March 2, 1943. A. DUWE 2,313,011

APPARATUS FOR CONTROLLING THE SPEED OF REVOLUTION OF MACHINES

Filed June 24, 1939 3 Sheets-Sheet 1

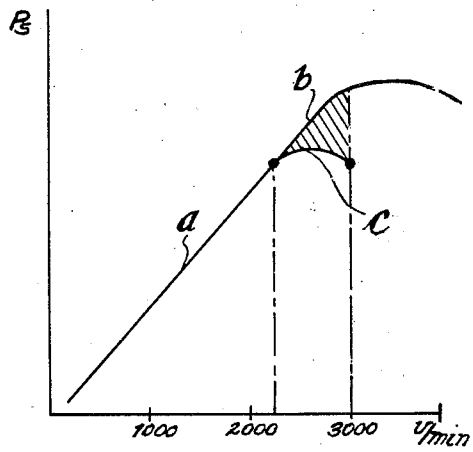
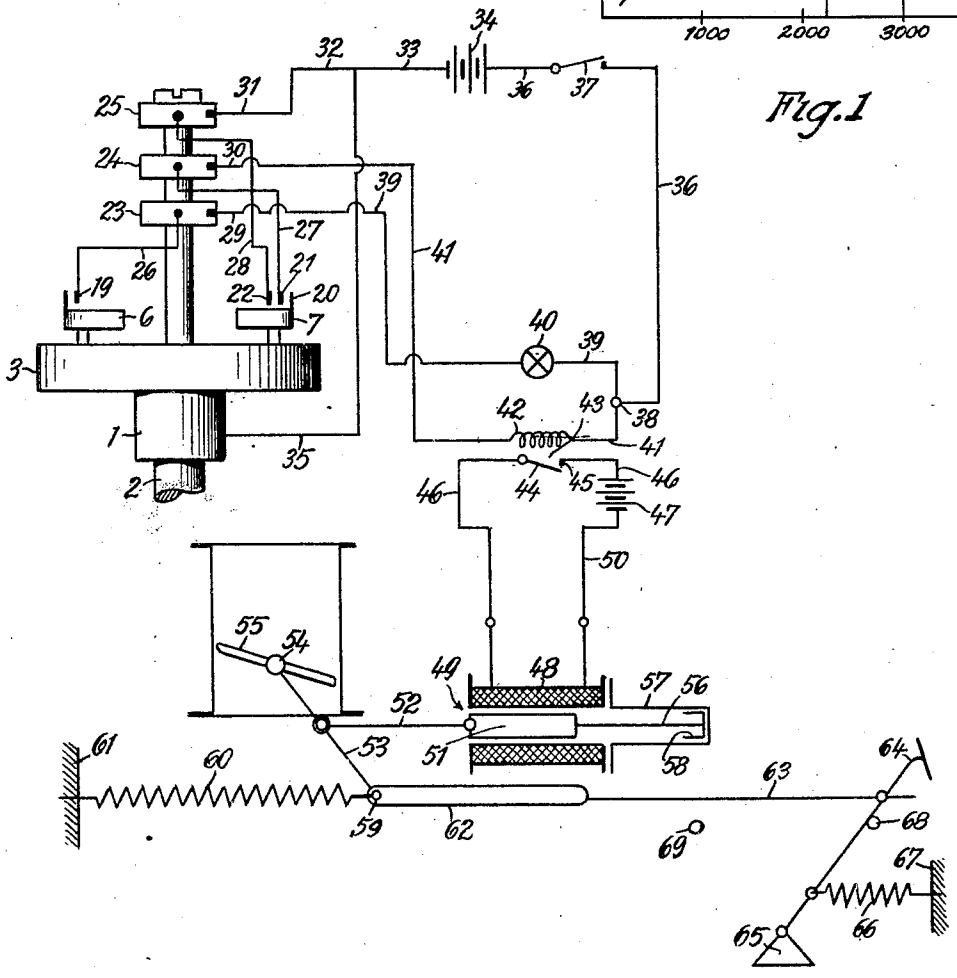


Fig. 5

Fig. 1



Inventor: August Duwe,

Attorney: Harold D. Penney.

March 2, 1943. A. DUWE 2,313,011

APPARATUS FOR CONTROLLING THE SPEED OF REVOLUTION OF MACHINES

Filed June 24, 1939 3 Sheets-Sheet 2

Fig. 2

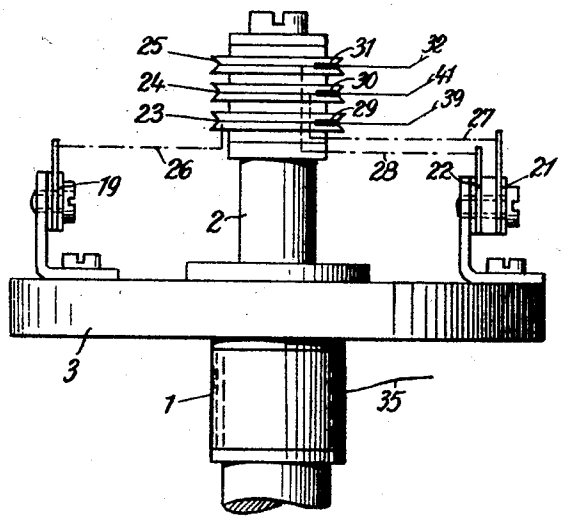


Fig. 4

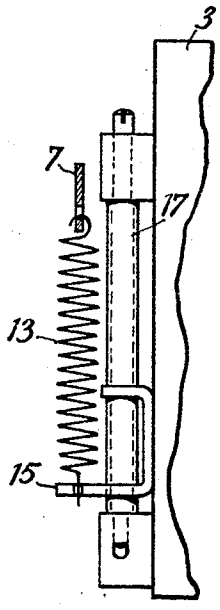
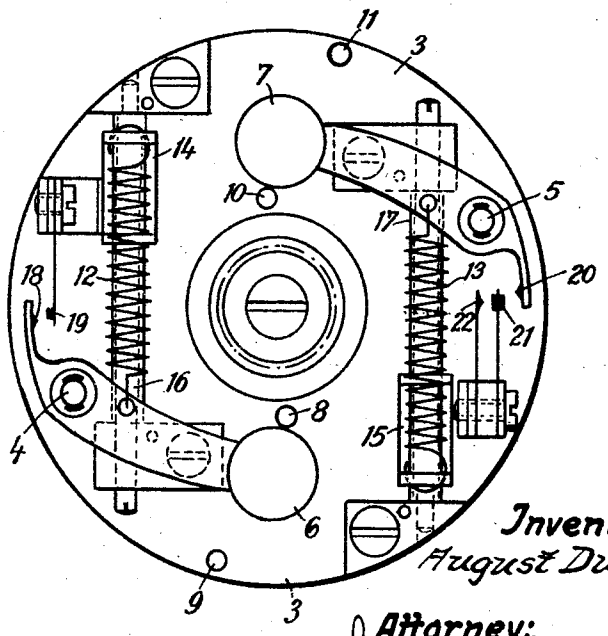


Fig. 3



Inventor:
August Duwe,

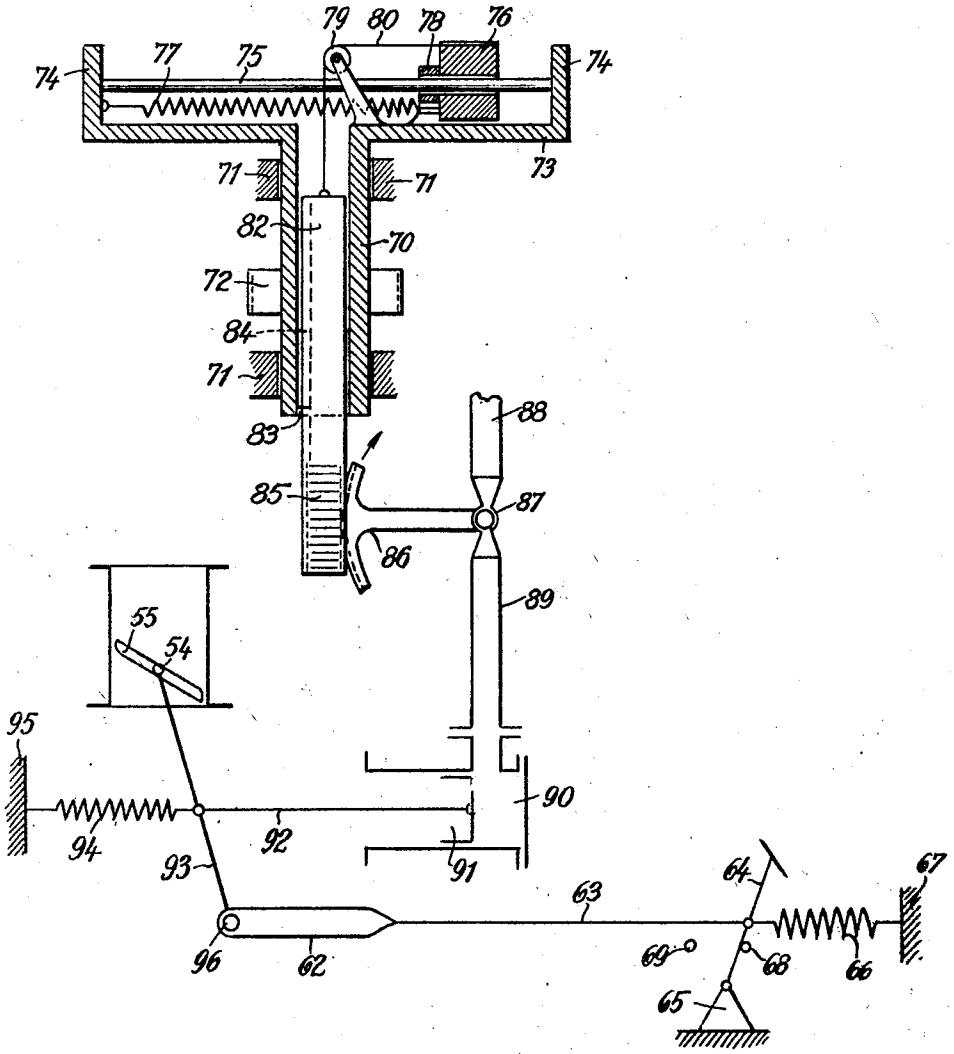
Attorney:
Harold D. Penney.

March 2, 1943. A. DUWE 2,313,011

APPARATUS FOR CONTROLLING THE SPEED OF REVOLUTION OF MACHINES

Filed June 24, 1939 3 Sheets-Sheet 3

Fig. 6



Inventor:
August Duwe,

Attorney:
Harold D. Penney.

...VI DEVICES.

Search Room

Patented Mar. 2, 1943

2,313,011

UNITED STATES PATENT OFFICE

2,313,011

APPARATUS FOR CONTROLLING THE SPEED OF REVOLUTION OF MACHINES

August Duwe, Villingen, Schwarzwald, Germany; vested in the Alien Property Custodian

Application June 24, 1939, Serial No. 280,947
In Germany June 27, 1938

10 Claims. (Cl. 264—17)

This invention relates to an apparatus having a centrifugally operated member or switch for supervising or controlling the speed of revolution of a machine or engine, for example, a vehicle engine.

It is desirable that the full power of the engine should be maintained until the maximum speed of revolution is reached. Only when the maximum speed is reached should a reduction in the speed of revolution be effected.

This result is obtained, in accordance with the present invention, by actuating a throttle member of the engine, for example the throttle valve of a vehicle motor, by the centrifugally operated member or switch in such a manner that, when the maximum permissible speed of revolution of the engine is reached, the throttle prevents this speed of revolution from being exceeded and by associating with a member which is controlled by the centrifugal switch and by which the throttle member is actuated a damping device by which the closing movement of the throttle is retarded. By this means the advantage is obtained that no drop in the power of the engine occurs before the maximum speed is reached, that is to say the full power of the engine is maintained until the maximum predetermined speed of revolution is reached. Only when the maximum predetermined speed to which the apparatus has been set is reached does an accurately regulable drop in power take place. Further in the apparatus of the invention, owing to the fact that the closing movement of the throttle is delayed, hunting of the engine, for example of the vehicle motor, is prevented.

In order that the invention may be readily understood and carried into effect two forms of controlling apparatus in accordance with the invention are illustrated diagrammatically and by way of example in the accompanying drawings, in which

Figure 1 illustrates a power curve of an engine in relation to the speed of revolution.

Figure 2 is a side elevation of part of the apparatus, comprising a disc carrying astatic centrifugal pendulums, the pendulums being omitted for the sake of clearness.

Figure 3 is a top plan view of the disc shown in Figure 2 and of the parts carried by it.

Figure 4 is a side elevation of a spring tensioning device for the astatic pendulums.

Figure 5 is a diagram of electrical connections for the apparatus illustrated in Figures 2–4, and

Figure 6 illustrates a second form of construction of the apparatus.

Referring to the drawings, the diagram in Figure 1 shows the relation between the power of the engine and the speed of revolution. The ordinates in the diagram represent the power of the engine in horse power whereas the abscissae represents the speed of revolution in revolutions per minute. As the speed of revolution increases the power also increases. For the engine to which the curve refers the power is a maximum at about 3500 revolutions per minute as illustrated by the power curve *a*—*b*.

If a supervising or controlling apparatus which is operated directly by a gravity-retracted ball governor were set to a maximum speed of revolution of about 3000 revolutions per minute, the fuel supply to the engine would be throttled soon after the speed had reached 2000 revolutions, that is to say the power curve would be changed so as to take the course indicated by the branch *c*. Therefore if such an apparatus were employed the ability of the vehicle to climb hills in low gear would be greatly reduced.

In the apparatus in accordance with the invention which is hereinafter described the dip in the power curve which is represented by the branch *c* of the curve is prevented. The engine maintains its power in accordance with the curve *a*, *b* until its speed of revolution reaches the predetermined maximum speed, that is to say so that the shaded area lying between the lines *b* and *c* would be eliminated.

In the form of construction of the apparatus according to the invention which is illustrated in Figures 2–5 a vertical shaft **2** can rotate in a bearing **1** which is mounted on the vehicle frame. The shaft **2** is rotated from the engine, for example the vehicle motor, the running of which is to be controlled or supervised. On the shaft **2** is fixed a disc **3** to which two vertical pins **4** and **5** (Figure 3) are attached. Two astatic pendulums **6** and **7** can pivot about these pins respectively. The stroke of the pendulums **6** and **7** is limited by stops **8**, **9** and **10**, **11** respectively which are fixed on the disc **3**. A spring **12** and **13** acts on each of the pendulums **6** and **7** respectively. One end of each spring is connected to its pertaining pendulum and the other end is fixed to a slide **14** and **15** respectively. Each of the slides **14** and **15** is adjustable by means of a screw-spindle **16**, **17** respectively which is mounted on the disc **3**. The tension of the springs **12**, **13** and, therefore, the speed at which the device responds can be altered by means of these screw-spindles. The slides **14** and **15** are adjusted in such a manner that the tension on the spring **13** is greater than that on the spring **12**.

Ordinarily, under the action of the springs **12** and **13** the pendulums **6** and **7** bear against the stops **8** and **10** which limit their stroke inwardly. Both pendulums **6** and **7** are electrically connected mainly through their pivot pins **4** and **5** to the supporting disc **3**.

The pendulum **6** carries the one contact **18** of a switch of which the other contact **19** is held,

when the pendulum 6 is in its normal or inoperative position, at a distance from the first contact 18. The switch 18, 19 is therefore open when the pendulum 6 is in its normal or inoperative position.

The second pendulum 7 carries the one contact 20 of a double switch of which the two other contacts 20 and 21 are situated at a distance from the contact 20 and from one another as long as the pendulum 7 is in its normal or inoperative position. The switch 20, 21 and 22 is therefore also ordinarily open.

Above the supporting disc 3 the shaft 2 is provided with three slip rings 23, 24, 25 which are insulated one from another. The lower slip ring 23 is connected by a conductor 26 to the contact 19. The middle slip ring 24 is connected to the contact 21 by a conductor 27 and the upper slip ring 25 is connected to the contact 22 by a conductor 28. The slip rings 23, 24 and 25 are contacted respectively by sliding contacts 29, 30 and 31. The sliding contact 31 is connected by conductors 32, 33 (Figure 5) to one pole of a battery 34. The bearing for the shaft 2 is also connected to this pole of the battery by the conductors 35 and 33. The other pole of the battery is connected by a conductor 36, in which a switch 37 which can be sealed is interconnected, to a branch point 38. From the branch point 38 a conductor 39 in which a signal lamp 40 is connected leads to the sliding contact 29. Instead of the signal lamp 40, or in addition to this signal lamp, an electromagnet can be connected in the conductor 39 by which an acoustic signalling device, for example a siren, can be set in operation.

Another conductor 41, in which the coil 42 of a relay 43 is connected, leads from the branch point 38 to the sliding contact 30. The armature 44 of the relay 43, and the contact 45, which coacts with the armature, are connected in a conductor 46 which leads on the one hand to one pole of a battery 47 and on the other hand to one end of the winding 48 of a solenoid 49. The other pole of the battery 47 is connected by a conductor 50 to the other end of the solenoid winding 48.

The core 51 of the solenoid 49 is connected at one end by a link 52 to a lever 53 which is fixed to the spindle 54 of the throttle valve 55 of the vehicle engine. The other end of the core 51 of the solenoid is connected by a rod 56 to the piston 58 of an air damping device which is slideable in a cylinder 57. The cylinder 57 is connected to a frame which carries the winding 48 of the solenoid.

The parts of the system of connections which has hitherto been described, for example the batteries, 34, 47, the signal lamp 40, the relay 43 and the solenoid 49 are mounted on the frame of the vehicle to which the engine of which the speed of revolution is to be supervised or controlled belongs.

A lateral pin 59 is attached to the free end of the above-mentioned lever 53 which is connected to the throttle valve 55. To this pin is fixed one end of a spring 60 which is anchored at the other end to a part 61 of the vehicle frame. The pin 59 engages in a loop-shaped frame 62 which is pivotally connected to a pedal lever 64 by means of a rod 63 which is attached to the frame 62. The pedal lever 64 can rotate about a bearing 65 on the vehicle frame and is also connected by a spring 66, which is stronger than the spring 60, with a part 67 of the vehicle frame.

The turning movement of the pedal lever 64 is limited in the one direction and the other by two stops 68 and 69 respectively. The spring 66 ordinarily holds the pedal lever 64 in contact with the stop 68. When the pedal is in this position the throttle 55 is closed and the pin 59 is situated at the left-hand end (in Figure 5) of the frame 62. As will be clear from the above explanation, the pedal 64 is connected to the throttle valve 55 by means of the frame 62 and the pin 59 which is acted upon by the spring 60, in such a manner that, when the pedal 64 is pressed forwards the throttle valve 55 is opened by the spring 60. The tension of the spring 60 can be regulated by means of any suitable tensioning device which is not illustrated in the drawings.

The method of operation of the device which has been described is as follows:

The astatic pendulums 6 and 7 (Figure 3) have the property of suddenly moving from their normal or inoperative position into their operative position when the speed of revolution to which they have been set is reached.

It will now be assumed that the device described has been set by means of the screw spindle 17 (Figure 3) to a maximum speed of 3000 revolutions per minute. It will further be assumed that the pedal 64 is pressed forwards, that is to say towards the stop 69. Then, since by means of the screw-spindle 16 the tension of the spring 12 is regulated to be lower than that of the spring 13, the pendulum 6 suddenly closes its pertaining contacts 18 and 19 at a speed of about 2800 revolutions per minute. A circuit is therefore established which runs from the battery 34 through the conductor 36, the switch 37, the branch point 38, the conductor 39, the lamp 40, the sliding contact 29, the slip ring 23, the conductor 26, the contacts 18 and 19, the disc 3, the bearing 1, the conductors 35, 33, and back to the battery 34. The lamp 15 is, therefore, illuminated or, as above described, the circuit of a siren is connected, so that the attention of the driver is called to the fact that the speed of the engine is approaching the maximum permissible speed.

When the maximum speed of 3000 revolutions per minute to which the device has been set is reached, the pendulum 7 swings suddenly outwards and closes the contacts 20, 21 and 22. Consequently a circuit is established which runs from the battery 34, the conductor 36, the switch 37, the branch point 38, the conductor 41, the relay winding 42, the sliding contact 30, the slip ring 24, the conductor 27, the contacts 21 and 22, the conductor 28, the slip ring 25, the sliding contact 31, the conductors 32, 33 and back to the battery 34. Therefore, the relay 43 is caused to respond. Owing to the attraction of the armature 44 of the relay, a circuit is then established which runs from the battery 47, the conductor 50, the solenoid winding 48, the conductor 46, the armature 44, the contact 45 and back to the battery 47. The solenoid 49 is, therefore, energised so that, by means of the link 52 and the lever 53, the core 51 of the solenoid closes the throttle valve 55 except to a certain extent which can be regulated. This extent by which the valve remains open can be regulated by altering the tension of the spring 60.

By throttling the supply of mixture to the engine by means of the throttle valve 55, the speed of revolution of the engine is quickly reduced. The centrifugal pendulums 6 and 7 suddenly re-

turn again into their inoperative positions, the pendulum 7 returning first and then the pendulum 6. After the return of the pendulum 7 into its inoperative position the throttle valve 55 again opens under the action of the spring 60.

By opening the switch 37 the lamp 40 and the relay 43 can be instantaneously disconnected if a limitation of the speed of revolution is not desired.

The use of the intermediate relay 43 prevents the spark, which is formed when the solenoid which is used to actuate the throttle valve 55 is disconnected, from damaging the sensitive contacts 20, 21 and 22 of the centrifugal pendulum 7. The contact 45 for the relay 43 and the part of the armature 44 which makes contact with it are made of specially resistant material, for example tungsten.

When the solenoid 49 is without current the throttle valve 55 can be adjusted as desired by means of the pedal 64. When the pedal 64 has been moved forwardly into any operating position then, owing to the above-described connection by means of the frame 62 and the spring-actuated pin 59, the throttle valve 55 can be moved at any time into the closed position independently of the pedal 64 by the solenoid 49. A too powerful closing of the throttle valve 55 when the solenoid 49 is energised is prevented by the damping device 57, 58.

The uppermost slip ring 25 and the sliding contact 31 can be omitted, and instead of the three contacts 20, 21 and 22 two contacts only may be provided. The parts 25, 31 and the group of three contacts 20, 21 and 22 are provided in case the apparatus contains, in addition to the device described, a further device for producing a different illumination of the lamp 40 when the two pendulums 6 and 7 come into action, for example, for producing a flashing light when the pendulum 6 responds and a continuous light when the pendulum 7 responds. The particular construction of this additional device is not described since the present invention is not concerned with it.

The form of construction which is illustrated in Figure 6 differs from the form of construction which has been previously described in that in the apparatus shown in Figure 6 the astatic pendulum operates by mechanical means a controlling device for actuating the throttle valve.

In Fig. 6 a vertical hollow shaft 70 is revoluble in bearings 71 which are mounted on the vehicle frame. The shaft 70 is rotated from the vehicle motor by means of a toothed wheel 72 which is keyed on the shaft. At the upper end of the shaft 70 there is provided a disc 73 which is provided at two diametrically opposite places on its edge with upwardly extending flanges 74. Between the flanges 74 is fitted a rod 75 on which a centrifugal mass, for example a ring 76, which acts in the same way as an astatic centrifugal pendulum, can slide. The centrifugal mass 76 is usually held against a stop 78 which is fixed to the disc 73 by means of an adjustable spring 77 of which one end is connected to one of the flanges 74 and the other end to the mass 76. A pulley 79 is also mounted on the disc 73. A wire or cord 80 passes around this pulley. One end of the wire 80 is connected to the mass 76, and the other end is fixed to a bar 82 which is movable upwards and downwards in the hollow of the shaft 70. The pulley 79 is mounted in such a manner that the part of the wire 80 which is attached to the pin is in line with the axis of the shaft 70. A pin 83 which is fixed in the interior of the hollow shaft 70 engages in a longitudinal groove 84 in the bar 82, so that the bar 82 rotates with the shaft 70. At its lower end the bar 82 is provided with a ring of teeth 85. With the teeth 85 engages a toothed sector 86 which is fixed on the shaft of a valve 87, which may be of the rotary slide valve kind. The valve 87 communicates on one side with a pipe 88 which is associated with the vehicle motor and in which there is suction. The valve 87 is also in communication on the other side by a pipe 89 with a cylinder 90 in which a piston 91 can move. The piston 91 is connected by a link 92 to a lever 93 which is fixed to the spindle 54 of the throttle valve 55 and corresponds to the lever 53 in Figure 5. The lever 55 is again connected by means of an adjustable spring 94 to a fixed part 95 of the vehicle frame. A lateral pin 96 which is provided on the lever 93 corresponds to the pin 59 of Figure 5 and engages in the above-described frame 62 which is connected to the pedal 64. In the construction illustrated in Figure 6, the strength of spring 94 which is connected to the lever 93 is also less than that of the spring 66 which is connected to the pedal 64.

The method of operation of the device illustrated in Figure 6 is similar to the method of operation of the device illustrated in Figures 2 to 5. When the maximum speed of revolution is reached the mass 76 flies suddenly outwards towards the stop 74 and thereby lifts the bar 72 by means of the wire or cord 80. Through the agency of the teeth 85 and the toothed sector 86, the valve 87 is therefore opened and the suction is communicated to the cylinder 90. Consequently, the piston 91 is drawn further into the cylinder 90 and the throttle valve is closed. Instead of the above described astatic pendulum, for example, the pendulums 6 and 7 shown in Figure 3, an ordinary tachometer, by which the previously-described contacts are closed in succession, can be used.

I claim:

1. Apparatus, for controlling the speed of an engine having a throttle, said apparatus comprising governor devices controlled by the engine, one operating at a slightly higher speed than the other; a control device controlled by the higher speed device and controlling the throttle for throttling the throttle when the higher speed is reached; means for at will opening the throttle when not throttled by said device; and signal means controlled by the other governor device for warning the operator that the higher speed device is about to control if the speed increases.

2. Apparatus as in claim 1 provided with a dash pot for retarding the control device to prevent hunting and to give the operator time to control the throttle after the signal means has operated.

3. Apparatus, for controlling the speed of an engine having a throttle, said apparatus comprising a shaft rotated by the engine; slip rings on the shaft; a body on the shaft; a pair of astatic pendulums on said body; springs of unequal power holding the respective pendulums from outward centrifugal movement; normally open signal and control switches associated with the pendulums of the weaker and stronger springs respectively, and adapted to be closed by movement of the pendulums when predetermined respective speeds are obtained; a relay having its magnet connected in circuit with the control

switch and a slip ring; electro-magnetic device controlled by the relay and controlling the throttle for throttling the throttle when the relay is operated; means for at will opening the throttle when not throttled by said device; and signal means in circuit with another slip ring and the signal switch for warning the operator that the device is about to control.

4. Apparatus, for controlling the speed of an engine having a throttle, said apparatus comprising a body rotated by the engine; a pair of astatic pendulums on said body; springs of unequal power holding the respective pendulums from outward centrifugal movement; normally open signal and control switches associated with the pendulums of the weaker and stronger springs respectively, and adapted to be suddenly closed by movement of the pendulums when predetermined respective speeds are obtained; a relay having its magnet connected in circuit with the control switch; electromagnetic device controlled by the relay and controlling the throttle for throttling the throttle when the relay is operated; the relay serving to prevent sparking at the switches; means for at will opening the throttle when not throttled by said device; and signal means in circuit with the signal switch for warning the operator that the device is about to control.

5. Apparatus, for controlling the speed of an engine having a throttle, said apparatus comprising a tubular shaft rotated by the engine and carrying a flanged disk; a diametric rod mounted on the flange; an astatic pendulum slidable on said rod; a spring drawing the pendulum toward the center of the disk against outward centrifugal force; a vertical rod slidable in the shaft and having ring teeth at the bottom; means for drawing the pendulum inward by action of downward movement of the vertical rod; a source of power-medium; a control device adapted to be controlled by the said medium for actuating the throttle; a toothed sector meshed with said ring teeth; means controlled by said sector for admitting said medium to the device for controlling the throttle for throttling the throttle when the sector is operated.

6. Apparatus for controlling the speed of an engine having a throttle, said apparatus comprising a shaft rotated by the engine; a disc fast on the shaft coaxial therewith; a pin on the disk near the periphery thereof; an astatic pendulum on said disk and disposed approximately circumferential to the disk and having a weight remote from the pin; a tension spring holding the weight from an outward centrifugal movement; and tensioned between a point on the disk at such an angle to the disk that the moment of the spring on the pendulum is decreased as the weight moves outward, whereby the movement of the pendulum is made sudden; a normally open control switch associated with the pendulum adapted to be closed suddenly by the movement of the pendulum when a predetermined speed is obtained and to be opened suddenly when the speed drops below said predetermined speed; a relay having its magnet connected in circuit with the control switch; an electromagnetic device controlled by the relay and controlling the throttle when the relay is operated; the relay and the suddenness of the opening movement of the pendulum serving to prevent sparking.

7. Apparatus, for controlling the speed of an engine having a throttle, said apparatus comprising governor devices controlled by the engine, and operated at slightly different higher and lower speeds; a control device controlled by the higher speed device and controlling the throttle for throttling the throttle when the higher speed is reached; means for at will opening the throttle when not throttled by said device; and signal means operated by the lower speed device at the lower speed and having the new function of warning the operator that the higher speed device is about to control if the speed increases further.

8. Apparatus as in claim 7, provided with a dash pot for retarding the control device to prevent hunting and to serve the new function of giving the operator time to control the throttle after the signal means has operated.

9. Apparatus for controlling the speed of an engine having a throttle, said apparatus comprising a body rotated by the engine; an astatic pendulum on said body suddenly actuated to a maximum position when a predetermined maximum speed is reached; a source of power medium; a throttle spring for opening the throttle; a retarded control device controlled by the said medium for closing the throttle at a predetermined retarded rate against the influence of the spring, the effective force of the medium against the spring being greater than the pressure of the spring; means controlled by said pendulum when actuated for causing said medium suddenly to apply its controlling force to the device for controlling the throttle at said retarded rate for throttling the throttle; and spring means normally overcoming the spring of the throttle for closing the throttle and operative at will for allowing the throttle spring to open the throttle when not throttled by said device; said throttle spring and pendulum being each free of operation or retardation by the other, whereby said maximum position always corresponds to the same maximum speed and said control device closes at said predetermined rate at all times while the pendulum is actuated to said maximum position and not at all before the pendulum reached said position, whereby the full power of the engine may be maintained until said maximum speed is reached, whereby maximum efficiency and output may be automatically maintained.

10. Apparatus, for controlling the speed of an engine having a throttle, said apparatus comprising a body rotated by the engine; an astatic pendulum on said body actuated when a predetermined maximum speed is reached; a source of power-medium; a throttle spring for opening the throttle; a control device controlled by the said medium for closing the throttle against the influence of the spring, the effective force of the medium against the spring being greater than the pressure of the spring; means controlled by said pendulum when actuated for causing said medium to apply its controlling force to the device for controlling the throttle at said rotated rate for throttling the throttle; and spring means normally overcoming the spring of the throttle for closing the throttle and operative at will for allowing the throttle spring to open the throttle when not throttled by said device.

AUGUST DUWE.