Nov. 10, 1942. A. G. F. WALLGREN ET AL 2,301,348

SPEED GOVERNOR FOR ENGINES

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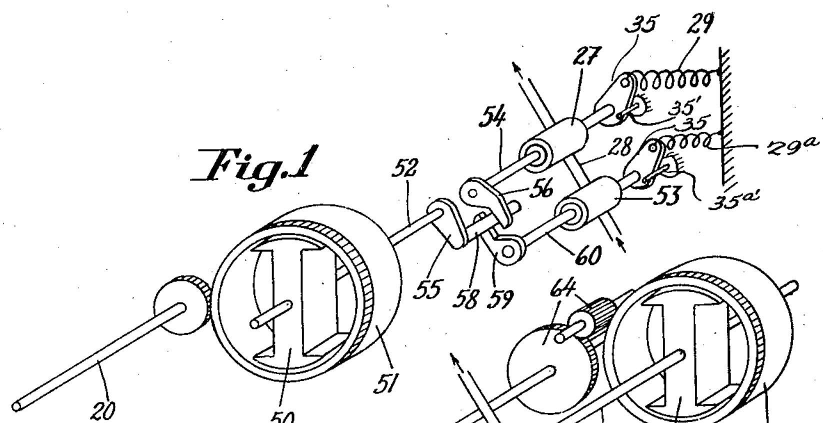
Fig.1



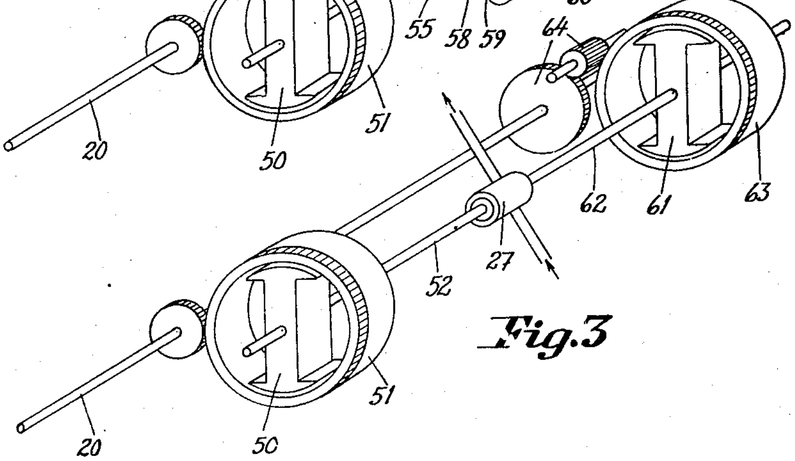


Fig.3

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Fig. 2

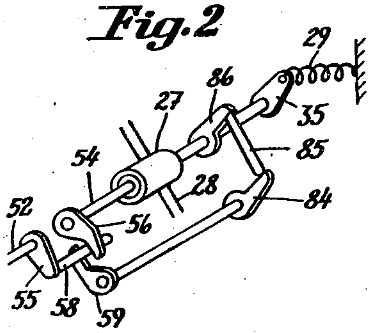


Fig. 4

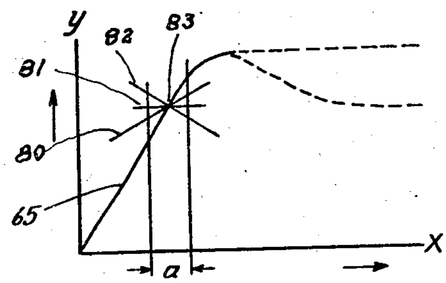


Fig. 5

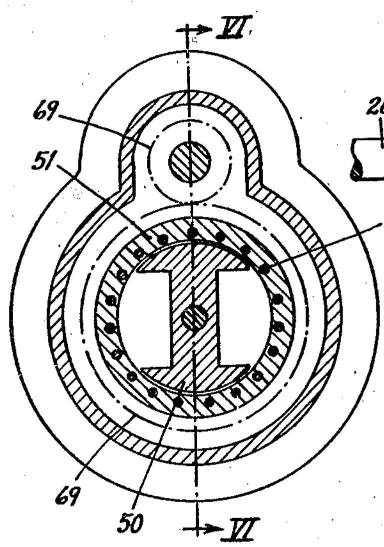
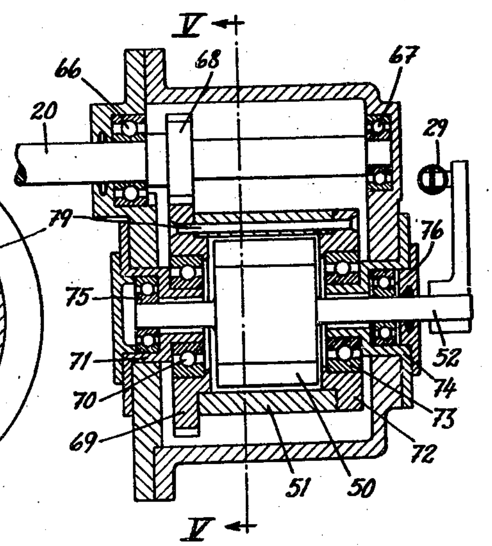


Fig. 6



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SPEED GOVERNOR FOR ENGINES

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6 Claims. (Cl. 264—13)

This invention refers to governors for engines, such as steam engines, steam and hydraulic turbines, internal combustion motors and the like, which are provided with members, for instance valves, adjustable guide blades, or fuel pumps for the control of the supply of energy medium to the power engine. The governors serve directly or indirectly to actuate these members so that the speed of rotation of the engines will be maintained constant or approximately constant, or will be adjustable at varying load.

It is one object of the invention to provide a novel type of governor, in which metallic friction has been obviated to a large extent and which is superior to governors hitherto in use as regards sensitivity and wear. Another object of the invention is to provide a governor which is simple in construction and consists of a small number of parts, so that it is considerably cheaper than the known governors. A further object of the invention is to provide a governor which is more safe in operation than the known governors.

Further and more detailed objects of the invention, together with the manner in which they and the above stated objects are attained, may best be understood from a consideration of the following description of the invention as embodied in suitable forms of machines, taken in conjunction with the accompanying drawings, forming a part of this specification, of which:

Fig. 1 shows more or less diagrammatically, and in a perspective view, a governor according to the invention;

Fig. 2 shows in a perspective view a modified detail of the governor according to Fig. 1;

Fig. 3 shows a perspective view of another governor according to the invention;

Fig. 4 shows a curve indicating the alteration of the adjusting power as generated in a governor according to the invention, with the speed of the engine;

Fig. 5 shows a section taken on the line V—V of Fig. 6 through a still further embodiment of a governor according to the invention;

Fig. 6 is a section on the line VI—VI of Fig. 5.

In the various figures, corresponding parts have been denoted by the same reference numerals. In Fig. 1, **20** designates a shaft, the number of revolutions of which is dependent on the number of revolutions of the driving shaft of the engine. The shaft **20** drives through a gearing an armature in the form of a cylindrical ring **51** of soft iron. The ring **51** surrounds a permanent magnet **50**, a suitable gap being provided between the two elements. The magnet **50** is preferably of a material having a great quantity of magnetic energy and being non-sensitive to shocks and high temperatures. To this end Al-Ni-alloyed steel, for example, is to be preferred to ordinary carbon steel. On rotation of the ring **51** a turning moment will be produced on the permanent steel magnet **50** which is rotatably mounted on a shaft **52** coinciding with the axis of the armature. From the shaft **52**, this turning moment is transmitted either directly to a control member **27** or over a device as will be described in the following. The member **27** may be a throttle valve in a conduit **28** for the supply of driving medium to an engine. A shaft **54** carrying the movable member of the valve **27** is through one or more links **35** connected to a spring **29**.

The spring **29** counterbalances the turning moment produced on rotation of the magnet **50**. The spring **29** is so dimensioned that equilibrium will be produced between the spring tension and the turning moment in a position of the valve **27** in which the supply of driving medium to the engine corresponds to normal number of revolutions at normal load. If the number of revolutions of the engine increases, the turning moment or torque will rise, the valve **27** being then throttled, so that the supply of driving medium is diminished and the engine is again caused to approach the initial speed. At a decrease of the speed of the engine, the turning moment will fall, the spring tension then overweighing so as to open the valve **27** so that the supply of driving medium is increased and the number of revolutions of the engine rises towards the normal one. The number of revolutions at which a balance sets in between the torque of the armature **50** and the moment of the spring **29**, that is to say the number of revolutions to which the engine is regulated by the governor, may be adjusted by changing the tension of the spring.

An engine, for instance an internal combustion motor, may be intentionally or unintentionally reversed. In case of intentional reversing or backward running, the shaft **52** may be connected directly to the shaft **54**. It is then only necessary to have the spring **29** to give the same tension in both turning directions of the adjusting member. Unintentional reversing may occur in motors constructed merely for one direction of rotation, for instance, on account of an incorrect assembly of the motor, so that premature ignition sets in. In order to protect such engine against dangerous speeds at unintentional reversing through too ample a supply of driving medium, an auxiliary throttle member 53 may be used, which is inserted in series with the control member 27 in the conduit 28 for the driving medium. The permanent magnet 50 serving as adjusting member is not connected directly to the shaft 54 actuating the control member 27 and being under the influence of the spring 29, but the torque of the shaft 52 is transmitted to the shaft 54 through an arm 55 having a pin 58, and through an arm 56 or the like, which are rigidly connected with the respective shafts. The pin 58 is not connected to the arm 56 but only abuts thereagainst on normal operation of the governor. When the engine stops, the spring 29 moves the control member 27 into its fully open position wherein it stops against a fixed abutment 35'. The adjusting member 50, which when stationary has no torque, is then free to move further therefrom by a certain angle in the same direction, without the control member 27 being actuated. Should the impulse member 51 be driven in a direction opposed to that intended for normal operation, the adjusting member will be subjected to a moment in this direction corresponding to the rotational speed, the pin 58 thus actuating another arm 59 secured on a shaft 60 which enters the throttle member 53. Shaft 60 is provided with an arm 35*a* to which is connected a spring 29*a* tending to turn the shaft 60 in a direction opening the valve 53. A stop 35*a'* is provided for holding the shaft in the full open position of the valve. Rotation of the shaft 60 against the force of spring 29*a* actuates the valve 53 so that the supply of driving medium through said conduit is diminished or cut off, or some other member will be actuated, which may cause the power engine to slow down or stop. If the cut-off member 53 be made easily actuated relatively to the turning moment of the adjusting member 50, as by making the spring 29*a* relatively light, such operation may take plate at a comparatively low number of revolutions of the power engine.

The steel magnet 50 may alternatively form the impulse member while the armature 51 is the adjusting member. In this case the permanent steel magnet may be formed as a ring surrounding an armature made from soft iron. Also, the external element 51 need not be made as an enclosing ring, and otherwise the magnet as well as the armature may be given any suitable form known per se from the art of magnets.

Fig. 2 shows a modification of a device for allowing reversal of the direction of rotation of the engine. On normal operation of the engine, the shaft 52 of the adjusting member actuates the control member 27 over the links 55, 58 and 56 in the same manner as in Fig. 1. At backward running, however, the torque of the adjusting member is transmitted to a link 59 which, in turn, causes the control member to be turned in one and the same turning direction as on normal operation, for instance through an arm 84, a rod 85, and a link 86 arranged on the shaft 54. In this case, the requisite control of the supply of driving medium will thus be obtained by a single member in the driving medium conduit 28.

In the embodiments above described, the adjustable torque balancing the adjusting member is effected by means of a spring. This torque imparts to the governor a different controlling character, if the same remains constant during the controlling movement, or if it is increased or decreased. On account of the special properties of a spring, there are to some extent restricted possibilities available for the automatic variation of the moment during the controlling movement. If the spring be replaced by a magnetically operating device, as shown in Fig. 3, the moment values thereof within the required ranges of speeds may be caused to follow any desired curve relatively to the corresponding values of the adjusting member, as will be explained more in detail in connection with Fig. 4 so that the governor will always obtain the controlling character aimed at with respect to rapidity and sensitivity within different ranges of speeds. The said device may consist of a permanent magnet 61 which is connected by a shaft 62 to the controlling member 27 and to the shaft 52 of the adjusting member 50. The magnet 61 is surrounded by a cylindrical ring 63 which is driven over a gearing 64 from the same shaft 20 as the armature 51, but in opposite direction to the latter. The device 61, 63 is of the same kind as the members 50, 51 although the turning moments produced by the same are directed oppositely relatively to each other. Also, the gear on shaft 20 which drives ring 63 is of greater diameter than the corersponding gear for driving ring 51, whereby ring 63 rotates at a higher speed than does ring 51.

A control of the strength of the turning moment in the device 61, 63 according to Fig. 3 may be effected, for example, by the two elements 61, 63 being axially displaceable relatively to each other. The surfaces of the elements facing one another may be conical so that the air gap therebetween is increased or decreased at such displacement. This also holds true with respect to the governor members 50, 51.

In all embodiments, the alteration of the torque of the adjusting member, in other words the alteration of the adjusting power, follows a curve 65, as will appear from Fig. 4, relatively to the speed of the engine. In the said figure, the horizontal X-axis represents the speed and the vertical Y-axis the torque. As will be seen from Fig. 4, the adjusting power is zero when the speed is naught. The adjusting power curve 65 rises from this zero value until at a certain speed it forms a more or less pronounced knee at a maximum value of the adjusting power, and may then extend in different ways at different dimensionings, as indicated by dotted lines. It is of essential importance for the invention that the rotational speed be given such a value that the adjusting power within a sufficient range of numbers of revolutions increases and decreases materially with an increased or decreased speed, that is to say, that the portion of the adjusting power curve having a sufficiently steep rise is made use of. This portion may consist, for instance, of the range of speed designated in the figure by *a*.

In Fig. 4, three lines 80, 81, 82 are shown, which represent diagrammatically different conceivable possibilities for the vibration of the power or torque of the counter-balancing element at the speeds in question. The curves 80—82 are imagined to intersect curve 65 at point 83 within or at the centre of the range of speeds *a*. The curve 80 rises with the speed and the vertical Y-distance between this curve and curve 65 represents on both sides of point 83 the magnitude of the adjusting power at different speeds exerted by the adjusting member on the control member. The curve 81 is imagined to extend parallel to the X-axis. It will be understood that the vertical distances, that is to say the adjusting powers, increase more rapidly when the speed of the power engine leaves point 83. Inasmuch as the curve 82 falls with an increased speed, the adjusting powers must become still greater at a certain change of the speed than in the two other cases. The curve 80 may be said to represent the power or turning moment in the case of a spring. By making this spring of sufficient length, the curve 81 may be approached. With a counterbalancing device according to Fig. 3, torque curves 80, 81 may be obtained, and it is even possible to reach a curve 82 with possibilities in consequence thereto to obtain the requisite adjusting power for smaller alterations of speed. Curve 80 may be obtained by the device shown in Fig. 3, if the gearing is so designed that the speed of ring 63 is sufficiently greater than that of ring 51 so that the coupling 61, 63 is operating on the bent portion of curve 65 while the coupling 50, 51 is operating on the straight inclined portion between the lines *a*. Curves 81 and 82 are obtainable if the gearing is designed so as to give the ring 63 a still higher speed so that the coupling 61, 63 operates in the broken line portion of the curve 65 beyond the bend, curve 81 being obtained if the speed-torque curve remains horizontal, while curve 82 is obtained if the torque decreases with an increase of speed.

Figs. 5 and 6 illustrate a constructive embodiment of a governor according to the invention. The driving shaft of the governor is designated by 20, as before, and is journalled in the casing of the governor by means of ball bearings 66, 67, or the like. A pinion 68 secured to the shaft 20 drives a gear 69 of non-magnetic material, such as brass. This gear wheel 69 is mounted on a rigid sleeve 71 by means of a bearing 70. The gear wheel 69 carries an armature 51 in the form of a cylindrical ring from soft iron. The ring 51 is supported on one side thereof by a non-magnetic element 72 mounted in a rigid sleeve 74 by means of a bearing 73. A permanent steel magnet 50 is provided inside the ring 51 and between the parts 69 and 72, the magnet with its shaft 52 being then rotatably mounted in bearings 75, 76. The shaft 52 is connected in turn to a control member 27 and a spring 29, or with a magnetic device according to Fig. 3 as above described.

The member 51 of soft iron may be provided with a preferably short-circuited winding, among other things for the purpose of giving the adjusting power curve 65 (Fig. 4) suitable form. In Figs. 5, 6, this winding is constituted by copper bars 79 extending axially through the armature 51 and being in electrically conducting connection with the brass rings 69, 72.

The invention is not limited to the subject matters of the description hereinbefore but may be varied in many respects, without the principle of the invention being departed from. The number of revolutions of the engine may happen to vary during one revolution, and to prevent the control member at such alterations of the speed, if not desired, from being brought into function, weights or the like may be arranged on the shaft connected with the adjusting member, said weights then causing damping of the movements of the member. A governor according to the invention may be used in combination with a so-called racing governor adapted to open the motor cylinders, so that compression cannot be effected. Such a racing governor is necessary at all kinds of governors for motors which may be driven unintentionally by other means than by the ordinary driving medium, for instance by the lubricating oil in certain types of internal combustion motors.

In certain cases the magnetic field may instead of by a permanent magnet be produced by an electro-magnet, either forming the rotating or the relatively stationary part of the governor. This electro-magnet is then fed with direct current through wires from a separate and constant source of current. Such embodiments are, however, more complicated and not as safe in operation as those described above in connection with the figures.

In power engines, such as hydraulic turbines, which require great adjusting forces for the shifting of the control member, the magnetic governor may obviously be arranged in known manner only to actuate an electric contact system or other impulse member for a so-called servo-motor, instead of actuating the control member directly, said servo-motor performing, in turn, the actual adjusting work.

What I claim is:

1. In a governor for actuating the speed control device of an engine, a rotatably mounted annular ring of magnetic material, a short circuited winding carried by said ring, means for rotating said ring at a speed proportionate to that of the engine, an armature of magnetic material turnably mounted concentrically within said ring so as to receive a turning moment proportional to the speed of the ring, means for yieldably resisting actuation of said device in a direction decreasing the speed of the engine, and means operatively connecting said armature with said device whereby rotation of said armature in either direction as a result of increase in speed of said impulse member actuates said control device against the resistance of said yieldable means to decrease the speed of the engine.

2. In a governor for actuating the speed control device of a reversible engine, a rotatably mounted impulse member, means for rotating said member in the same direction as and at a speed proportionate to that of the engine, a turnably mounted adjusting member magnetically coupled to said impulse member so as to receive a turning moment in the same direction as and proportional to the speed of the impulse member, said control device including two control members either of which is independently operable to reduce the speed of the engine, means for yieldably resisting actuation of each of said control members in a direction decreasing the speed of the engine, means operatively connecting said adjusting member to one of said control members whereby rotation of said adjusting member in one direction as a result of increase in speed of said impulse member actuates said one control member to decrease the speed of the engine, and means operatively connecting said adjusting member to the other of said control members whereby rotation of said adjusting member in a direction opposite to the aforesaid as a result of increase in speed of said impulse member actuates said other control member to decrease the speed of the engine.

3. In a governor for actuating the speed con-

trol device of a reversible engine, a rotatably mounted annular ring of magnetic material, a short circuited winding carried by said ring, means for rotating said ring in the same direction as and at a speed proportionate to that of the engine, an armature of magnetic material turnably mounted concentrically within said ring so as to receive a turning moment in the same direction as and proportional to the speed of the ring, said control device including a control member movable in one direction to increase the speed of the engine and movable in the opposite direction to decrease the speed of the engine, yieldable means for resisting movement of the control member in the last mentioned direction, and means operatively connecting said armature with said control member whereby rotation of said armature in either direction as a result of increase in speed of said impulse member moves said control member in a direction against the resistance of said yieldable means to decrease the speed of the engine.

4. In a governor for actuating the speed control device of an engine, a rotatably mounted impulse member, means for rotating said member at a speed proportionate to that of the engine, said speed control device including an element turnable in one direction to increase the speed of the engine and turnable in the opposite direction to decrease the speed of the engine, an adjusting member connected to said element and magnetically coupled to said impulse member so as to receive a turning moment directly proportionate to the speed of the impulse member, and means for yieldably resisting turning of said element under the influence of said turning moment including a second adjusting member connected to said element, a second impulse member magnetically coupled therewith, and means for rotating said second impulse member at a speed proportionate to the speed of the engine but at a higher speed than and in the opposite direction from the first mentioned impulse member.

5. A device as set forth in claim 4 including means for varying the air gap between one of the impulse members and the associated adjusting member.

6. In a governor for actuating the speed control valve mechanism of an engine, a rotatably mounted annular ring of magnetic material, a short circuited winding carried by said ring, means for rotating said ring at a speed proportionate to that of the engine, an armature of magnetic material turnably mounted concentrically within said ring so as to receive a turning moment proportional to the speed of the ring, means connecting said armature to said valve mechanism for direct operation of the latter by the former, and means for yieldably resisting actuation of said mechanism in a direction decreasing the speed of the engine.

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