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IDLING DEVICE FEATURING ACTUATOR-CONTROLLED SPRING

Filed Oct. 5, 1955 3 Sheets-Sheet 1

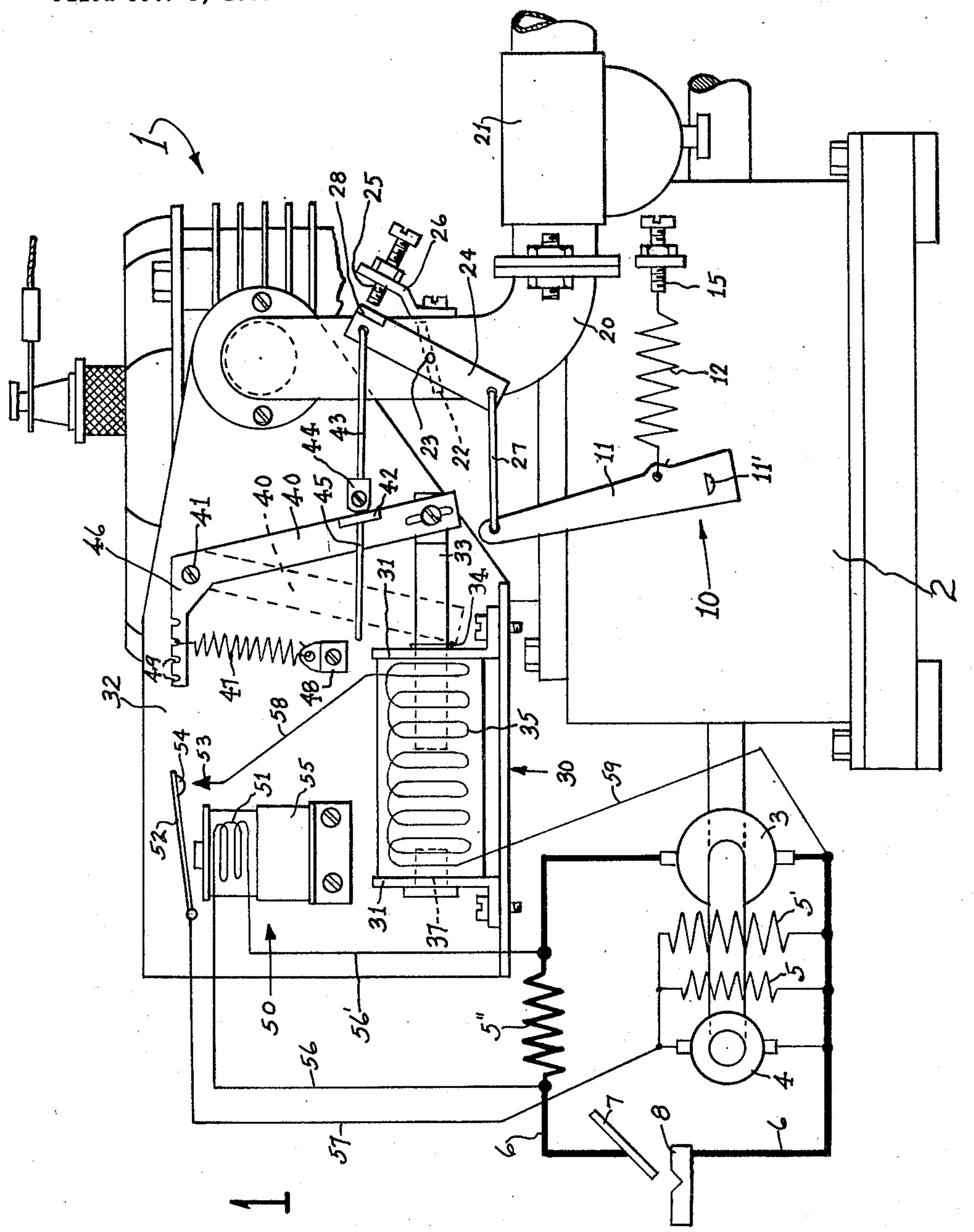

FIG. 1

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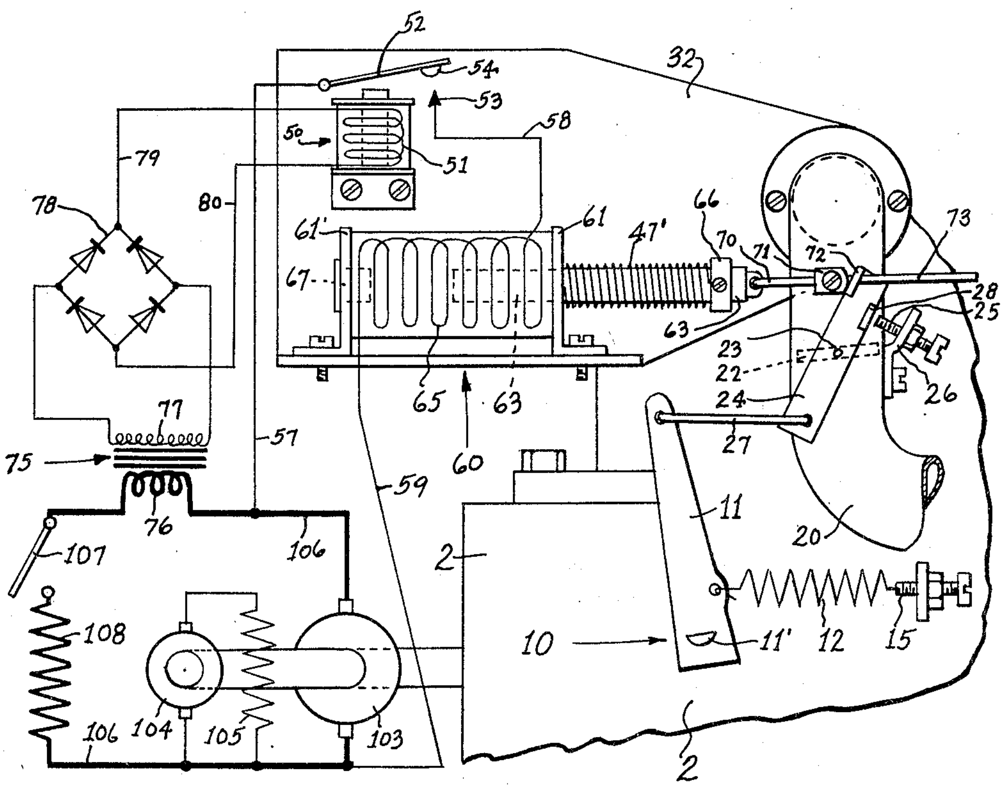

FIG. 2

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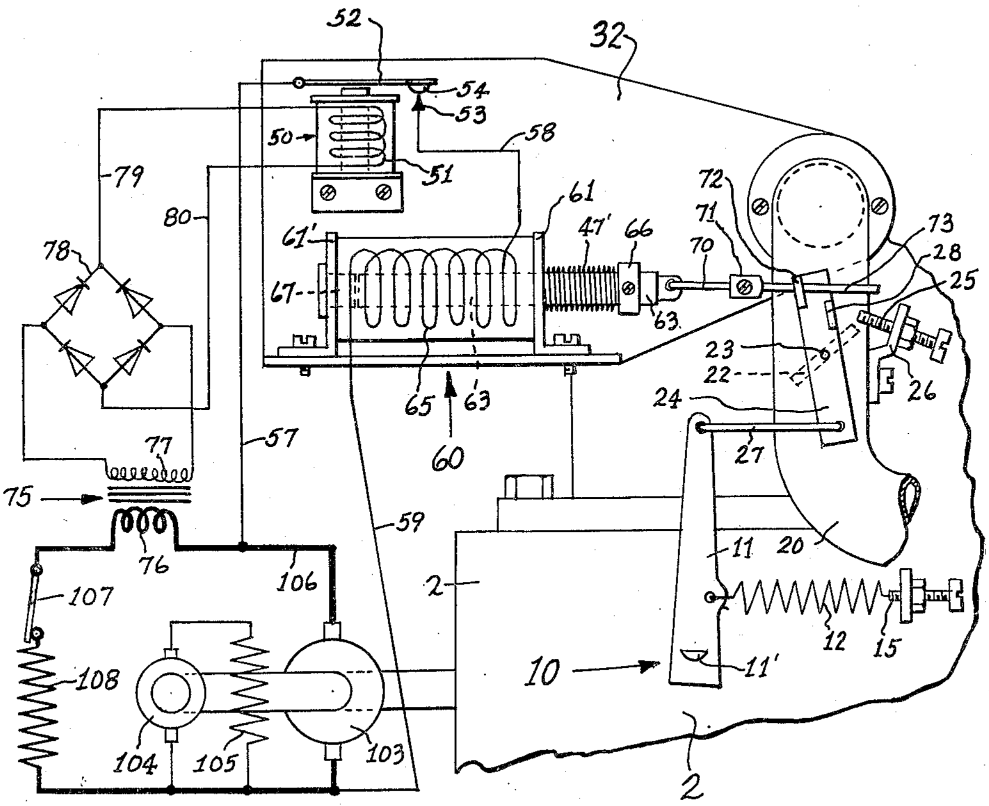

FIG. 3

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IDLING DEVICE FEATURING ACTUATOR-CONTROLLED SPRING

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4 Claims. (Cl. 290—40)

This invention deals with an idling device for engine-generator sets employing internal combustion engines wherein a load-responsive relay controls an electromagnetic actuator which, in turn, controls the effect of a throttle-closing spring in a manner establishing a slow governed engine speed at the no load condition (idling condition) and the required faster governed engine speed when electric load is connected.

In the past, idling devices have been proposed in which the engine speed is continuously under the control of the primary mechanical (centrifugal) governor, it being necessary, in some manner, to insure that the centrifugal governor operates under relatively light spring bias during the period without load, and under full normal spring bias during the period when the electrical load is connected. Arrangements suggested heretofore intended to achieve this purpose, involve certain basic and undesirable alterations of the centrifugal governor itself, such as substituting two light-acting loading springs for the usual full strength loading spring. Idling devices of these types have been rather difficult to install and to adjust, especially if the device is added after the generator set has left the factory. Furthermore, in most of the suggested structures, it is not conveniently possible to make adjustment to raise or lower the governed idling speed because adjustment of the higher speed operation is not independent of the adjustment of slow speed operation. A further disadvantage of such structures is that they have not been suited for using generated current as the motive energy when the necessary change in spring biasing of the centrifugal governor is effected.

Usually, the only fully practical motive energy for operating an idling device is an electromagnetic actuator energized by generated current rather than by a battery. It is the principal object of the present invention to provide an arrangement, including an electromagnetic actuator energized by shunt connection with one generator of the generator set, to control the action of a simple spring which is interconnected with the actuator and the governed throttle system, so that said spring opposes the conventional governor loading spring during periods without electrical load and does not oppose the loading spring during the period when electrical load is in effect.

In broad aspect, the present invention embodies the following elements:

1. An engine-generator set having a governed throttle system, including a centrifugal governor connected to the throttle, the governor having a loading spring of such force as to enable regulation of the throttle for predetermined load speed operation under varying load;

2. A normally effective throttle-closing spring which opposes the governor loading spring to reduce effectively the spring loading of the centrifugal governor and thereby to enforce, when required, a governed slow (idling) speed;

3. An electromagnetic actuator, energizable by shunt connection with generated current and connected to the throttle-closing spring in a manner whereby when the actuator is energized, it will begin overcoming the force of said throttle-closing spring, permitting engine acceleration toward load speed and, after acceleration, the actuator will hold ineffective the throttle-closing spring, enabling regulation of the throttle for load speed operation, and

4. A load-responsive switching relay, responsive to load demand on the engine-generator set, and controlling the energization of the actuator whereby the actuator is energized from the initiation to the termination of load demand, said actuator being de-energized from the termination to the initiation of load demand.

The invention will be more readily understood by reference to the accompanying drawings, in which Figure 1 illustrates diagrammatically a D. C. engine-generator set as used for welding application, with the welding arc interrupted and the throttle-closing spring opposing the governor's loading spring, thus effecting a slow (idling) speed. Figure 2 illustrates an A. C. engine-generator set, with the load switch open and the engine operating at slow (idling) speed, while Figure 3 is the same arrangement as in Figure 2, but the positions of the elements are those when the load switch has been closed, and the force of the throttle-closing spring is removed so that the engine is operating at the higher governed speed to serve the load.

Referring again to the drawings, and particularly to Figure 1, numeral 1 indicates an internal combustion engine, such as a gasoline engine, having a crankcase 2, and driving a D. C. welding generator 3 and an exciter generator 4. The exciter generator has a shunt field 5 and this generator also energizes field 5′ of the welding generator. The welding generator also has a series field 5″. Numeral 6 indicates the load circuit (which is depicted by a bold line), while numeral 7 represents the welding electrode, and 8 the workpiece being welded. In this figure, the arc has not been struck.

The engine has a carburetor 21 and fuel intake pipe 20 connecting the carburetor with the engine inlet. A conventional throttle (or throttle valve) 22 is located in intake pipe 20, and is mounted on a pivot 23 having fixed thereto the usual throttle arm or lever 24. Lever 24 has a flange 28, which may bear against an adjustable stop screw 25 to limit the maximum closure of throttle 22. Said stop screw is carried by bracket 26 mounted on intake 20. A conventional mechanical governor (hereinafter referred to as the centrifugal governor) is indicated generally as 10. The centrifugal operating mechanism thereof is well known, and is not illustrated, and such mechanism may be inside crankcase 2, and is connected with governor arm 11 by rocker shaft 11′ to exert a force on arm 11 which is proportionate to engine speed, and this force urges arm 11 leftwardly in the drawings. This centrifugal force is opposed by governor loading spring 12, and governor arm 11 is connected with throttle arm 24 by a link 27. Loading spring 12 is of such force that if it is opposed only by the centrifugal mechanism, throttle 22 will be regulated in a manner to maintain the predetermined high operating speed that is necesary when the welding arc is in effect. An adjustment screw 15 enables adjustment of such predetermined high operating speed.

An electromagnetic actuator is indicated generally by numeral 30. It is mounted on an iron or steel angle-shaped panel or bracket 32 which is rigidly attached to the engine, as by being clamped between intake pipe 20 and the engine proper, as shown. Actuator 30 includes iron end frames or brackets 31 and 31′ which, together with panel 32, provide the return magnetic circuit of the actuator. Actuator 30 has a plunger 33, which slides within the usual tube 34 made of brass or other nonmagnetic material, and the actuator has an operating winding **35**, as well as a fixed stop or core **37**, extending partly into the winding.

A long lever **40**, having an upper leftward extension **46**, is pivotally mounted on panel **32** at **41**, and is attached to the end of plunger **33** in swiveling relation therewith. Level **40** has a flange **42** having an opening therein, in which is slidably supported the free or extending end **45** of a connecting link **43** which has its right end swivelly attached to the upper end of throttle arm **24**. An adjustable collar **44** is affixed to link **43** and it delivers the thrust of lever **40** to throttle arm **24**, in the direction of closing of throttle **22**. A spring **47**, which may be termed a throttle-closing spring (or a forced-idle spring), urges lever **40** rightwardly, thus transmitting the force of said spring, through several elements including link **43**, throttle arm **24**, and link **27**, to governor arm **11**. Said throttle-closing spring force is in direct opposition to the force of the governor loading spring **12**. One end of spring **47** is carried by a fixed bracket **48**, while the other end is connected to extension **46** of lever **40**, and may be set at different positions by means of notches **49**, so as to apply more or less force in opposition to loading spring **12**. It will be apparent that if actuator winding **35** is sufficiently energized, lever **40** necessarily will be drawn back, as indicated, to the broken line position, and that such action will remove completely the force or effect of throttle-closing spring **47**.

It is necessary that actuator winding **35** be energized for the period that the welding arc is in use, and the necessary control of this is obtained by means of a load-responsive switching relay indicated generally as **50**. This relay has an operating winding **51** which, through means of wires **56** and **56'** is energized by connection across the series field **5''**, so that a portion of the welding current will flow through winding **51**, to pull down armature **52** and close relay switching contacts **53** and **54**. When these contacts are closed, winding **35** is energized with current from exciter generator **4**, the shunt connection being through means of wires **57**, **58** and **59**.

Relay **50** is shown as equipped with a copper delay ring **55** which assures a slow break on the part of contacts **53** and **54**, insuring some time delay to prevent de-energization of operating winding **35** during any very brief interruption of the welding arc. In practice, it is usual to provide more complex time-delay arrangements, so as to obtain a longer time-delay than is conveniently obtainable by use of a delay ring but, here, the particular expedients for accomplishing the time-delay form no part of the present invention and, therefore, a simple form of time-delay is illustrated.

The positions of the elements in Figure 1 are those of governed slow (idling) speed operation. Winding **35** is not energized, hence the actuator is in ineffective position. Spring **47** is shown connected in the second notch **49**, under which condition the force of the spring is less than that of governor loading spring **12**, so that there is a certain remaining spring-biasing effect which, in combination with the force of the centrifugal mechanism (not shown), will result in a governed idling speed of the engine. Throttle **22** will be slightly advanced and retarded, as necessary, to maintain the uniform idling speed, and all of the elements connected therewith, including lever **40**, plunger **33**, and link **43**, will move in unison with the throttle and governor.

If spring **47** were connected with the fourth (outermost) notch **49**, the effective force of spring **47** then would be greater, as for instance, to maintain flange **28** of throttle arm **24** against stop screw **25**. Thus, if desired, throttle-closing spring **47** may be of sufficient force to assure a quite slow idling speed, but spring **47** should not be so strong as to hold throttle **22** so forcefully closed that the initial force of actuator **30** will be insufficient to cause acceleration. It will be noted particularly that the idling speed can be adjusted whenever desired, by selecting a particular notch **49**, and that this adjustment has no effect on the adjusted high operating engine speed which is separately adjusted by adjustment **15**.

When welding is to be resumed, the operator touches electrode **7** to workpiece **8**, thus causing energization of winding **51** and effecting closure of contacts **53** and **54**, so that operating winding **35** of actuator **30** will be energized immediately to the extent of whatever voltage is being produced at that moment by exciter generator **4**. Assuming that the adjusted force of spring **47** has been selected to insure a fairly slow idling speed, the voltage of generator **4** will be much below that which will be in effect after acceleration, and the energization of winding **35** will be weak. Even so, there is necessarily some degree of pull exerted by plunger **33**, which is in opposition to the force of spring **47** and thus slightly increases the effective loading of the centrifugal governor. Throttle **22** must, therefore, be advanced to at least some slight extend which, in turn, increases speed which results in the plunger **33** exerting still more force in opposition to that of throttle-closing spring **47**. Engine acceleration therefore will build up quite rapidly and, at a certain point, the pull of plunger **33** will be sufficient to complete the movement of lever **40** to the indicated broken line position at which condition all of the effect of spring **47** is entirely removed. Winding **35** now has become sufficiently energized so that actuator **30** is easily sufficiently powerful (via contact of plunger **33** with core **37**) for the purpose of holding spring **47** completelv ineffective.

Contacts **53** and **54** will remain closed while the welding arc is established as well as for a short time after breaking of the arc and, upon opening of these contacts, the operating winding is de-energized, so that the force of spring **47** is released and this spring immediately opposes the force of loading spring **12** and thus closes the throttle to the idling speed basis, while at the same time restoring plunger **33** to the illustrated extended position. It will be apparent that the idling device of Figure 1 may be attached to the engine-generator set without any modification of centrifugal governor **10**. Also, it will be apparent that the particular arrangement and interconnection of the throttle-closing spring, actuator plunger, and governed throttle system, are such that weak energization of the actuator, as obtainable by shunt connection with one of the generators of the generator set, is sufficient to bring about the needed acceleration when the electrical load is connected, which in the case of the welding application is when the arc is struck.

Figure 2 illustrates an engine-generator set for supplying A. C. power, such as for operating portable tools, lights, etc. The A. C. load generator is indicated as **103**, the exciter as **104**. Field **105** may be common to both generators **103** and **104**, as is a popular practice in small A. C. engine-generator sets. The load circuit represented by numeral **106** and shown by a bold line has a switch **107** and a load **108**. While a single switch and a single load are indicated in practice, the engine-generator set may serve a number of large or small appliances at different times, each with its own switch.

The electromagnetic actuator of Figure 2 is indicated generally by numeral **60**, and includes iron end brackets **61**, **61'**, plunger **63**, operating winding **65**, and a fixed core or stop **67**, extending partly into the winding. An adjustable collar **66** is provided on the outer end of plunger **63**. A simple form of throttle-closing spring is illustrated in Figure 2, and is indicated by numeral **47'**. The helical spring is merely disposed around the extended portion of plunger **63**, whereby it presses rightwardly against collar **66**. The force of spring **47'** normally is exerted on arm **24**, and thus opposes the force of governor loading spring **12**, by means of a link **70** which is connected at one end with the end of plunger

63 and has a free end 73 slidably supported in flange 72 formed on throttle arm 24. A collar 71 is affixed to link 70 to deliver the thrust. In Figure 2, spring 47′ is exerting sufficient force to close the throttle effectively to a suitably slow (idling) speed basis. While spring 47′ is considerably expanded in Figure 2, as compared with its condition in Figure 3, it will be understood that the effect of spring 47′ is fairly uniform at all times and that, if the spring were removed from the plunger to permit complete expansion, it would become, say, twice the length of that occupied in Figure 2.

The load-responsive relay of Figure 2 is a conventional D. C. electromagnetic switching relay, and it is energized when current flows in load circuit 106, by means of a current transformer 75 and rectifier 78. Transformer 75 (which preferably may be a saturable transformer of the type disclosed in copending application Serial No. 533,128, filed on September 8, 1955, by William E. McFarland) has its coarse primary winding in series with load circuit 106, and the stepped-up voltage of the secondary winding 77 passes through rectifier 78 and wires 79 and 80 to thus energize the operating winding 51 whenever load switch 107 is closed to initiate flow in the load circuit. This action pulls down armature 52, to close and hold closed contacts 53 and 54. The closed contacts complete the energization circuit of the actuating winding 65, current being fed from A. C. load generator 103, through wires 57, 58 and 59. As in the case of Figure 1, the small initial energization of the actuator is sufficient to establish the cumulative acceleration. When the generated voltage rises sufficiently, plunger 63 is pulled fully inwardly to the position indicated in Figure 3, and spring 47′ then is ineffective, and governor 10 will control the operation at the predetermined load speed so long as the load circuit current flow continues.

There is a particular advantage in utilizing A. C. for energizing operating winding 65. In the case of the so-called self-excited A. C. plants, as illustrated, which have only one field, the generated voltage initially may drop to a quite low value when the connected load 108 happens to be a large motor.

This would result in adversely weak energization of actuating winding 65. By using A. C. energization of the winding, however, the wire size of winding 65 may be relatively coarse to obtain relatively forceful initial plunger pull, considering the collapse of generated voltage. Even though the winding is relatively coarse, it will not overheat during the period of full speed operation, as frequency then is perhaps three times higher than at idling speed operation which, together with the closed magnetic circuit of the actuator, limits the current consumption of the actuator to a few watts.

In the condition outlined by Figure 3, the higher operating speed is already in effect, and throttle 22 is well advanced, indicating at least a medium size load 108. Governor 10 will open the throttle still wider if more load is connected. As soon as load switch 107 is again opened, actuator 60 is ineffective in overcoming the effect of spring 47′, and the spring immediately closes the throttle for deceleration, whereupon the positions of the elements designated by Figure 2 are again in effect.

I claim:

1. In an idling device for an internal combustion engine-generator set supplying power to a load circuit, the engine thereof having a governed throttle system including a centrifugal governor connected to the throttle, said governor having a loading spring of such force as to enable regulation of the throttle for maintaining predetermined load speed operation under varying load when said loading spring is unopposed by the hereinafter mentioned throttle-closing spring, the improvement comprising a throttle-closing spring arranged when in effect, to oppose the force of said governor loading spring to effectively reduce the spring loading of said centrifugal governor and thereby enforce an idling speed, an electromagnetic actuator, energizable by generated current through shunt connection with a generator of said engine-generator set, said actuator being connected to said throttle-closing spring in a manner whereby, when it is energized, it will begin overcoming the force of said throttle-closing spring permitting engine acceleration toward predetermined load speed and, after acceleration, it holds ineffective said throttle-closing spring enabling regulation of the throttle for load speed operation, and a switching relay, responsive to load demand on said engine-generator set and constructed and arranged to control the energization of said actuator whereby said actuator is energized from the initiation to the termination of load demand and is de-energized from the termination to the initiation of load demand.

2. An idling device according to claim 1 in which said actuator is a plunger electromagnet, and interconnecting means between said throttle-closing spring, plunger, and governed throttle system arranged and constructed in a manner whereby, when said electromagnet is de-energized the throttle-closing spring will apply its force on said governed-throttle system in opposition to said governor loading spring and at the same time hold said plunger in extended position and, when said electromagnet is energized, the plunger will apply force on said throttle-closing spring to remove the force of said throttle-closing spring from operative effect upon said governed throttle system.

3. An idling device according to claim 2 in which said switching relay is an electromagnetic relay having normally-open contacts, and having an operating winding in series with the load circuit, whereby said relay is responsive upon initiation of load circuit current flow to close said contacts and thereby connect said actuator in shunt with a generator of said engine-generator set.

4. An idling device according to claim 1, in which said engine-generator set is an A. C. set including an A. C. load generator for supplying power to a load circuit, and in which said switching relay is an electromagnetic relay having normally-open contacts and an operating winding energizable upon load circuit current flow to effect the closure of said contacts, said actuator being energized by shunt connection with said A. C. load generator when said normally open relay contacts are closed.

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