

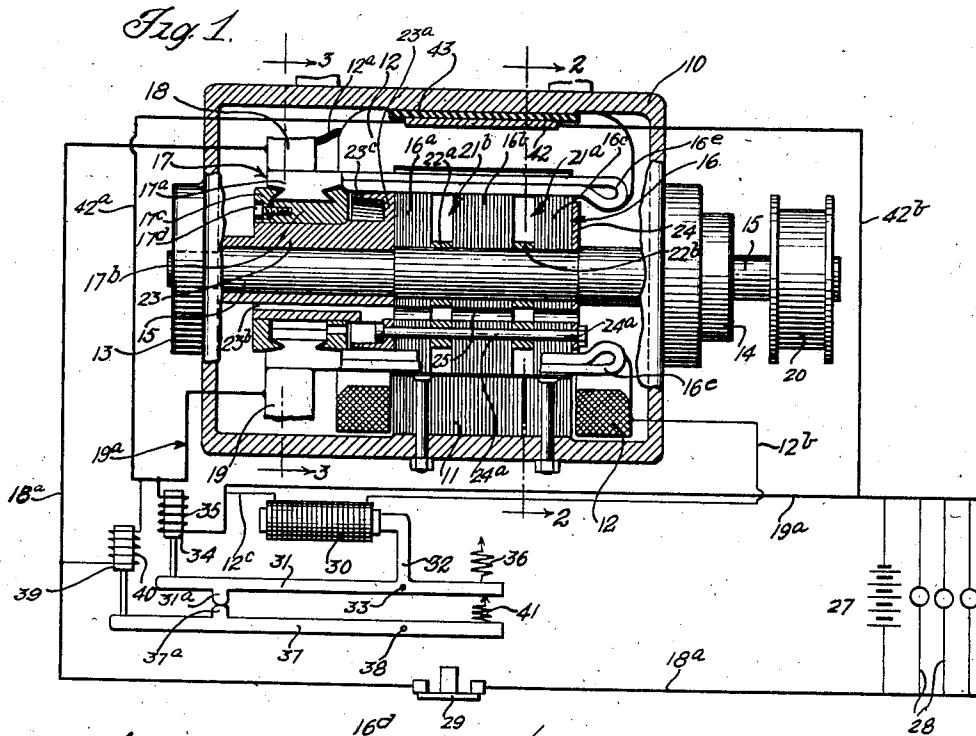
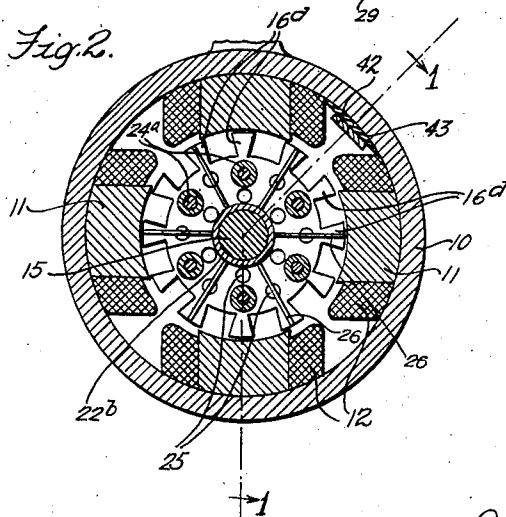
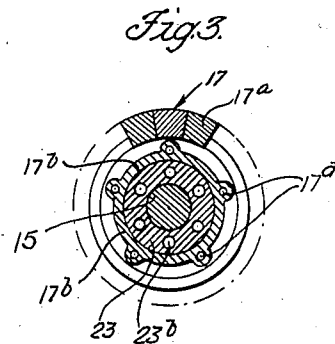
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G. E. HULSE

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APPARATUS FOR GENERATOR REGULATION

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UNITED STATES PATENT OFFICE.

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APPARATUS FOR GENERATOR REGULATION.

Application filed March 12, 1923. Serial No. 624,583.

This invention relates to an art and apparatus for regulating generators, particularly direct current generators, subject to operation at variable speed.

5 One of the objects of this invention is to provide a simple and practical art and apparatus for reliably and dependably regulating the output of a generator in accordance with its internal condition; and to provide
10 an art and apparatus of the above character for safe-guarding the generator against overloading beyond its capacity, which may vary appreciably according to various conditions under which the generator may be operated. Another object is
15 to provide an art and apparatus of the above character in which the rotary element or armature of the generator is amply protected and safeguarded throughout its various conditions of operation. Another object
20 is to provide durable and compact apparatus for regulating the output of a generator in a thoroughly practical, dependable and efficient manner. Other objects will be
25 in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of
30 elements, arrangements of parts and in the several steps and relation and order of each of the same to one or more of the others, all as will be illustratively described herein, and the scope of the application of which will be indicated in the following claims.

35 In the accompanying drawing, in which similar reference characters refer to similar parts throughout the several views, and in which there is shown one of various possible embodiments of the mechanical features
40 of this invention,

Figure 1 is a sectional view of a generator and shows also diagrammatically the circuit arrangements, the sectional view of the generator being more particularly a section on
45 the line 1—1 of Fig. 2;

Figure 2 is a transverse section taken on the line 2—2 of Fig. 1, and

Figure 3 is a transverse section taken on the line 3—3 of Fig. 1.

50 Referring now to the drawing, there is shown at 10 the main or field frame of a direct current generator provided with field poles 11 (see Fig. 2), illustratively shown herein as four in number and each provided
55 with a field coil 12. The main frame 10 is

provided with end bearings 13 and 14 in which is rotatably supported the armature shaft 15 carrying the armature laminations, generally indicated at 16 in operative relation to the field poles 11, and a commutator
60 generally indicated at 17 provided with the brushes 18 and 19 which may be operatively mounted with respect to the commutator 17 in any suitable manner. The armature
65 shaft 15 is extended exteriorly of the main frame 10 to permit its connection to any suitable source of driving power, and at 20 is shown a pulley by means of which
70 such a connection, as by means of a belt, may be made. At this point it may be noted that the generator is preferably of the type used in car-lighting systems and hence is preferably driven from one of the
75 car axles. The rate of drive of the generator armature 16 will therefore vary with the varying rate of speed at which the car axle is rotated.

The armature 16 is provided with preferably a plurality of recesses extending transversely of the axis of the armature, and
80 in Fig. 1 there are shown two substantially annular spaces or recesses 21^a and 21^b extending substantially circumferentially about the armature shaft. The recesses 21^a and
85 21^b may conveniently be formed by subdividing the laminations of which the armature core is composed into several sections, such as the sections 16^a, 16^b and 16^c, spaced
90 from one another as by means of the collars 22^a and 22^b surrounding the shaft 15. The armature sections, together with the spacing collars may be rigidly held in assembled
95 relation, as by means of the flanged end 23^a of a sleeve 23 rigidly mounted upon one end of the shaft 15 and the end plate 24 at the
100 other end of the shaft 15, suitable clamping bolts 24^a passing through suitable openings acting to draw the end plates 23^a and 24 together and thus to clamp the armature laminations as above described in assembled
105 relation.

The laminations which go to make up the armature sections 16^a, 16^b and 16^c are toothed as at 16^d (see Fig. 2) to provide the usual
110 slots in which are passed the armature windings 16^e (see Fig. 1) connected to the bars of the commutator 17 in the usual manner.

The commutator, generally indicated at 17, comprises a suitable number of commutator bars 17^a mounted upon a sleeve 17^b

to which they are rigidly clamped in assembled relation, as by the annular clamping ring 17^c secured thereto as by the clamping screws 17^a. The sleeve member 17^b and the clamping ring member 17^c are suitably flanged, as shown in Fig. 1, to engage the diverging and inwardly projecting parts of the bar 17^a, suitable insulating material being interposed therebetween; and thus hold the commutator bars 17^a securely in assembled relation. The sleeve 17^b is rigidly mounted upon the sleeve member 23, in turn rigidly mounted upon the shaft 15, and it will be noted that the several parts going to make up the commutator 17 are thus placed in intimate thermal relation with the main supporting sleeve member 23.

Extending axially through the armature core sections 16^a, 16^b and 16^c so as to form communications from the respective ends of the armature core 16 to the several annularly shaped spaces or recesses 21^a and 21^b are a plurality of air-ducts 25, shown more clearly in Fig. 2, and suitably distributed throughout the armature core sections. These ducts may be formed in any suitable manner and may, for example, be made by aligning a like plurality of openings stamped in each of the laminations. Moreover, a suitable and like number of openings in the end flanges 23^a and 24 are provided to register with the aligned openings in the armature core sections. The air-ducts 25, moreover, are distributed in a radial direction throughout the armature core and certain of these air-ducts are positioned in relatively close proximity to the aligned teeth 16^f in the core.

Within the annular spaces 21^a and 21^b, and preferably equi-angularly spaced about the shaft, are a plurality of vanes 26 extending radially and outwardly to the outer periphery of the armature core. These vanes are substantially similarly related with respect to each of the annular spaces, and it will therefore be sufficient to describe in detail the construction of the vanes in one of these recesses as, for example, the recess or space 21^a more clearly shown in Fig. 2.

Referring now to Fig. 2, it will be noted that the plurality of vanes 26 are preferably mounted upon the collar 22^b in any suitable manner as, for example, by welding thereto, and are spaced about the periphery thereof. The blades or vanes 26, upon rotation of the armature, act to draw air through the air-ducts 25 and discharge the same outwardly through the peripherally extending recess with which they are associated, and it may at this point be noted that the rate of flow of the air will vary substantially directly with the rate at which the armature is driven. Moreover, it will be noted that in positioning each of the blades 26 substantially radi-

ally, the action thereof will be substantially the same irrespective of the direction of rotation of the armature and hence, where the generator armature is subjected to reversals, as is characteristic of axle-driven generators, the desired action, as more clearly herein-after described, will be uniformly attained.

Moreover, suitable air-ducts 23^b extending in an axial direction are provided in the commutator supporting sleeve 23 (see Fig. 3) and the air-ducts 23^b are preferably aligned with certain of the air-ducts 25 in the armature core sections so that when the action above described takes place the vanes or blades 26 will act also to draw air inwardly through the ducts 23^b in the commutator supporting sleeve 23. As is more clearly shown in Fig. 1, it will be noted that the radially extending flange 23^a of the sleeve member 23 is provided with an annular flanged extension 23^c directed toward the commutator 17 but spaced therefrom so as to restrict somewhat the inward flow of air through the end flange 23^a and so as also to insure the inward flowing of air through the ducts 23^b in the sleeve member 23.

Considering now more particularly certain other details of the regulating apparatus and also the circuit connections, it will be seen that to the brushes 18 and 19 of the generator are connected suitable conductors 18^a and 19^a, respectively, which lead to a suitable translation or work circuit which may include a storage battery 27 and a lamp circuit 28 bridged across the conductors 18^a and 19^a. An automatic switch, indicated at 29, is inserted in one of the conductors, as the conductor 18^a for example, and is adapted to connect the generator to the work circuit upon the attainment by the generator of a suitable working voltage.

The field windings 12 are connected in shunt to the terminals or brushes 18 and 19 of the generator through a carbon pile 30 and, referring to Fig. 1, it may be noted that a conductor 12^a connects one of the field terminals to the brush 19 of the generator, and a conductor 12^b connects the other terminal of the field windings 12 to one side of the carbon pile 30, a conductor 12^c completing the field circuit by connecting the other terminal of the carbon pile 30 to the main conductor 18^a which is in connection with the other terminal or brush 18 of the generator.

A bell crank lever 31—32 is pivoted as at 33 and through the arm 32 thereof is adapted to vary the compression of the carbon pile 30. The arm 31 of the lever is connected to the core 34 operated upon by a current coil 35 inserted in one of the main conductors, as 19^a. A spring 36 is adapted to oppose the action of the current winding 35 and tends normally to compress the pile 30.

Another lever 37 is pivotally mounted as at 38 and is operated upon by a core 39 of a voltage coil 40 bridged across the main conductors 18^a and 19^a so as to be responsive to the generator voltage. A spring 41 opposes the action of the voltage coil 40 and is adapted to permit adjustment of the action of the coil, as is the spring 36 adapted to adjust the action of the current coil 35.

The lever 37 is provided with a lug 37^a substantially aligned with a lug 31^a on the lever arm 31 so that upon a movement of the lever 37 by the coil 40 the lugs will be interengaged and the regulating action of the voltage coil 40 transmitted through the bell crank lever 31—32 to the carbon pile 30.

Upon the interior of the field frame 10 and in intimate thermal contact therewith is mounted a current-conducting member 42 conveniently positioned between two adjacent field poles 11 (see Fig. 2) and insulated from the field frame 10 as by the insulating member 43 which is preferably of a material of good heat conductivity. The current-carrying member 42 has a positive temperature coefficient so that as its temperature is raised its resistance will be increased. The member 42 may be made of any suitable metal or an alloy of metals having a positive temperature coefficient and is preferably in the form of a plate so as to expose a substantial area not only to insure a good transfer of heat thereto from the field frame 10 but also to provide a substantial area exposed to the interior of the generator frame 10. The member 42 is connected, as by means of the conductors 42^a and 42^b, in shunt relation to the current coil 35.

Considering now the regulating action, it may be noted first that the shunt member 42 if at a given temperature permits the current coil 35 to regulate the output of the generator within a predetermined limit which may be fixed, as for example, by the adjustment of the spring 36. As the speed of the generator varies, the current coil 35, acting through the bell crank lever 31—32 upon the carbon pile 30, controls the field current so as to maintain the output of the generator substantially constant throughout the varying speed of the generator.

As the generator heats up due to continued operation, the shunt member 42 will respond to the rise in temperature of the field frame and its resistance will be increased to a like extent, thus decreasing the amount of current shunted around the current coil 35 and thus in effect lowering the standard at which the current coil 35 maintains the output of the generator constant. During the rotation of the armature, the blade members 26 in the recess 21 in the armature core act to draw air through the air ducts 25 in the armature core as well as through the ducts 23^b through the com-

mutator and act to discharge the air in a general radial direction. The air thus drawn through the air ducts 25 absorbs the heat losses within the armature and its core as well as those set up in the commutator itself and in being discharged is directed not only onto the heat-responsive member 42 but also upon the interior of the frame 10. The shunt member 42 being in thermal contact with the field frame 10 and being directly affected by the heated air is thus made responsive to the temperature conditions not only of the field frame but also of the armature and its core and the commutator as well.

In this connection it might be noted that the blade members 26 forming in effect a blower, and in acting to draw the air through the air ducts 25 and 23^b, permit the shunt member 42 to be directly responsive to the internal temperature conditions of the entire rotary member, or of the armature as well as of the commutator of the generator. The temperature of the armature is dependent not only upon the I²R losses within the armature conductors, which heating effect tends to heat the armature core as well, but also upon the hysteresis and eddy current losses within the armature core itself. These latter energy losses which appear as heating effects are substantially proportional to the speed at which the rotary core is driven and at relatively high speeds are of material magnitude and effect. The air passing through the air ducts, however, effectively absorbs these heat losses. Moreover, it may be noted that, when the generator is operating at relatively high speeds and at or near full load, the relatively high currents generated in the armature windings 16^a results in excessive sparking at the commutator bars. This sparking is manifested at the commutator bars in the form of heat, and thus the temperature of the air passing through the ducts 23^b in the commutator sleeve 23 is at once raised, thus also effectively absorbing the heat thus generated in or at the commutator bars. Moreover, it will be noted that the rate at which the air is passed through the air ducts is substantially proportional to the speed of the armature. The air thus passed through the armature core and commutator and absorbing the heat losses and effects therein thus not only prevents overheating in the armature and commutator but also communicates directly to the heat-responsive shunt 42, the internal heating effects in the armature, and its core and in the commutator. The shunt member 42 may thus charge the standard at which the current coil 35 regulates the generator output in accordance directly with the internal and other heating conditions in the entire rotary member. The generator may thus be at once relieved from continuing an output

in excess of its capacity, which is determined in part by the allowable heating that takes place therein, and thus also excessive and destructive sparking at the commutator is prevented. It will thus be seen that ample provision has been made for safeguarding the generator against operation at a detrimentally high capacity when running at relatively high speeds, and also for safeguarding the commutator against overheating and sparking.

The voltage-responsive coil 40 is adapted to limit the voltage sustained in the circuit and preferably is so adjusted that it becomes effective and operative through the lugs 37^a and 31^a to affect the carbon pile 30 when the storage battery 27 approaches full charge with consequent rise in voltage thereof. The voltage coil 40 may thereupon act to regulate the voltage of the generator at such a value as to permit the battery substantially to float across the generator terminals. It will be noted, however, that the current coil 35, in being inserted in one of the main conductors 19^a, is adapted to respond to the current supplied to or demanded by either the storage battery 27 or the work or lamp circuit 28 and is thus adapted whenever required by the conditions in the circuit to limit the output of the generator. Moreover, it will be seen that the regulating action of the current coil 35 is effectively predetermined or governed by the heating effects within not only the generator frame itself but also the rotary parts thereof, and that moreover its limiting action is controlled by the rate at which the generator is driven. It will be understood that the range of speed throughout which the generator is driven may, as in car-lighting, attain relatively great magnitudes, and it will moreover be seen that the generator is amply safe guarded throughout its range of speeds. It will thus be seen that there has been provided in this invention an art and apparatus in which the several objects hereinabove set forth, as well as many advantages, are effectively achieved.

As many possible embodiments may be made of the mechanical features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. In apparatus of the character described, in combination, a generator having a frame member and a rotary current-carrying member, one of said members being provided with a duct therein, regulating means for said generator arranged to control a function of the output of said generator and

including a heat responsive device, and means for passing a heat-absorbing medium through said duct to be heated in its passage therethrough, said device being positioned to be affected by the heated medium.

2. In apparatus of the character described, in combination, a generator having a frame member and a rotary current-carrying member, regulating means for said generator arranged to control a function of the output thereof and including a heat responsive device, and means for passing a heat-absorbing medium into thermal relation with one of said members to be heated thereby, said device being positioned to be affected by the medium heated by said one of said members and to be affected thermally by the other of said members.

3. In apparatus of the character described, in combination, a generator, regulating means including a current coil for preventing the output of said generator from exceeding a predetermined limit, and current-carrying means having a positive temperature coefficient shunted about said current coil and arranged to be affected by the temperature of said generator, whereby as the temperature of said generator rises said regulating means is affected to maintain said output within a lower limit.

4. In apparatus of the character described, in combination, a generator having a rotary current-carrying member, regulating means including a coil arranged to maintain the output of said generator within a predetermined limit, a current-carrying device arranged to have its current-carrying capacity varied with changes in temperature and arranged to affect the action of said coil, and means relating said device thermally to said rotary member, thereby to be responsive to the heating of the latter.

5. In apparatus of the character described, in combination, a generator, regulating means including a coil for controlling a function of the output of said generator, and a resistance capable of having its ohmic value vary with changes in temperature and arranged to be responsive to the temperature of said generator and to affect the action of said coil substantially proportionately to changes in its ohmic resistance.

6. In apparatus of the character described, in combination, a variable speed generator, regulating means including a coil for preventing the output of said generator from exceeding a predetermined limit, and current-carrying means having a positive temperature coefficient shunted about said coil and associated with said generator to be affected by those heat losses in said generator that are proportional substantially to the speed of said generator.

7. In apparatus of the character described, in combination, a variable speed generator,

regulating means for said generator arranged to control a function of the output thereof, and regulating means for said first-mentioned regulating means and responsive to the temperature changes in a part of said generator and arranged to affect said first-mentioned regulating means substantially commensurately with said temperature changes.

8. In apparatus of the character described, in combination, a variable speed generator having a commutator, regulating means arranged to maintain the output of said generator at or below a predetermined value in spite of changes in the speed of said generator, and a regulator for said regulating means arranged to be responsive to the heating of said commutator and to vary the action of said regulating means in accordance substantially with changes in temperature of said commutator.

9. In apparatus of the character described, in combination, a generator having a rotary armature and a commutator associated therewith, regulating means for said generator including a heat responsive device arranged upon increase in the temperature thereof to reduce the output of said generator, and means arranged to cause a current of air to flow in a path in which is included first said commutator and then said device, whereby the air is heated by the commutator and is caused to affect said device.

10. In apparatus of the character described, in combination, a generator having a rotary current-carrying member, regulating means for said generator including a heat-responsive device arranged upon increase in the temperature to reduce the output of said generator, and means associated with said rotary member arranged to direct a current of air heated by said rotary current-carrying member against said device.

11. In apparatus of the character described, in combination, a generator having a rotary current-carrying member, regulating means including a coil arranged to maintain the output of said generator within a predetermined limit, and a current-carrying device having a positive temperature coefficient shunted about said coil and arranged upon an increase in the temperature thereof to affect said coil to regulate said generator within a lower limit of output, and means associated with said rotary member arranged to direct a current of air heated by said rotary current-carrying member against said device.

12. In apparatus of the character described, in combination, a generator having an armature provided with a core having air ducts, regulating means for said generator including a heat-responsive device arranged upon increase in temperature to reduce the

output of said generator, and means associated with said armature arranged to cause a flow of air through said ducts to be heated by said armature and to direct a current of said air against said device.

13. In apparatus of the character described, in combination, a generator having an armature provided with a core having air ducts, regulating means for said generator including a heat-responsive device arranged upon increase in temperature to reduce the output of said generator, and a blower for causing a flow of air through said armature ducts to be heated by said armature and arranged to direct a current of said heated air against said device.

14. In apparatus of the character described, in combination, a generator having an armature provided with a core having air ducts, regulating means for said generator including a heat-responsive device arranged upon increase in temperature to reduce the output of said generator, and a blower rotatable with said armature and related to said air ducts so as to cause a flow of air therethrough to be heated by said armature, said heat-responsive device being positioned in the path of flow of heated air.

15. In apparatus of the character described, in combination, a generator having an armature provided with a core having a substantially centrally positioned circumferentially extending recess therein and air ducts extending axially from either end of said armature and connecting at their inner ends with said recess, regulating means for said generator including a heat-responsive device arranged upon increase in temperature to reduce the output of said generator, said device being associated with said generator and positioned in the radial plane of said recess in said armature core but exteriorly thereof, and blade members positioned within said recess arranged to draw air through said ducts and direct a current of said air against said heat-responsive device.

16. In apparatus of the character described, in combination, a generator having an armature provided with a core having a substantially centrally positioned circumferentially extending recess therein and air ducts extending axially from either end of said armature and connecting at their inner ends with said recess, regulating means for said generator including a heat-responsive device arranged upon increase in temperature to reduce the output of said generator, said device being associated with said generator to be affected thermally by the heating of the stationary parts thereof and positioned in the radial plane of said recess in said armature core but exteriorly thereof, and blade member positioned within said re-

cess arranged to draw air through said ducts and direct a current of said air against said heat-responsive device.

17. In apparatus of the character described, in combination, a generator having a field frame and an armature provided with a core having air ducts, regulating means for said generator including a heat-responsive device arranged upon increase in temperature to reduce the output of said generator, said device being associated in thermal relation with said field frame, and means associated with said armature arranged to cause a flow of air first through said ducts to be heated thereby and then against said device.

18. In apparatus of the character described, in combination, a generator having a rotary current-carrying member, regulating means for said generator including a heat responsive device arranged upon increase in the temperature thereof to reduce the output of said generator, and means for passing a heat-absorbing medium into thermal relation with said rotary member to be heated thereby, said device being arranged to be affected by said heated medium.

19. In apparatus of the character described, in combination, a generator having

a rotary current-carrying member, regulating means for said generator arranged to control a function of the output of said generator, regulating means for said first-mentioned regulating means and including a heat responsive device, and means for passing a heat-absorbing medium into thermal relation with said rotary member to be heated thereby, said heat responsive device being arranged to be affected by said heated medium.

20. In apparatus of the character described, in combination, a generator having a rotary armature and a commutator associated therewith, a plurality of air ducts passing through said commutator, regulating means for said generator including a heat-responsive device arranged upon increase in the temperature thereof to reduce the output of said generator, and means for drawing air through said air ducts to be heated by said commutator and for directing a current of heated air against said device.

In testimony whereof, I have signed my name to this specification this fifth day of March, 1923.

GEORGE E. HULSE.