence of—
FORÉE BAIN,
MARY F. ALLEN.