Dec. 10, 1946. C. F. SCHORN 2,412,360

POWER CONTROL

Filed March 4, 1942 2 Sheets-Sheet 1

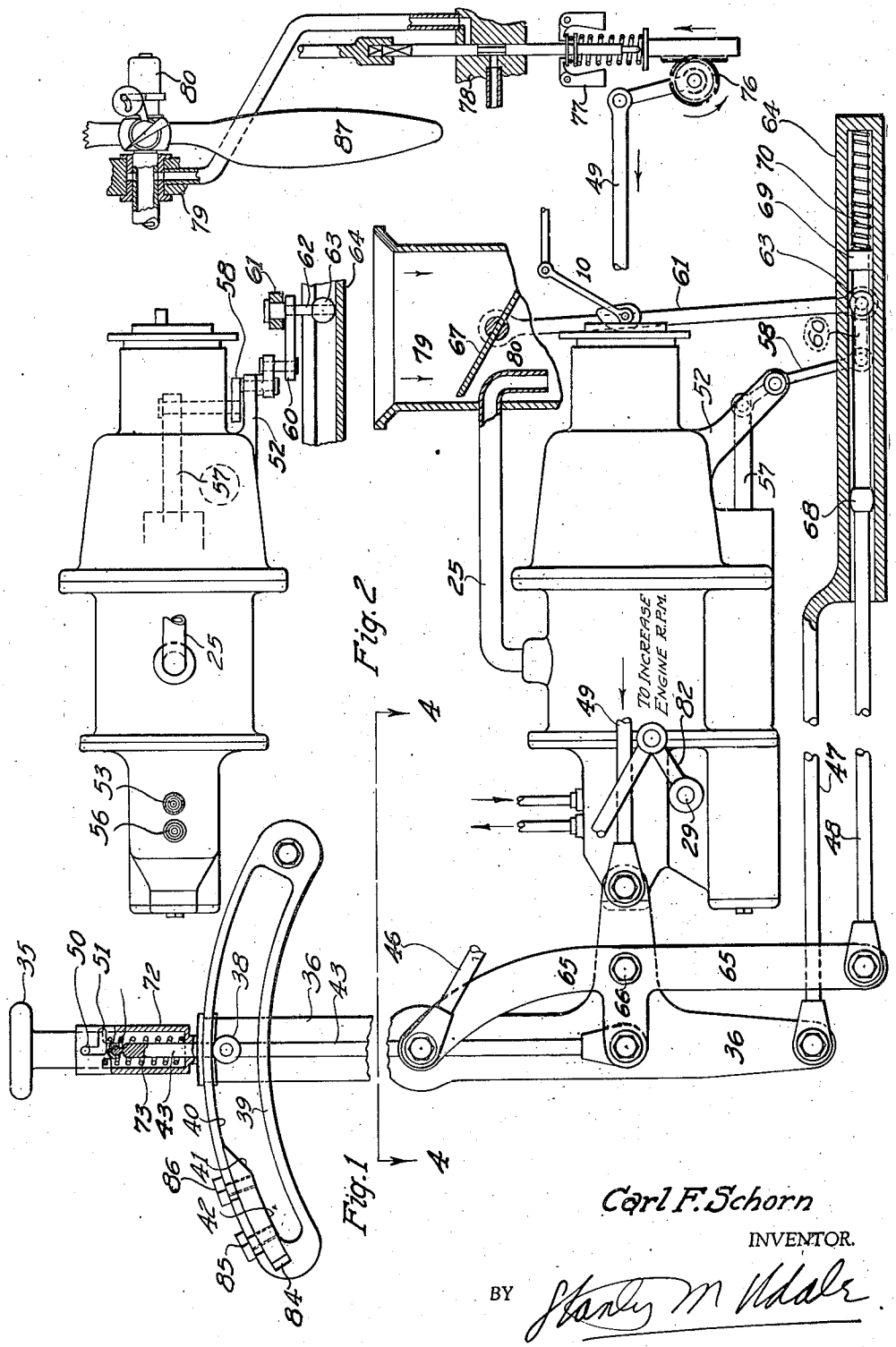


Fig. 2

Fig. 1

Carl F. Schorn

INVENTOR.

BY Stanley M Udale

Dec. 10, 1946. C. F. SCHORN 2,412,360

POWER CONTROL

Filed March 4, 1942 2 Sheets-Sheet 2

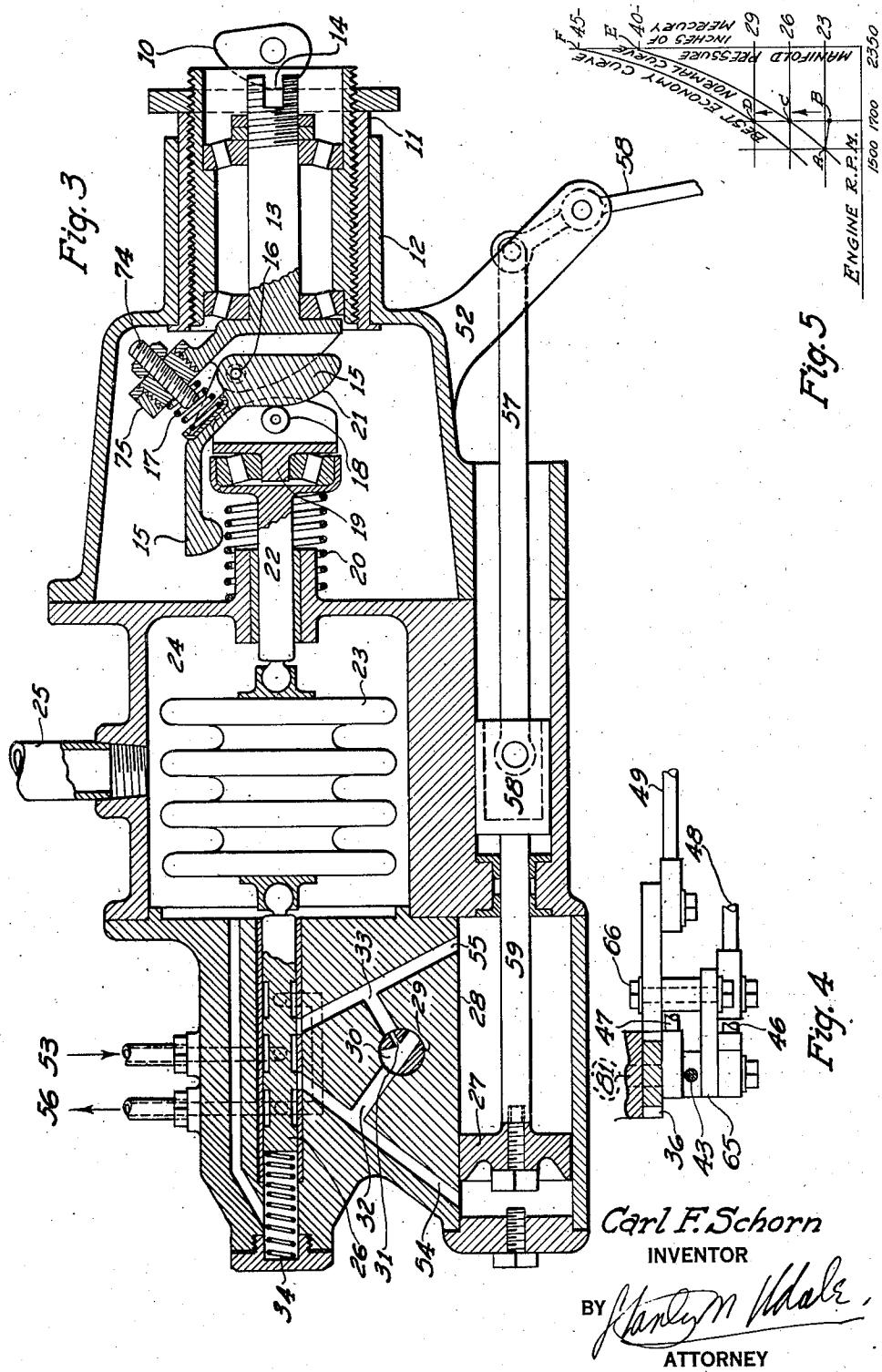


Fig. 3

Fig. 5

Fig. 4

Carl F. Schorn
INVENTOR

BY Stanley M. Wadle
ATTORNEY

Patented Dec. 10, 1946 2,412,360

UNITED STATES PATENT OFFICE

2,412,360

POWER CONTROL

Carl F. Schorn, Detroit, Mich., assignor to George M. Holley and Earl Holley

Application March 4, 1942, Serial No. 433,371

4 Claims. (Cl. 170—135.6)

1

This invention relates to the control of a variable pitch propeller driven by an airplane engine in which the pitch is automatically adjusted to keep the engine at any desired speed.

The object of this invention is to improve the existing power controls so that a manually operated lever will select the speed of the engine desired and that this speed will automatically select the manifold air pressure desirable at that speed. The product of revolutions per minute and manifold air pressure is roughly proportional to indicated horsepower.

Another object of this invention is to avoid the need for the use of broken links so that straight through pull and push links can be used. As a result, the control unit can be bench-tested, as it is a self-contained unit.

Other objects are to facilitate the operation of the device when cold and to provide means to render the device inoperative when idling the engine, and in both circumstances, to permit the manual operation of the throttle. The reason manual operation is necessary at low speed, especially at idling speeds, is that the centrifugal control of the variable pitch propeller is in operation at low speed.

In the drawings:

Fig. 1 shows the general elevation of the mechanism.

Fig. 2 shows a plan view of part of the control mechanism.

Fig. 3 shows in cross sectional elevation the combined centrifugal and barometric controls.

Fig. 4 shows a plan view of the manually operated lever and the links connected to it.

Fig. 5 shows the normal relation between revolutions per minute and manifold air pressure, and also the relation for best economy.

In Fig. 1 a speed control lever 36 slidably engaging with a quadrant 39 controls the pitch of a propeller 87 through a link 49, rack and pinion 76, centrifugal governor 77, a hydraulic pitch-changing device 78, 79, 80. This device forms no part of this invention and is a well known device in general use for several years. A cam 10 provides a control to change the datum of the centrifugal mechanism to obtain better economy curves. This is shown in Fig. 3 where its rotation causes a sleeve 11 to slide in a bearing 12. The sleeve 11 carries a rotating shaft 13 driven through a slot 14 at a speed in proportion to the speed of the engine. Governor weights 15, one of which is shown pivoted at 16, rotate clockwise at high speed compressing the spring 17 and ultimately engaging with a stop 74 located in a rotating arm 75.

2

A cam face 21 on the weight 15 engages with the roller 18 mounted on the rotating element 19. A light spring 20 causes the roller 18 to be held in contact with the cam face 21. By this means, as the weight 15 rotates clockwise, the roller 18 is moved to the left the desired amount, thus compressing the spring 20 and sliding a shaft 23 to the left which engages with a number of barometric elements 23, which are located in a chamber 24 which is in communication through a pipe 25 with the pressure on the engine side of a throttle 67 in an air entrance 79. The pressure in the chamber 24 is usually described as at manifold air pressure (see Fig. 1). The reason for this is that a supercharger is generally used, in which case this connection 25 is on the engine side of the supercharger (not shown) which is usually located just before the inlet valve air entrance to the engine cylinder. To simplify the disclosure the supercharger is not shown. The barometric element 23 engages on the right with the sliding shaft 22 and on the left with a servomotor valve 26 which, in its turn, engages with a compression spring 34, which takes up the back lash between the valve 26 and the barometric element 23 and the sliding shaft 22. The governor characteristics are controlled by the spring 17 slightly modified by the springs 20 and 34.

The movement to the left of the valve 26 causes a piston 27 to move to the right in the cylinder 28. Oil under pressure is admitted to the servomotor through the pipe 53 and when the valve 26 is moved to the left, as it is when there is a decrease of pressure in the chamber 24, oil flows down a passage 54 and pushes this piston 27 to the right. The oil at the right of the piston 27 then escapes through a passage 55 through the valve 26 to an oil outlet 56.

A rod 57 is pivoted to the guide 58 which is connected to a piston rod 59 mounted on the piston 27. The rod 57 is connected to a link 58 mounted on a bracket 52 (Fig. 2). The link 58 is formed in the shape of a crank and is connected to a link 60 (Fig. 2). The link 60 is connected to the throttle arm 61 (Fig. 1) through a pin 62 on the end of which is a ball 63. The ball 63 slides in a slot in the element 64. This element 64 is connected to the rod 47 which is pivotally mounted on the control lever 36. A lever 65 is mounted on a pivot 66, which pivot is mounted on this main speed control lever 36. This lever carries a link 48 which slides inside the element 64. A rounded end 68 of the link 48 en-

gages with the ball 63 when the lever 65 is rotated anti-clockwise and the ball 63 then engages with a movable stop 69 which, when moved to the right, compresses a spring 70, manually closing the throttle 67 by means of a throttle lever 61.

A rod 43 is pivotally connected to the lever 65 and this rod 43 carries a roller 38 which engages with a surface 40 of the quadrant 39. When the roller 38 engages with an inclined surface 41 and rides on a surface 42, the lever 65 is rotated.

The order to free the device from the servomotor and prevent interference with the above mentioned manual means for closing the throttle, a by-pass valve 29 is provided which gives a free opening 30 between the passages 54 and 55 when this valve is rotated anti-clockwise about 45° (Fig. 3). In the position shown, which is the operative position, a small opening 31 causes the device to function as described above, but permits a circulation of a small quantity of oil at all times in addition to that which leaks around the piston 27. A by-pass passage 32 connects the passage 54 with the valve 29 and a by-pass 33 connects the passage 55 with the valve 29.

A rod 46 is pivotally connected to the lever 65 at the point which is normally located opposite a pivot 81 on which the lever 36 is mounted and rotated (Fig. 4). Hence, rotation of the lever 36 does not normally move the link 46. The link 46 travels with the link 47 and at a slightly faster rate than the link 47, and hence slightly faster than the element 64. The link 46 is connected with the lever 82 to the valve 29. Hence, whenever the roller 38 rides on the surface 42 and is depressed, the valve 29 rotates anti-clockwise and the servomotor 26, 27, 59, 58, 57 is rendered inoperative. At the same time the rounded end 68 engages with the ball 63 and the throttle 67 is thus closed manually.

In order to permit this servomotor to be rendered inoperative at any time and not merely when the lever 36 is rotated anti-clockwise into the position for minimum speed, a handle 35 on the throttle lever 36 is made so that it can be depressed and when it is depressed, it slides inside a cylinder 72 integral with the lever 36, compressing a spring 73 and carrying with it the rod 43 and the roller 38. In order that the handle 35 can rotate without rotating the rod 43, a ball joint is provided on the end of the rod 43. In order that the handle 35 can be locked in the depressed position, a pin 50 is provided in the handle and an L-shaped slot 51 in the cylinder 72 is also provided. Hence, when the handle 35 is depressed compressing the spring 73, the pin 50 is lowered to the level of the horizontal leg of the L-shaped slot 51. The handle 35 is then rotated anti-clockwise looking down and the pin 50 is carried over to the right inside the L-shaped slot 51. The roller 38 is thus locked in the lower position and the valve 29 is thus moved to permit free circulation between the sides of the piston 27. Hence, under this condition, the speed control lever 36 becomes an ordinary throttle control lever, that is, it can be used to open the throttle further than the position selected by centrifugal governor so that extra power is available if the automatic mechanism fails.

Fig. 5 shows the relation between the revolutions per minute and the manifold air pressure measured in inches of mercury. As the revolutions per minute increase, the permissible manifold pressure increases. Hence, any increase in speed calls for an increase in manifold pressure.

The curve to the left shows the relation between the revolutions per minute of the engine and manifold air pressure for best economy, that is, the relation which exists when cruising lean and running the engine slower and opening the throttle wider than with the normal curve. When the cam 10 is rotated anti-clockwise, the manifold pressure follows the curve of better economy. The curve to the right shows the normal curve with the cam 10 in the position as shown in the drawings. The slower an engine runs at any given power, the less fuel it consumes as a rule.

The adjustable stop 74, Fig. 3, which is mounted on the rod arm 75 limits the maximum response to speed of the centrifugal weight lever 15, so as to limit the maximum boost pressure. Otherwise, during a dive an excessive boost pressure would be possible. Points E and F (Fig. 5) represent the maximum boost pressures controlled by the adjustable stop 74 and the movable cam 10. The point E corresponds to maximum boost pressure with a normal curve with the cam 10 in position shown and the point F to the maximum boost pressure with the maximum economy curve with cam 10 rotated counter-clockwise.

The inclined surface 41 (Fig. 1) may be mounted on a slidable element 84 held on the quadrant 39 by studs 85 and 86. The holes in the quadrant 39 may be slotted so that the exact location of the inclined surface 41 may be adjusted.

Operation

When the speed control lever 36 is moved counterclockwise, the roller 38 rotates on the surface 40 down the inclined surface 41 and along the surface 42. When the throttle lever 36 is moved in the anti-clockwise direction (Fig. 1), that is to say, in the idling position, the rod 48 moves to the right and engages with the ball end 63 and closes the throttle lever 61, causing the throttle 67 to close. In other words, the control ceases to be automatic. The end of the rod 48 is provided with the element 66 which is rounded to permit freedom of motion in the hollow element 64. When the control lever 36 is in its low speed position, the end 68 engages with the ball 63 which, in its turn, engages with the sliding element 69 and compresses the spring 70. The throttle lever 61 is thus moved anti-clockwise and the throttle 67 is closed manually.

As the lever 65 is rotated counter-clockwise by the depression of the rod 43, it carries over to the left the link 46 which causes the lever 82 to rotate anti-clockwise and thus moves with it the valve 29 in the anti-clockwise direction, which as described above, places the passage 30 (Fig. 3) in a position to allow free communication on both sides of the piston 27. The servomotor thus becomes inoperative during the idling position and hence no unusual effort is required to close the throttle 67 to the idling position.

Let us assume that the engine is running at 1500 revolutions per minute and manifold air pressure corresponding to the point A on the normal curve of Fig. 5. Let us assume further that the throttle 67 is to be opened. This is accomplished as follows:

The speed control lever 36 is moved in the clockwise direction. The link 49 acts on the propeller pitch gear 77—80. Immediately the revolutions per minute would increase and the manifold air pressure would fall to the point B, because the element 69 would not immediately engage the ball 63. The lowered manifold air pres-

sure is due to the increased air flow at a given throttle and the fall in pressure causes the element 23 to expand. As a result, the valve 26 is moved to the left, thereby admitting oil pressure from the line 53 to the passage 54. The piston 27 then moves to the right carrying with it the rod 57. The rod 60 moves to the left carrying with it the pin 63 which moves the throttle lever 61 clockwise, opening the throttle 67 and raising the manifold air pressure in 30 and hence in pipe 25 and in the chamber 24, to the point C, which would also be located on the normal curve. Meanwhile, the governor 77 maintains the speed of the propeller constant at the speed determined by the position of the lever 36.

If this point C is not on the desired normal curve, it is corrected by changing the contour of the cam surface 21. When the cam 10 is moved to the left counter-clockwise and the sleeve 11 moves to the left at any given speed, the capsule 23 is translated to the left, carrying with it the valve 26, compressing the spring 34. Oil pressure then flows down the pipe 53, passage 54, the piston 27 moves to the right, the link 60 moves to the left carrying with it the ball 63. The throttle 67 is then moved towards the wide open throttle position, but the link 49 is not moved and therefore, the revolutions per minute of the engine remain stationary and therefore, the point C moves up to point D. The point D is vertically above the point C because the speed is constant and the distance C—D corresponds to the distance between the two curves, the better economy curve and the normal curve. The capsule responds to changing pressures virtually on a straight line; hence the cam 10 need be calibrated for only two positions.

The probable relationship is that point A corresponds to 23" mercury at 1500 R. P. M.; point B corresponds to 22" mercury at 1700 R. P. M.; point C corresponds to 26" mercury at 1700 R. P. M.; point D corresponds to 29" mercury at 1700 R. P. M.; point E corresponds to 40" mercury at 2350 R. P. M.; and point F corresponds to 45" mercury at 2350 R. P. M.

What I claim is:

1. In combination with an internal combustion engine having an air entrance and a throttle valve therein adapted to control the air flow to the air inlet of the engine, a variable pitch propeller driven by said engine and an engine-driven, variable speed centrifugal governor for controlling the engine speed by varying the pitch of said propeller, a manually operated control device for said governor and connected to the variable speed means of said governor so as to control the speed

of the engine by varying the pitch of the propeller, a throttle lever, an automatic controlling device therefor comprising a second engine-driven centrifugal governor, a barometric device operatively connected to said second centrifugal governor and slidably mounted so that it is moved bodily thereby, a variable pressure chamber enclosing said barometric device and connected to the air inlet so as to be maintained at the pressure of the air entering the engine, a source of fluid under pressure, a servomotor valve operatively connected to the barometric device and to the second governor so constructed and arranged that it controls the flow of said fluid under pressure, a servomotor operatively associated with said servomotor valve and adapted to be operated by said fluid under pressure and by said servomotor valve, a link connection from said servomotor to said throttle lever adapted to move the throttle so as to maintain the pressure in the air entrance to the engine at the pressure required to move the servomotor valve into its neutral position.

2. A device as set forth in claim 1 in which there is a casing supporting said automatic mechanism and in which second centrifugal governor is slidably mounted with respect to said casing, means for sliding the second centrifugal governor, the pressure responsive device and the servomotor valve laterally so as to vary the pressure automatically maintained in the air entrance to the engine with each speed of the engine.

3. A device as set forth in claim 1 in which there are additional valve means so located that when open it renders the servomotor inoperative, manually controlled mechanism for said valve mounted on said manually operated control device and so constructed and arranged as to be operated at any position of said control device, a yieldable link connecting the throttle with the manually operated device and adapted to manually control the throttle lever when said servomotor is inoperative.

4. A device as set forth in claim 1 in which there are additional valve means so located that when open it renders the servomotor inoperative, a link connected to said valve and to said manually operated control device, a second link also connected to said manually operated device and so constructed and arranged as to push the throttle lever into the closed position when the manually operated control device is set in the position of minimum speed of the engine so that the throttle may be easily closed whenever the automatic throttle control device is disconnected.

CARL F. SCHORN.