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SPEED REGULATION OF DYNAMOTORS

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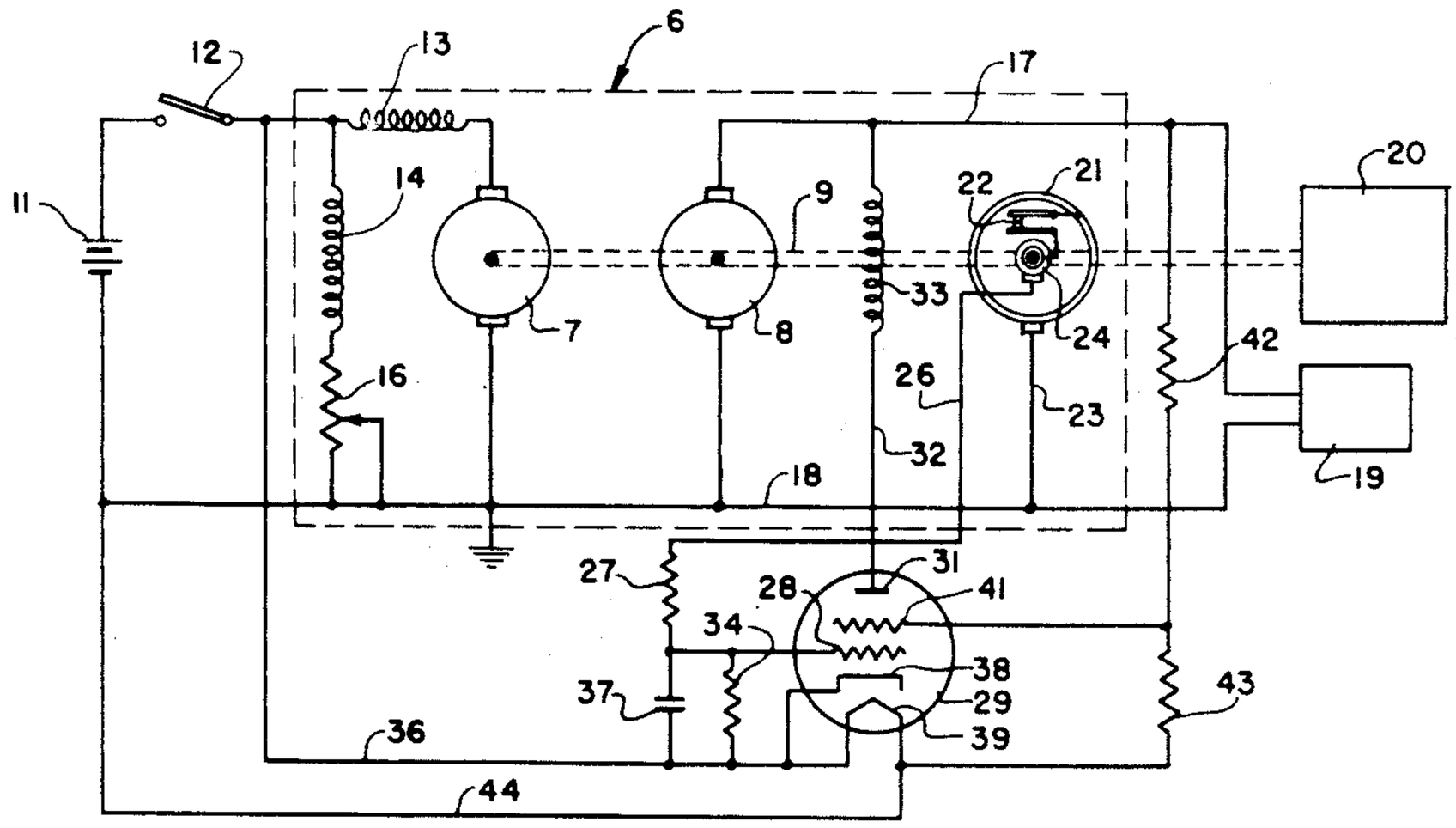

FIG. 1

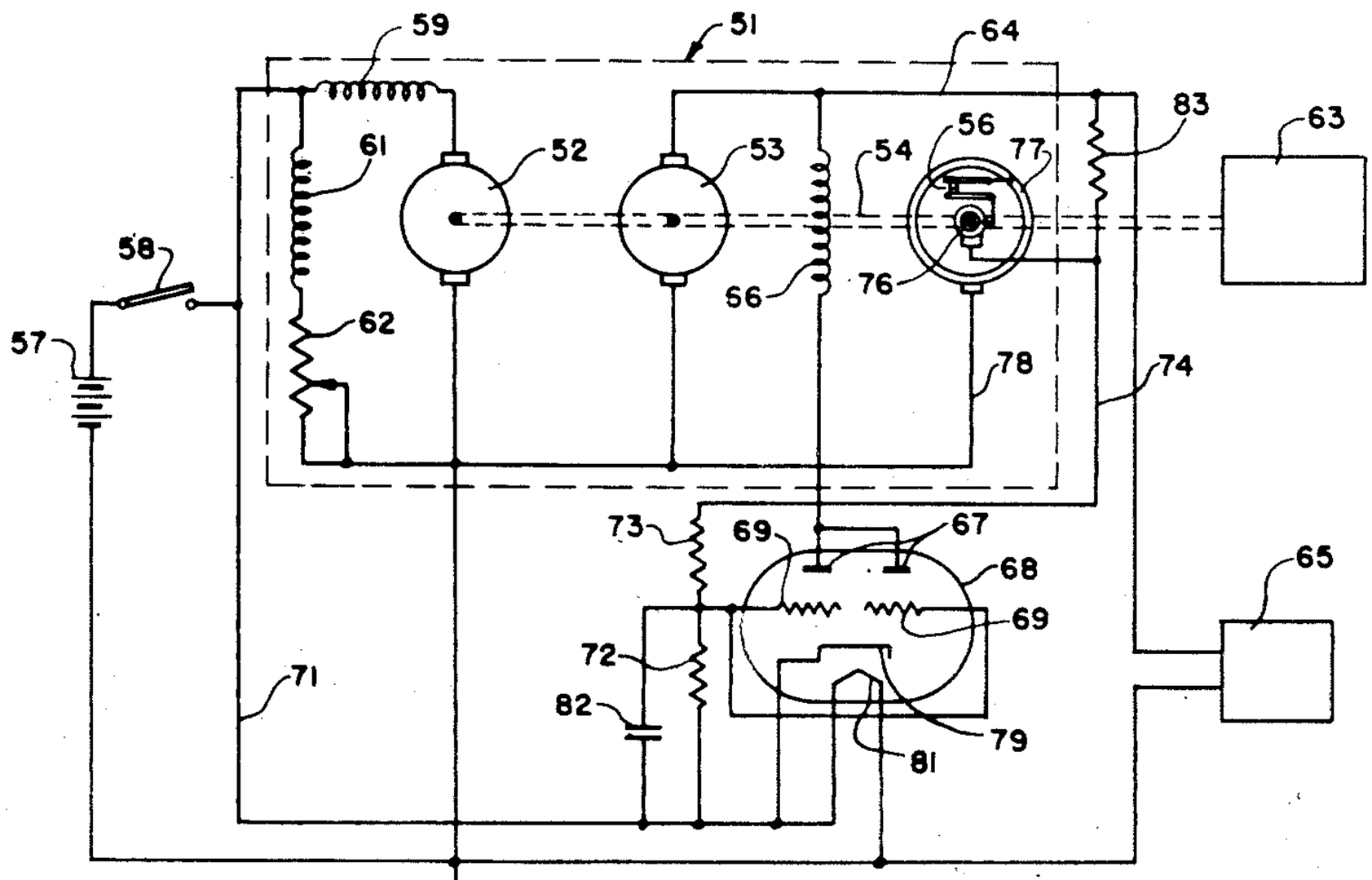

FIG. 2

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SPEED REGULATION OF DYNAMOTORS

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5 Claims. (Cl. 318—325)

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The present invention relates to an improved dynamotor control circuit, and more particularly for the speed regulation thereof.

It is now the custom to install automatic telegraph apparatus on mobile units, either for air or ground travel, which communicate between each other or with a fixed station over radio channels. It is thus necessary to provide some sort of operating motor, usually of a low voltage direct current type, to run such telegraph apparatus, which motor must be regulated as to speed of operation within relatively narrow limits. The size and weight of the motor and speed control means are limited because of mobile application, where such are kept to a minimum and, therefore, it is desirable to provide compact small units.

Accordingly, an object of the present invention is to provide speed regulating equipment which is compact and small but which will operate satisfactorily and efficiently.

Further, another object is to produce such equipment at as low a cost as possible.

Likewise, it is desirable that the apparatus be made in a manner to reduce the maintenance and replacement of parts due to wearing out, arcing of governor contacts, etc.

Therefore, still another object of the invention is to provide apparatus which will require replacement of parts to a minimum.

One of the disadvantages of previous regulating systems has been the amount of radio interference caused during its operation.

Accordingly, a still further object of the invention is to provide a regulation system which causes as little radio interference as possible.

A first embodiment of the invention, utilized with a dynamotor provided with a shaft for operating the telegraph recorder, comprises governor contacts on the dynamotor shaft, a regulating field in the dynamotor, a power vacuum tube preferably of a beam type which normally operates in the negative grid region for varying the current in the regulating field winding under the control of the governor contacts, and a condenser in the grid circuit of the tube for preventing sudden changes in vacuum tube operating potentials and consequently destructive high voltage transients in the regulating field.

A second embodiment is similar to the first embodiment except that it utilizes a zero bias or Class B power tube normally operating in the positive grid region, such tube being preferable in mobile applications where a low voltage is present, such as of the nature of 6 to 12 volts.

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The features and advantages of the invention will become apparent from the following detailed description, when read in conjunction with the accompanying drawing, in which

Fig. 1 shows an embodiment of the invention utilizing a negative bias tube controlling the speed regulation, and

Fig. 2 shows a second embodiment of the invention utilizing a zero bias tube controlling the speed regulation.

With reference to Fig. 1, a control circuit has been provided for use with a dynamotor primarily utilized for air mobile application where a direct current source of 26 volts is usually supplied. It is to be understood, however, that the instant application is not limited to a 26 volt current source only but instead by the supplying of proper value resistances, etc., the circuit may be utilized over a voltage range. It should be noted, however, that because of the type of tube used, in this case a 25L6, the circuit will not operate with the current source being less than approximately 20 volts.

A dynamotor indicated generally by the numeral 6 is provided which is formed with a (low voltage) motor commutator 7, a (high voltage) generator commutator 8, both of which operate from separate windings on a common armature, not shown, and which are provided with a common shaft 9. The motor commutator 7 receives a relatively low (26 volt) direct current potential from a battery 11, through a manually operable switch 12, through a series field 13 to the commutator 7 and thence from the commutator to ground over an obvious circuit. A shunt field 14 is provided and is further provided with a variable resistor 16 for setting the upper speed limit of the dynamotor 6.

The generator commutator 8 supplies a direct current output voltage of approximately 250 volts over a conductor 17 to a load 19 which in the present instance is an electronic device of any desired type, and over a conductor 18 to ground.

The shaft 9 is utilized for operating a telegraph recorder, indicated generally as 20, which may be of any suitable design. It is because of such use that the speed of the shaft 9 must be regulated within narrow limits.

Secured to the shaft 9 is a large commutator disc 21 provided with a pair of centrifugally operated governor contacts 22 which are designed so as to remain closed during the normal operating speed of the dynamotor 6, that is, up to a predetermined speed and which will thereaft-

er open as the speed of rotation increases above the predetermined limit. A brush associated with the commutator 21 is connected over a conductor 23 to the grounded conductor 18. A small commutator ring 24 on the shaft 9 is also connected to the governor contacts and has an associated brush which is connected by conductor 26, through a resistor 27 to the control grid 28 of a vacuum tube 29.

Anode 31 of vacuum tube 29 is connected over a conductor 32 to a regulating field 33 provided to control the speed of rotation of the dynamotor 6, the regulating field 33 being connected at its opposite side to the output lead 17. The control grid 28 of the tube 29 is also connected through a resistor 34 and over a conductor 36 to the conductor joining the manually operable switch 12 and the series field 13, the conductor 36 serving as a source of potential from the battery 11 for the control grid 28. A condenser 37 is connected between the resistor 27 and the conductor 36 in parallel with the resistor 34. The conductor 36 also provides potential for a cathode 38 of the tube 29 and a cathode heater 39. A screen grid 41 is also connected through a resistor 42 to the 250 volt direct current output lead 17 of the generator commutator 8, the circuit being completed through a resistor 43 and over a ground return conductor 44 which is provided from the opposite side of the cathode heater 39 to the negative side of the battery 11 and to ground.

If it is assumed that the switch 12 is in its closed position, the dynamotor 6 thus will commence to operate thereby causing the commutators 7 and 8 to rotate and an output voltage to be supplied over the conductor 17. Under the starting speed of the commutators and the normal operating speed thereof, the governor contacts 22 will be closed which will result in the control grid 28 of the vacuum tube 29 being biased negatively with respect to the cathode 28 over the following circuit: From the positive side of battery 11, through the now closed switch 12, over the conductor 36, through the resistors 34 and 27, over the conductor 26 to the small commutator ring 24, through the closed governor contacts 22 to the large commutator ring 21, and over conductor 23 to grounded conductor 18. Inasmuch as a potential is also supplied over conductor 36 directly to the cathode 38, it may be seen that the resistor 34, which together with resistor 27 forms a voltage divider, causes the control grid 28 of the tube 29 to be an amount negative with respect to the cathode 38 equal to the IR drop across the resistor 34 which is adequate to block the tube 29.

During the time that the governor contacts 22 are closed, the condenser 37 will be charging over a circuit which may be traced from positive battery 11, through the closed switch 12, over the conductor 36, through the condenser 37, through the resistor 27, over the conductor 26, through the closed governor contacts 22 and their associated commutators, and over the conductor 23 to grounded conductor 18.

It might be noted that once the generator commutator 8 supplies output voltage to the conductor 17 potential will be applied to the screen grid 41 from the output lead 17, through the resistors 42 and 43, and over the conductor 44 to ground. The potential actually applied to the screen grid 41 will be the output potential from conductor 17 minus the IR drop produced by the resistors 42 and 43, which form a voltage divider.

Under the above conditions the apparatus will operate satisfactorily to produce an adequate output potential for the load 19, which as stated in this case is a radio transmitter, whereas the shaft 9 will operate at a speed within the required limits for operating the telegraph recorder 20.

If it is now assumed that the speed of operation of the shaft 9 has increased to such an amount as to be above the predetermined speed and under which condition the governor contacts 22 will be opened centrifugally in a manner well known in the art, the circuit which had previously been traced for supplying biasing voltage to the control grid 28 and which was indicated as being from the conductor 36, through the resistors 34 and 27, over the conductor 26 to the small commutator ring 24, and thence through the closed governor contacts 22 and finally to ground over conductor 23, will be broken upon the opening of the governor contacts and thus the control grid 28 will drop to a zero value with respect to the cathode which receives potential directly over the conductor 36. Under this condition and as previously described because of the characteristic of the tube utilized, the tube 29 will commence to conduct over a circuit which may be traced from positive output lead 17, through the regulating field 33, over the conductor 32 to the anode 31, through the tube 29 to cathode 38, and thence to ground over conductor 36 and through the switch 12 and battery 11. As a result of the flow of current through the regulating field 33, the speed of rotation of the dynamotor 6 will be reduced due to the increase in the magnetic field in a manner well known in the art. Thus, the speed of rotation of the shaft 9 will be reduced until such time as a speed is reached which is below the predetermined maximum limit at which time the governor contacts 22 will once again close resulting in the grid 28 being again biased negatively with respect to the cathode, all as previously described, which results in the tube 29 being extinguished or rendered nonconductive. Under this condition no current will flow through the tube and thus through the regulating field 33, resulting in the magnetic effect being eliminated and allowing normal operation of the dynamotor 6.

It may also be seen that at such time as the governor contacts 22 were opened, if no means were provided, the tube 29 due to its inherent characteristics would immediately conduct at its maximum value, which would result in a high transient voltage appearing across the regulating field 33 which would exceed the safe operating voltage of the tube 29. However, by provision of the condenser 37, at such time as the governor contacts 22 were opened the condenser 37, which as previously described had been charged from battery 11, will discharge through resistor 34. As a result of such potential being applied to the control grid 28, the anode current of the tube 29 will not rise instantaneously to a maximum value but instead will attain such maximum value over a gradual (exponential) curve. Thus, by the provision of the condenser 37, high voltage transients which might adversely affect the regulating field 33 and the tube 29 are completely eliminated.

It should be noted that while the instant circuit might be designed with a tube which would

operate on a positive grid bias principle rather than on a negative grid bias principle, as in the instant example, the use of such latter type of tube is preferable because it reduces the amount of current necessary through the various circuits and primarily through the governor contacts 22, thereby reducing the possible sparking and subsequent radio inteference in the circuit which otherwise would be present upon the opening and closing of the governor contacts. Further, it reduces the amount of pitting of the governor contacts which otherwise would greatly reduce the life thereof and necessitate frequent replacements.

While the above embodiment has been described as supplying an output potential to a load 19 which is in the form of an associated electronic device, it is obvious that the output may be connected to any desired load which operates on a high direct current potential. Further, the present use of a speed regulated shaft is not limited to use for operating a telegraph recorder 20 but may be utilized for operating any suitable device.

While the above description included but a single change from normal speed to too high a speed and back again and the subsequent speed regulation operation, it is to be noted that because of the circuit employed, the speed regulation is constant, that is, at any time as the speed becomes too high the governor contact will be opened and the circuit will function to reduce the speed of the dynamotor 6 until the correct operating speed is reached at which time the governor contacts will again close and the operation will continue until some subsequent time at which too high a speed will be reached, at which time the regulating circuit will once again function.

It might be noted that the variable resistor 16 has been provided in association with the series field 13 and the shunt field 14 so that at such time as the governor contacts 22 are opened, the motor will not "run away" as may otherwise occur.

The embodiment shown in Fig. 2 of the drawings is provided primarily for ground mobile application such as vehicles where the direct current potential source is usually of the order of 6 or 12 volts rather than 26 volts as described for the first embodiment. In order to achieve a speed regulation system for such application and potential a different type of tube is utilized, such as a 6N7, which operates with positive grid bias with respect to the cathode rather than negative as described with respect to tube 29 in the embodiment shown in Fig. 1.

Specifically, a dynamotor 51 is provided, which is similar to that previously described, having a motor commutator 52, a generator commutator 53, both of which operate from separate windings on a common armature, not shown, and having a main shaft 54 to which is connected a pair of centrifugally operated governor contacts 56 and associated commutators. The motor commutator 52 is operated from a low current direct voltage source 57, through a manually operable switch 58, and thence through a series field 59 to the commutator 52, the other side of which is grounded over an obvious circuit. A shunt field 61 is provided with a variable resistor 62 connected across the two sides of the commutator 52, the variable resistor 62 being for a similar purpose as resistor 16 of Fig. 1. The shaft 54 is utilized to operate a telegraph recorder 63, and

thus necessitates speed regulation thereof, as was true with respect to Fig. 1.

The generator commutator 53 provides a high direct current output over a conductor 64 to a load 65 which in the present instance is an electronic device, the opposite side of which is grounded over an obvious circuit. A regulating field 66 is connected from the output conductor 64 to the anodes 67 of a twin triode vacuum tube 68. The twin triode 68 is provided with a pair of control grids 69 which are normally provided with biasing current from the voltage source 57, through the switch 58, over a conductor 71, through a resistor 72, through a resistor 73, over a conductor 74 to the brush of a small commutator ring 76, through the closed governor contacts 56 to a large commutator ring 77, through the associated brush and over a conductor 78 to ground. Because of the value of the resistors 72 and 73, which form a voltage divider, the grids 69 will be biased approximately to zero or slightly negatively. The cathode 79 and cathode heater 81 receive full potential from the source 57, through switch 58 and over the conductor 71. A condenser 82 is connected between the conductor 71 and the midpoint of the resistors 72 and 73 forming the voltage divider.

As in the above description with respect to Fig. 1, if it is assumed that the manually operable switch 58 is closed the dynamotor 51 will function to arrive at a normal operating speed for driving the shaft 54 and operating the telegraph recorder 63 and will impress a high direct current to the output conductor 64. Under this condition the twin triode 68 will not be conducting because as described above a circuit is traced through the then closed governor contacts 56 for biasing the grids 69 to approximately zero or slightly negative which is below the grid voltage for allowing the tube to conduct to any great extent. At such time, however, as too high a speed of rotation is attained the governor contacts 56 will open thereby precluding the tracing of a circuit therethrough to ground over conductor 78, which results in the high output lead 64 supplying potential through a resistor 83, which previously had been shunted to ground through the closed governor contacts, over the conductor 74 and through the resistor 73 to the control grids 69. As a result of such potential being applied to the grids 69 their bias will rise positively to a value which will allow the tube 68 to become conducting thereby establishing a circuit from the high potential conductor 64, through the regulating field 66 to the anodes 67, thence through the now conducting tube 68 to the cathode 79 and over the conductor 71 and through the battery 57 to ground. Under this condition, because of the current flowing in the regulating field 66, it will, through a magnetic effect, cause a reduction in speed in the rotation of the dynamotor 51 thereby resulting in the speed of rotation of the shaft 54 being reduced. At such time as the speed of the shaft 54 is reduced to a value below the predetermined maximum the governor contacts 56 will once again close causing the circuit just described for biasing grids 69 positively to be shunted through the resistor 83 and the closed governor contacts to ground and re-establishing the circuit from the potential source 57 to the grids 69 which is a value of slightly negative voltage, as previously described. Under this condition the regulating field 66 will not be excited and the dynamotor 6 will increase speed.

It should be noted that the condenser 82 does not charge positively during the time that the governor contacts 56 are closed as was the case with the embodiment shown in Fig. 1, inasmuch as the condenser is so placed in the circuit as to obtain its positive charge from the opposite side, that is, from the dynamotor output circuit 64, through the resistor 83, over the conductor 74, and through the resistor 73, but instead is charged slightly negatively at this time from battery 57. However, at such time as the governor contacts 56 open indicating that the dynamotor 51 is operating too fast and at which time the triode 68 is rendered conductive, as described above, the initial potential surge supplied from the output conductor 64, through the resistor 83, over the conductor 74, and through the resistor 73 will be absorbed by the condenser 82 allowing the condenser to become charged positively and thereafter will be applied directly to the grids 69 of the triode. In this manner the triode 68 is prevented from rising to its maximum output instantaneously, the condenser acting to cause the triode to reach its maximum output in a manner as shown in an exponential curve. The result of such action is to preclude high transient voltages from appearing across the tube 68 and the regulating field 66 which might otherwise cause injury to the tube and/or field.

It may also be noted that at such time as the tube 68 is extinguished due to the closure of the governor contacts 56, as has been described before, the condenser 82 will then discharge through the resistor 72, similarly as has been described above to eliminate any transient voltages.

Thus, under the above description it has been seen that the speed regulator circuit operates constantly, that is, at every instance as the speed increases to too great a value the regulator circuit will operate to reduce the speed to a value below the predetermined maximum. In this manner a constant speed is provided for the shaft 54 operating the automatic telegraph printer 63. It is obvious, of course, that the device 63 need not necessarily be a telegraph printer but instead may be any apparatus which it is desired to operate in mobile applications which operates from a regulated speed which speed must be limited and kept within narrow limits.

It is also obvious that while particular values have been assigned to the sources of potential and the potential output, and specific types of tubes have been indicated as to be utilized, that the circuit may operate within the scope of the present invention in instances where both input or output voltages may be different and with the use of various other types of tubes.

While the instant invention has been described in two specific embodiments and for utilization with particular apparatus, it is obvious that it could be incorporated in or with apparatus of other types where similar needs are present, and further is not to be limited to the specific embodiments shown but for any embodiments within the scope and spirit of the present invention.

What is claimed is:

1. In a speed regulation system, in combination with a dynamotor including a regulating field and speed responsive governor contacts, a source of power for operating said dynamotor, an electron tube having at least an anode, a cathode and a control grid, said anode being connected to said regulating field and said control grid being connected to said governor contacts, means to normally bias said control grid to a negative

value with respect to said cathode from said source of power thereby rendering said tube nonconductive, said governor contacts opening upon the attainment of a predetermined speed of said dynamotor and thereby causing said control grid to be biased to zero causing said tube to be rendered conductive, said regulating field being controlled by said tube to cause the speed to be reduced, and means connected to said grid to prevent said grid from being reduced to zero instantaneously, whereby transient voltages are eliminated.

2. In a speed regulation system, a dynamotor including a regulating field and speed controlled contacts, a source of power for operating said dynamotor, an electron tube biased from said source of power and controlled by said contacts for controlling the current in said regulating field, said tube being normally biased to a nonconductive condition under predetermined operating speeds of said dynamotor but being rendered conducting upon the attainment of too high a speed by said dynamotor and the resultant opening of said contacts and the removal of bias, and means connected in a circuit of said tube to prevent said tube from attaining a maximum output instantaneously upon said removal of bias, whereby transient voltages are eliminated.

3. In a speed regulating system for a dynamotor including a regulating field and governor contacts which are responsive to the speed of said dynamotor, a source of power for operating said dynamotor, said contacts opening upon said dynamotor attaining a predetermined speed of operation, an electron tube for controlling the current in said regulating field, said tube being biased by said source of power and controlled by said governor contacts whereby when said governor contacts are closed said tube is biased to cut-off and when opened the cut-off bias is removed allowing the output of said tube to attempt to rise to a maximum value instantaneously, and means connected in a circuit of said tube to prevent the output of said tube from rising to a maximum value instantaneously when said cut-off bias is removed, whereby transient voltages are eliminated.

4. In a speed regulation system, a prime mover including a regulating field and speed controlled contacts, a source of power for operating said prime mover, an electron tube having its grid connected to said contacts and being controlled by said contacts for controlling the current in said regulating field, said tube being biased from said source of power to be normally nonconductive under predetermined operating speeds of said prime mover but being rendered conducting through the removal of bias upon the attainment of too high a speed by said prime mover and the resultant opening of said contacts, and means connected in a circuit of said tube to prevent said tube from attaining a maximum output instantaneously upon said removal of bias from said tube, whereby transient voltages are eliminated.

5. In a speed regulating system, a prime mover, a source of power for said prime mover, speed responsive contacts operated by said prime mover, an auxiliary field in said prime mover, an electron tube normally biased below cut-off from said source of power having its anode connected to said auxiliary field and its grid connected to said speed responsive contacts, whereby when said contacts are opened said grid will be biased to cause said tube to conduct thereby

regulating the speed of said prime mover through said auxiliary field, and a capacitor connected in shunt with a resistor between the grid cathode space of said tube for preventing said tube from attaining a maximum output instantaneously, whereby transient voltages are eliminated.

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