

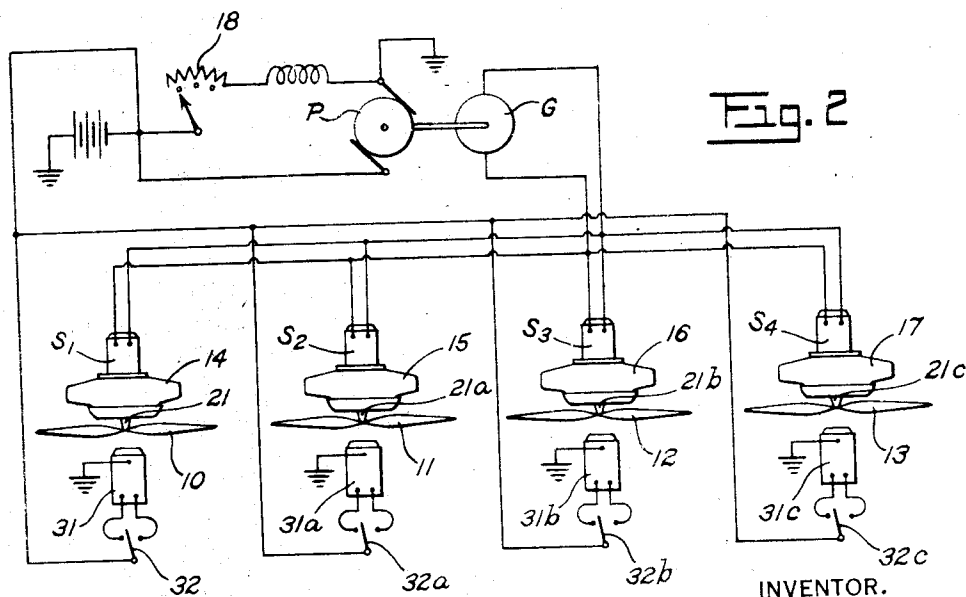
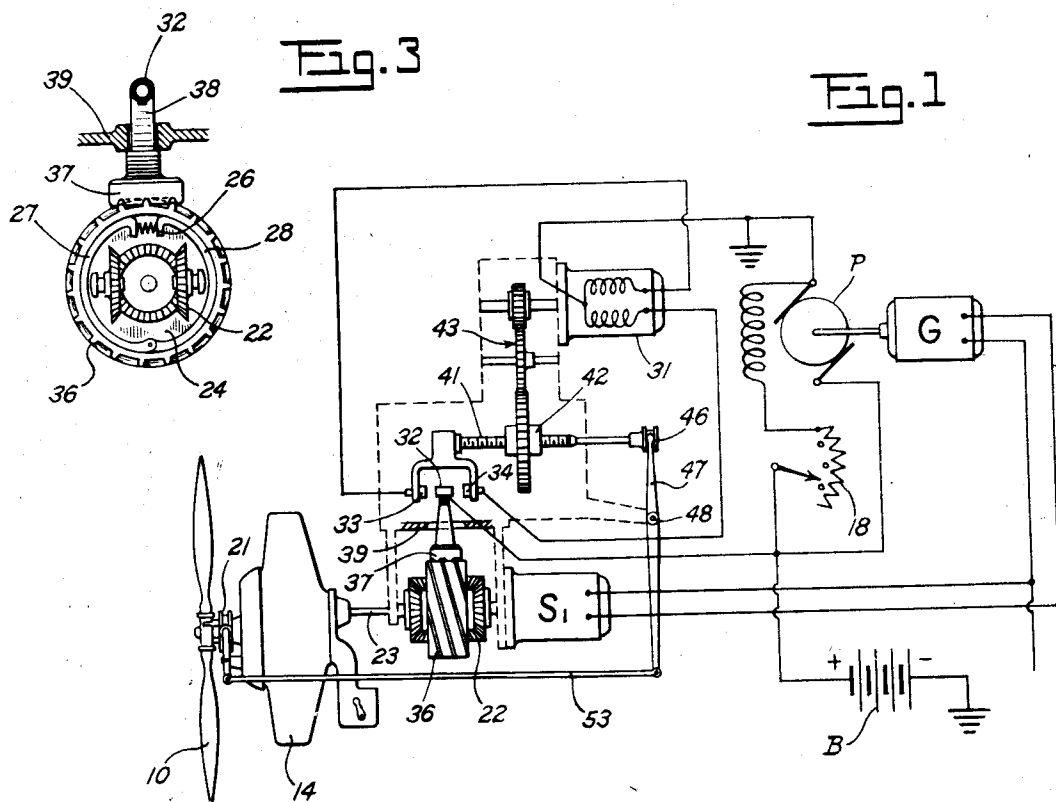
May 30, 1939.

D. M. BERGES

2,160,324

INTERNAL COMBUSTION ENGINE

Filed Dec. 15, 1937



INVENTOR.
Donald M. Berges
BY *Martin J. Linneman*
ATTORNEY.

UNITED STATES PATENT OFFICE

2,160,324

INTERNAL COMBUSTION ENGINE

Donald M. Berges, Montclair, N. J., assignor to
Eclipse Aviation Corporation, East Orange,
N. J., a corporation of New Jersey

Application December 15, 1937, Serial No. 179,995

4 Claims. (Cl. 170—135.6)

This invention relates to propeller control mechanism and more particularly to a speed control mechanism.

This invention finds particular use as a control mechanism for controllable pitch propellers and especially as a means for maintaining constant speed of the propeller and its driving mechanism by variations in the pitch of the propeller.

In connection with the operation of airplanes, the desirability of having means by which the speed of the engine, especially an internal combustion engine, could be maintained constant has long been known. Among the advantages to be obtained from maintaining a constant engine speed might be mentioned the improvement in "take-off" characteristics. There are, of course, many other conditions of flight in which the constant speed control mechanism is of particular advantage.

One of the objects of the present invention is to provide a practical propeller pitch control mechanism.

Another object of the invention is to provide speed responsive means for controlling the pitch of a propeller, or of a plurality of propellers. In the latter phase of the invention, a feature is the provision of means for automatically correcting for any deviation, on the part of one or more of the propellers, from a pre-selected speed, such correcting means being adapted to vary the pitch of the deviating propeller or propellers sufficiently to bring such propeller or propellers back to the speed pre-selected to be the normal.

Other objects and advantages will be apparent from the attached specification and the accompanying drawing which illustrates what is now considered the preferred embodiment.

In the drawing:

Fig. 1 is a diagrammatic representation of an application of the invention to a single propeller and its driving engine;

Fig. 2 shows the electrical connections for a plurality of engine and propeller sets; and

Fig. 3 is a transverse view of the switch actuating mechanism of Fig. 1.

Reference characters 10, 11, 12 and 13 point to the propellers of four associated engines 14, 15, 16 and 17, respectively, each propeller having a pitch varying gear connecting therewith, in the manner in which the gear 21 connects with the propeller 10 in Fig. 1, the corresponding pitch varying mechanisms for the propellers 11, 12 and 13 being indicated in Fig. 2 at 21a, 21b, and 21c, respectively. The respective pitch varying mechanisms may be as more fully illustrated and

described in Patent No. 1,852,499 granted to J. R. Zipay on April 5, 1932, and the actuating means for the respective pitch varying mechanisms may be similar to that indicated in part at 46, 47 and 53 for the pitch varying mechanism 21, it being understood that there will be similar actuating means individual to each of the other mechanisms 21a, 21b and 21c. As shown the member 46 is shiftable along its axis in response to the axial travel of the screw shaft 41 the operation of which will be more fully described hereinafter.

In addition to driving its propeller, each engine crankshaft drives one gear of a differential gear set, the drive from the engine 14 to its differential gear set 22 being indicated at 23 in Fig. 1, and the other engines being similarly connected to similar differential gear sets not shown. Also driving a member of each differential gear set is a synchronous motor S₁ for gear set 22, and S₂, S₃ and S₄ for the gear sets not shown. As shown in Fig. 2, the motors S₁, S₂, S₃ and S₄ receive current from generator G which is in turn energized by mechanical connection with a constant speed motor P fed from a battery B or other suitable electricity source. Motor P may be set to operate at the desired ("preselected") speed by adjustment of rheostat 18.

Also fed from battery B, as shown, is a second series of motors 31, 31a, 31b and 31c, each of which is adapted to drive a gear train and screw shaft actuating mechanism, there being one such mechanism associated with each of the actuating means 46, 47 and 53 above described, and each of said gear trains and screw actuating mechanism being preferably similar to the one shown at 43 and 42 in association with the motor 31 of Fig. 1. Each of the motors 31, 31a, 31b and 31c is normally de-energized, but each is adapted to rotate on closure of a switch mechanism operable by the differential action on its associated differential mechanism corresponding to the differential mechanism 22 which actuates motor controlling switch mechanism 32 associated with the motor 31 in Fig. 1. As shown switch mechanism 32—and the same will preferably be true of each of the corresponding switch mechanisms 32 (a, b, c) which are associated with the differential mechanisms for the other engines—is movable in a rectilinear path within the limits established by the positioning of the complementary switch contacts 33 and 34, and engagement of the switch contact 32 with the contact 33 will result in energization of the windings of motor 31 which control and produce clockwise rotation of said motor, while engagement of the contact 32 with the con-

tact 34 will produce energization of those windings of the motor which control and effect counterclockwise rotation of said motor. Switch contact 32 moves toward 33 or 34 only in the event of, and in response to, a difference in speed between shaft 23 and motor S₁ (signifying a deviation of engine 14 from the pre-selected speed). Contacts 33 and 34, on the other hand, move only in response to axial travel of screw 41 to which they are integrated or otherwise positively connected. Screw 41 moves axially in response to rotation of nut 42, and rotation of nut 42 occurs only in response to rotation of motor 31 and the reduction train 43 connecting motor 31 with nut 42.

The means for producing rectilinear travel of the contact 32 in the event of and in response to the difference in speed between shaft 23 and motor S₁ is shown as including radially acting clutch elements 27 and 28 pivotally mounted on the cage 24 of the differential gear set and normally urged into torque transmitting engagement with the inner cylindrical surface of an externally threaded screw or helical cam 36 which meshes with a correspondingly helically grooved member 37 whose outer extension 38 is constrained by suitable means (as a rectilinear slot in the housing wall 39) into movement along a path which will carry the current conducting portion 32 thereof into ultimate engagement with either the contact 33 or the contact 34, to energize propeller control motor 31 for clockwise or counterclockwise rotation as the case may be. Thus the member 37 constitutes in effect, the equivalent of an internally threaded nut adapted to travel in the plane of the axis of an actuating screw within said nut in response to rotation of said screw, but as shown the member 37 does not completely encircle the member 36, as in the case of an ordinary screw and nut, which is therefore in effect merely a sector or a segmental portion of said nut.

On the opposite end of screw 41 there is a collar 46 receiving one end of a yoke or bifurcated lever 47 fulcrumed at 48 and operatively attached to a linkage (as 53) in the manner in which linkage 53 is shown as connecting with propeller shifting gear 21 of propeller 10, there being one such linkage for each propeller shifting gear (21, 21a, 21b, 21c, Fig. 2), as above described.

From the foregoing it will be understood that the operation is:

Set speed of motor P at that desired. This sets speed of all synchronous motors. If the speed of the engine to be synchronized is not exactly right, cage 24 of differential 22 will move either clockwise or counterclockwise (see Fig. 3) depending upon whether the speed of engine is greater or less than speed desired. Motion of differential cage 24 is transmitted through the clutch shoes 27 and 28 to the member 36 to produce rectilinear movement of the member 37 and the contact portion 32 carried thereby into ultimate engagement with either the contact 33 or the contact 34, to energize propeller control motor 31 for clockwise or counterclockwise rotation as the case may be. Such rotation moves shaft 41 which carries contacts 33 and 34, and also changes the speed of the engine by its effect upon members 53 and 21. By reason of the movement thus imparted to contacts 33 and 34, as they are carried along with the screw 41, there is the tendency to break the circuit between member 32 and either the member 33 or the

member 34, depending upon which is engaged with 32 at the moment. This gives the necessary follow-up motion required for perfect synchronizing. During this follow-up motion cage 24 of differential 22, screw 36, member 37, contact 32 and stop 33 or 34 moves enough to break contact, propeller control motor 31 stops and engine speed is as desired. Change in engine load, or a change in the speed of the synchronous motor will cause the above cycle to recur to maintain the engine at the desired speed.

Inasmuch as the speeds of all the synchronous motors must be the same it follows that the engines to which they are connected will be in synchronism.

The purpose of the clutch connection between the cage 24 and the member 36 is to provide for an overload for release of the driving connection to the member 32 in the event that an unforeseen over-travel of the member 32 should result in a condition wherein further movement of said part 32 would be impossible because of a limitation upon the extent of possible axial travel of the screw shaft 41 which of course produces a corresponding limitation upon the extent to which the contacts 33 and 34 can yield when either is engaged by the member 32. Should such a condition occur there might be a breakage of parts if it were not for the ability of the friction shoes 27 and 28 to slip around along the surface of the member 36 and thereby relieve the overload upon the parts.

What is claimed is:

1. The combination with a plurality of variable speed internal combustion engines of means including an equal plurality of electric motors operable in response to deviation of said engines from a pre-selected speed, restoring means responsive to operation of said motors to return said engines to said pre-selected speed, and means for de-energizing said motors in response to the return of said engines to said pre-selected speed, said de-energizing means including electric circuits individual to each of the motors, each circuit having a shiftable circuit breaker associated therewith, and means individual to each circuit breaker for shifting said circuit breakers in synchronism with the rotation of their respective motors, said shifting means including a gear train constituting a part of said restoring means.

2. The combination with a plurality of variable speed internal combustion engines of means including an equal number of electric motors operable in response to deviation of said engines from a pre-selected speed, restoring means responsive to operation of said motors to return said engines to said pre-selected speed, means for de-energizing said motors in response to the return of said engines to said pre-selected speed, said de-energizing means including electric circuits individual to each of the motors, each circuit having a pair of separately shiftable but inter-engageable contacts therein, means for shifting one of each pair of shiftable contacts in synchronism with the rotation of its associated motor, and means responsive to every deviation of any of any of the engines from a pre-determined speed to produce movement of the other of the pair of shiftable contacts in the circuit of the motor corresponding to the deviating engine.

3. In combination with a plurality of variable speed internal combustion engines of the propeller driving type, means including a correspond-

ing plurality of electric motors for varying the pitch of said propellers, to return the respective driving engines to a pre-selected speed, means for energizing each of said motors in response to departure of said engines from said pre-selected speed, said energizing means including a source of current, a circuit from said source, said circuit including said electric motor, speed deviation responsive means for closing said circuit, said speed deviation responsive means including a gear whose speed varies with variations in engine speed, a second gear whose speed remains constant, a differential connection therebetween, a circuit closing element movable with said differential connection, a co-operating circuit closing element in the path of movement of said first-named circuit closing element, and means for moving said co-operating circuit closing element along said path in synchronism with the rotation of the motor whose circuit includes said two circuit-closing elements.

4. The combination with variable speed inter-

nal combustion engines of means including electric motors operable in response to deviation of said engines from a pre-selected speed, means responsive to operation of said motors to return said engines to said pre-selected speed, means for energizing said motors, said energizing means including a source of current and a circuit from said source, said circuit including said electric motor, speed deviation responsive means for closing said circuit, said speed deviation responsive means including a contact actuating member having an inner cylindrical surface, a plurality of clutch elements frictionally engageable with said inner cylindrical surface to transmit torque thereto up to a predetermined maximum capacity, and means including a differential gear carrying cage for driving said clutch elements whenever the speed of one of the differential gears deviates from the pre-selected constant speed of another of said gears.

DONALD M. BERGES.