Dec. 21, 1948. I. J. SNADER ET AL 2,456,747

SPEED GOVERNOR

Filed March 23, 1944 2 Sheets-Sheet 1

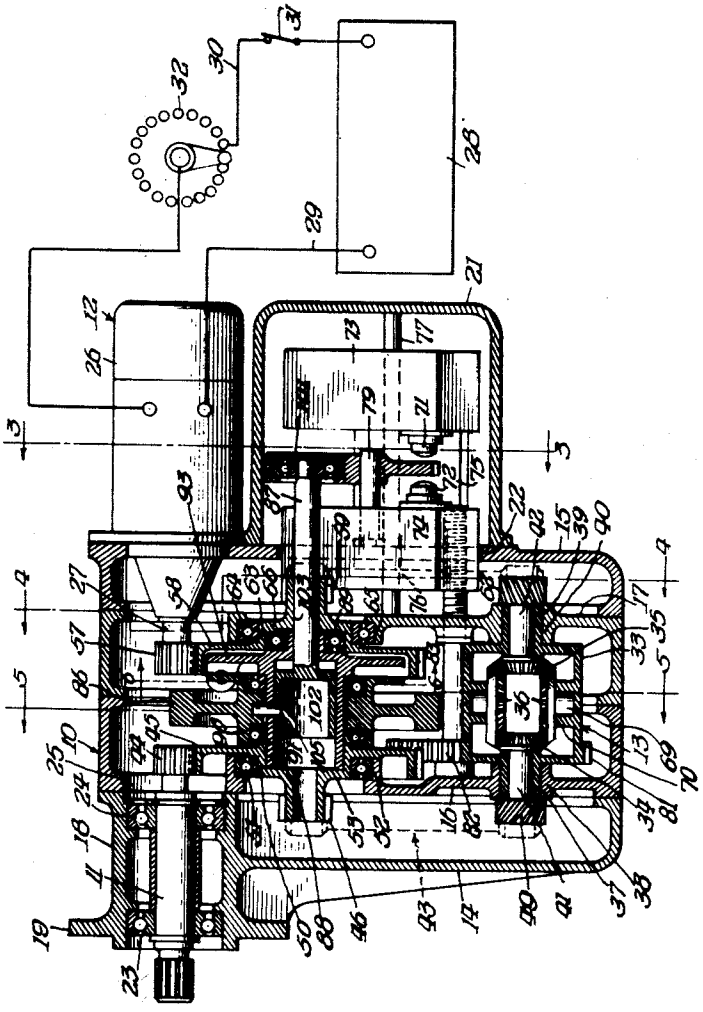


Fig. 2

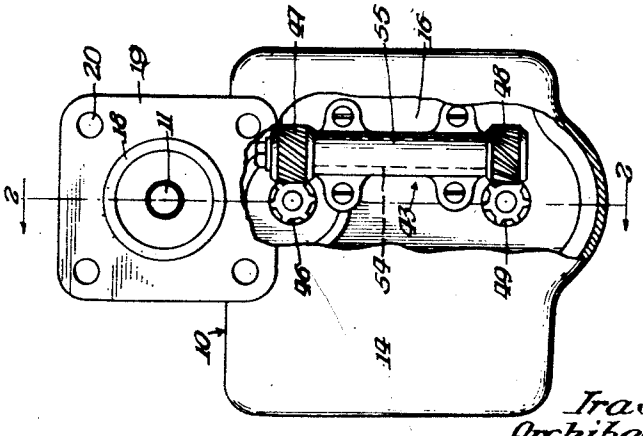


Fig. 1

Inventor
Ira J. Snader
Archibald G. Forsyth
By Fred Gerlach Atty

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SPEED GOVERNOR

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2 Sheets-Sheet 2

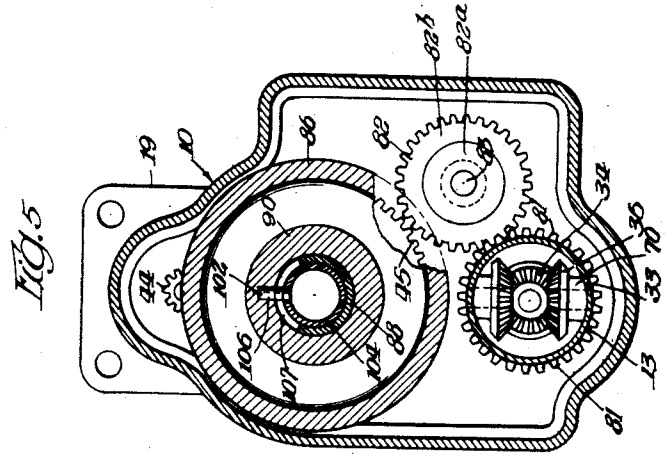


Fig. 5

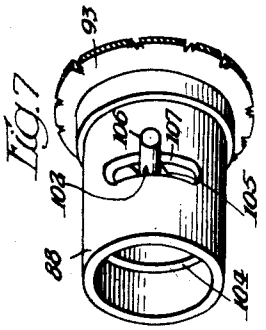


Fig. 7

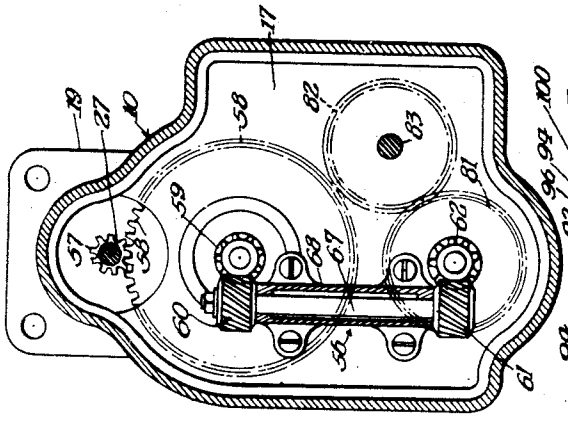


Fig. 4

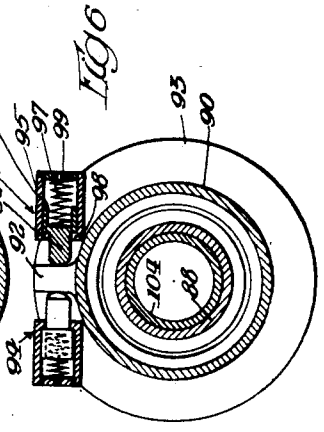


Fig. 6

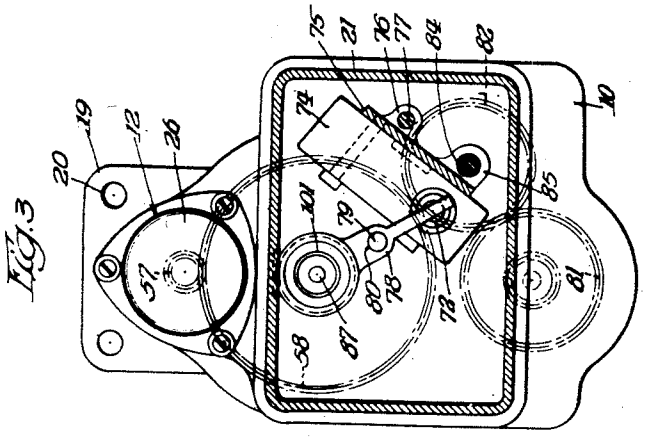


Fig. 3

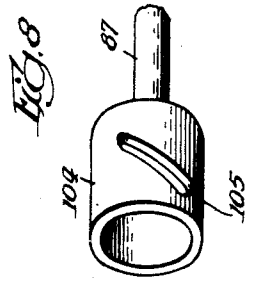


Fig. 8

Inventors
Ira J. Snader
Archibald G. Forsyth
By Fred L. Gerlach Atty.

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UNITED STATES PATENT OFFICE

2,456,747

SPEED GOVERNOR

Ira J. Snader, Detroit, Mich., and Archibald Graham Forsyth, Cheam, England, assignors of one-half to Avco Manufacturing Corporation, a corporation of Delaware, and one-half to The Fairey Aviation Company, Ltd., Hayes, Middlesex, England

Application March 23, 1944, Serial No. 527,836

8 Claims. (Cl. 264—11)

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The present invention relates generally to governor mechanisms for speed controlling purposes. More particularly the invention relates to that type of governor mechanism which is primarily designed for use in connection with an airplane having a controllable pitch propeller and a propeller driving internal combustion engine, and operates by varying the pitch or attack angle of the propeller blades to control or govern the engine so that it operates at a predetermined speed.

One object of the invention is to provide a governor mechanism of this type which is an improvement upon, and has certain advantages over, previously designed governor mechanisms for the same purpose and is characterized by the fact that it embodies a novel arrangement of parts and involves a new mode of operation.

Another object of the invention is to provide a governor mechanism of the type under consideration which, due to its design and construction, so controls the engine that the latter in connection with either gradual or abrupt acceleration or deceleration is quickly brought back to its predetermined speed with a minimum of so called "hunting" action.

A further object of the invention is to provide a governor mechanism of the last mentioned character which is adapted to be driven by the engine to be governed and comprises in addition to an engine driven member and coacting elements for effecting control of the speed of the engine, means operative in response to variation in the speed of the member due to gradual variation of the speed of the engine from its predetermined speed to actuate the elements so that they result in the engine returning to its predetermined speed, and means operative in response to variation in the speed of the member due to an abrupt variation in the speed of the engine substantially instantaneously to actuate the elements so they result in the engine returning to its predetermined speed, and in which the means responsive to abrupt variation in the speed of the engine is independent of, or separate from, the means that is responsive to gradual variation in the speed of the engine.

A still further object of the invention is to provide a governor mechanism which effectively and efficiently fulfills its intended purpose and not only is simple in design but also may be produced at a comparatively low cost.

Other objects of the invention and the various advantages and characteristics of the present governor mechanism will be apparent from

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a consideration of the following detailed description.

The invention consists in the several novel features which are hereinafter set forth and are more particularly defined by claims at the conclusion hereof.

In the drawings which accompany and form a part of this specification or disclosure and in which like numerals of reference denote corresponding parts throughout the several views:

Figure 1 is a front elevation of a governor mechanism embodying the invention, certain parts of the housing of the mechanism being broken away or omitted for illustrative purposes;

Figure 2 is a vertical longitudinal section of the governor mechanism taken on the line 2—2 of Figure 1 and illustrating in detail the design and arrangement of the various operating parts of the mechanism;

Figures 3, 4, 5 and 6 are vertical transverse sections taken respectively on the lines 3—3, 4—4, 5—5 and 6—6 of Figure 2;

Figures 7 and 8 are fragmentary perspective views of certain parts of the means for substantially instantaneously actuating the engine controlling elements when the speed of the engine driven member varies due to abrupt acceleration or deceleration of the engine with which the mechanism is associated.

The governor mechanism which is shown in the drawings constitutes the preferred form or embodiment of the invention. It is primarily designed or adapted for use in connection with an airplane (not shown) having a controllable pitch propeller and a propeller driving internal combustion engine (both not shown) and, as hereinafter described, operates by varying the angle of the propeller blades to govern or control the engine so that it runs at a predetermined speed. As its primary or principal parts the mechanism comprises a housing 10, an engine driven member in the form of a shaft 11, an electric pilot motor 12 and a differential type gear unit 13.

The housing 10 surrounds and supports the various operating parts of the governor mechanism and is formed of a plurality of complemental detachably connected sections in order that it may be dismantled in connection with assembly or removal of such operating parts. It is horizontally elongated as shown in Figure 2 and comprises a front wall 14, a rear wall 15 and a pair of upstanding partitions 16 and 17 in addition to top, bottom and side walls. The front and rear walls of the housing extend vertically and are spaced apart by the top, bottom and

side walls. The front wall is provided at its upper portion with a horizontally extending open ended tubular part 18 and this extends longitudinally of the housing and is provided at its front end with an integral outwardly extending annular flange 19. The latter is provided with apertures 20 for receiving bolts or other attaching devices whereby the governor mechanism as a whole may be fixedly retained in its desired operative position with respect to the internal combustion engine that it is designed to control. The rear wall 15 of the housing is disposed in parallel relation with the front wall 14 and supports an exteriorly disposed cup-shaped sub-housing 21. The latter extends horizontally and has the free margin of the continuous side wall thereof bolted or otherwise fixedly secured to the central portion of the rear wall 15. The interior of the sub-housing 21 communicates with the interior of the main housing 10 by way of an opening 22 in said central portion of the rear wall 15. The upstanding partition 16 is located adjacent, but spaced inwards of, the front wall 14. It extends transversely of the housing and is arranged in parallel relation with said front wall 14. The upstanding partition 17 is located adjacent, but spaced inwards of, the rear wall 15 and, like the partition 16, extends transversely of the housing. The two partitions 16 and 17 are spaced apart as shown in Figure 2.

The shaft 11 constituting the engine driven member of the governor mechanism extends horizontally. It extends longitudinally through, and is in centered relation with, the tubular part 18 at the upper end of the front wall 14 of the housing and is supported for rotation about the longitudinal axis thereof by way of an outer ball bearing 23 and an inner ball bearing 24. The outer races of such bearings are suitably secured to the end portions of the tubular part 18. The outer end of the shaft is adapted to be connected by a flexible shaft or other coupling (not shown) to one of the driven elements or parts of the engine, such, for example, as the cam shaft, in order that the shaft 11 is driven conjointly with the engine. The inner end of the engine driven shaft 11 extends through an opening 25 in the upper end of the partition 16 and terminates in the space between the two partitions. For purposes of the present disclosure it will be assumed that the engine driven shaft 11 is driven by the engine in a counterclockwise direction as viewed in Figure 5 (see arrow in Figure 2).

The electric pilot motor 12 is located at the rear of the housing 10 and comprises a casing 26 and an armature shaft 27. It is so positioned that the armature shaft 27 thereof is in axial alignment with the engine driven shaft 11. The casing of the electric pilot motor 12 is disposed exteriorly of the housing and is provided at the inner end thereof with an outwardly extending annular flange which is bolted or otherwise fixedly secured to the upper portion of the rear wall 15 of the housing. The inner end of the armature shaft 27 of the motor extends through openings or holes in the rear wall 15 and the partition 17 of the housing and terminates in the space between the two partitions 16 and 17. A battery 28 serves to supply electric current to the pilot motor 12. One side of the battery is connected to one of the terminals of the motor by way of a conductor 29. The other side of the battery is connected to the motor terminal by way of a conductor 30. The last mentioned conductor is provided with a switch 31 and a rheostat 32. The rheostat serves as a medium for varying the speed of the electric pilot motor 12 when the switch 31 is closed. The motor is so designed that the armature shaft 27 thereof rotates reversely to the engine driven shaft 11, i. e., in a clockwise direction as viewed in Figure 4 (see arrow in Figure 2). When the electric pilot motor 12 is in operation the governor, as hereinafter described, operates to control the engine so that it runs at a predetermined speed, i. e., a speed which is directly proportional to the speed of the pilot motor. By adjusting the speed of the motor through the medium of the rheostat 32 the engine with which the governor is associated may be controlled or governed to operate or run at any desired predetermined speed.

The differential type gear unit 13 is located in the bottom of the housing 10 between the upstanding partitions 16 and 17. It is driven by the engine driven shaft 11 and the electric pilot motor 12 and consists of a cylindrical casing 33, a pair of primary bevel pinions 34 and 35 and a pair of secondary bevel gears 36. The cylindrical casing 33 extends horizontally and embodies front and rear end walls. The front wall is provided with a forwardly extending tubular trunnion 37 which is journalled in a bearing 38 on the lower portion of the upstanding partition 16. The rear end wall of the casing of the differential type gear unit 13 is provided with a rearwardly extending tubular trunnion 39 and this, as shown in Figure 2, extends through, and is journalled in, a bearing 40 on the lower portion of the upstanding partition 17 and is axially aligned with the trunnion 37. The two trunnions 37 and 39 permit the casing of the gear unit to revolve or rotate about a horizontal axis. The bevel pinion 34 is disposed adjacent the inner face of the front end wall of the cylindrical casing 33 and is mounted on, and fixedly secured to, the end of a horizontal longitudinally extending shaft 41. The latter, as shown in Figure 2, extends through, and is rotatably mounted in, the tubular trunnion 37. The front end of the shaft 41 terminates in the space between the front wall 14 and the upstanding partition 16 of the housing 10. The bevel pinion 35 is axially aligned with the bevel pinion 34 and is disposed adjacent the inner face of the rear end wall of the gear unit casing 33. It is the same in size as the bevel pinion 34 and is mounted on, and fixedly connected to, the front end of a horizontal longitudinally extending shaft 42. Such shaft extends through, and is rotatably mounted in, the tubular trunnion 39 and is of such length that the rear end thereof terminates in the space between the upstanding partition 17 and the rear wall 15 of the housing. A gear train 43 extends between the engine driven shaft 11 and the bevel pinion 34 and serves to drive the latter from the former. Such gear train comprises a pinion 44, a gear 45 in mesh with the pinion 44, a pair of meshing spiral gears 46 and 47 and a pair of meshing spiral gears 48 and 49. The pinion 44 is disposed in the upper front portion of the space between the upstanding partitions 16 and 17 and is fixedly connected to the inner end of the engine driven shaft 11. The gear 45 is driven by the pinion 44 and is disposed beneath the latter. It extends transversely of the housing and embodies a hub 50 which is surrounded and rotatably supported by a ball bearing 51. The outer race of such bearing fits within a circular hole 52 in the central portion of the partition 16. The spiral gear 46 is connected to the front end of the hub

50 by way of a crosswall 53, as shown in Figure 2. The spiral gear 47 is driven by the spiral gear 46 and is mounted on, and fixedly secured to the upper end of a vertically extending shaft 54. The latter is located directly in front of the partition 16 and is journalled in a bearing 55 which is mounted on the front face of said partition 16. The spiral gear 48 is fixedly connected to the lower end of the shaft 54. The spiral gear 49 is driven by the spiral gear 48 and is fixedly connected to the front end of the shaft 41 for the pinion 34. When the shaft 11 is driven the gear train 43 serves to drive the bevel pinion 34 of the differential type gear unit 13. Because of the design and character of the gear train the bevel pinion 34 is driven in a clockwise direction as viewed in Figure 5. A gear train 56 extends between the armature shaft 27 and the bevel pinion 35 and serves to drive the latter from the former. As shown in Figures 2 and 4 such gear train consists of a pinion 57, a gear 58 in mesh with the pinion 57, a pair of meshing spiral gears 59 and 60, and a pair of meshing spiral gears 61 and 62. The pinion 57 is the same in size as the pinion 44 and is mounted on, and fixedly connected to, the inner end of the armature shaft 27 of the electric pilot motor 12. The gear 58 is driven by, and disposed beneath, the pinion 57 and is the same in size as the gear 45 of the gear train 43. It extends transversely of the housing 10 and has a hub 63. The latter is surrounded, and rotatably supported by, a ball bearing 64, the outer race of which is mounted in a circular hole 65 in the central portion of the upstanding partition 17. The spiral gear 59 is disposed in the space between the partition 17 and the rear wall 15 of the housing and is connected to the hub 63 of the gear 58 by way of a crosswall 66. The spiral gear 60 is driven by the spiral gear 59 and is mounted on the upper end of a vertically extending shaft 67. The latter is journalled in a bearing 68 which is secured to the rear face of the partition 17. The spiral gear 62 is driven by the spiral gear 61 and is mounted on, and keyed or otherwise fixedly secured to, the rear end of the shaft 42 for the bevel pinion 35. When the electric pilot motor is in operation the gear train 56 serves to drive the bevel pinion 35 from the armature shaft 27 of the motor. Because of the arrangement and design of the gear train 56 the bevel pinion 35 is driven reversely to the pinion 34. The bevel gears 36 are disposed in opposed and spaced apart relation and mesh with the bevel pinions 34 and 35. They are disposed in, and extend lengthwise of, the cylindrical casing 33 and embody outwardly extending, centrally disposed stub axles 69. The latter, as shown in Figure 2, are journalled in bearings 70 on the inner face of the side wall of the casing 33. When the engine driven shaft 11 is driven at the same speed as the armature of the electric pilot motor due to the fact that the engine with which the governor mechanism is associated is running at its predetermined speed the bevel pinions 34 and 35 of the differential type gear unit 13 rotate at the same speed but in opposite directions with the result that the casing 33 of the unit remains stationary. In the event that the engine increases in speed beyond the predetermined speed the bevel pinion 34 rotates faster than the bevel pinion 35 and operates through the medium of the bevel gears 36 to rotate the casing of the gear unit in a clockwise direction as viewed in Figure 5. In the event that the engine decreases in speed, i. e., decelerates from its predetermined speed the bevel pinion 34 rotates at a lower or less speed than the bevel pinion 35 and operates through the medium of the bevel gears 36 to rotate the casing 33 in a counterclockwise direction as viewed in Figure 5.

As previously pointed out the governor mechanism is adapted to control or govern the speed of the engine with which it is associated by varying the angle or pitch of the propeller blades of the controllable pitch propeller. The controllable pitch propeller which is disclosed in, and forms the subject matter of, United States patent application Serial No. 498,367, filed on August 12, 1943, by Archibald G. Forsyth, now abandoned, represents one form or type of controllable pitch propeller with which the present governor is designed for use. Such controllable pitch propeller includes in addition to a hub and axially rotatable blades on the hub, pitch change mechanism comprising a magnetic clutch type device for effecting increase in the pitch of the propeller blades and a magnetic clutch type device for effecting decrease in the pitch of the propeller blades. The increase pitch device is controlled by a normally open push button switch 71 and the decrease pitch device is controlled by a normally open push button switch 72. The two switches are located in the sub-housing 21. They are positioned one directly opposite the other and are arranged so that the buttons thereof face or oppose one another and are spaced apart a small distance. The switch 71 for the increase pitch device is mounted on a block-like carrier 73 in the outer portion of the sub-housing 21. The other switch, i. e., switch 72, for the decrease pitch device is mounted on a block-like carrier 74 in the inner portion of the sub-housing 21. The two carriers are cross connected by way of a plate 75. The latter embodies a laterally extending sleeve type bracket 76 which is slidably mounted on a suitably supported horizontal rod 77 in the sub-housing 21. The plate 75 together with the bracket 76 and the rod 77 supports the two switch carriers so that they are conjointly slidable horizontally in either direction. A transversely extending diagonally positioned arm 78 is disposed in the sub-housing 21 and is arranged so that the lower end thereof extends between the buttons of the switches 71 and 72. When the carriers 73 and 74 are shifted towards the front of the front wall 14 of the housing 10 the switch 71 for the increase pitch device is closed as the result of the button thereof striking against, and being urged inwards by, the lower end of the arm 78. When the two carriers are conjointly shifted in the opposite direction, i. e., away from the front wall of the housing the switch 72 for the decrease pitch device is closed as the result of the button thereof contacting and being urged inwards by the lower end of the arm 78. The arm 78 is supported by a horizontally extending pin 79. The latter extends lengthwise of the housing and has the front end thereof suitably attached to the central portion of the rear wall 15 of the housing 10. The rear end of the pin extends through a transverse open ended hole 80 in the central portion of the arm 78 with the result that the arm is permitted to slide horizontally. Said arm, except in connection with abrupt acceleration or deceleration of the engine, remains stationary. A pair of gears 81 and 82 and a horizontal longitudinally extending screw shaft 83 serve conjointly to shift the switch carrying carriers 73 and 74 in response to rotation of the cylindrical casing 33

of the differential type gear unit 13. The gear 81 surrounds, and is formed as an integral part of, the side wall of the casing 33. The gear 82 is in mesh with the gear 81 and is fixedly connected to the front end of the screw shaft. As shown in Figure 5 the gear 82 comprises an inner part 82a and an outer tooth equipped part 82b. The inner part is in frictional engagement with the outer part. Under normal torques the outer and inner parts rotate as a unit. Should, however, the electric motor 12 stop for any reason whatsoever, or should there be a great difference in the speed of the engine driven shaft and the speed of the armature shaft of the motor the outer part 82b will slip relatively to the inner part and thus prevent injury to the various operating elements or members of the governor. Said screw shaft is journalled in bearings on the upstanding partitions 16 and 17 and is suitably held against axial displacement. The rear end of the screw shaft extends into an internally threaded socket 84 in a bracket 85 on the plate 75. The screw thread connection between the screw shaft 83 and the bracket 85 is so designed or arranged that when the screw shaft is rotated in a counterclockwise direction as viewed in Figures 3, 4 and 5, due to clockwise rotation of the casing 33 of the differential gear type unit 13 in response to acceleration or over speeding of the engine driven shaft 11 the carriers 73 and 74 for the switches 71 and 72 are shifted towards the front wall 14 of the housing 10, thus resulting in closing of the switch 71 for the increase pitch device of the controllable pitch propeller. As soon as the switch 71 for the increase pitch device is closed as the result of shift of the carriers 73 and 74 towards the front wall of the housing the blades of the propeller are increased in pitch, thus resulting in the engine decreasing in speed. If the casing 33 of the differential type gear unit 13 rotates in a counterclockwise direction as viewed in Figure 5 due to deceleration of the engine from its predetermined speed the screw shaft 83 is driven by the gears 81 and 82 in a clockwise direction as viewed in Figures 3, 4 and 5, and results in the carriers 73 and 74 being shifted rearwards, i. e., away from the front wall 14 of the housing 10. Rearward shift of the two carriers results in closing of the switch 72 for the decrease pitch device and such device when energized or actuated causes the blades of the propeller to decrease in pitch, thus effecting an increase in speed of the engine. When the engine driven shaft 11 is rotating at the same speed as the armature shaft of the electric pilot motor 12 due to the engine running at its predetermined speed the casing of the differential type gear unit 13 is stationary or at rest and the carriers 73 and 74 are so positioned with respect to the arm 78 that the switches 71 and 72 are in their open position. Should, however, the engine increase in speed for any reason whatsoever the carriers are shifted towards the front wall of the housing with the result that the switch 71 for the increase pitch device is closed and such device, as previously pointed out, effects increase in pitch of the propeller blades with the resultant decrease in the speed of the engine. Should the engine decrease in speed for any reason whatsoever the carriers are shifted away from the front wall of the housing with the result that the switch 72 for the decrease pitch device is closed and such device operates to decrease the pitch of the propeller blades and effect corresponding increase in speed of the engine. The differential type gear

unit 13 together with its auxiliary parts including the gears 81 and 82 and the screw shaft 83, is essentially slow acting and is relied upon to effect governing of the engine in connection with gradual acceleration or deceleration of the engine.

In addition to the parts heretofore described the governor mechanism includes means independent of the differential type gear unit 13 for substantially instantaneously bringing the engine back to its predetermined speed in connection with abrupt or sudden acceleration or deceleration thereof. Such means comprises a floating flywheel type member 86 and a slide rod 87. The member 86 surrounds and is rotatable to a limited extent relatively to a horizontal sleeve 88. Such sleeve extends lengthwise of the housing 10 of the governor mechanism and is located between and in axial alignment with the gear 45 of the gear train 43 and the gear 58 of the gear train 56. The front end of the sleeve fits within, and is keyed or otherwise fixedly secured to, the hub 50 of the gear 45 with the result that the sleeve is driven by the gear 45. The rear end of the sleeve is surrounded and rotatably supported by a ball bearing 89, the outer race of which fits and is secured in the hub 63 of the gear 58. The flywheel type member 86 embodies an annular hub 90 and this extends loosely around the central portion of the sleeve 88 and is supported by way of a pair of ball bearings 91. The inner races of the bearings are fixed to the sleeve 88 and the outer races are seated in annular grooves in the hub 90 of the flywheel type member 86. The two bearings 91 support the member 86 so that it is rotatable relatively to the sleeve which, as previously pointed out, is connected for drive by the gear 45. The rear end of the annular hub 90 of the member 86 is provided with an outwardly extending radial lug 92 and the rear end of the sleeve is provided with an outwardly extending annular flange 93 as best shown in Figures 2 and 6. The flange is provided on the front face thereof with a pair of oppositely disposed and oppositely acting spring devices 94 and these coact with the lug 92 to connect the floating flywheel type member 86 for drive by the sleeve 88 while at the same time permitting the member to underrun the sleeve to a limited extent in connection with abrupt acceleration of the engine and to overrun the sleeve to a limited extent in connection with abrupt deceleration of the engine. As shown in Figure 6 the spring devices 94 are located on opposite sides of the lug 92 and consists of tubular shells 95, plungers 96 and compression springs 97. The shells are suitably connected to the front face of the annular flange 93 and are in longitudinal alignment. The inner ends of the shells, i. e., the ends that are adjacent or near one another, are provided with inwardly extending flanges 98 and the outer ends of the shells are provided with screw plugs 99. The plungers 96 have the inner ends thereof in abutment with the sides of the lug 92. The outer ends of the plungers embody enlarged heads 100, which fit slidably within the shells and coact with the inwardly extending annular flanges 98 at the inner ends of the shells to limit sliding movement of the plungers in the direction of the lug 92. The compression springs 97 are disposed in the shells and extend between the heads 100 and the screw plugs 99. By turning the screw plugs the loading of the springs may be adjusted or varied. The spring devices 94 normally cause the floating flywheel type member 86 to rotate conjointly with the sleeve 88. However, in connection with abrupt

acceleration of the engine as may occur when the airplane is placed in a steep diving attitude the devices permit the member 86, due to its inertia, to underrun the sleeve 88 to a limited extent. In the event that the engine with which the governor mechanism is associated abruptly or suddenly decelerates, as, for example, may occur when the airplane is placed in a steep climbing angle or attitude, the spring devices 94 permit the member 86, due to its momentum, to overrun to a limited extent the sleeve 88. After abrupt acceleration or deceleration of the engine the spring devices return the member 86 to its normal position with respect to the sleeve 88. The slide rod 87 extends lengthwise of the housing 10 and has its rear end operatively connected to the upper end of the arm 78 by a ball bearing 101 and its front end operatively connected to the floating flywheel type member 86 by a cam arrangement 102. The central portion of the slide rod extends through, and is slidably mounted in, a bore 103 in the crosswall 66 and the helical gear 59. The front end of the slide rod embodies an enlarged hollow head 104 and this is slidably mounted in the sleeve 88 and is connected for drive by the sleeve while at the same time it is permitted to slide longitudinally towards and away from the front wall of the housing 10. The inner race of the ball bearing 101 is shrunk around or otherwise fixedly secured to the slide rod 87 and the outer race is secured within a circular hole in the upper end of the arm 78. Because of the mode of mounting such inner and outer races the ball bearing 101 permits the rod 87 to rotate relatively to the arm while at the same time it so connects the arm to the rod that the arm is shiftable with the rod. When the rod 87 is slid rearwards, i. e., away from the wall 14 of the housing 10, the arm 78 is correspondingly moved and serves to close the switch 71 for the increase pitch device of the controllable pitch propeller. When the slide rod 87 is slid forwards the arm 78 is correspondingly moved and operates to close the switch 72 for the decrease pitch device. The cam arrangement 102 serves to shift the slide rod 87 in response to rotation of the member 86 relatively to the sleeve 88 in connection with abrupt or sudden acceleration or deceleration of the engine. It consists of a diagonal cam slot 105 and a pin 106. The cam slot 105 is formed in the enlarged head 104 on the front end of the slide rod 87 and is so arranged that its leading end extends towards the rear of the housing 10 and its trailing end extends forwards, that is, in the direction of the front wall 14 of the housing. The pin 106 is connected to, and extends inwards from, the annular hub 90 of the floating flywheel type member 86. The central portion of the pin extends through a circumferential slot 107 in the sleeve 88 and the inner end of the pin extends into the cam slot 105. The pin is so arranged that when the member 86 is in its neutral or normal position with respect to the sleeve 88 the inner end thereof is disposed in the central portion of the cam slot 105. The cam arrangement 102 is so arranged that when the pin is in the central portion of the cam slot as the result of the member 86 being in its neutral position with respect to the sleeve 88 the slide rod 87 holds the arm 78 midway between the buttons of the switches 71 and 72. Because the engine driven shaft 11 is rotated in a counterclockwise direction as viewed in Figure 5 of the drawings the sleeve 88 and the floating flywheel type member 86

revolve in a clockwise direction. When the engine abruptly or suddenly accelerates from its predetermined speed for any reason whatsoever the sleeve 88 overruns the member 86 due to the inertia of the latter and as a result of the inner end of the pin 106 of the cam arrangement 102 moves into the trailing end of the cam slot 105. Such movement on the part of the inner end of the pin operates to shift the slide rod 87 rearwards and thus cause the arm 78 to close the switch 71 of the increase pitch device thereby effecting slow down of the engine. When the engine abruptly or pronouncedly decelerates from its predetermined speed the floating flywheel type member 86, due to its momentum, overruns the sleeve 87 with the result that the inner end of the pin 106 moves into the leading end of the cam slot 105. Such movement on the part of the inner end of the pin causes the slide rod 87 to be shifted forwards thereby resulting in the arm 78 closing the switch 72 for the decrease pitch device and effecting speed up of the engine to its predetermined speed. As soon as the engine reaches its predetermined speed, or directly before, the member 86 is shifted by the action of one of the spring devices 94 into its neutral or normal position with respect to the sleeve 88, thus resulting in the cam arrangement 102 shifting the rod 87 so as to return the arm 78 to its neutral or inoperative position with respect to the switches 71 and 72.

The operation of the governor mechanism is as follows:

When the speed of the engine corresponds to the speed determined or set by the electric pilot motor 12 the cylindrical casing 33 of the differential type gear unit 13 is stationary and the floating flywheel type member 86 rotates conjointly with the sleeve 88 and is so positioned by the spring devices 94 that the inner end of the pin 106 of the cam arrangement is disposed in the central portion of the cam slot 105. So long as the speed of the engine corresponds to the speed determined by the pilot motor 12 the buttons of the switches 71 and 72 are out of contact with the arm 78 and remain open. In the event that the engine gradually increases in speed for any reason whatsoever the gear unit 13, due to difference in the speed of drive of the bevel pinions 34 and 35, operates through the medium of the gears 81 and 82 and the screw shaft 83 to shift the carriers 73 and 74 towards the front wall 14 of the housing 10. Such shift on the part of the carriers results in the switch 71 being closed due to abutment of its button with the lower end of the arm 78. As soon as the switch 71 is closed the propeller blades are increased in pitch with the result that the engine slows down or decelerates. When the engine slows down or decelerates to its predetermined speed the gear unit 13 shifts the carriers 73 and 74 back to their neutral position wherein the switches thereof are out of contact with the arm 78. In the event that the engine gradually decreases in speed for any reason whatsoever the carriers 73 and 74, due to the action of the differential type gear unit 13, are shifted rearwards thereby resulting in closing of the switch 72 as soon as the latter's button contacts the lower end of the arm 78. Closing of such switch results in decrease in pitch of the propeller blades and resultant speeding up of the engine. When the engine speeds up to its predetermined speed the switch carrying carriers 73 and 74 return to their neutral position in response to the action of the gear unit 13. Dur-

ing either gradual acceleration or deceleration of the engine from its predetermined speed the floating flywheel type member 86 rotates conjointly with the sleeve 88 and the slide rod 87 remains in its neutral position. In the event that the engine should abruptly accelerate as a result of the airplane being placed in a steep or sharp dive the member 86, due to its inertia, underruns the sleeve 88 with the result that the cam arrangement 102 is substantially instantaneously brought into play and the shaft 87 is thereby shifted rearwards. Rearward shift on the part of the shaft 87 causes rearward displacement of the arm 78 and causes the arm to close the switch 71 thereby resulting in an increase in pitch of the propeller blades and diminution in the speed of the engine. Should the engine abruptly or suddenly decelerate from its predetermined speed as the result of the airplane being placed in an extremely high climbing attitude the member 86, due to its momentum, overruns the sleeve 88 and brings into play the cam arrangement 102 in such manner that the latter causes the slide rod 87 and the arm 78 to move forwards. Forward movement on the part of the arm 78 causes closing of the switch 72 and results in the propeller blades decreasing in pitch and the engine correspondingly increasing in speed.

By increasing or decreasing the speed of the electric pilot motor 12 through the medium of the rheostat 32 the engine will be governed so as to run at an increased or decreased predetermined speed. In other words, when it is desired to increase the speed of the engine to any desired R. P. M. the rheostat is adjusted so as to decrease the amount of resistance in the motor circuit. If it is desired to decrease the speed of the engine the pilot motor is slowed down by manipulation of the rheostat so as to increase the amount of resistance in the motor circuit. By adjusting the rheostat the engine will be controlled automatically by the governor mechanism so that it operates at any desired predetermined speed.

The herein described governor mechanism is highly efficient in operation and effectively and efficiently fulfills its intended purpose. It is in the form of a compact unit and responds substantially instantaneously to abrupt acceleration or deceleration of the engine with which it is associated.

Whereas the governor has been described as being particularly designed for use in connection with an airplane engine and as controlling the engine through the medium of a controllable pitch propeller it is to be understood that it may be used for other purposes and in other capacities. It is also to be understood that the invention is not to be restricted to the details set forth since these may be modified within the scope of the appended claims without departing from the spirit and scope of the invention.

Having thus described the invention what we claim as new and desire to secure by Letters Patent is:

1. A governor mechanism adapted to maintain an engine at a predetermined speed and comprising a rotary member provided with means whereby it may be connected for drive by one of the driven parts of the engine, a second rotary member provided with means for driving it at a predetermined speed, speed control means, means operative automatically when the first mentioned member is driven at a speed different from the second member due to gradual acceleration or deceleration of the engine from its predetermined speed gradually to actuate the speed control means, and means wholly separate from the fourth mentioned means, including a rotary part connected for drive by the first mentioned member, and operative automatically and substantially instantaneously when said first mentioned member is driven at a speed different from said second member due to abrupt or sudden acceleration or deceleration of the engine from its predetermined speed abruptly to actuate said speed control means.

2. A governor mechanism adapted to maintain an engine at a predetermined speed and comprising a rotary member provided with means whereby it may be connected for drive by one of the driven parts of the engine, a second rotary member provided with means for driving it at a predetermined speed, speed control means, means including a differential type gear unit with certain parts thereof connected for drive by the members, respectively, and operative automatically when the first mentioned member is driven at a speed different from the second member due to gradual acceleration or deceleration of the engine from its predetermined speed gradually to actuate the speed control means, and means wholly separate from said differential type gear unit, including a rotary part connected for drive by the first mentioned member, and operative automatically and substantially instantaneously when said first mentioned member is driven at a speed different from said second member due to abrupt or sudden acceleration or deceleration of the engine from its predetermined speed abruptly to actuate said speed control means.

3. A governor mechanism adapted to maintain an engine at a predetermined speed and comprising a rotary member provided with means whereby it may be connected for drive by one of the driven parts of the engine, a second rotary member provided with means for driving it at a predetermined speed, speed control means, means operative automatically when the first mentioned member is driven at a speed different from the second member due to gradual acceleration or deceleration of the engine from its predetermined speed gradually to actuate the speed control means, and cam means wholly separate from the fourth mentioned means, including a rotary part connected for drive by the first mentioned member, and operative automatically and substantially instantaneously when said first mentioned member is driven at a speed different from said second member due to abrupt or sudden acceleration or deceleration of the engine from its predetermined speed abruptly to actuate said speed control means.

4. A governor mechanism adapted to maintain an engine at a predetermined speed and comprising a rotary member provided with means whereby it may be connected for drive by one of the driven parts of the engine, a second rotary member provided with means for driving it at a predetermined speed, speed controlling means, means including a differential type gear unit with certain parts thereof connected for drive by the members, respectively, and operative automatically when the first mentioned member is driven at a speed different from the second member due to gradual acceleration or deceleration of the engine from its predetermined speed gradually to actuate the speed controlling means, and cam means wholly separate from the differential type

gear unit of the fourth mentioned means, including a rotary part connected for drive by the first mentioned member, and operative automatically and substantially instantaneously when said first mentioned member is driven at a speed different from said second member due to abrupt or sudden acceleration or deceleration of the engine from its predetermined speed abruptly to actuate said speed controlling means.

5. A governor mechanism adapted to maintain an engine at a predetermined speed and comprising a rotary member provided with means whereby it may be connected for drive by one of the driven parts of the engine, a second rotary member provided with means for driving it at a predetermined speed, speed controlling means including a pair of elements movable into and out of engagement with one another and adapted when in engaging relation to effect actuation of the speed controlling means, means operative automatically when the first mentioned member is driven at a speed different from the second member due to gradual variation in the speed of the engine from its predetermined speed gradually to move one of the elements into engagement with the other element, and means separate from and in addition to the fourth mentioned means, including a rotary part connected for drive by the first mentioned member, and operative automatically and substantially instantaneously when said first mentioned member is driven at a speed different from said second member due to abrupt or sudden variation in the speed of the engine from its predetermined speed abruptly to move the other element into engagement with the one element.

6. A governor mechanism adapted to maintain an engine at a predetermined speed and comprising a rotary member provided with means whereby it may be connected for drive by one of the driven parts of the engine, a second rotary member provided with means for driving it at a predetermined speed, speed controlling means including a pair of elements movable into and out of engagement with one another and adapted when in engaging relation to actuate the speed controlling means, means including a differential type gear unit with certain parts thereof connected for drive by the members, respectively, and operative automatically when the first mentioned member is driven at a speed different from the second member due to gradual variation in the speed of the engine from its predetermined speed gradually to move one of the elements into engagement with the other element, and means separate from and in addition to the last mentioned means, including a rotary part connected for drive by the first mentioned member, and operative automatically and substantially instantaneously when said first mentioned member is driven at a speed different from said second member due to abrupt or sudden variation in the speed of the engine from its predetermined speed abruptly to move the other element into engagement with the one element.

7. A governor mechanism adapted to maintain an engine at a predetermined speed and comprising a rotary member provided with means whereby it may be connected for drive by one of the driven parts of the engine, a second rotary member provided with means for driving it at a predetermined speed, speed controlling means including a pair of elements movable into and out of engagement with one another and adapted when in engaging relation to effect actuation of the speed controlling means, means operative automatically when the first mentioned member is driven at a speed different from the second member due to gradual variation in the speed of the engine from its predetermined speed gradually to move one of the elements into engagement with the other element, and cam means separate from and in addition to the last mentioned means, including a rotary part connected for drive by the first mentioned member, and operative automatically and substantially instantaneously when said first mentioned member is driven at a speed different from said second member due to abrupt or sudden variation in the speed of the engine from its predetermined speed abruptly to move the other element into engagement with the one element.

8. A governor mechanism adapted to maintain an engine at a predetermined speed and comprising a rotary member provided with means whereby it may be connected for drive by one of the driven parts of the engine, a second rotary member provided with means for driving it at a predetermined speed, speed controlling means including a pair of elements movable into and out of engagement with one another and adapted when in engaging relation to actuate the speed controlling means, means including a differential type gear unit with certain parts thereof connected for drive by the members, respectively, and operative automatically when the first mentioned member is driven at a speed different from the second member due to gradual variation in the speed of the engine from its predetermined speed gradually to move one of the elements into engagement with the other element, and cam means separate from and in addition to the last means, including a rotary part connected for drive by the first mentioned member, and operative automatically and substantially instantaneously when said first mentioned member is driven at a speed different from said second member due to abrupt or sudden variation in the speed of the engine from its predetermined speed abruptly to move the other element into engagement with the one element.

IRA J. SNADER.
ARCHIBALD GRAHAM FORSYTH.

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