Dec. 21, 1948. I. J. SNADER 2,456,746

SPEED GOVERNOR

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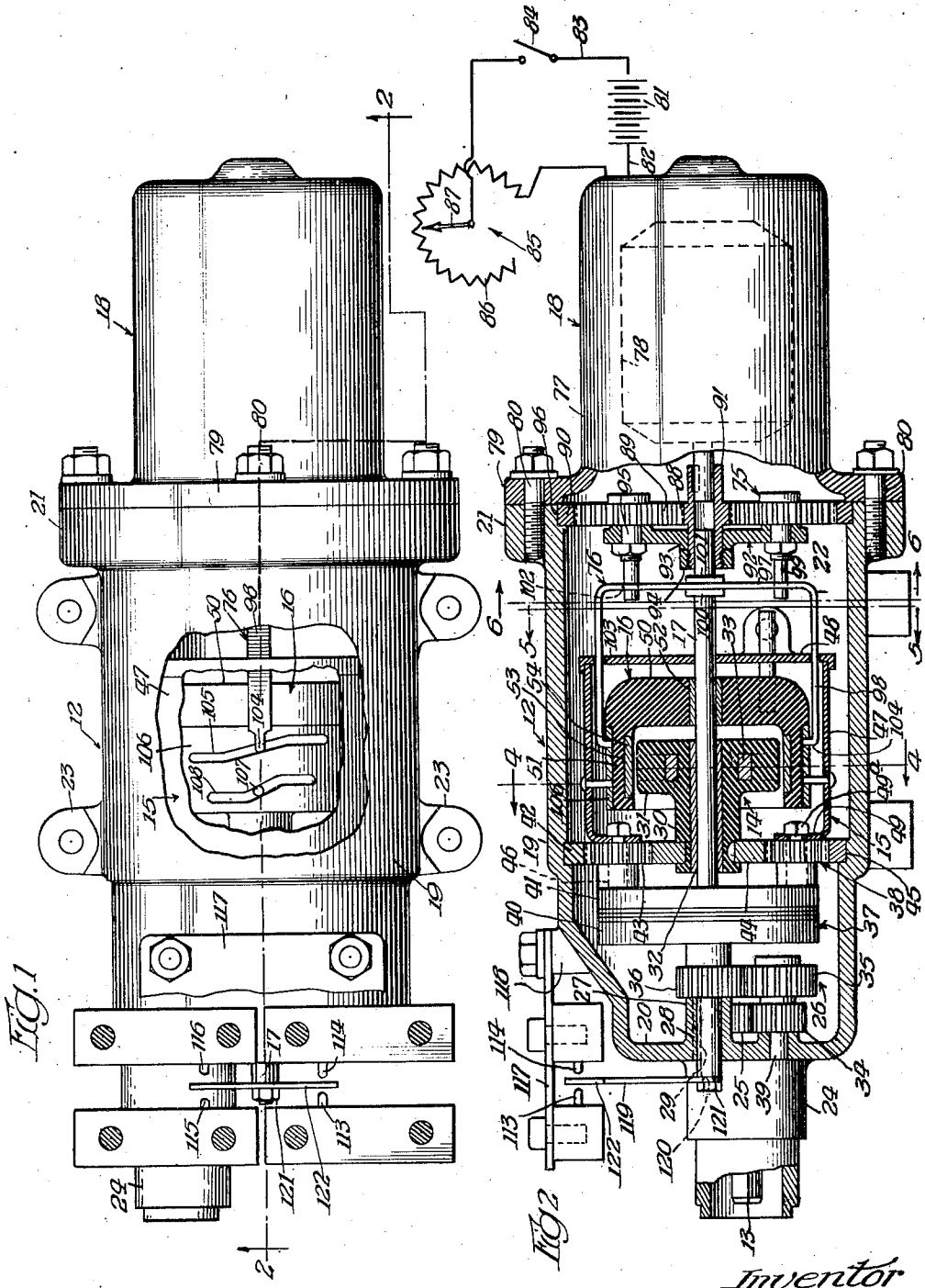


FIG. 1

FIG. 2

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Fig. 3

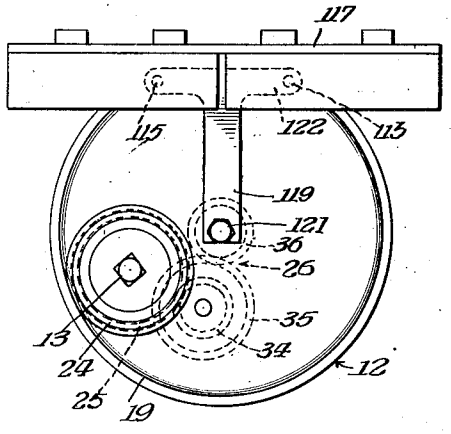



Fig. 4

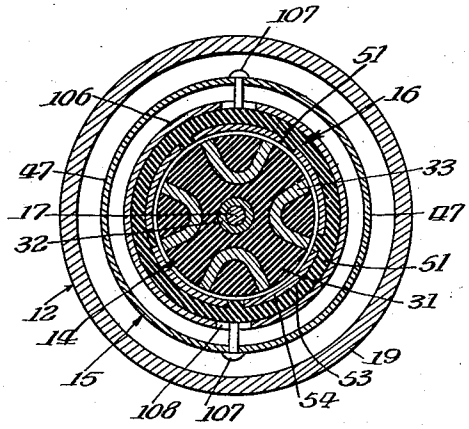



Fig. 5

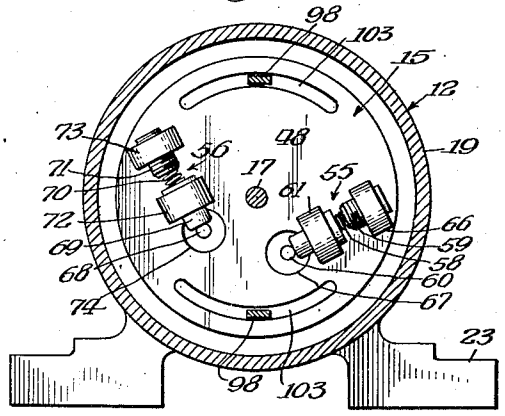



Fig. 6

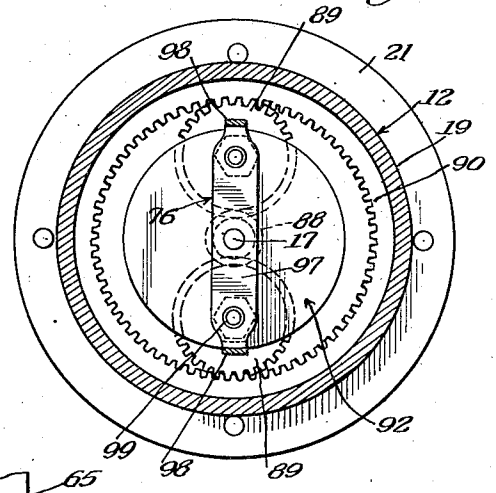
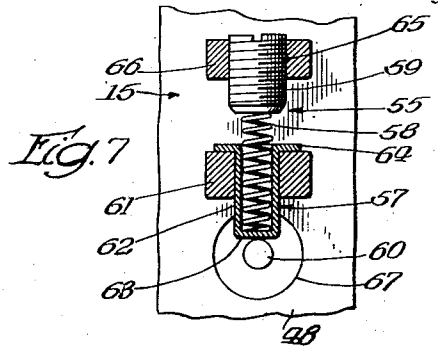



Fig. 7




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Fig. 8.

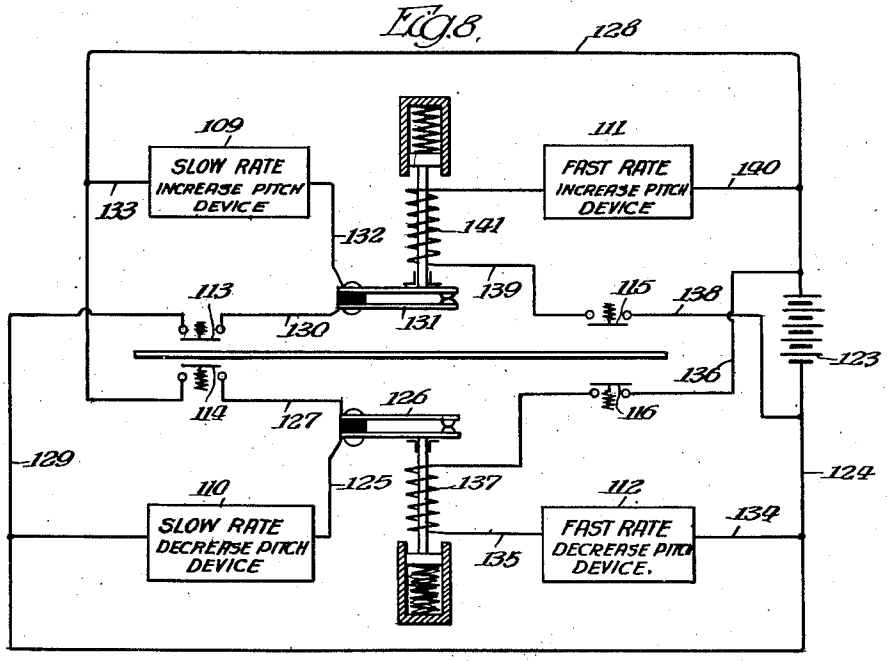



Fig. 9

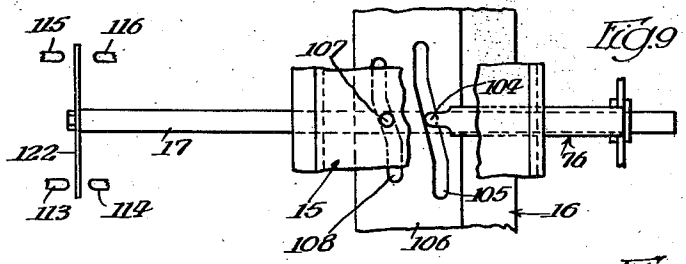



Fig. 9a

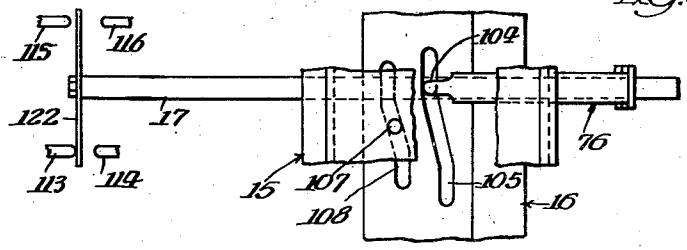
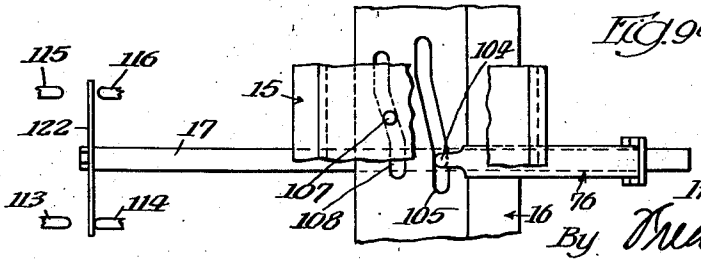



Fig. 9b




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Fig. 10

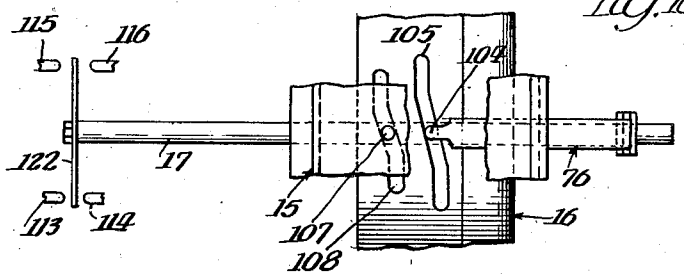



Fig. 10a

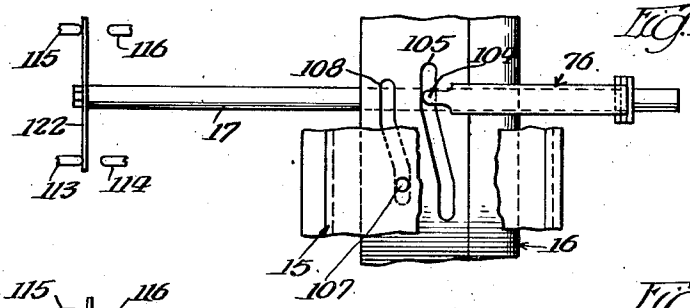



Fig. 10b

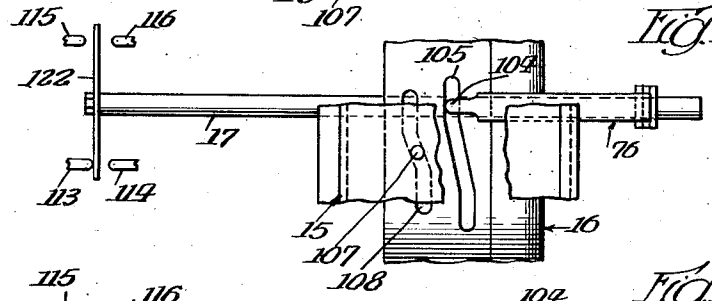



Fig. 10c

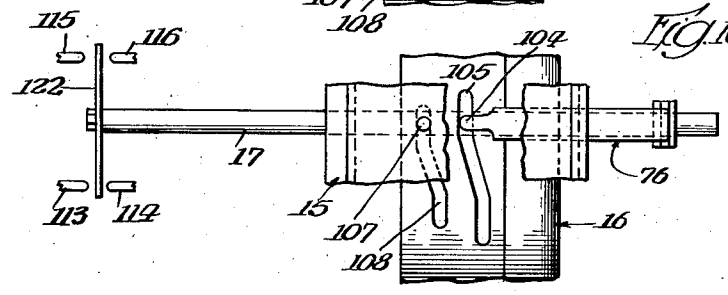
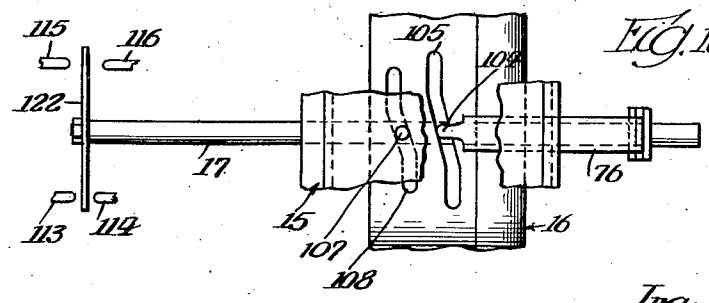



Fig. 10d

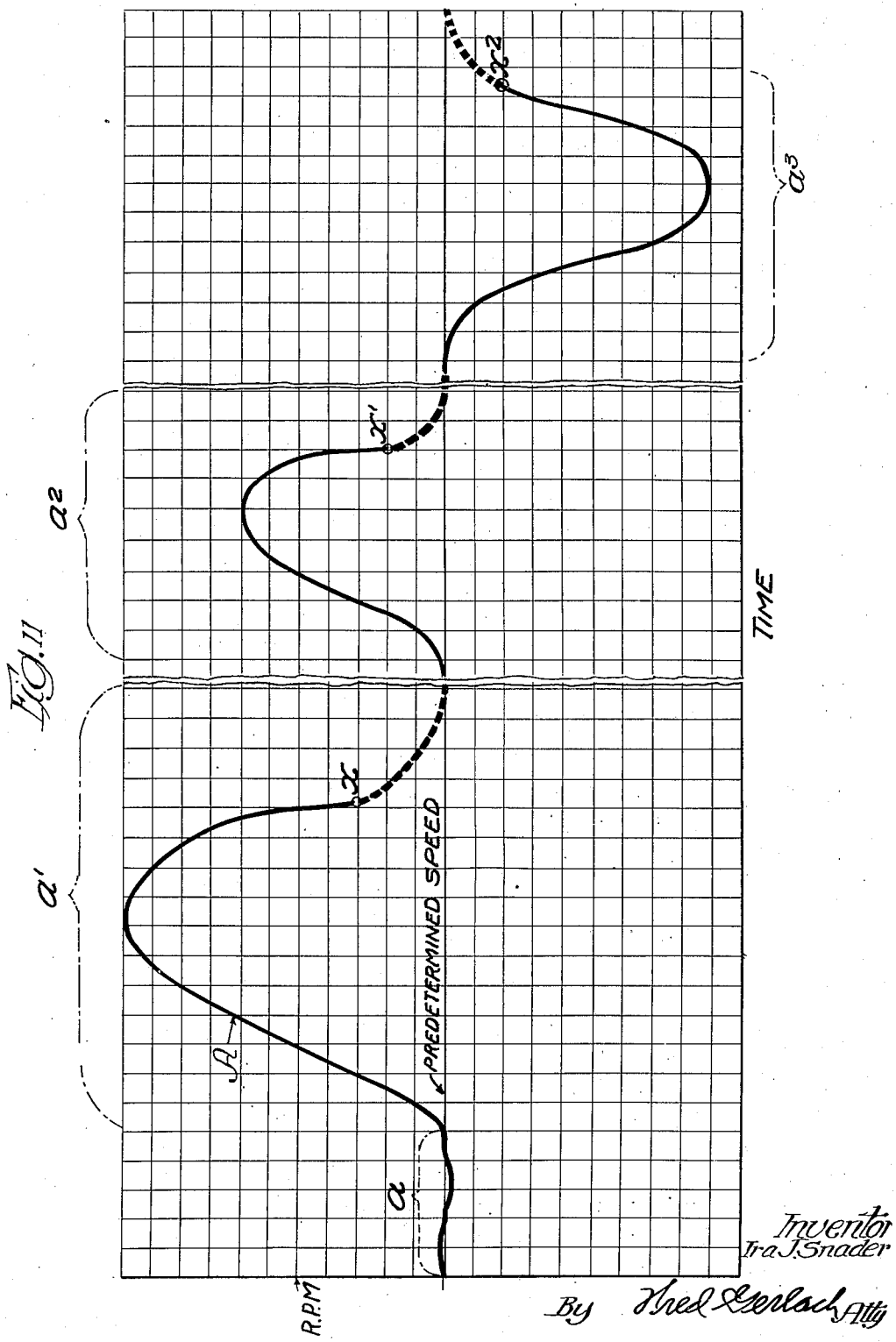



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SPEED GOVERNOR

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Patented Dec. 21, 1948

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# UNITED STATES PATENT OFFICE

2,456,746

## SPEED GOVERNOR

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Application December 17, 1943, Serial No. 514,729

3 Claims. (Cl. 264—11)

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The present invention relates generally to governors. More particularly the invention relates to that type of governor 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 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 of this type which is an improvement upon, and is more efficient than, previously designed governors for the same purpose.

Another object of the invention is to provide a governor of the type under consideration which, due to its design, construction and mode of operation, so controls the engine that the latter in connection with abrupt or pronounced acceleration or deceleration is quickly brought back to its predetermined speed without any so-called "hunting" action.

A further object of the invention is to provide a governor which effectively and efficiently fulfills its intended purpose and is characterized by compactness as well as cheapness of construction.

Other objects of the invention and the various advantages and characteristics of the present governor will be apparent from 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 plan view of a governor embodying the invention, certain parts being broken away or omitted for illustrative purposes;

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

Figure 3 is a view of one end of the governor;

Figure 4 is a transverse section taken on the line 4—4 of Figure 2 and showing in detail the rotary magnetic member, the shell and the floating drum constituting certain of the engine driven parts of the governor;

Figure 5 is a transverse section taken on the line 5—5 of Figure 2 and showing the arrangement and manner of mounting of the spring devices for maintaining the floating drum in its

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normal or neutral position with respect to the shell;

Figure 6 is a transverse section taken on the line 6—6 of Figure 2;

Figure 7 is an enlarged detail of one of the spring devices shown in Figure 5;

Figure 8 is a circuit diagram showing the switches which are governor actuated and serve to control the actuating devices of the controllable pitch propeller with which the governor is associated;

Figures 9, $9^a$ and $9^b$ are diagrammatic views showing the manner in which the operating parts of the governor operate or respond in connection with gradual acceleration and deceleration of the propeller driving engine;

Figures 10, $10^a$, $10^b$, $10^c$ and $10^d$ are diagrammatic views showing the manner in which the operating parts of the governor operate or respond in connection with abrupt acceleration of the engine; and

Figure 11 is a graph including a theoretical speed or performance curve of the governor controlled engine, illustrating the manner in which the governor so controls the engine that the latter in connection with abrupt acceleration or deceleration is quickly brought back to its predetermined speed without hunting.

The governor which is shown in the drawings constitutes the preferred form or embodiment of the invention. It is primarily designed 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 control or govern the engine so that it runs at a predetermined speed. As its primary or principal parts the governor comprises an elongated housing 12, an engine driven shaft 13 at one end of the housing, a rotary magnetic member 14 in the housing, a shell 15 around the rotary magnetic member, a floating drum 16 in associated relation with said rotary magnetic member, an axially slidable control shaft 17 and an electric pilot motor 18.

The housing 12 consists of a continuous side wall 19 and an end wall 20 at one end of the side wall. The other end of the side wall is provided with a continuous outwardly extending flange 21. The side and end wall of the housing together define a chamber 22 in which substantially all of the operating parts of the governor are mounted. The side wall of the governor housing is provided on opposite sides thereof with apertured lugs 23 for receiving bolts or other attaching de-

vices whereby the governor 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 shaft 13 is longitudinally arranged with respect to the housing 12 and is journalled in, and extends through, a bearing 24 which, as best shown in Figure 2, is formed integrally with the end wall 20 of the housing. 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 13 is driven conjointly with the engine. The inner end of the shaft 13 projects into the end of the chamber 22 that is adjacent the end wall 20 of the housing 12 and has a pinion 25 fixedly connected thereto. Such pinion, as described hereafter, forms part of a gear train 26 for driving the magnetic member 14 from the engine driven shaft 13.

The rotary magnetic member 14 is disposed in the central portion of the chamber 22 in the housing 12 and is loosely mounted on the central portion of the control shaft 17. The latter extends longitudinally through, and is centrally disposed with respect to, the housing 12 and, as hereafter described, serves, in response to axial shift thereof, to actuate the control devices for the controllable pitch propeller. The end of the control shaft 17 that is adjacent the end wall 20 of the housing 12 extends through, and is slidably mounted in, a tubular element 27 and has the extremity thereof disposed externally of the housing 12 and adjacent the bearing 24 for the engine driven shaft 13. The tubular element 27 is formed as an integral part of the housing end wall 20 and has a key 28 which fits in a groove 29 in the adjacent end of the control shaft 17 and coacts therewith to prevent rotation of the shaft while at the same time permitting the shaft to slide or shift axially.

The magnetic member 14 comprises an elongated hub 30 and an enlarged cylindrical body 31 at the end of the hub that is remote from the end wall 20 of the housing. It also comprises a metallic bushing 32 in the hub, and an annular series of U-shaped permanent magnets 33 in the cylindrical body 31. The hub and body of the member 14 are formed of any suitable non-magnetic material. The bushing 32 is fixedly secured within the hub 30 and surrounds loosely the central portion of the control shaft 17. The magnets 33 are embedded in the cylindrical body 31 of the member 14 and are arranged so that the ends thereof extend through the periphery of the body (see Figure 4). The rotary magnetic member 14 is driven from the engine driven shaft 13 by way of the gear train 26 which, as previously pointed out, includes the pinion 25 on the inner end of the shaft 13. In addition to the pinion 25 the gear train includes or comprises a gear 34, a pair of gears 35 and 36, an overload clutch 37, and planetary gearing 38. The gear 34 meshes with, and is driven by, the pinion 25 and is rotatably mounted on a stub shaft 39. The latter is fixed to, and projects inwards from, the housing end wall 20. The gear 35 is fixed to the inner end of the gear 34. It is journalled on the inner end of the stub shaft 34 and meshes with, and serves to drive, the gear 36. The latter surrounds and is loosely mounted on the axially slidable control shaft 17 and abuts against, and is held against displacement in one direction by, the inner end of the tubular element 27. The overload clutch



37 is of conventional construction and surrounds, and is loosely mounted on, the control shaft 17. It is disposed in the chamber 22 between the gear 36 and the rotary magnetic member 14 and embodies a drive member 40 and a driven member 41. The planetary gearing 38 surrounds the central portion of the control shaft 17, as shown in Figure 2. It is disposed between the overload clutch 37 and the rotary magnetic member 14 and consists of a ring gear 42, a pair of planetary pinions 43 and a sun gear 44. The ring gear 42 is fixedly secured within an internal annular groove 45 in the central portion of the housing side wall 19 and has internal teeth. The planetary pinions 43 of the planetary gearing 38 are in mesh with the internal teeth of the ring gear 42 and are positioned one diametrically opposite the other. They are rotatably mounted on a pair of stub shafts 46, and these are connected to diametrically opposite portions of the driven member 41 of the overload clutch 37. The sun gear 44 is disposed between, and meshes with, the planetary pinions 43. It extends around, and is suitably fixedly secured to, the outer or free end of the hub 30 of the rotary magnetic member 14. The gear train 26 comprising the pinion 25, the gears 34, 35 and 36, the overload clutch 37 and the planetary gearing 38, is preferably such that the planetary pinions 43 of the planetary gearing revolve bodily around the control shaft 17 at the same speed as the engine with which the governor is associated. For purposes of the present disclosure it will be assumed that the engine driven shaft 13 is driven by the engine in a clockwise direction as viewed in Figure 3. Because of the arrangement of the various pinions and gears of the gear train 26 between the shaft 13 and the rotary magnetic member 14 such member will also be driven in a clockwise direction and the planetary pinions 43 will revolve bodily in such direction.

The shell 15 surrounds the rotary magnetic member 14 and is located in the central portion of the housing 12 directly inwards of the planetary gearing 38. It is cup shaped, as shown in Figure 2, and comprises a cylindrical side wall 47 and an end wall 48. The side wall is arranged in concentric relation with the magnetic member 14 and has at the end thereof that is adjacent the planetary gearing 38 an inwardly extending annular flange 49 which, as shown in Figure 2, is connected by screws 49a to the inner ends of the stub shafts 46 for the planetary pinions 43. The end wall 48 of the shell 15 is fixedly or rigidly connected to the other end of the cylindrical side wall 47. Because the inwardly extending flange 49 at said one end of the side wall of the shell is connected to the stub shafts that serve rotatably to support the planetary pinions 43 the shell 15 rotates at engine speed during drive of the engine with which the governor is associated. In view of the fact that the gear train 26 includes the overload clutch 37 drive of the shaft 13 is permitted even though the shell 15 is held or locked against rotation. The overload clutch also permits rotation of the shell 15 in the event that the shaft 13 is at rest as the result of stoppage of the propeller driving engine. During normal operation of the governor the clutch 37 maintains a drive connection between the gear 36 and the planetary gearing 38 and the shell 15 is driven by the shaft 13 at the same speed as the engine.

The floating drum 16 is located within the shell 15 and surrounds the rotary magnetic member

14. It is loosely mounted on the axially slidable control shaft 17 and comprises a circular end wall 50 and a cylindrical side wall 51. Such walls are formed of non-magnetic material. The central portion of the end wall 50 embodies a metallic bushing 52 and this surrounds loosely the central portion of the control shaft 17 and permits the drum to rotate relatively to the shaft and the shaft to move axially relatively to the drum. The cylindrical side wall 51 of the drum is joined to the outer marginal portion of the end wall 50 and extends around the cylindrical body 31 of the rotary magnetic member 14. The inner periphery of the side wall 51 is of slightly greater diameter than the periphery of the magnet carrying body 31 of the magnetic member 14 and has an annular series of arcuate grooves 53 in which are seated strips 54 of iron or any suitable material that is subject to magnetic influence. If desired the strips 54 may be of a material having a low resistance to electric current flow and the member 16 driven by the "eddy currents" induced therein or an induction motor "squirrel cage" could be built into the inner surface of the wall 51. When the rotary magnetic member 14 is driven as the result of drive of the engine driven shaft 13 the drum 16 is driven as the result of magnetic forces which are produced by, or emanate from, the permanent magnets 33 in the cylindrical body 31 of the member 14. The strips 54 are greater in number than the permanent magnets 33 in order that the drive of the drum 16 by the rotary magnetic member 14 is continuous as distinguished from intermittent. The planetary pinions 43 and the sun gear 44 of the planetary gearing 38 are so proportioned or of such size that under normal operating conditions of the governor the floating drum 16 is driven at the same speed as the shell 15, i. e., at engine speed. Because of the manner in which the drum is mounted the drum is free to move axially with respect to the shell 15 and the drum and shell are permitted to rotate relatively to one another. The floating drum 16 is maintained in what may be termed a neutral or normal position with respect to the shell by way of a pair of spring devices 55 and 56. The latter are mounted on the outer face of the end wall 48 of the shell 15. They operate in opposition to one another and, as shown in Figure 5, are disposed at right angles to one another. As shown in Figure 7, the spring device 55 consists of a thimble 57, a compression spring 58 and an adjusting screw 59 and coacts with a pin 60. The thimble 57 is slidably mounted in an apertured lug 61 on the outer face of the end wall 48 of the shell 15 and comprises a cylindrical side wall 62, an end wall 63 at one end of the side wall, and an outwardly extending annular flange 64 at the other end of the side wall. The side wall has a greater length than the thickness of the lug 61 and the flange 64 serves as a stop for limiting sliding movement of the thimble in the direction of the end wall 63. The compression spring 58 is arranged so that one end thereof fits within the side wall 62 of the thimble and abuts against the end wall 63. The other end of the spring abuts against the adjusting screw 59 which is mounted in an internally threaded aperture 65 in a lug 66. Such lug is mounted on the end wall 48 of the shell 15 and is disposed opposite and in spaced apart relation with the lug 61. Turning of the screw 59 relatively to the lug 66 serves to vary or adjust the loading of the compression spring 58. The pin 60 extends lengthwise of the governor housing 12 and has one end thereof embedded in the end wall 50 of the floating drum 16. The other end of the pin extends through a circular hole 67 in the end wall 48 of the shell 15 and normally abuts against the end wall 63 of the thimble 57. The hole 67 is of materially greater diameter than the pin 60 in order to permit turning or rotation of the floating drum 16 relatively to the shell. Normally the free end of the pin 60 is in centered relation with the hole and the thimble is in the position shown in Figure 7. The spring device 56 coacts with a pin 68 and is the same as the device 55 so far as construction and operation are concerned. It comprises a thimble 69, a compression spring 70 and an adjusting screw 71. The thimble is carried by, and slidably mounted in, an apertured lug 72 on the outer face of the end wall 48 of the shell 15 and the adjusting screw 71 is carried by a lug 73 which is also mounted on the outer face of the shell end wall 48 and is disposed in opposed relation with the lug 70. The pin 68 is disposed in parallel relation with the pin 60 and has one end thereof embedded in the end wall 50 of the floating drum 16. The other end of the pin 68 extends through an enlarged circular hole 74 in the shell end wall 48 and normally abuts against the end wall of the thimble 69. The pin 68 and the hole 74, respectively, correspond in diameter to the pin 60 and the hole 67. Because the hole 74 is of greater diameter than the pin 68 the drum is permitted to turn or rotate to a limited extent relatively to the shell 15. Normally the pin 68 is in centered relation with the hole 74 and abuts against the end wall of the thimble 69. The two spring devices 55 and 56 tend, as previously pointed out, to maintain the drum in its normal or neutral position with respect to the shell 15. When the drum turns or rotates in one direction relatively to the shell one of the spring devices is compressed and when the drum turns or rotates in the opposite direction relatively to the shell the other spring device is compressed. By reason of the fact that the outer ends of the pins 60 and 68 extend across the end walls of the thimbles of the spring devices the drum is permitted to move axially in either direction relatively to the shell. When the governor is in operation and the engine abruptly or rapidly accelerates or decelerates the floating drum 16, due to inertia or momentum, substantially instantaneously turns relatively to the shell 15, the extent of turning being determined by the size of the holes 67 and 74 and the action of the spring devices 55 and 56. However, in connection with gradual increase or decrease in speed of the engine the drum 16 rotates at the same speed as the shell and is maintained in its neutral position with respect to the shell by the spring devices 55 and 56.

The electric pilot motor 18 is located in opposed relation with the engine driven shaft 13 and operates through the medium of planetary gearing 75 to drive a U-shaped member 76 in the chamber 22 in the housing 12. As shown, it is a direct current motor and comprises a casing 77 and an armature 78. One end of the motor casing is provided with an outwardly extending annular flange 79 and this fits against the outwardly extending annular flange 21 on the side wall 19 of the governor housing and is connected thereto by way of bolts 80. If desired a synchronous motor may be used in place of the direct current motor 18 and the frequency of the alternating current supplied thereto varied to

run the motor at the desired speed. The armature is rotatably mounted in the casing and is arranged so that the shaft thereof is in axial alignment with the control shaft 17. A battery 81 serves to supply current to the pilot motor 18. One side of the battery is connected to one of the terminals of the motor by way of a conductor 82 and the other side of the battery is connected to the other motor terminal by way of a conductor 83. The last mentioned conductor is provided with a switch 84 and a rheostat 85. The rheostat serves as a medium for varying or changing the speed of the electric pilot motor 18 when the switch 84 is closed. It is of conventional or standard construction and comprises a resistance element 86 and a rotary arm 87. The arm is movable over the resistance element in order that more or less of the resistance element may be cut into, or out of, the circuit for the pilot motor 18. The armature of the motor is driven in the same direction as the engine driven shaft 13, i. e., in a clockwise direction as viewed from the end of the governor that has the shaft 13. When the pilot motor 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.

The planetary gearing 75 is disposed around the inner end of the armature shaft of the pilot motor 18 and comprises a sun gear 88, a pair of planetary pinions 89, and a ring gear 90. The sun gear is in axial alignment with the armature shaft and has an elongated hub 91, the outer end of which fits around, and is keyed to, the inner end of the armature shaft. The inner end of the hub 91 of the sun gear extends loosely around, and serves slidably to support, the adjacent end of the axially movable control shaft 17. The planetary pinions 89 mesh with, and are driven by, the sun gear. They are positioned one diametrically opposite the other and are carried by a rotatable spider 92. The latter embodies a hub 93 which extends loosely around the inner end of the elongated hub 91 of the sun gear 88 and is held against axial displacement in one direction by way of a nut 94 on said inner end of the sun gear hub. The spider 92 comprises in addition to the hub 93 a pair of radially extending diametric arms and these are provided at their outer ends with shoulder equipped stub shafts 95 which extend lengthwise or longitudinally of the governor housing 12 and serve rotatably to support the planetary pinions 89. The ring gear 90 of the planetary gearing 75 is seated in an annular groove 96 in the end of the governor casing that is provided with the outwardly extending flange 21. As shown in Figure 2, the ring gear 90 is clamped against rotation in the groove 96 by the flange 79 of the pilot motor casing and has internal teeth which mesh with the planetary pinions 89. When the pilot motor 18 is in operation with the armature shaft thereof revolving in the same direction as the rotary magnetic member 14, the drum 16 and the shell 15, the sun gear 88 drives the planetary pinions 89 and the spider 92 so that they rotate in a corresponding direction.

The U-shaped member 76 comprises an intermediate part 97 and a pair of arms 98 and is driven conjointly with the spider 92 by way of a pair of pins 99. The intermediate part 97 of the member 76 is disposed between and in parallel relation with the spider 92 and the shell end wall 48 and has a central hole through which the adjacent end of the control shaft 17 extends loosely. An inner collar 100 and an outer collar 101 are fixedly mounted on the control shaft 17 in straddled relation with the central portion of the intermediate part 97 of the U-shaped member 76 and form a connection between the U-shaped member and the control shaft whereby the U-shaped member is permitted to rotate freely around the control shaft while at the same time the member and control shaft are connected together for conjoint sliding movement in either direction lengthwise of the governor housing. The pins 99 extend longitudinally of the governor housing and have the outer ends thereof secured to the inner ends of the stub shafts 95 for rotatably supporting the planetary pinions 89 of the planetary gearing 75. The other or inner ends of the pins 99 extend loosely through holes 102 in the end portions of the intermediate part of the U-shaped member 76. When the planetary gearing 75 is driven by the pilot motor 18 the pins 99 operate to rotate the U-shaped member 76. Because the pins 99 fit loosely in the holes 102 the U-shaped member together with the control shaft 17 is permitted to shift bodily to and from the spider 92. The arms 98 of the U-shaped member 76 are connected to the ends of the intermediate part 97 and project towards, and in overlying relation with, the floating drum 16. They are located on opposite sides of the control shaft 17 and extend through a pair of diametrically opposite arcuate slots 103 in the end wall 48 of the shell 15. The free ends of the arms 98 are disposed over the inner end of the side wall of the floating drum 16 and have inwardly extending pin type cam followers 104 which fit, respectively, in a pair of diagonal cam grooves 105 in a metallic ring 106. The ring extends around, and is fixedly secured to, the outer periphery of the cylindrical side wall 51 of the floating drum 16. The cam grooves are disposed diametrically opposite one another and are arranged so that the leading ends thereof extend towards the U-shaped member 76 and their trailing ends extend away from the member. When the U-shaped member 76 is driven by the spider 92 of the planetary gearing 75 at the same rate of speed as the floating drum 16 the control shaft 17 is held in a neutral position, the arms 98 of the U-shaped member are disposed in the central portions of the arcuate slots 103 and the pin type cam followers 104 are disposed in the central portions of the cam grooves 105. In the event that the drum 16 increases or decreases in speed relatively to the fixed driving speed of the U-shaped member 76, due to gradual increase or decrease in the speed of the engine with which the governor is associated, the cam grooves 105 will coact with the pin type cam followers 104 and shift the U-shaped member and control shaft axially, the direction of axial shift being dependent upon whether the floating drum 16 over-runs or under-runs the speed of rotation of the U-shaped member 76. If the floating drum 16 and the U-shaped member 76 are, as heretofore assumed, being driven in a clockwise direction as viewed from the end of the governor with the driven shaft 13, and the engine gradually increases in speed the floating drum 16, which under normal decreases or increases of speed, is driven at the same rate of speed as the shell 15, over-runs the motor driven U-shaped member 76 with the result that the trailing ends of the cam grooves 105 move into contact with

the pin type cam followers 104 and shift the U-shaped member together with the control shaft 17 towards the engine driven shaft 13. On the other hand, should the engine with which the governor is associated gradually decrease in speed the floating drum 16 will under-run the constantly driven U-shaped member 76 with the result that the leading ends of the cam grooves 105 will move into engagement with the pin type cam followers 104 and cause the U-shaped member 76 together with the control shaft 17 to move axially away from the engine driven shaft 13. As hereinafter described, axial shift of the control shaft 17 serves to control the controllable pitch propeller so that it in turn increases or decreases the pitch or attack angles of the propeller blades to return the motor to the speed that is set up or established by the pilot motor 18. The cam grooves 105, as shown in Figure 1, are but slightly angled with the result that the axial throw of the control shaft 17 is but slight when the cam grooves are brought into play as the result of over-running or under-running of the floating drum 16 with respect to the motor driven U-shaped member 76. The arcuate slots 103 in the end wall 48 of the shell 15 permit limited turning of the floating drum 16 in either direction with respect to the U-shaped member 76. The cam grooves 105 and the pin type cam followers 104 come into play or coact to effect limited axial shift of the control shaft when the floating drum 16 is turning or rotating conjointly with the shell 15 and the drum over-runs or under-runs the speed of drive of the U-shaped member 76 as the result of gradual increase or decrease in the speed of the engine.

As heretofore pointed out, the floating drum 16, because of inertia or momentum, turns to a limited extent with respect to the shell 15 in the event that the engine pronouncedly or abruptly accelerates or decelerates. In order to effect substantially instantaneous axial shift of the control shaft 17 and resultant quick governing or control of the engine in connection with turning of the floating drum 16 relatively to the shell 15 a cam arrangement in the form of a pair of pin type cam followers 107 and a pair of cam grooves 108 is provided. The pin type cam followers 107 are fixed to, and extend inwardly from, the side wall 47 of the shell 15 and are disposed adjacent the pin type cam followers 104 and one diametrically opposite the other. The cam grooves 108 are formed in the metallic ring 106 around the outer periphery of the side wall 51 of the floating drum 16 and are arranged in side by side relation with the cam grooves 105. They extend diagonally at a more abrupt angle than the cam grooves 105 and are arranged so that the leading ends thereof extend towards the U-shaped member 76 and their trailing ends extend away from said member. The length of the cam grooves 108 is such that the ends of such grooves are laterally offset to the same extent as the ends of the cam grooves 105. The pin type cam followers 107 are arranged so that the ends thereof project into the cam grooves 108 and are so positioned that when the floating drum 16 is held in its normal or neutral position with respect to the shell 15 as the result of the action of the spring devices 55 and 56 their inner ends are disposed in the central portions of said cam grooves 108. Assuming that the engine driven shaft 13 is rotating in a clockwise direction and the engine with which the governor is associated abruptly accelerates for any reason whatsoever, such, for example, as may occur



in the event that the airplane is placed into a steep dive, the shell 15 will, because of the inertia of the floating drum 16, rotate in a clockwise direction relatively to the drum with the result that the pin type cam followers 107 will slide along the leading ends of the cam grooves 108. Such sliding movement on the part of the cam followers 108 will cause the floating drum to move or slide bodily in the direction of the engine driven shaft 13, and effect corresponding axial shift of the control shaft 17. Shift of the floating drum towards the shaft 13 results in corresponding axial shift of the control shaft 17 by reason of the fact that the floating drum is operatively connected to the control shaft through the medium of the U-shaped member 76. In connection with initial abrupt acceleration of the engine the shell 15 over-runs the floating drum 16 and the drum advances slightly with respect to the U-shaped member 76 with the result that both cam arrangements are brought into play and the control shaft 17 is shifted axially toward the engine driven shaft 13 a greater distance than it would be shifted if only the cam arrangement in the form of the pin type cam followers 104 and the cam grooves 105 were brought into play. In the event that the engine with which the governor is associated abruptly decelerates such, for example, as may occur when the airplane is placed in a steep or high climbing attitude, the floating drum 16, because of its momentum, over-runs the shell 15 to the extent permitted by the pins 60 and 68 in their respective holes 67 and 74 with the result that the trailing ends of the diagonally disposed cam grooves 108 slide into engagement with the inner ends of the pin type cam followers 107. Because of the angular arrangement of the trailing ends of the cam grooves 108 such ends coact with the cam followers 107 in such manner as to shift the floating drum 16 toward the pilot motor 18 and effect corresponding shift of the control shaft 17. Such corresponding shift of the control shaft 17 is attributable to the fact that the floating drum is operatively connected to the control shaft through the medium of the U-shaped member 76. In connection with initial abrupt deceleration of the engine the shell 15 under-runs the floating drum 16 and the drum lags or is angularly displaced to a slight extent with respect to the U-shaped member 76 and hence both cam arrangements are brought into play and the control shaft 17 is axially displaced in the direction of the pilot motor to a greater extent than is the case where the cam arrangement in the form of the cam type followers 104 and the cam grooves 105 is brought into play due to gradual deceleration of the engine with respect to the pilot motor 18.

As previously pointed out, the governor is adapted to control or govern the speed of the airplane engine with which it is associated by varying the angle of the propeller blades of the controllable pitch propeller. The controllable pitch propeller which is disclosed in, and forms the subject matter of, an application for United States patent filed by Archibald G. Forsyth on August 12, 1943, Serial No. 498,367, 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 including a magnetic clutch type device for effecting increase in the pitch of the propeller blades at a slow rate, a magnetic clutch type

device for effecting decrease in the pitch of the propeller blades at a slow rate, a magnetic clutch type device for effecting increase in pitch of the propeller blades at a fast rate, and a magnetic clutch type device for effecting decrease in pitch of the propeller blades at a fast rate. Such devices are diagrammatically illustrated in Figure 8 of the drawings and are designated, respectively, by the reference numerals 109, 110, 111 and 112. These four devices are controlled, respectively by normally open push button switches 113, 114, 115 and 116. Such switches are mounted on a bracket 117 on the exterior of the governor housing 12 and adjacent the engine driven shaft 13 and, as hereinafter described, are controlled automatically in response to axial shift of the control shaft 17. The bracket 117 is bolted to a lug 118 on the side wall 19 of the governor housing and overhangs the end of the control shaft that projects through the end wall 20 of the governor housing. The switches 113 and 114 are mounted one directly opposite the other on the bracket 117 and are arranged so that the buttons therefor face or oppose one another and are spaced apart but a small distance. The switches 115 and 116 are mounted on the bracket 117 to one side of the switches 113 and 114, respectively, and are arranged so that their buttons face one another and are spaced apart a distance greater than the distance between the buttons for said switches 113 and 114. An upstanding arm 119 forms an operating connection between the switches and the end of the control shaft 17 that extends through the end wall 20 of the governor housing. The lower end of the arm is provided with a hole 120 and is fixedly or rigidly secured to the exposed end of the control shaft 17 by way of a bolt or cap screw 121 which extends through the hole 120 and into an internally threaded socket in the exposed end of the control shaft. The other or upper end of the arm is provided with an elongated crosspiece 122, one end of which extends between the buttons for the switches 113 and 114 and the other end of which extends between the buttons for the switches 115 and 116. Closing of the switch 113 results in closing of the hereinafter described circuit for the device 109 and results in the propeller blades being increased in pitch at a slow rate and the engine correspondingly decreasing in speed. When the control shaft 17 is shifted axially to a limited extent in the direction of the engine driven shaft 13 as the result of the cam arrangement in the form of the pin type cam followers 104 and the cam grooves 105 being brought into play because of a gradual increase in speed of the engine over the fixed or set speed of the U-shaped member 76 the arm moves away from the governor housing and effects closing of the push button switch 113 for the slow rate increase pitch device 109. When the control shaft 17 is shifted axially to a limited extent in the opposite direction, i. e., away from the shaft 17 as the result of the last mentioned cam arrangement being brought into play due to the engine gradually decreasing in speed the arm 119 is moved towards the governor housing and results in closing of the switch 114 for the slow rate decrease pitch device 110. Closing of such switch 114 completes the hereinafter described circuit for the device 110 and results in the propeller blades being decreased in pitch at a slow rate and a corresponding increase in speed of the engine. When the control shaft 17 is shifted axially in the direction of the engine driven shaft 13 to a greater extent as the result of both cam arrangements being brought into play due to initial abrupt increase in speed of the engine the arm 19 is moved away from the governor housing 12 and causes closing of the switch 115 for the fast rate increase pitch device 111. Closing of the switch 115 completes the circuit for the device 111 and results in the propeller blades being increased in pitch at a fast rate. When the control shaft 17 is shifted away from the engine driven shaft 13 as the result of both cam arrangements being brought into play due to initial abrupt decrease in speed of the engine the arm 119 moves towards the governor housing and effects closing of the switch 116 for the fast rate decrease pitch device 112. Closing of the switch 116 completes the hereinafter described circuit for the device 112 and results in a fast rate decrease in pitch of the propeller blades. Due to automatic control of the switches by the governor the engine is governed so that it maintains a predetermined speed corresponding to the speed of drive of the U-shaped member 76.

The circuit for the slow rate decrease pitch device 110 comprises a battery 123, a conductor 124 leading from one side of the battery to one terminal of the device 110, a conductor 125 leading from the other terminal of the device 110 to one contact of a normally closed switch 126, a conductor 127 leading from the other contact of the switch 126 to one contact of the push button 114, and a conductor 128 leading from the other contact of the switch 114 to the other side of the battery. When the switch 114 is closed, as hereinbefore described, the aforementioned circuit is closed with the result that the device 110 decreases the pitch of the propellers at a slow rate and causes the engine to accelerate or increase in speed. As soon as the engine accelerates to the same speed as the speed of the U-shaped member 76 the control shaft 17 is automatically shifted to its neutral position thereby resulting in opening of the switch 114.

The circuit for the slow rate increase pitch device 109 includes the battery 123 and comprises a conductor 129 leading from the conductor 124 to one contact of the push button switch 113, a conductor 130 leading from the other contact of the switch 113 to one contact of a normally closed switch 131, a conductor 132 leading from the other contact of the switch 131 to one terminal of the slow rate increase pitch device 109, and a conductor 133 leading from the other terminal of the device 109 to the conductor 128. When the switch 113 is automatically closed as the result of the engine gradually accelerating or over-speeding the aforementioned circuit is completed with the result that the device 109 causes a slow rate increase in pitch of the propeller blades and the engine decreases in speed. As soon as the engine decreases in speed to the speed of the U-shaped member 76 which, as hereinbefore pointed out, is rotated or driven at a constant speed by the pilot motor 18, the control shaft 17 is automatically shifted into its normal or neutral position and the switch 113 opens, thus breaking the circuit for the device 109.

The circuit for the fast rate decrease pitch device 112 comprises a conductor 134 leading from the conductor 124 to one terminal of the device 112, a conductor 135 leading from the other terminal of the device 112 to one contact of the

switch 116, and a conductor 136 leading from the other contact of the switch 116 to the conductor 128. As shown in Figure 8, the conductor 135 includes a solenoid 137 which is operatively connected to the switch 126 in the circuit for the slow rate decrease pitch device 110 and serves when the circuit for the device 112 is closed as the result of closing of the switch 116, to open the switch 126 and break the circuit for the device 110. When the switch 116 is closed as the result of the engine abruptly under-speeding or decelerating the circuit through the device 112 is completed with the result that the propeller blades are decreased in pitch at a fast rate. As soon as the engine speeds up to the speed determined by the pilot motor 18 the control shaft 17 will have been shifted to its neutral position and the switches 114 and 116 thereby opened and effecting an opening of the circuit for the devices 110 and 112. The solenoid 137 for opening the switch 126 is included in the circuit for the fast rate decrease pitch device 112 as hereinbefore described. Pronounced shift of the control shaft 17 towards the pilot motor in connection with initial abrupt deceleration or underspeeding of the engine causes the crosspiece 122 of the arm 119 to close the switch 114 before it closes the switch 116. However, as soon as the switch 116 is closed the circuit for the slow rate decrease pitch device 110 is automatically opened as the result of the action of the solenoid 137 even though the switch 114 is held in its closed position by the crosspiece 122.

The circuit for the fast rate increase pitch device 111 includes the battery 123 and comprises a conductor 138 leading from the conductor 124 to one contact of the switch 115, a conductor 139 leading from the other contact of the switch 115 to one terminal of the device 111, and a conductor 140 leading from the other terminal of the device 111 to the conductor 128. The conductor 139 includes a solenoid 141 which is operatively connected to the normally closed switch 131 in the circuit for the slow rate increase pitch device 109 and serves when the circuit for the device 111 is closed, to open the switch 131 and thus break the circuit for the device 109. When the switch 115 is closed as the result of the engine initially abruptly accelerating or over-speeding the circuit for the device 111 is closed with the result that such device increases the pitch of the propeller blades at a fast rate. When the speed of the engine is decreased to that of the pilot motor driven U-shaped member 76 the control shaft 17 will have automatically shifted to its neutral position, resulting in opening of the switches 113 and 115. The solenoid 141 is included in the circuit for the device 111 because when the arm 119 is moved away from the governor housing in connection with initial abrupt acceleration or over-speeding of the engine the switch 113 is closed before the switch 115 and it is hence necessary to break or open the circuit for the device 109 as soon as the circuit for the device 111 is closed by closing of the switch 115. When the switch 115 is closed the solenoid 141 maintains the normally closed switch 131 in its open position and hence the circuit for the slow rate increase pitch device 109 is opened even though the switch 115 is closed.

The operation of the governor is as follows:

When the speed of the engine corresponds to the speed determined by the pilot motor 18 the floating drum 16 is in a normal or neutral position with respect to the shell 15 and rotates conjointly with such shell and the control shaft 17 is in its neutral position wherein it maintains the arm 119 in a position wherein the crosspiece 122 thereof is out of contact with any of the push button switches 113, 114, 115 and 116. So long as the speed of the engine corresponds to the speed predetermined by the pilot motor 18 the pin type cam followers 104 are disposed in the central portion of the cam slots 105 and the pin type cam followers 107 are disposed in the central portion of the cam slots 108, as shown in Figure 9. In the event that the engine gradually increases in speed for any reason whatsoever the floating drum 16 which in connection with gradual engine acceleration is turned or rotated conjointly with the shell 15, over-runs the pilot motor driven U-shaped member 76 with the result that the pin type cam followers 104 move into the trailing ends of the cam slots 105, as shown in Figure 9a. Such movement on the part of the cam followers 104 causes the U-shaped member 76 and the control shaft 17 to move a limited extent in the direction of the engine driven shaft 13. Shift of the shaft 17 to a limited extent towards the engine driven shaft 13 results in closing of the switch 113 and this in turn causes actuation of the slow rate increase pitch device 109. Immediately upon actuation of such device the propeller blades are increased in pitch at a slow rate with the result that the engine slows down or decelerates. As soon as the engine decelerates or slows down to the predetermined speed the pin type cam followers 104 move into the central portions of the cam grooves 105 and result in the U-shaped member 76 and the control shaft 17 moving towards the pilot motor 18 into their neutral position and resultant opening of the switch 113 for the slow rate increase pitch device 109. In the event that the engine gradually decreases in speed for any reason whatsoever the floating drum 16 which in connection with gradual deceleration of the engine rotates conjointly with the shell 15, underspeeds the pilot motor driven member 76 with the result that the pin type cam followers 104 move into the leading ends of the cam slots 105, as shown in Figure 9b. As the cam followers 104 move into the leading ends of the cam slots 105 they cause the pilot motor driven U-shaped member 76 and the control shaft 17 to move to a limited extent in the direction of the pilot motor 18. Limited shift of the control shaft in the direction of the pilot motor causes the arm 119 to close the switch 114 and results in actuation of the slow rate decrease pitch device 110. Immediately upon actuation of such device the propeller blades are decreased in pitch at a slow rate with the result that the engine increases in speed until it reaches its predetermined or governed speed. At such time the pin type cam followers 104 move into the central portions of the cam slots 105 and retract the U-shaped member 76 and the control shaft 17 to their neutral position. Retraction of the control shaft results in opening of the switch 114. Because of the high sensitivity of the governor the engine will return to its predetermined speed directly after gradual acceleration or deceleration thereof.

In the event that the engine should abruptly accelerate as the result of the airplane being placed in a steep or sharp dive the operation of the governor is as follows:

At the initial part of abrupt acceleration of the engine the floating drum 16 slightly over-runs the pilot motor driven U-shaped member 76

and the shell 15 over-runs the drum, thus bringing into play both cam arrangements. As shown in Figure 10a over-running of the drum with respect to the member 76 results in the pin type cam followers 104 moving into the trailing ends of the cam grooves 105 and the pin type cam followers 107 moving into the leading ends of the cam grooves 108. Movement of the cam followers 104 into the trailing ends of the cam grooves 105 combined with movement of the cam followers 107 into the leading ends of the cam grooves 108 and resultant shift of the floating drum 16 in the direction of the engine driven shaft 13 results in the control shaft 17 being shifted to its full extent in the direction of the shaft 13 and consequent closing of the push button switch 115 for the fast rate increase pitch device 111. As soon as the switch 115 closes the device 111 increases the pitch of the propeller blades at a fast rate. As soon as there is no increase in the rate of acceleration of the engine as the result of increase in pitch of the blades at a fast rate the floating drum 16 is returned to its neutral position with respect to the shell 15, as shown in Figure 10b. This is due to the action of one of the spring devices 55 and 56 and occurs at a point near the peak of acceleration of the engine. When the drum is returned to its neutral position with respect to the shell as the result of spring action the pin type cam followers 107 move into the central portions of the cam grooves 108 and shift the floating drum towards the pilot motor 18 to its neutral position. Shift of the drum to such position effects corresponding shift of the control shaft 17 and resultant opening of the switch 115 for the fast rate increase pitch device 111. In view of the fact that the engine at the peak of its acceleration is over-running the pilot motor 18 the cam arrangement in the form of the cam followers 104 and the cam grooves 105 remains active to the extent that it serves to retain closed the switch 113 for the slow rate increase pitch device 109. After the engine reaches its peak of acceleration it starts abruptly to decelerate. During deceleration of the engine before the engine reaches its predetermined speed as set or determined by the pilot motor 18 the floating drum 16, because of its momentum, over-runs the shell 15 and causes the pin type cam followers 107 to move into the trailing ends of the cam grooves 108, as shown in Figure 10c. As the result of the cam followers 107 moving into the trailing ends of the cam grooves 108 the floating drum is shifted from its neutral position toward the pilot motor 18 and returns the control shaft 17 to its neutral position even though the pin type cam followers 104 remain in the trailing ends of the cam grooves 105. As soon as the control shaft is moved into its neutral position as the result of under-speeding of the shell with respect to the drum the switch 113 for the slow rate increase pitch device 109 opens and the governor is in a satisfied or no-governing condition. Such condition occurs prior to the engine dropping in speed to its predetermined speed. After the governor is placed in its no-governing position as heretofore pointed out, the engine, due to momentum of its parts, coasts down to its predetermined speed. During coasting of the engine to its predetermined speed one of the spring devices 55 and 56 returns the floating drum 16 to its neutral position with respect to the shell 15 and the pin type cam followers 104 move into the central portions of the cam grooves 105. Thus when the engine in connection with coasting thereof reaches its predetermined speed the governor is in its no-governing or neutral position and hunting is thus eliminated. The point at which the governor assumes its no-governing position or condition prior to the levelling off of the engine to its predetermined speed depends upon the degree of abruptness of acceleration. If the magnitude of abruptness of acceleration is great then the governor will assume its non-governing condition in connection with deceleration of the engine quite a bit ahead of the engine decelerating to its predetermined speed. If the degree of abruptness of engine acceleration is comparatively small then the governor assumes its no-governing position at a point directly in advance of the engine due to its momentum levelling off to the predetermined speed, i. e., the speed determined or fixed by the pilot motor 18. By automatically arranging for the governor to assume a satisfied or no-governing condition in advance of the engine reaching its predetermined speed after abrupt acceleration the engine will automatically level off to its predetermined speed with substantially no hunting. In other words, the arrangement of the governor is such that in connection with pronounced acceleration of the engine for any reason whatsoever the switches for the increase pitch devices are opened ahead of the time when the engine levels off to its predetermined speed, thus compensating for the momentum effect of the engine which would normally cause the engine to pass its predetermined speed and resultant hunting under governor control. The compensating or anticipating feature of the present governor is entirely automatic and self-adjusting, depending upon the magnitude of abrupt acceleration or deceleration of the engine.

In the event that the engine should abruptly decelerate as the result of the airplane being placed in an extremely high climbing attitude the governor operates in the same manner as it does in connection with abrupt acceleration except that the operating parts move reversely and the slow rate decrease pitch device 110 and the fast rate decrease pitch device 112 are brought into play instead of the slow rate increase device 109 and the fast rate increase pitch device 111. In connection with abrupt deceleration of the engine the governor automatically assumes its non-governing or neutral condition prior to the engine returning to its predetermined speed. As soon as the governor cuts out or assumes its no-governing position the engine, due to the inertia of the parts thereof, levels off or coasts to the predetermined speed and hence hunting of the engine is eliminated in connection with return of the engine to its predetermined speed, i. e., the speed that is governed or controlled by the speed of drive of the pilot motor 18.

By increasing or decreasing the speed of the pilot motor 18 through the medium of the rheostat 85 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 86 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 so that it operates at any desired predetermined speed. It is contemplated that the engine will be started before closing of the switch

84 in the circuit for the pilot motor 18. When the engine is started while the pilot motor is at rest the overload clutch 37 provides the necessary slippage. After starting of the motor the rheostat is adjusted to the desired point and the switch 84 is closed. As soon as the pilot motor is energized as the result of closing of the switch 84 the governor operates in the manner heretofore described automatically to maintain the engine at a predetermined speed. Because the engine after abrupt acceleration tends to return under governor control to the predetermined speed at a different rate of speed than it returns to its predetermined speed after abrupt deceleration the spring of one of the spring devices 55 and 56 is loaded to a greater extent than the spring of the other device. By properly adjusting the loading of the springs of such devices the governor may be set so as to eliminate the tendency of the engine to over-run the predetermined speed in connection with return after abrupt acceleration or deceleration.

The graph constituting Figure 11 includes a curve A. Such curve is a theoretical performance curve of the engine as controlled or governed by the subject governor. Part $a$ of the curve represents the speed charcteristics of the governor controlled engine in connection with gradual acceleration and deceleration of the engine. As heretofore pointed out in connection with either a gradual acceleration or deceleration of the engine, only the cam arrangement in the form of the pin type cam followers 104 and the cam grooves 105 is brought into play. Part $a^1$ of the curve represents the speed characteristics of the engine in connection with an extremely abrupt acceleration of the engine. During pronouncedly abrupt acceleration of the engine the engine, as shown by part $a^1$ of the performance curve, rapidly accelerates and during rapid acceleration the operating parts of the governor are in the position shown diagrammatically in Figure $10^a$ of the drawings. In such position of the governor parts the switch 115 for the fast rate increase pitch device 111 is maintained closed and the blades of the propeller are increased in pitch at a fast rate. When the engine reaches its peak of acceleration in connection with abrupt acceleration as occurs in connection with a sharp dive of the airplane the operating parts of the governor are in the position shown diagrammatically in Figure $10^b$ of the drawings. In such position of the governor operating parts the floating drum 16 is in its normal or neutral position with respect to the shell 15 due to the action of the spring device and only the cam arrangement in the form of the cam followers 104 and the cam grooves 105 is in play or operation. As heretofore pointed out, when such cam arrangement is effective the switch 113 for the slow rate increase pitch device 109 is closed and the propeller blades are increased at a slow rate. During rapid deceleration of the engine due to increase in blade angles after pronouncedly abrupt acceleration, the governor cuts out or assumes its no-governing position at approximately the point $x$ on the part $a^1$ of the performance curve A. When the point $x$ is reached the operating parts of the governor, due to under-running of the shell 15 with respect to the floating drum 16, are in the position shown diagrammatically in Figure $10^c$. After the point $x$ is reached and the governor is in its cut out or no-governing position the engine, due to its momentum, slows down or levels off to its predetermined speed. During levelling off of the engine to its predetermined speed the operating parts of the governor return to their neutral position as shown diagrammatically in Figure $10^d$. Thus, as shown by part $a^1$ of the performance curve A in the graph constituting Figure 11, the operating parts of the governor are in their neutral position when the speed of the engine levels off to its predetermined speed. Part $a^2$ of the performance curve represents the speed characteristics of the engine in connection with less abrupt acceleration. As shown by part $a^2$ of the curve the governor cuts out or assumes its no-governing position at the point $x^1$ which is nearer the predetermined speed than the point $x$ which, as heretofore pointed out, is where the governor cuts out after pronounced acceleration of the engine. In connection with a less pronounced abrupt acceleration of the engine the governor cuts out or assumes its no-governing condition at a point nearer the predetermined speed due to the fact that deceleration of the engine after the engine reaches the peak of its acceleration is more gradual and hence the shell 15 does not over-run the floating drum 16 until a point near the predetermined speed. As described heretofore the cutting out of the governor before the engine returns to its predetermined speed is automatic and is self-adjusting, depending entirely upon the magnitude or rate of acceleration of the engine over its predetermined speed. Part $a^3$ of the curve A represents the speed characteristics of the engine in connection with abrupt deceleration due to the airplane with which the governor control engine is associated being placed in a steep climbing attitude.

The herein described governor is highly efficient in operation and effectively and efficiently fulfills its intended purpose. Its design and construction are such that the tendency of the engine, with which the governor is used, to hunt in connection with governor control, is reduced to a minimum. In other words the governor is so designed and arranged that when the engine acceleration or deceleration ceases under governor control the engine will be operating at the desired or predetermined R. P. M.

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 I claim as new and desire to secure by Letters Patent is:

1. A governor adapted to maintain an engine at a predetermined speed and comprising a rotary member provided with means for connecting it for drive by one of the operating parts of the engine, a second rotary member provided with means for driving it at a contant predetermined speed, a movably mounted speed control element, means automatically operative when the first mentioned member is driven at a speed different from the second mentioned member due to gradual acceleration or deceleration to move the element to a limited extent, and cam means operative automatically and substantially instantaneously when the first mentioned member is

driven at a speed different from the second mentioned member due to abrupt acceleration or deceleration to move the element to a greater extent.

2. A governor adapted to maintain an engine at a predetermined speed and comprising a first speed control means, a second speed control means, a rotary part provided with means for connecting it for drive by the engine, a rotatably and slidably mounted element responsive to magnetic influence and disposed adjacent said part, a magnetic mmeber adjacent the element provided with means for connecting it for drive by the engine and adapted when the engine is driven at its predetermined speed or gradually accelerates or decelerates from its predetermined speed to drive the element at the same speed as the part, said element being adapted when slid to actuate the second speed control means and being further adapted in connection with abrupt acceleration of the engine to underrun the part and in connection with abrupt deceleration of the engine to overrun the part, cam means between the part and the element adapted to slide the element in connection with under-running and over-running of said element with respect to the part, a second member provided with means for driving it at a constant speed, and means operative when the element is driven at a different speed from the second member due to gradual acceleration or deceleration of the engine to actuate the first speed control means.

3. A mechanical governor adapted to maintain an engine at a predetermined speed and comprising a first speed control means, a second speed control means, a rotary part provided with means for connecting it for drive by the engine, a rotatably and slidably mounted element adjacent said part adapted when slid to actuate the second speed control means and provided with driving means therefor whereby it rotates at the same speed as the part when the engine is running at its predetermined speed or gradually accelerates or decelerates from its predetermined speed, underruns the part in connection with abrupt acceleration of the engine and overruns the part



in connection with abrupt deceleration of the engine, cam means between the part and the element adapted to slide the element in connection with under or over-running of said element with respect to the part, a rotary member positioned in associated relation with the part and element and provided with a pilot motor for driving it at a constant speed, and cam means operative when the element is driven at a speed different from the member due to gradual acceleration or deceleration of the engine from its predetermined speed to actuate the first speed control means.

IRA J. SNADER.


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