Sept. 9, 1952 J. S. DALE 2,610,050

LOAD-LIMIT APPARATUS FOR HYDRAULIC ENGINE GOVERNORS

Filed March 16, 1951

2 SHEETS—SHEET 1

Fig. 1

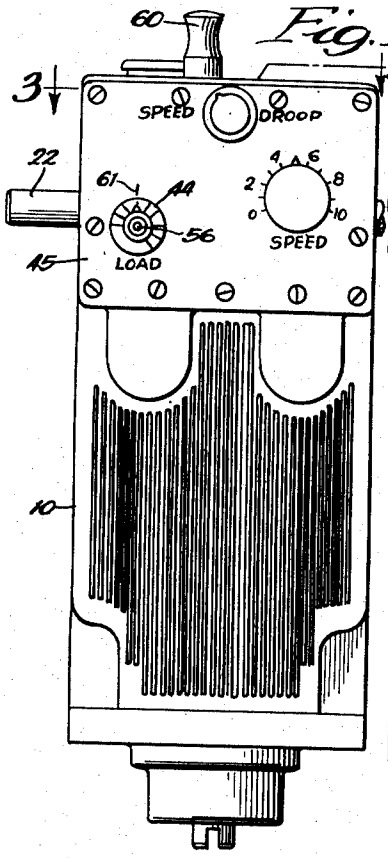


Fig. 3

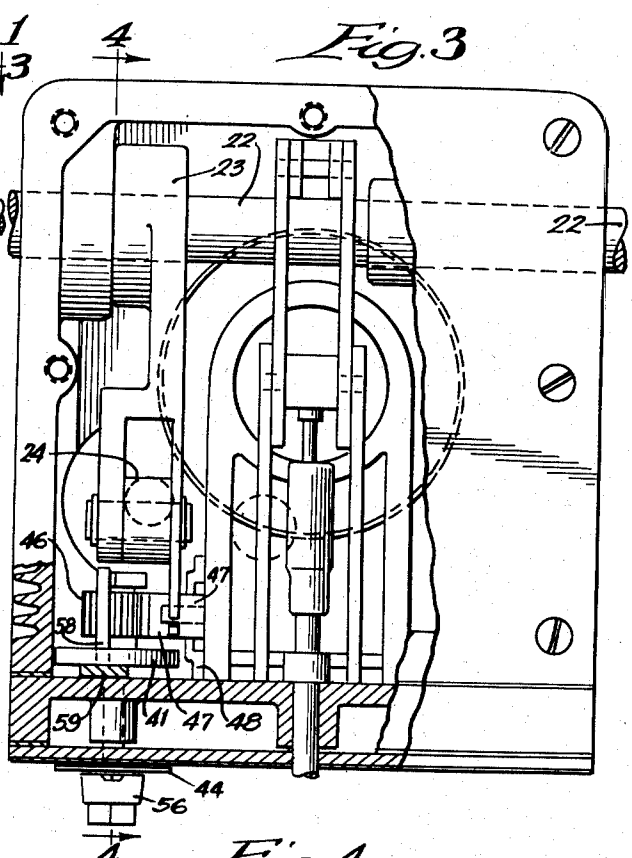


Fig. 4

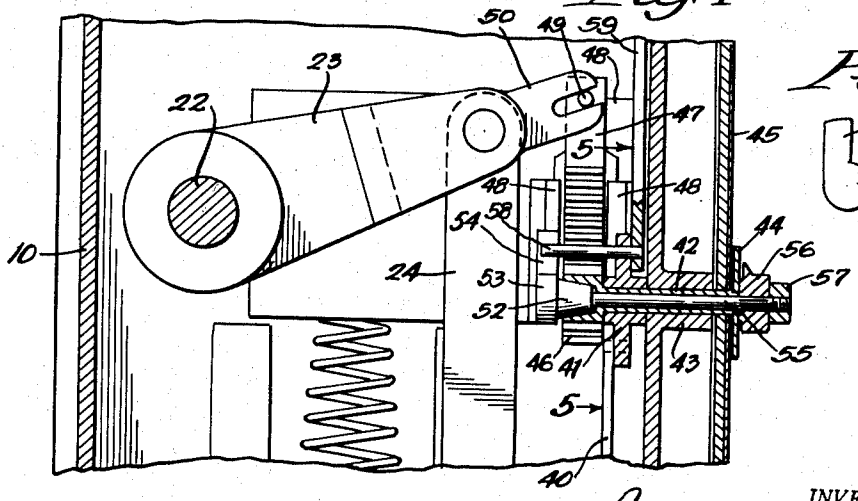
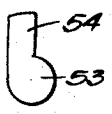


Fig. 7



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LOAD-LIMIT APPARATUS FOR HYDRAULIC ENGINE GOVERNORS

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Fig. 2

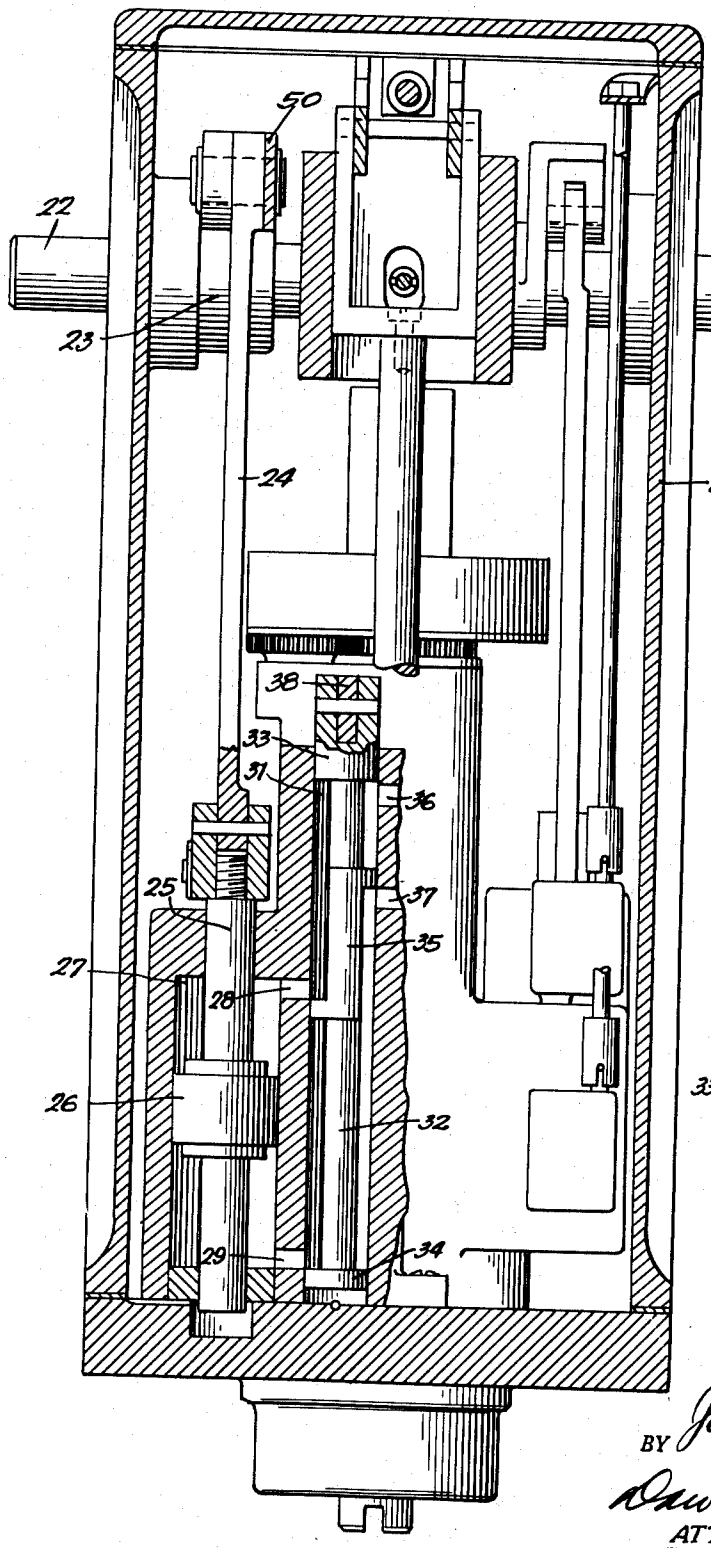


Fig. 5

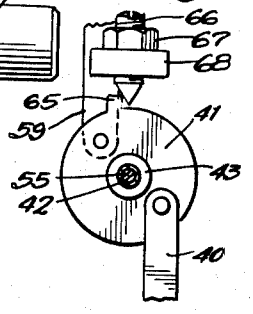
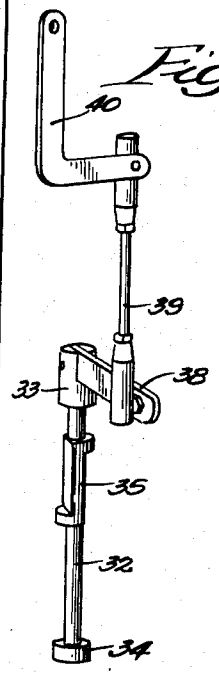


Fig. 6



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LOAD-LIMIT APPARATUS FOR HYDRAULIC ENGINE GOVERNORS

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Application March 16, 1951, Serial No. 215,923

2 Claims. (Cl. 264—3)

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This invention relates to governor apparatus; in particular, it relates to improved mechanism, adapted for use in a centrifugal governor of the type employing a hydraulically-actuated servo-piston, for limiting the load on the prime mover being governed and for controlling the response rate of the governor to speed changes.

Large diesel engines are almost invariably controlled by an engine governor, the function of which is to hold the engine at a substantially constant speed despite variations in load. This is accomplished in most cases by providing in the governor a centrifugal speed-responsive element which is operably connected to the fuel-supply control of the engine.

While mechanical governors are still used to a considerable extent, the most satisfactory engine governors are of the hydraulic type, in which the speed-responsive element controls a pilot valve the function of which is solely to guide the flow of hydraulic fluid and thereby to alter as needed the position of a servo-piston mechanically linked to the engine fuel control. The advantage of the hydraulic governor over mechanical governors lies primarily in the fact that the energy required for moving the hydraulic fluid and for actuating the servo-piston is supplied by a pump, and the work actually performed by the pilot valve is negligible in amount. Such a governor, therefore, can be much more sensitive to changes in speed resulting from load variations than a mechanical governor, since the work required for movement of the fuel supply control of the engine must in the mechanical governor be supplied by the speed-responsive element itself.

This invention is primarily concerned, therefore, with engine governors of the hydraulic type. Such governors, if carefully designed and manufactured, are amazingly sensitive, the sensitive element being the pilot valve.

Since the pilot valve is an exceedingly sensitive, delicately-balanced element, and is the heart of an engine governor of the hydraulic type, it is highly desirable that harsh mechanical interference with, or interruption to, its normal function, be avoided. This invention relates specifically to means for controlling, in an engine governor of the hydraulic type, the maximum rate at which fuel may be fed to the controlled engine and the rate at which changes in speed of the engine are reflected by changes in the position of the fuel-supply control. Accordingly, it may be stated generally that the primary object of the present invention is to provide, for an

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engine governor of the hydraulic type, a load-limiting mechanism whereby the maximum rate of fuel supply can be conveniently controlled by the operator without interfering with the normal action of the governor pilot valve.

In furtherance of the primary object just stated, other objects of the invention include the provision of a convenient visual indicator showing the degree of load on the engine at any given time and having combined therewith convenient manually-adjustable means for setting the maximum engine load at any value desired, within the performance limits of the engine.

Another object consists in providing, in a governor of the hydraulic type, a load-limit control apparatus whereby the operator can note at a glance the load on the engine at any given time, both in absolute terms and as a fraction of the load-limit for which the governor is set.

Other objects and advantages of my invention will appear as the specification proceeds.

In the appended drawing, I have shown my invention as applied to an engine governor of the hydraulic type. While hydraulic-type governors vary in many respects, they have in common the characteristics that hydraulic fluid is placed under pressure by a pump, is guided to one side or the other of a servo-piston by means of a centrifugally-controlled pilot valve, and the servo-piston is mechanically linked to an engine fuel-supply control, whereby the position of the servo-piston controls the rate at which fuel is supplied to the engine. The present invention is susceptible of application to any such governor, and it is to be understood that the governor apparatus broadly disclosed in the appended drawing is merely illustrative of hydraulic type engine governors generally.

In the drawing, Fig. 1 is a front elevation view of a casing of a governor provided with my invention, the view showing the visual load indicator and the manually-adjustable means for load-limiting; Fig. 2 is a sectional view, partially broken away, of the governor of Fig. 1, this view bringing out the structural details of the reversing valve which comprises an element of my invention; Fig. 3 is a plan view of the governor of Fig. 1, partially cut away to reveal some of the interior structure, the section being taken along the line 3—3 of Fig. 1; Fig. 4 is a vertical sectional view generally along the line 4—4 of Fig. 3, certain parts being shown in elevation rather than in section; Fig. 5 is a fragmentary sectional view along the line 5—5 of Fig. 4; Fig. 6 is a perspective view of certain linkage connecting the man-

ually-adjustable load-limit control to the reversing valve with which it is associated; and Fig. 7 is a plan view of a cam element which forms a part of my invention.

Referring now to the drawing, particularly Fig. 2, the casing of the governor is generally denoted 10, and mounted therein in suitable bearings I have shown an output shaft 22, which, when the governor is installed on an engine, will normally be connected by mechanical linkage to the fuel-supply control. A crank or lever arm 23 is keyed to shaft 22, and, at its outer end, crank 23 has pivoted to it a link 24. Link 24 is pivoted at its lower end to piston rod 25 of servo-piston 26.

The servo-piston 26 is mounted for reciprocal movement within a cylinder 27, the upper end of piston rod 25 passing through the top of cylinder 27 in a suitably machined bearing.

A port or conduit 28 provides communication between the upper end of cylinder 27 and adjoining valve chamber 31, while a port 29 provides communication between valve chamber 31 and the lower end of cylinder 27.

Valve chamber 31 is cylindrical in shape and carries within it a valve rod 32 containing an upper land 33, a lower land 34, and an intermediate spool valve member 35. Lands 33 and 34 are machined to slide snugly within valve chamber 31, and the side walls of valve member 35 are similarly so machined, thus providing a partition or isolating wall between the zone of chamber 31 above spool member 35 and the corresponding zone below member 35.

The structure of the pilot valve and hydraulic pump apparatus of the illustrated governor are not shown in the drawing, since such elements may be conventional and form no part of this invention. A pilot valve with which my present invention may be used is shown, for example, in my U. S. Patent No. 2,571,842, issued October 16, 1951. I have, however, indicated a passage or conduit 36 and a passage or conduit 37, each of which opens into valve chamber 31. For purposes of the present application, it may be assumed that conduits 36 and 37 communicate with the centrifugally-actuated pilot valve of the governor, and that a reduction in engine speed will cause the pilot valve to guide hydraulic fluid under pressure through conduit 37, while an increase in engine speed will cause the pilot valve to force liquid under pressure through conduit 36.

When valve member 32 occupies the position shown in Fig. 2, which is the normal operating position, hydraulic fluid forced through conduit 37 into the lower end of chamber 31 will pass through port 29 into cylinder 27 and raise servo-piston 26, thus rotating shaft 22 in the direction to increase the rate of fuel supply to the controlled engine. Similarly, hydraulic fluid forced through conduit 36 will pass through the upper portion of chamber 31 and through port 28 into the upper end of cylinder 27, thus forcing the servo-piston 26 downward and causing a decrease in the rate of fuel supply to the engine. In either case, escaping fluid from the end of the cylinder 27 into which the servo-piston 26 is advancing will be provided for in the pilot valve structure. In other words, when high pressure fluid in conduit 36 is forcing the servo-piston downward, vent for the hydraulic fluid beneath piston 26 is provided by way of conduit 37, and vice versa.

The arrangement just described is conventional in engine governors of the hydraulic type, although the provision of the spool valve 35, with its associated apparatus, is a novel contribution of my own, first described broadly in my earlier and co-pending application, Serial No. 139,076, filed January 17, 1950.

The upper end of valve member 32 is connected by means of linkage comprising arm 38, link 39, and link 40, to a disc 41, to which link 40 is pivoted at its upper end.

Disc 41 is journaled for free rotation on a hollow shaft 42 which is itself carried in a journal bearing 43 formed in the forward face of casing 10. At its forward end, shaft 42 is provided with a dial plate 44 swaged or otherwise affixed to shaft 42 so as to rotate with it. Dial plate 44 is a visual indicator of the degree of load imposed on the engine at any given time.

The rear end of shaft 42 carries a gear member 46, mounted and adapted for cooperation with a vertically-disposed rack 47. Rack 47 is slideably mounted on a suitable bracket 48 carried by frame 10. Rack 47 meshes with gear 46, and is equipped at its upper end with a pin 49 carried within a slot cut into the end of projecting end portion 50 of lever 23 heretofore mentioned. As may be seen from Fig. 4, rotation of shaft 22, which is mechanically coupled to the engine fuel-supply control, will cause rack 47 to rise or fall and will consequently lead to rotation of gear 46. Since gear 46 and dial plate 44 turn together, it will be apparent that the angular position of dial plate 44 at any given time is a direct indication of the rate of fuel supply to the engine at that time.

Turning now to the details of gear 46, it may be noted that its rear face is cut away to provide a female conical surface, in which a clutch cone 52 rides. Cone 52 is equipped at its rear axial face with a cam element 53 having a projection 54 thereon. The forward axial face of cone 52 receives a shaft 55 which is carried within the hollow interior of shaft 42; the forward end of shaft 55 carries an indicator knob 56 splined thereon. The extreme outer end of shaft 55 is threaded to receive a lock-nut 57, which may be provided with a knurled rim for easy thumb-and-finger operation.

It will be seen from the foregoing description that the female conical surface of gear 46 and the conical surface 52 cooperate to form a clutch which will lock together cam element 53 and gear 46 whenever lock-nut 57 is in a tightened position such that the cooperating clutch parts are gripping tightly. When lock-nut 57 has been loosened, however, gear 46 and indicator dial 44 can turn independently of knob 56 and cam element 53.

Disc 41, on the side opposite the pivot which holds link 40, carries an elongated pin 58, shrink-fitted or otherwise rigidly secured to the disc in a position parallel to its axis. Pin 58 extends beyond disc 41 a short distance in the direction toward the casing 10, and that end of pin 58 serves as a pivot for a link 59 extending upward and terminating in a manual plunger 60 extending from the top of the governor casing. Plunger 60 serves as a manual shut-down device; its operation will be more fully described hereinafter.

The other end of pin 58 extends inwardly for a sufficient distance to cross the locus of projection 54, so that as cam member 53 rotates, it will, at a point near the top of its path, engage pin 58 and thus force disc 41 to rotate with cam member 53.

To facilitate use of my load-limit mechanism,

an indicator arrow or hairline **61** may be placed on the instrument panel, and graduated marks for cooperation therewith may be placed on the face of indicator dial **44**. Similarly, an indicator pointer or hairline may be placed on knob **56**.

Operation

In the operation of my load-limit control, the operator will first loosen lock-nut **57** and turn knob **56** until the indicator thereon is pointing to the graduated mark or dial **44** which he desires to represent the load limit. The operator will then tighten lock-nut **57** and thus lock together for rotation as a unit gear **46**, dial **44**, knob **56**, and cam member **53**.

The relative positions of knob **56** and cam member **53** on shaft **55** are such that projection **54** is brought into contact with pin **58**, at or slightly before that angular position of gear **46** at which the pointer on knob **56** is directly opposite hairline **61** on the panel.

The operation of the apparatus described will, therefore, be as follows: When the controlled engine is started, its fuel supply will be fixed by the governor as a function of the load without any interference whatever from the described apparatus, so long as the load is lower than the value fixed by the operator's adjustment of knob **56**. When that load limit is reached, projection **54** will engage pin **58** and force a slight rotation of disc **41**, which, in turn, will force a slight upward movement of link **40**. That movement will result in raising valve member **32**, thus reducing the effective area of ports **28** and **29**, and slowing down the further movement of servo-piston **26**. If the load continues to increase, valve member **32** will be raised to a position at which hydraulic fluid is by-passed around the lands of valve members **35** and **34**, thus creating equalized pressures on the respective sides of the servo-piston **26** and thus preventing further movement of the servo-piston.

Reduction in engine load below the predetermined value will cause rotation of cam element **53** in a clockwise direction (as viewed from the front panel) and pull projection **54** out of engagement with pin **58**. This will restore the governor to its conventional operating position, and the governor will thereupon control the engine in the usual way.

Manual pressure on plunger **60** will raise the valve member **32** to the point at which hydraulic fluid from port **37** will be routed into the chamber above servo-piston **26** rather than below it. This will cause a reduction in the speed of the engine, and the pilot valve will respond by forcing still more hydraulic fluid through port **37**. This operation will continue until the engine has been shut off. The details of this shutdown device are disclosed in my co-pending application, Serial No. 139,076, filed January 17, 1950, and are not claimed herein per se as a part of the present invention.

The modification of Fig. 5

A modification of the apparatus just described is shown in Fig. 5; that structure provides a control over the normal position of disc **41** and thereby permits the operator, by a simple screwdriver adjustment, to control the normal degree of opening of the ports **28** and **29**. That result is accomplished by providing a small radial projection **65** on the edge of disc **41** and providing, for cooperation therewith, a tapered stop-screw

66, equipped with a lock-nut **67** and carried in a small boss or projection **68** extending inward from the casing of the governor. If desired, as a matter of mechanical convenience, projection **65** may be displaced axially from the principal plane of disc **41**. Adjusting screw **66** corresponds functionally to the apparatus shown in Fig. 16 of my aforementioned co-pending application, and it is, accordingly, not claimed per se as a part of the present invention.

It will be understood by those skilled in the art that many changes and variations in matters of detail may be made in my invention without departing from its spirit; it is, accordingly, my desire that the illustrated embodiment be regarded as exemplary only, and that the scope of my invention be determined primarily by reference to the appended claims.

I claim:

1. In a hydraulic engine governor having a casing, an output shaft, a cylinder, a servo-piston reciprocable therein, a pilot valve, and a conduit circuit adapted to carry hydraulic fluid from the pilot valve to the respective ends of said cylinder, a load indicator comprising a dial mounted for rotation externally of said casing, mechanical coupling means between said output shaft and said indicator dial operative to compel rotation of said indicator responsively to rotation of said output shaft, a shaft mounted for rotation coaxially with said indicator dial, said shaft passing through said dial, a cam carried by the inner end of said shaft, a manually adjustable knob carried by the outer end of said shaft, rotation of said knob permitting the selection within a range of values of the relative angular positions of the indicator dial and the cam, means adapted for releasably locking said cam and said indicator dial in a selected relative position, a cam follower mounted for free rotation coaxially with said indicator dial and said cam shaft, an adjustable valve in said conduit circuit, and mechanical connecting means relating the cam follower to said adjustable valve operative when the cam engages the cam follower to alter pressures in said cylinder and thus to prevent further movement by the servo-piston in the direction tending to move the cam into engagement with the cam follower.

2. Apparatus according to claim 1 wherein the manually adjustable knob is splined to said cam shaft, and wherein said cam shaft and said indicator dial respectively are provided with shaped surfaces adapted to form a friction clutch, and wherein said locking means comprises a lock nut on the forward end of said cam shaft operative when tightened to pull the shaped surfaces together into firm frictional engagement.

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