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GOVERNOR WITH BUILT-IN OVERSPEED TRIP

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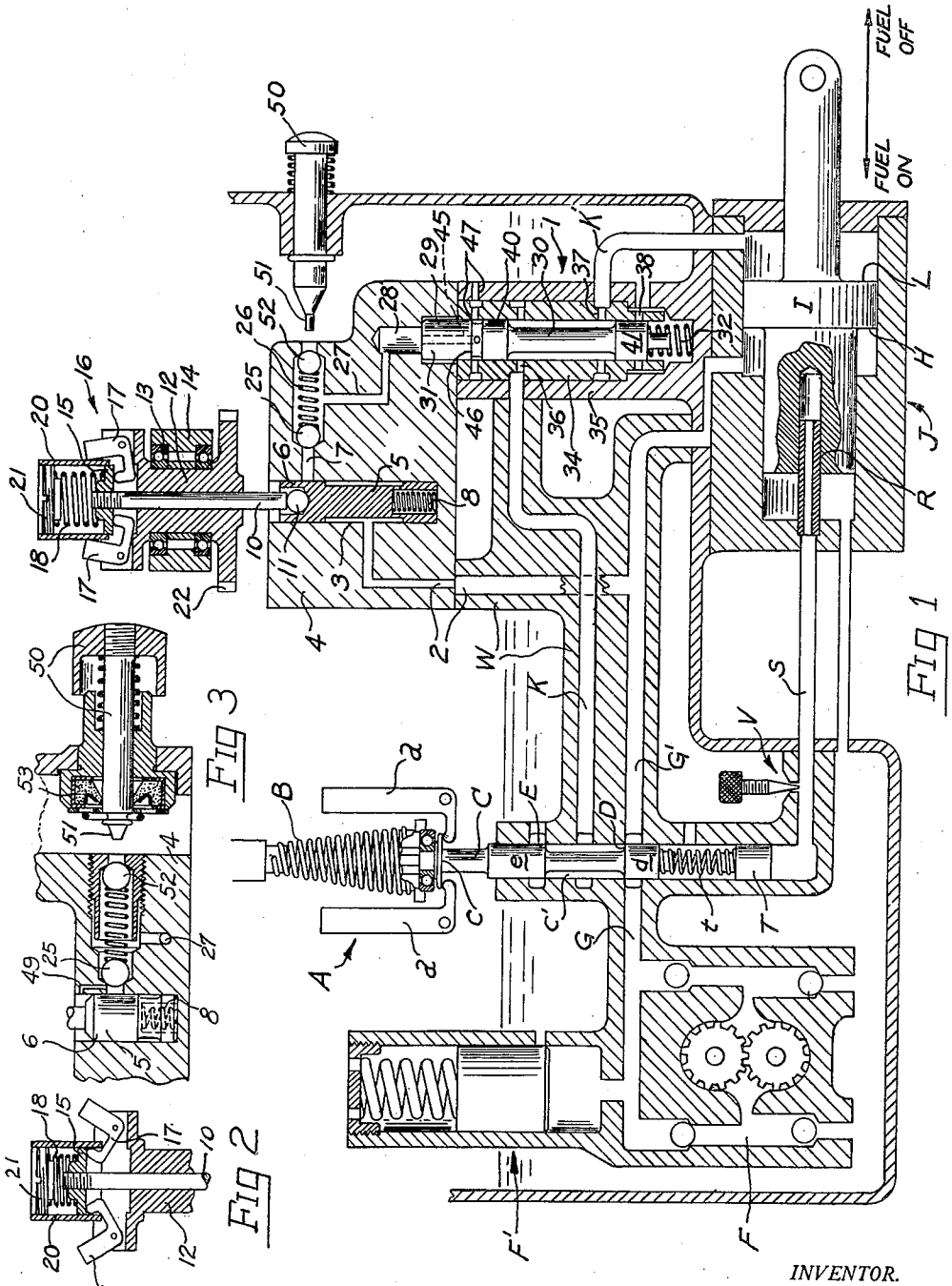


Fig 1

Fig 3

Fig 2

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GOVERNOR WITH BUILT-IN OVERSPEED TRIP

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The invention relates to an improved hydraulically acting overspeed governor (hereinafter overspeed trip) and to an improved hydraulically acting combination speed regulating and overspeed trip governor mechanism supplied with operating fluid from a common source without sacrifice of certainty or safety of operation and without possibility of the regulating part of the mechanism interfering with the trip part and vice versa. The above indicates the general objects.

The speed regulating or main governor mechanism herein shown schematically (left part of Fig. 1 principally) is substantially according to A. Kalin Patent 2,219,229, October 22, 1940, being arranged (e. g.) for isochronous governing of Diesel engines. As in the patent a flyweight-operated pilot valve controls admission of substantially constant pressure fluid in respect to a double acting, differential type, engine-fuel-regulating servo-motor, the constant pressure fluid being admitted to a relatively large servo-motor piston area thereof to increase engine fuel supply and to a relatively small area of the same piston to reduce and cut off the fuel supply. The overspeed trip mechanism hereof has a special-flyweight-operated, normally closed master valve controlling a branch conduit for the constant pressure fluid and, when overspeed occurs, the master valve effects admission of said fluid to a trip or slave valve mechanism which causes engine shut-down by venting all the fluid from operating contact with the relatively large area of the engine-regulating servomotor piston whereupon the constant pressure fluid maintained in contact with the relatively small area of the servomotor piston moves said piston quickly to its fuel-off or no-fuel position and there retains it. The trip mechanism has provision for temporary manual emergency or testing control of the tripping action, as when an attendant is at hand and can keep the engine within a safe operating speed regardless of its tendency to overspeed and re-operate the trip mechanism. Also provision is made (two exemplary forms shown) whereby any constant pressure fluid which may leak past the master trip valve while the speed regulating governor mechanism is properly in control of the engine cannot operate the slave valve and cause undesired shutting down of the engine. The discussion of this paragraph indicates more specific objects of the invention. Others will be brought out in the following description of an illustrative form of the invention.

In the drawing, Fig. 1 is a schematic view showing essentially the entire governor and trip

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mechanism; Fig. 2 is a fragmentary view showing the position of the overspeed trip flyweights when tripping or engine shut-down is called for, and Fig. 3 is a relatively enlarged detail central sectional assembly view of a preferred form of an overspeed trip latch and manual control or reset valve of the overspeed trip mechanism as actually arranged in a typical installation.

Referring to Fig. 1, the isochronous governor flyball mechanism generally designated A has a speeder spring B operatively connected with a governor pilot valve plunger C at a thrust plate *c* thereon through which the speeder spring acts downwardly against arms of the pivoted flyweights *a* to control governor ports D and E which normally or during steady state are closed by lands *d* and *e* respectively of the valve plunger. Fluid is supplied by a gear pump F such as shown in the Kalin patent, the output line or duct G of which has its pressure controlled by a conventional accumulator mechanism F'. The duct G extends uninterruptedly in the governor speeder case, represented schematically at W, past the pilot valve port D to duct portion G' for maintaining application of the substantially constant (i. e. accumulator controlled) pressure at a relatively small area H of piston I of the engine fuel regulating servomotor J. The operating stem of the servomotor is connected to the engine fuel adjusting system as usual (e. g. to the injector racks in case of a Diesel engine). A valve chamber *c'* formed principally by a neck portion of the pilot valve plunger C communicates through a "regulating fluid" duct K with the servomotor J partly through the slave valve I of the overspeed trip portion of the mechanism (right, Fig. 1) to be described later. K' indicates the portion of the duct K which leads from the slave valve I to the servomotor cylinder so that the regulating fluid acts against the relatively large effective area L of the piston I.

Operation of the piston I in the indicated "fuel-on" direction results from lowering of the pilot valve C, as during increased loading of the engine (flyweights moving inwardly), the pilot valve land *d* then opening port D to enable constant pressure fluid from duct G to flow through ducts K and K' to area L forcing the piston I to the left due to the difference in areas H and L. Movement of the piston I in the "fuel-off" direction as when the engine load is decreased (causing outward movement of the flyweights) results from raising of the pilot valve plunger C thus dumping regulating fluid from operating contact with the larger piston face L through the port E as will be apparent.

During each speed-regulating movement of the servomotor piston I engine stabilizing compensation or feed-back is effected by a hydraulic system including an actuating compensation fluid pump R, the delivery of which leads through a suitable compensation fluid duct S to the working chamber of a receiving compensation piston T located in a portion of the pilot valve bore and connected to the pilot valve plunger C as by a spring *t*. A suitable leak-off or compensation-neutralizing valve V is incorporated in a portion of the passage S, the valve communicating the compensation fluid duct with a sump portion of the governor fluid reservoir.

Referring to the overspeed trip portion of the mechanism, a branch portion 2 of the constant pressure fluid duct G' leads to a valve bore 3, which may be formed in a special section 4 of the governor power case, the branch 2 intersecting the bore 3 between its ends. The bore 3 is slidably occupied by the master trip valve plunger 5 having an upper land 6 normally maintained in closing relation to an outlet port or passage 7 against the action of a biasing spring 8 at the bottom of the plunger tending to raise the plunger and open the port. An actuating rod 10 for the master valve plunger 5 rests on a thrust ball 11 in an axial socket at the top of the plunger, the rod being freely supported in the axial bore of a rotary head 12 which in turn is suitably mounted for free rotation as on bearings 13 in a bracket 14 located above the power case section 4. The upper end of the actuating rod is suitably connected to a thrust plate 15 of the trip flyweight mechanism 16. A counterpoise spring 18 in a tubular casing 20 fixed to the top of the rotary head 12 acts through the thrust plate 15 initially to hold a pair of flyweights 17 in the position illustrated in Fig. 1. Adjustment of the pressure of the spring 18 is afforded by a threaded cap piece 21 in the casing 20.

The head 12 of the flyweight mechanism 16 is rotated through the intermediary of gear teeth 22 on its lower end portion which are in constant mesh with teeth on any suitable rotary part of the speed regulating governor mechanism, for instance teeth on the ballhead (not shown) which supports the flyweight mechanism A. Preferably the rotary head 12 of the trip mechanism is turned two or three times as fast as the main governor head so that the mass of the flyweights 17 can be relatively small but still be adequately sensitive in operation at the adjusted overspeed or tripping point.

The counterpoise spring 18 is of ordinary coil spring form and when the flyweights move with increased rotational speed of the head 12 from their inwardly inclined position (Fig. 1) into approximately vertical position (not shown) the increasing spring resistance to outward movement is not enough to keep pace with the increased effective centrifugal force due to the increased radius; and the flyweights move quickly from (e. g.) vertical into the limited outward position (Fig. 2) wherein the lower arms of the flyweights may be stopped by engagement with the lower rim of the spring casing 20.

When the actuating rod 10 rises approximately to the extent allowed by the illustrated outward position of the flyweights, the upper land of the master valve 5 uncovers the port 7 and the constant pressure fluid from passage G' opens a spherical one-way or ball-check valve plug 25 against the force of its return spring 26. The fluid is then admitted to a passage 27 leading to

a chamber 28, the lower end of which is defined by a counterbore 29 in the casing section 4. The slave or trip valve plunger 30 has a spring 32 below it which normally maintains an upper end or piston portion 31 of the plunger against the shoulder provided by the bottom (literally top) of the counterbore 29. The piston portion 31 may be of considerably less diameter than the counterbore to avoid having to align the plunger therewith.

The guide for the slave or trip valve plunger 30 is a sleeve 34 seated tightly in a portion or section 35 of the governor power case and formed to provide an inlet port 36 communicating with the regulating fluid duct K and two outlet ports, one at 37 normally communicating with the portion K' of said duct K leading to the larger face L of the piston I and the other, at 38, leading to any suitable sump or negligible pressure portion of the governor housing. In the illustrated position of the slave or trip valve plunger 30, passages K and K' communicate so that the engine is fully under control of the flyweight mechanism A. The piston portion 31 of the plunger 30 slidably fits the upper end of the receiving bore for it in the ported sleeve 34.

The tripping or engine-stopping operation results from rise in pressure of fluid in the chamber 28 above the slave valve plunger 30 the fluid acting on the piston portion 31 of the plunger to move the plunger downwardly until a land portion 40 thereof (just below the piston portion 31) closes the port 36 of duct K and a lower land 41 of the plunger opens the sump communicating port 38. When the latter port is opened, pressure which has been maintained against the large face L of the piston by action of the main governor pilot valve C is dumped from the servomotor cylinder. Constant pressure from the lines G and G' then moves the servomotor piston I in the fuel-off direction and to the end of the possible piston stroke, shutting down the engine.

Referring further to the master or actuator valve plunger 5 of the overspeed trip, that plunger must be reasonably free in its bore 3 in order to be certain of operation at all times, hence the upper land 6 of the plunger cannot be too tightly fitted into the bore. The plunger, incidentally, is raised from its initial position during governor operation due to play of the flyweights 17 between their initial inwardmost position and a vertical or nearly vertical position but insufficiently outward to cause tripping. Thus the plunger 5 is not likely to be friction-bound as by accumulations of foreign matter in the hydraulic fluid. Leakage of hydraulic fluid past the plunger 5 during the time the main governor is in control can gradually slip past the check valve 25 into the chamber 28; and, unless special provision is made as hereinafter described to prevent it, such leakage or slip can cause untimely operation of the overspeed trip by depressing the slave valve plunger 30. To prevent that from occurring, normally expected seepage past the plunger 5 and check valve 25 is vented through an axial duct 45 in the plunger 30 and connected radial orifices opening into a ring cavity 46 of the plunger. Cooperating passages 47 in the sleeve 34 and case section 35 lead to the sump. When full accumulator pressure is admitted to the chamber 28 by operation of the overspeed trip flyweights 17 and valve 5, there is always a sufficient volume of fluid acting against the plunger piston 31 to render the drainage normally afforded by the passages 45—47 insignificant. Full

downward movement of the slave valve plunger 30 at proper times is thus assured. When the ring cavity 46 passes the ports afforded by passages 47 those passages are sealed by the piston portion 31 and no further drainage is possible, hence fluid trapped in the chamber 28 by the check valve 25 insures maintenance of the trip mechanism (i. e. slave valve 30) in engine stopping operation.

An alternative restricted venting means for fluid which may slip past the master valve plunger 5 is shown in Fig. 3 wherein the passage 7 leading to the check valve 25 is vented to sump by an inverted L-shaped passage 49, the upper end of which is normally open to discharge the leakage fluid into the open top of the bore 3 for the plunger 5. Just before the latter is pushed up by the spring 8 far enough to open the port or passage 7 the passage 49 is closed by upper valve plunger land 6 as will be apparent so as not to interfere with the tripping operation of the mechanism 1.

When it is desired to render the trip mechanism hereof temporarily or continually inoperative, as when an attendant is at hand to make sure that the engine will not race or reach a dangerous overspeed, such attendant depresses a spring returned plunger 50, Figs. 1 and 3, movably carried by the main governor case and with its inner reduced end or pin portion 51 aligned for contact with a pressure release check valve ball 52. The plunger 50 extends through a seal 53 (Fig. 3 only). When the chamber containing the two check valves 25 and 52 is vented to sump by opening of the valve 5 the slave or trip valve 30 is returned to its normal or raised position by its spring 32 and the main governor can then take control of the engine by resupplying the regulating servomotor J through passages K and K' and otherwise performing as previously described.

I claim:

1. In combination with a hydraulic relay speed regulating engine governor having a pilot-valve-controlled servomotor of the differential piston area type, wherein pressure fluid controlled by the pilot valve is admitted selectively into operating contact with a relatively large piston area of the servomotor to increase engine fuel and released from operating contact therewith to decrease and shut off engine fuel, a hydraulically acting overspeed trip centrifugal governor mechanism operatively connected to the same pressure source as that of the speed regulating governor and having a master valve which, on overspeeding of the engine, diverts fluid from said source to a slave valve which in turn dumps the fluid from operating contact with said relatively large piston area to shut down the engine.

2. In combination, a hydraulic relay speed governor wherein a pilot valve and cooperating means responsive to speed changes of a governed machine controls admission to and venting of operating fluid in respect to a relatively large effective area of a speed-regulating servomotor having a relatively smaller opposite effective area continually exposed to substantially constant pressure fluid, a hydraulically acting overspeed governor mechanism having overspeed responsive means controlling a normally closed master valve arranged to admit such constant pressure fluid to a spring biased slave valve, the latter being operable as a piston by the constant pressure fluid admitted thereto to dump fluid from operating contact with the relatively large effective area of the servomotor.

3. The mechanism according to claim 2 including a spring closed check valve between the master valve and slave valve to maintain the slave valve in an operating position against the spring biasing force thereon.

4. In a hydraulically acting speed governor, a speed regulating hydraulic relay governor mechanism including a two-way hydraulically acting servomotor piston and cooperating opposed fluid chambers and speed responsive valve means selectively subjecting the servomotor piston through respective chambers to operating fluid pressure for movement of the piston in opposite directions, an overspeed governor speed responsive mechanism including speed responsive means interconnected with the aforesaid speed responsive means for operation concurrently therewith at all times, a common fluid supply for both mechanisms, a master valve operated by the overspeed responsive means to divert fluid from said source, and a slave valve operable to dump operating fluid from one chamber of the servomotor, the slave valve including a plunger having a piston portion exposed to pressure from said source by operation of the master valve to cause the fluid dumping operation.

5. In a hydraulically acting speed governor, a speed regulating hydraulic relay governor mechanism including a two-way hydraulically acting servomotor piston having opposed operating chambers and speed responsive valve means selectively subjecting the servomotor piston through respective chambers to operating fluid pressure for movement of the piston in opposite directions, an overspeed governor speed responsive mechanism including speed responsive means interconnected with the aforesaid speed responsive means for operation concurrently therewith at all times, a common fluid supply for both mechanisms, a master valve operated by the overspeed responsive means to divert fluid from said source, a slave valve operable to dump operating fluid from one chamber of the servomotor, the slave valve including a plunger having a piston portion and cooperating cylinder exposed to pressure from said source by operation of the master valve to cause the fluid dumping operation, and restricted vent means for said cooperating cylinder controlled by said piston portion of said plunger so that the vent is closed when the slave valve plunger is in its fluid dumping position.

6. A hydraulic overspeed governor mechanism for engines, comprising a rotary head with spring biased flyweight means thereon, a master valve including a valve plunger operatively connected with the flyweight means and cooperating inlet and outlet ports, the former connected with a source of fluid pressure, said plunger having an inactive or normal position blocking one of the ports, a slave valve including a spring biased valve plunger operable from an inactive position to an active position wherein it can initiate and cause an engine shut-down operation, the slave valve plunger having a piston portion and cylinder therefor, the cylinder being connected with said outlet port of the master valve for operation of the slave valve plunger into its active position, a normally restricted vent between the master valve and the cylinder to prevent accumulation of operating fluid which may slip through the master valve in its inactive or normal position from operating the slave valve plunger, one of

said valve plungers operating to close the vent in the active position of that plunger.

7. A hydraulic overspeed governor mechanism for engines, comprising a rotary head with spring biased flyweight means thereon, a master valve including a valve plunger operatively connected with the flyweight means and cooperating inlet and outlet ports, the former connected with a source of fluid pressure, said plunger having an inactive or normal position blocking one of the ports, a slave valve including a spring biased valve plunger operable from an inactive position to an active position wherein it can initiate and cause an engine shut-down operation, the slave valve plunger having a piston portion and cylinder therefor, the latter being connected with said outlet port of the master valve for operation of the slave valve plunger into its active position, a normally restricted vent for the cylinder to prevent accumulation of operating fluid which may slip through the master valve in its closing position from operating the slave valve plunger, said slave valve plunger operating to close the vent in the active position of the slave valve plunger.

8. The mechanism according to claim 6 wherein there is a spring closed check valve between the master valve and cylinder, the restricted vent

is between said outlet port of the master valve and the check valve, and the master valve plunger closes the vent.

9. The mechanism according to claim 6 wherein a valve chamber is interposed between the master valve outlet port and the slave valve plunger cylinder, said chamber having two spring closed fluid trap or check valves both blocking exit of fluid from the chamber when fluid is in operating contact with the piston portion of the slave valve plunger, one of the check valves being operable manually to vent the trapped fluid from the chamber to render the overspeed governor mechanism inactive.

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