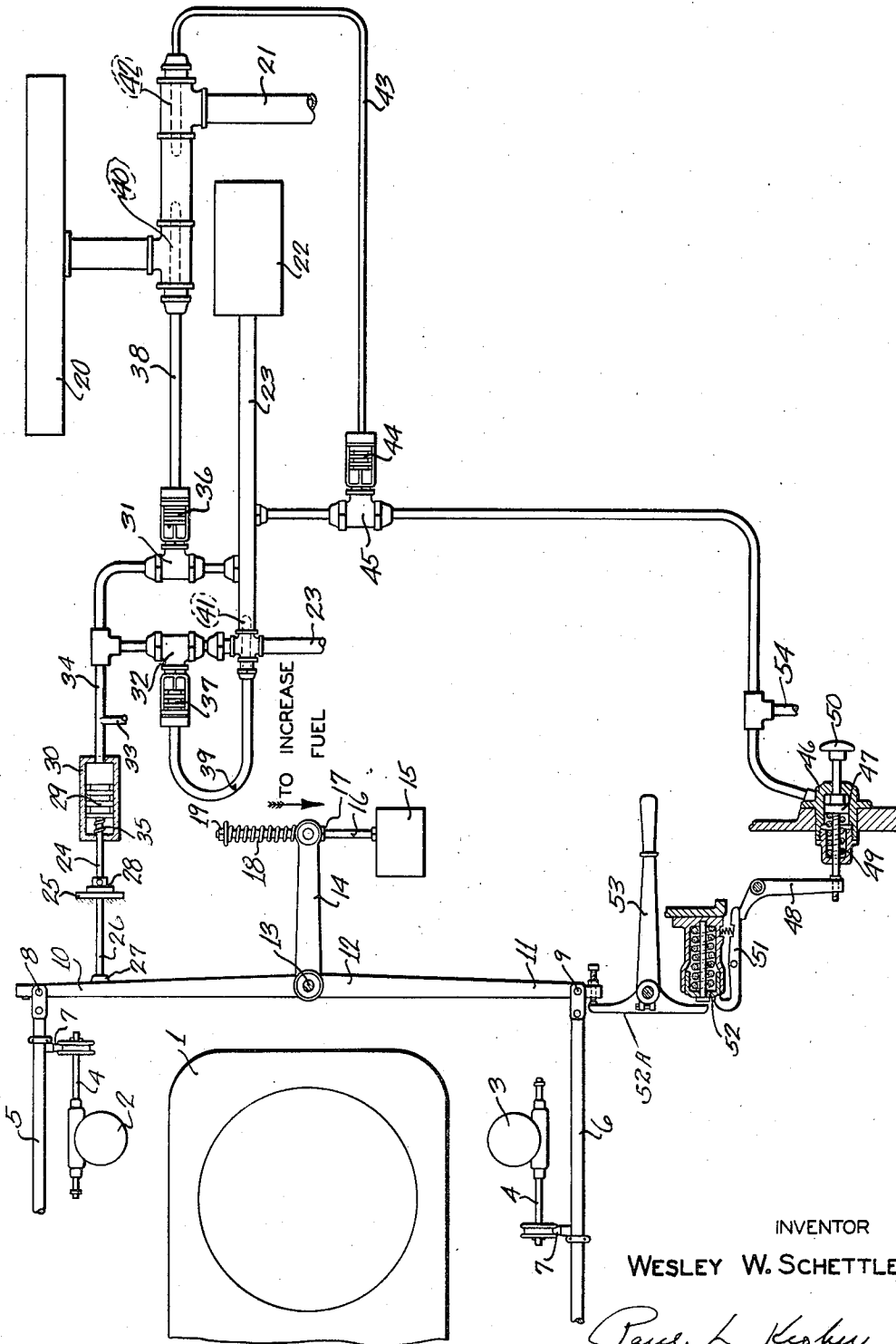


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THERMAL CONTROL OF INTERNAL
COMBUSTION ENGINES

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My invention relates to thermal control of internal combustion engines, and more particularly to power limiting means that function automatically to protect the engine from damage caused by excessive temperatures resulting from overloading.

The apparatus of the present invention has special application to governor-controlled Diesel engines, and the principal object is to provide improved means which operate independently of the governor in response to the temperature of the engine cooling fluid, the lubricating oil, or both, to limit, and in certain instances to reduce the loading or power output of the engine when the temperature of these media become excessive. In practicing the invention the load is limited by restricting the fuel supply rate to that corresponding to the normal full load rate or less, and this is accomplished without interfering with the governor operation, the governor automatically resuming control of the fuel supply when the engine temperature has dropped to normal values.

Another object is to provide means of this character which can be readily adjusted or preset to limit the loading of the engine to any desired fraction of its maximum power rating, when the engine temperature becomes abnormal.

Another object is to provide means for automatically stopping the engine when the cooling water or lubricating oil attains a temperature above that at which the load limiting means becomes effective, denoting the existence of a harmful condition other than a mere overloading of the engine.

Other objects and advantages will hereinafter appear in the following description, reference being had to the accompanying drawing which shows, diagrammatically, the means of my invention as applied to a Diesel engine.

Referring now by numerals of reference to the drawing, there is indicated at 1 the end portion of a Diesel engine which, by way of example, is shown as being of dual-injection type. In this type each cylinder is provided with a pair of fuel pumps, designated 2 and 3, which, with their associated injection nozzles (not shown), are customarily located on relatively opposite sides of the cylinder block. Each of the pumps embodies suitable means for varying its injection rate, such means usually comprising a slide valve disposed within the pump casing, regulated by an endwise movable rod 4. The pumps on the same side of the engine are arranged in align-

ment to facilitate their joint control as by endwise movable yoke bars 5 and 6, suitable means 7 serving to connect the yoke bars to the pump control rods 4. The yoke bars 5 and 6 are pivotally connected at 8 and 9 to the ends 10 and 11, all respectively, of a rockable cross-bar 12 which is secured at its center to a vertical shaft 13 having a crank arm 14 extending at right angles therefrom. The injector pumps are so arranged and interconnected that movement of the cross-bar 12 in one direction simultaneously increases their fuel delivery rate, while movement of the cross-bar in the opposite direction reduced the amount of fuel delivered to the engine.

Under normal operating conditions engine power is controlled by the governor 15, of any suitable type, which is operatively connected to crank arm 14 by a yieldable coupling device that permits of relative movement between the governor-actuated element and the described control transmission, the purpose for which will hereinafter appear. The governor actuated element is represented in the present example as an endwise movable rod 16. Threaded for adjustment on the rod 16 is a nut 17 which forms a seat for the outer end of crank arm 14, a portion of the rod beyond the nut being extended loosely through a suitable opening in the crank arm. A spring 18 on the outer end of the rod, held between an end nut 19 and the crank arm, tends to urge the crank arm against nut 17. The governor exhibits a demand for increased fuel supply by moving rod 16 inwardly, as indicated by an arrow, such movement being transmitted to arm 14 through spring 18. If the arm is locked, or held against movement in a direction to increase the fuel supply, rod 16 shifts relative to the arm, the spring becoming compressed and nut 17 moving out of engagement with the arm.

The engine is provided with the usual cooling system which includes a radiator 20 connected by suitable supply and return conduits to the engine water jacket. A portion of the water conduit leading from the engine to the radiator is indicated at 21. As a further means for maintaining the engine temperature within safe limits the engine is shown equipped with a radiator 22 through which circulates the lubricating oil, the use of an oil cooling radiator being common in connection with heavy-duty Diesel engines such as are employed for locomotive propulsion. To simplify the drawing the complete oil circulating system is not shown, conduit 23 rep-

representing a portion thereof in the pressure side of the system. The pressure of the lubricating system is utilized, in the present example, to actuate a plunger into the path of movement of cross bar 12, and when so actuated the plunger forms a detent or limit stop for the cross bar, preventing movement thereof in a direction to increase the rate of fuel supply to the engine. It will be understood that any convenient source of fluid under pressure will serve the foregoing purpose of actuating the limit member. The plunger or detent 24 is mounted for reciprocating movement in a suitable bracket 25 and when in an extended position, as shown, its end 26 forms an abutment for a boss 27 carried by cross bar 12. A collar 28 adjustably secured to the plunger, as by a set screw, is adapted to engage bracket 25, serving to limit the plunger movement. It will readily appear that by suitably adjusting the position of collar 28 on the plunger, the extended position of the latter may be changed to effect variable limits to cross-bar movement.

As a means for moving plunger 24 into so-called power limiting position, responsive to abnormal or dangerous engine heat conditions, there is provided a piston 29 operable in a cylinder 30 which is connected through valves 31 and 32 to the source of fluid under pressure, in the present example, the lubricating oil system. Opening of either of the valves 31 or 32 admits fluid to cylinder 30, causing displacement of the plunger to its outermost position. A bleeder pipe 33 is connected to the supply line 34 adjacent the cylinder leads therefrom to the lubricating oil reservoir (not shown), the bleeder pipe serving to discharge oil from the cylinder when the pressure is cut off by the valves 31 and 32 to allow the plunger to return to its retracted or inoperative position under the influence of a spring 35. By providing a bleeder passage of small sectional area the oil pressure on piston 29 will not be reduced, by reason of the discharge flow, below that necessary to maintain the piston extended.

The valves 31 and 32 are adapted to open under the influence of any suitable thermal responsive means, such means in the present example consisting of bellows 36 and 37 connected respectively by tubes 38 and 39 to bulbs 40 and 41 containing a readily expansible fluid, valve actuators of this type being well known in the art. The bulbs are located in the flow paths of their respective oil and water circulating systems as close as is practical to the hottest zones in these systems. When the temperatures of the controlling fluids reach a definite, predetermined value, expansion of the fluid in the bulbs extends the bellows, causing the valves to open.

The operation of the described mechanism is as follows: Let it be assumed that valve 31 is set to open when the temperature of the cooling water reaches 180 degrees F., a value which is above normal operating temperatures and which would not be reached except under conditions of prolonged overloading. The open valve allows oil under pressure to flow into cylinder 30, to force the piston 29 and attached plunger rod 24 into engagement with the cross bar 12, moving the same in a direction to reduce the fuel supplied to the engine. The extent to which the fuel supply is reduced is determined by the setting of collar 28 which can be adjusted to effect a limitation of engine power to any desired fractional part of its maximum power rating. As will be readily understood, a rise in the temperature of

the lubricating oil above a predetermined limit, as fixed by a proper setting of valve 32, will likewise result in a displacement of plunger 24 to limit engine power, and the plunger will remain in its power limiting position until both of the valves 31 and 32 are closed in accordance with a return to normalcy of the temperatures in both systems.

Adjunctive to the described means for limiting the power of the engine there is provided a means adapted for both manual and automatic operation to stop the engine in the event of an emergency, and which automatically stops the engine should the temperature thereof attain a value beyond that to which the above described power limiting mechanism is responsive. The emergency stop organization includes a thermostat bulb 42 suitably located in the cooling water circuit, connected by tube 43 to the bellows 44 of a valve 45, the latter valve being similar to valve 31 except that it is adjusted to open when the temperature of the cooling fluid reaches a predetermined higher value than that temperature to which valve 31 is responsive. Valve 45 controls the flow of fluid from a suitable pressure source, for example, the lubricating system, to a cylinder 46 containing a piston 47 that operates a trip lever 48; movement of the piston under fluid pressure being opposed by a spring 49 that serves to return the piston to an inoperative position when fluid pressure thereto is cut off by valve 45. An extension on piston 47 carries a knob 50 to facilitate manual actuation of the piston whereby to effect an emergency stop of the engine. The trip lever 48 functions through a pivoted detent 51 to release a spring-pressed plunger 52 which, when released, moves a pivoted stop arm 52A into engagement with the cross-bar 12, forcing the latter member into an extreme position to cut off the supply of fuel to the engine. The trip mechanism is adapted to be reset by means of a lever 53 which may be used to actuate the stop arm 52A to force plunger 52 inwardly sufficiently to allow the spring-pressed detent 51 to catch and retain the plunger. As in the case of cylinder 30, suitable means are provided to relieve the cylinder 46 of fluid when the pressure thereto is cut-off, as, for example, the bleeder pipe 54 which leads to the engine crank case or oil reservoir.

The described system for imposing a limit to the fuel supply of the engine when its temperature reaches dangerous proportions, and for stopping the engine by completely cutting off its fuel supply when the power limiting means fails to check a rising temperature are especially valuable for application to Diesel-driven trains. During the operation of a train the driving engines are frequently subjected to severe overloads, which, if continued, cause overheating and damage to the engine. Since trains are required to maintain definite schedules and to make side track connections to avoid other trains, it is imperative that notice of impending excessive engine temperatures be given in time to avoid the necessity of stopping the train, and that such notice be transmitted for direct effect on the engine control without the requirement of human intervention. The described apparatus accomplishes the foregoing purpose and may be readily applied to existing engines without materially altering the prevailing types of fuel control systems. By the provision of the described yieldable or lost-motion connection between the engine governor and the control transmission a relatively small force on the rockable cross bar is sufficient to effect a re-

duction or limitation of engine power, since the force of the governor mechanism, particularly high when operating at overload stage, does not have to be overcome.

- 5 Although the invention has been described by making specific reference to a presently preferred arrangement and combination of control features, many of the agencies, their location and arrangement may be varied; accordingly, the description
10 is to be understood solely in an illustrative and not a limiting sense.

I claim:

1. In combination in an internal combustion engine having separate cooling systems for the
15 cylinder block and the lubricating oil, a fuel feed control member, a detent arranged for movement into the path of said control member whereby to limit to a predetermined extent the movement of said control member in a direction tending to in-
20 crease fuel feed, thermostats responsive to temperature conditions in the cylinder block and lubricating oil cooling systems and means under the joint control of said thermostats for actuating the detent as aforesaid when the temperature in
25 either of said systems attains a predetermined value.

2. The subject matter of claim 1 wherein said

detent includes adjustable means for limiting its range of movement into the path of said fuel feed control member, whereby the limitation imposed on fuel increasing movement of the control member may be varied.

3. In combination in an internal combustion engine having cooling systems for the cylinder block and the lubricating oil, a fuel feed control member, and means responsive to heat conditions in said cooling systems adapted to limit fuel in-
5 creasing movement of said control member, said means comprising a detent arranged for movement into the path of said control member, a fluid pressure motor for actuating said detent, a pair of valves adapted independently to effect
15 energization of said motor, and a pair of thermostats each adapted to control one of said valves, one of said thermostats being adapted to open its associated valve responsive to a predetermined temperature condition in the cylinder block cool-
20 ing system, and the other thermostat being adapted to open its valve responsive to a predetermined temperature condition in the lubricating oil cooling system, said motor operating to move said detent into the path of said control member when
25 either of said valves is opened.

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