June 18, 1968 J. J. O'DONNELL 3,388,695

SAFETY SHUT-DOWN FOR DIESEL ENGINES

Filed Feb. 17, 1967

Fig. 1.

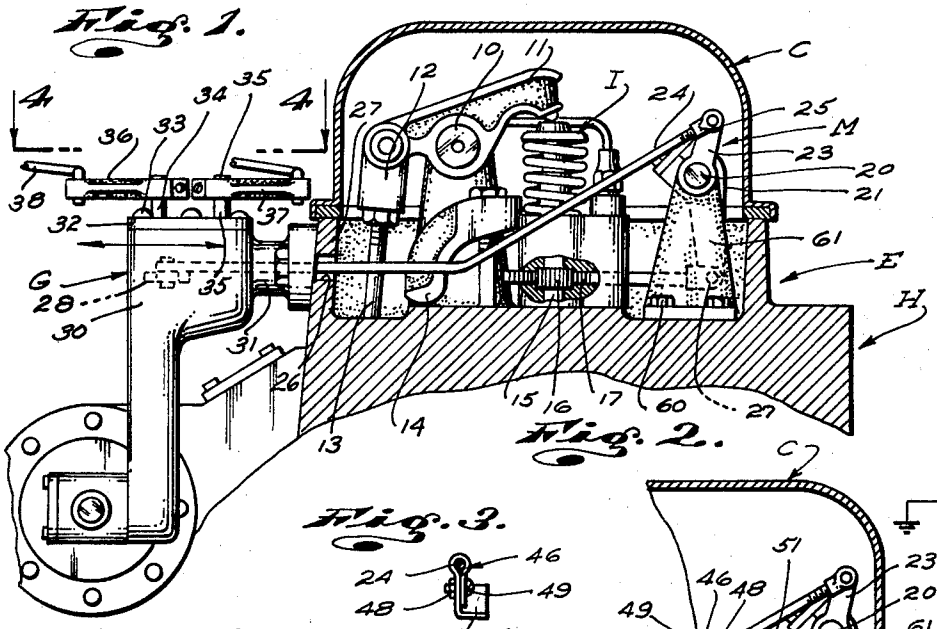


Fig. 2.

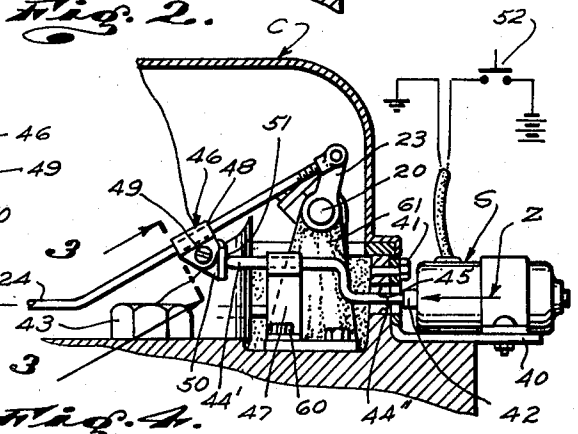


Fig. 3.

Fig. 5.

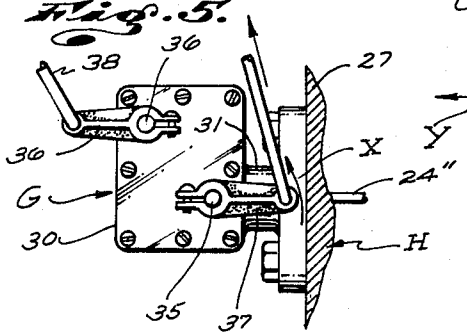


Fig. 4.

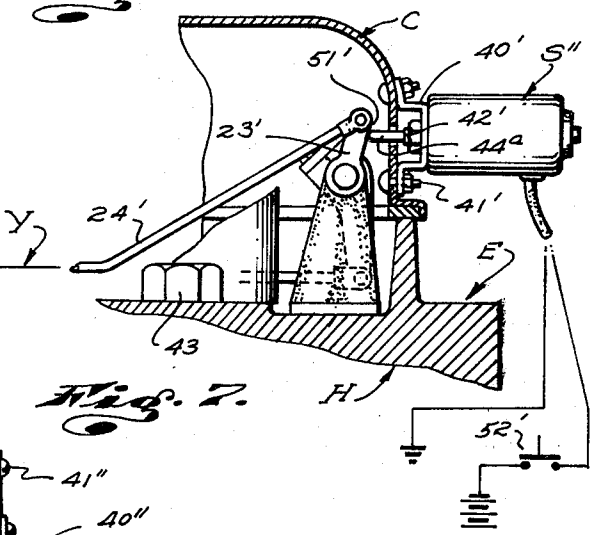


Fig. 6.

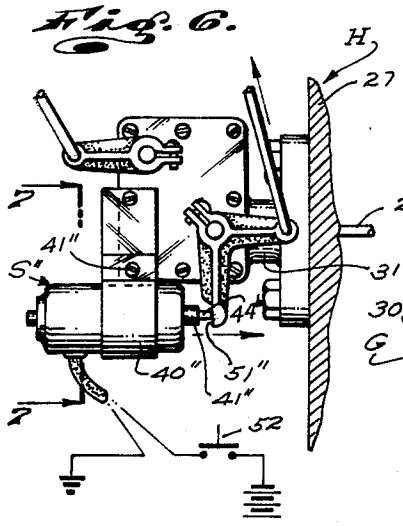
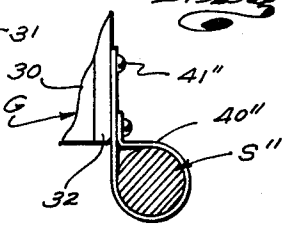


Fig. 7.



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SAFETY SHUT-DOWN FOR DIESEL ENGINES

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ABSTRACT OF THE DISCLOSURE

In a diesel engine having a governor, a plurality of fuel injector units with gear and rack operated metering valves and operating means coupled with and between the racks and governor to open and close the valves and including a rotatable control rack shaft related to the plurality of injector units, drive cranks on the shaft and operatively coupled with the racks, a drive crank on the shaft and a drive rod between the drive crank and a differential link of the control linkage of the governor; an electrically operated shut down means to selectively rotate the shaft to close the metering valves and stop the flow of fuel through the injector units independent of the governor and including a solenoid fixed to the engine and having an axially shiftable drive rod opposing and normally spaced from a stop part on the operating means and operable, when energized, to urge said operating means to that position where the valves of the injector units are fully closed and manually operable switch means remote from the engine to selectively energize the solenoid.

Diesel engines having injector units with rack and gear controlled metering valves and control means therefore, such as is set forth above, are produced by General Motors Corporation and are commonly known as G.M. Diesels. Many thousands of such diesels have been produced and are in use throughout industry.

In many situations where such diesel engines are used to drive equipment, it is necessary that means be provided to stop the engines positively and rapidly in order to prevent the equipment being driven thereby from inflicting great injury upon persons near the equipment, to prevent the equipment from causing damage to other property or in some circumstances, from damaging or destroying itself, as when control of its operation is lost.

In the past, safety shut down means have been provided for such engines, which means have involved diaphragms pneumatically coupled with the air intake manifolds of the engines to which they are related. These diaphragms, ordinarily, are arranged in the manually operated linkage connected with the stop or shut down levers of the engine governors and are under control of manually operable valves, arranged in the pneumatic lines which extend between and connect the diaphragms and engine manifolds.

Such pneumatic means have proven to be of questionable effectiveness since it frequently happens that when an emergency arises and it is necessary to stop the engines with which such means are related, sufficient pressure is not present to operate the diaphragm against the resistance of the governor, injector units and various parts of the operating means therebetween. It is to be noted that the governors in such diesel engines serve two purposes. First, they limit the maximum speed of the engines and, second, they maintain a uniform idling speed, regardless of engine friction and temperature. These purposes necessitate a variation in the amount of fuel injected into the cylinders of the engine by the injector units. To accomplish this, a centrifugal type governor mechanism is used to govern the position of the injector control shaft of the operating means independent of the manually operated accelerator linkage, which connects with the

governor. The governor mechanisms are arranged in separate housings fixed to the exterior of the engines and are driven thereby. The governors are interposed and operatively connected between the manually operable accelerator linkage and the drive rod of the operating means for the racks and are characterized by a primary shaft projecting from the housing with a lever arm thereon, which arm connects with the manually operable accelerator linkage and a differential link within the housing comprising a part of the control linkage of the governor and with which the drive rod of the operating means is connected.

Since these governors serve to maintain uniform idling speed, they serve to normally prevent stopping or shut down of the engines with which they are related. Accordingly, such governors are provided with secondary shafts upon which stop levers are carried. The stop levers are suitably operatively connected with the control linkage so that when they are manually or otherwise shifted from a normal position to a stop position, they mechanically urge the control linkage to a position where the operating means shifts the racks of the injector units to their closed position, against the resistance of the governor mechanism and where fuel through the injector units and into the cylinders is shut off to stop the engines.

It is the above-noted stop levers to which the above-noted diaphragm type of shut down means is related.

In practice, the stop levers of the governors are or can be related to other parts of the governor in any one of several different manners. Since the manner in which the stop levers are related to the other parts of the governors does not affect the novelty of the invention and since the presence of such levers with their attending function is all that concerns the inventions, further detailed consideration of the governors need not be entered into.

An object of my invention is to provide a manually operable shut down means for diesel engines of the general character referred to above, which means is fast, positive and trouble free in operation.

A further object is to provide a means of the character referred to which functions independent of the operating conditions of the engine and serves to immediately and positively stop further operation of the engine by positively shutting off or stopping the flow of fuel through the engine injector units.

Another object of my invention is to provide a means of the character referred to which is easy and economical to manufacture, install and maintain, and such means which is extremely easy and convenient to operate.

The above and other objects and features of my invention will be fully understood from the following detailed description of typical preferred forms and applications of my invention, throughout which description reference is made to the accompanying drawings, in which:

FIG. 1 is a sectional view of a portion of a diesel engine of the kind or make with which my new safety shut down is to be related;

FIG. 2 is a sectional view of a portion of the engine construction shown in FIG. 1 with my new shut down means related thereto;

FIG. 3 is a sectional view taken as indicated by line 3—3 on FIG. 2;

FIG. 4 is a view similar to FIG. 2 showing another form of my invention;

FIG. 5 is a view of the engine governor taken as indicated by line 5—5 on FIG. 2;

FIG. 6 is a view similar to FIG. 5 showing my invention applied to the governor construction; and

FIG. 7 is a sectional view taken as indicated by line 7—7 on FIG. 6.

The portion of the engine E shown in FIG. 1 of the drawings is illustrative of portions of a G.M. Diesel with

certain liberties taken with respect to size, shape, proportion and arrangement of parts, to facilitate this disclosure.

FIG. 1 shows the upper portion of the head H of the engine with certain parts and/or portions of the engine valve means and fuel injector means related thereto. Since this engine construction and the operation thereof is well known to those skilled in the art, the several parts shown will be identified in the following, but consideration of the operation thereof will only be entered into to the extent required for an understanding of the invention.

The engine parts shown include, the rocker arm shaft **10**, one of the plurality of injector rocker arms **11** carried by the shaft **10**, a clevis **12** on the rocker arm, a push rod **13** connected with and depending from the clevis, an injector retainer crab **14**, and one of the several injector units I.

A portion of the injector unit I is broken away to show a part of the injector plunger **15**, the pinion **16** on the plunger and the inner portion of the control rack **17** engaged with the pinion. As pointed out above, and as is well known in the art, the injector unit includes certain metering valve means (not shown), which means controls the amount of fuel injected into the engine cylinder with which the injector is related and which valve means is opened and closed by rotation of the plunger by means of the pinion and rack, that is by axial shifting of the rack.

The racks of the several injector units are shifted simultaneously by an operating means M, which means includes an elongate, control rack shaft **20** rotatably mounted to extend longitudinally above the head, laterally offset from and parallel with the line of injector units I. The shaft **20** carries a plurality of operating levers **21**, one for each rack. The levers **21** depend from the shaft and are suitably pivotally coupled with the outer ends of their related racks, as indicated in phantom lines at **22** in FIG. 1 of the drawings.

The operating means M further includes a drive lever or arm **23**, which arm projects upwardly from the shaft and to which the inner end of an elongate transversely extending drive rod **24** is pivotally connected, as at **25**.

The other or outer end of the drive rod **24** extends laterally through an opening **26** provided in an upwardly projecting peripheral flange **27** on the head H and connects with the differential link **28** of the engine governor G.

The governor G involves a housing having an upwardly opening box-like portion **35** in which the governor control linkage, including the link **28**, is arranged and which has a laterally projecting flanged neck portion **31** fixed to the head, in axial alignment with the opening **26** therein and through which the rod **24** freely projects.

The portion **30** of the governor housing has a cover plate **32** arranged in fixed position on the housing by suitable screw fasteners **33**. The primary and secondary shafts referred to above and identified the numerals **34** and **35** project upwardly through the cover plate **32**. The shaft **34** carries an accelerator lever arm **36** and the shaft **35** carries a stop lever **37**. The arm **36** connects with suitable manually operable accelerator linkage **38** and the lever **37** connects with suitable manually operable stop linkage **39** which normally extends to a manually engageable stop lever or handle (not shown).

The stop lever **37** is shiftable in the direction indicated by the arrows X in FIG. 5 of the drawings from a normal inoperative position to an actuated position wherein it results in overriding the action of the governor G and urges the rod **24** in the direction indicated by the arrow Y to effect closing of the injector valve means and to stop the flow of fuel through the injector units into the engine cylinders.

Since the stop lever **37** is normally inoperative it can be considered as a separate means from the governor and can be considered as a part of the operating means M for the purpose of this disclosure.

In addition to the foregoing and in accordance with normal engine construction, a valve cover C is provided on the head to overlie and cover the various means and mechanisms referred to above and related to the head.

In the form of my invention shown in FIG. 2 of the drawings, the safety shut-down includes a solenoid S fixed to the exterior of the upwardly projecting peripheral flange **27** of the head H, by means of a suitable bracket **40** and screw fasteners **41**. The solenoid S is arranged on that side of the head H opposite the side thereof at which the governor G is arranged and with its core **42** projecting laterally inwardly on an axis parallel with and adjacent to the transverse vertical plane in which the push rod **24** of the operating means M operates.

The inner end portion of the rod **24** which connects with the drive lever **23** on the shaft **20** is inclined upwardly relative to the other portion is substantially horizontal. The upwardly inclined portion of the rod **24** is inclined to effect connection of the rod with the upper end of the lever **23** and also serves to direct and arrange the rod so that it occurs above and clear of certain head bolts **43** (see FIGS. 2 and 4 of the drawings) which occur centrally of the head and in substantially the same transverse vertical plane as the rod **24**.

The invention further includes an elongate drive rod **44** suitably fixed to the core **42** of the solenoid S to project laterally inwardly through an opening **45** established in the upwardly projecting flange **27** on the head and a stop part **46** on the rod **24**, opposing and normally spaced from the drive rod.

The inner end portion **44'** of the drive rod **44** is vertically offset from the outer end portion **44''** thereof, so that the inner portion of the rod is spaced above and clear of the head bolt **43** referred to above and so that the stop part **46** on the inner upwardly inclined portion of the drive rod **44** is clear of said head bolt.

An upwardly projecting bracket **47** with a tubular or sleeve-like guide, through which the inner portion **44'** of the rod **44** is engaged, is provided to maintain the inner portion **44'** of the drive rod in proper axial alignment with the stop part **46**.

The stop part **46** can be any suitable means on or fixed to the rod **24**, which presents a flat, laterally outwardly disposed surface to oppose and to be engaged by the inner end of the rod **44**. In the case illustrated, the stop part **46** is a simple formed sheet metal part having a folded portion **48** engaged about the rod and held in tight clamped engagement therewith by a screw fastener **49** and a bent tab portion **50** establishing a flat, laterally outwardly disposed stop surface **51**, which surfaces opposes and is engageable with the inner end of the rod **44**, as clearly illustrated in FIG. 2 of the drawings.

The solenoid S is electrically connected with a suitable power source and is under control of a normally open button switch **51**, which switch, when closed, results in the solenoid being energized to urge the core **42** thereof in the direction indicated by the arrow Z (see FIG. 2), thereby urging the rod **24** in the direction indicated by the arrow Y, to stop the flow of fuel through the injector units and into the cylinders of the engine and to thereby immediately shut down or stop the engine.

The switch **51** is as the end of an elongate electric cord or line L and is such that it can be positioned wherever desired or can, if desired, be transported about the job site where the engine is operated.

In practice, the guide bracket **47** for the inner portion **44'** of the rod **44** can be fixed in place by means of one of the several available screw fasteners normally occurring in the head, for example, it can be held by one of the fasteners **60** which serve to secure the supports or standards **61** for the shaft **20** to the head.

In the form of the invention illustrated, in FIG. 4 of the drawings, the solenoid S' is fixed to the exterior of the valve cover C, at the exterior thereof. The solenoid

S' is arranged with its axis parallel with the plane in which the drive lever or arm 23 is operated or swings. The valve cover C is provided with an opening 45' in alignment with the solenoid S' and through which the push rod 44' carried by the solenoid 42' projects. The side or edge of the lever arm 23 of the means M dispose towards the side of the valve cover C at which the solenoid S' is arranged, defines a stop surface 51' which opposes the inner end of the rod 44'. The inner end of the rod 44' is normally spaced from the surface 51' of the arm 23' which establishes the stop part in this form of my invention and is engaged by the rod 44' when the solenoid is energized and the push rod 44' is urged laterally inwardly. Engagement of the rod 44 on the surface 51' of the stop part of arm 23 in the manner set forth above and further inwardly shifting of the rod 44' urges the operating means M to that position where fuel through the injector units I is stopped, independently of the operation of the governor G and the accelerator linkage 38.

The solenoid S', like the solenoid S, is under control of a suitable manually operable switch 51'.

It will be apparent that instead of the push rod 44' engaging the surface 51' on the arm 23, it could be arranged to engage a similar and suitable surface on one of the several lever arms 21 on the shaft 20 without departing from the spirit of this invention.

Such modification would simply require moving the location of the solenoid S longitudinally of the valve cover as necessary and desired.

In the second and last considered form of my invention, the solenoid S' is carried by a suitable sheet metal bracket 40' fixed to the valve cover C by suitable bolt fasteners 41'.

It will be apparent that the brackets 40 and 40' in the two forms of the invention illustrated in FIGS. 2 and 4 of the drawings are interchangeable and that the angle or L-shaped form of bracket shown in FIG. 2 of the drawings could be employed to support the solenoid S' in the form of the invention illustrated in FIG. 4 of the drawings and that the U-shaped bracket 40' shown in FIG. 4 of the drawings could be employed to mount the solenoid S in FIG. 2 of the drawings.

It will be apparent that while I have illustrated the first two forms of the invention applied to an inline or straight engine having a single row of cylinders and related injector units, the invention will operate effectively and efficiently in V-type engines having a pair of parallel rows of cylinders, injector units and related operating means for the injector units. In V-type diesel engines of the character here referred to, a single governor is employed. The governor in such engines is related and operatively connected with a pair of operating rods, such as the operating rods 24 referred to above, one for each bank of cylinders. The connection between the governor and the pair of operating rods is such that if one rod and its related parts is moved, as by means of my solenoid opearted shut down, the other rod, with its related parts, is moved simultaneously and synchronically therewith.

In the form of the invention illustrated in FIG. 6 of the drawings, the solenoid S'' is carried by the governor G and the stop part 46'' is established on or by the stop lever 37'' of the governor. The lever 37'', as pointed out above, is or may properly be considered a part of the operating means for the injector units and distinct from the governor itself.

The solenoid S'' which is mounted on the governor G by means of a sheet metal bracket 40'' and screw fasteners 41'' has a push rod 44'' fixed to the core 42''. The outer end of the rod 44'' is normally spaced from and opposes a flat stop surface 51'' on the stop part 46''. The stop part 46'' in this third form of the invention is shown as a second or stop arm formed integrally with the stop lever 37''. The stop lever is formed to define the flat stop surface 51''.

It will be apparent that when the solenoid S'' is energized, as by means of a switch 51'', and the stop arm is moved in the direction indicated by the arrows Z'', the drive rod 24'' is moved in the direction indicated by the arrow Y'', overriding the action of the governor and stopping the flow of fuel through the injector units of the engine, for immediate shut down of the engine.

It is to be noted that the invention that I provide is extremely economical to manufacture, and is extremely easy and economical to install. The cost of the entire means that I provide is less than the cost of the pneumatic lines and control valves of the pneumatically operated shut down means now in use. Further, the solenoids employed in my invention are considerably and materially smaller in dimensions than the diaphragms employed by the prior art in shut down means and, as is clearly illustrated, is capable of being arranged in any one of several manners with the operating means M of the diesel engines thereby affording great versatility of application.

It is to be further noted that with the electrically operated means that I provide, the control switch can be carried or arranged at the end of an elongate flexible power cord or line so that it can be arranged and/or positioned wherever desired and can be repositioned or transported about, as circumstances require. Such is not practical or feasible with the pneumatically operated means presently employed in the art as the air conducting control lines therefore are characteristically established of metal tubing and are incapable of being moved about freely.

Having described only typical preferred forms and applications of my invention, I do not wish to be limited to the specific details herein set forth, but wish to reserve to myself any modifications and/or variations that may appear to those skilled in the art and which fall within the scope of the following claims.

Having described my invention, I claim:

1. In a diesel engine having a plurality of fuel injector units each with a rack and pinion operated metering valve, a governor connected with manually operable accelerator linkage and operating means between the governor and the racks of the injector units and including a rotatably mounted rack shaft adjacent the injector units, operating levers on the shaft connected with the racks of the injector units, a lever arm on the shaft, a drive rod between the operating lever and the governor and a manually operable lever on the governor and operable to shift the operating means in one direction to close the metering valves independently of the operation of the governor; a flat stop surface on the operating means disposed opposite to said one direction, a solenoid mounted in fixed position adjacent said operating means with the axis of its core parallel with the axis of travel of said surface, manually operable switch controlled power supply means to selectively energize the solenoid and an elongate push rod having an outer end fixed to the core and an inner end normally spaced from the opposing said surface and engageable with said surface when the solenoid is energized to urge the operating means in said one direction and to close the metering valves.

2. A structure as set forth in claim 1 wherein said stop surface is defined by a stop part fixed to the drive rod of the operating means, said solenoid is mounted on a flange portion on a cylinder head with which the injector units and operating means are related and said push rod is supported and guided between its opposite ends by a bracket fixed to and projecting from the head.

3. A structure as set forth in claim 1 wherein said stop surface is defined by a stop part fixed to the drive rod of the operating means, said solenoid is mounted on a flange portion on a cylinder head with which the injector units and operating means are related and said push rod is supported and guided between its opposite ends by a bracket fixed to and projecting from the head, the end portion of the drive rod connected with the drive lever being up-

wardly inclined to clear parts of the engine construction occurring below the drive rod, said stop part occurring an said inclined portion of the drive rod and spaced above the axis of the solenoid, said push rod having an inner end portion in alignment with the stop surface defined by the stop part and engaged with said bracket and an outer portion downwardly offset from the inner portion, and in axial alignment with and connected to the core.

4. A structure as set forth in claim 1 wherein the stop surface is defined by a portion of the drive lever, and the solenoid is mounted on the exterior of a valve cover fixed to a cylinder head with which the injector units and operating means are related, said valve cover having an opening in alignment with the core and through which the push rod freely projects.

5. A structure as set forth in claim 1 wherein the stop surface is defined by a stop part on the stop lever and the solenoid is fixed to the governor by means of a mounting bracket.

6. A structure as set forth in claim 1 wherein the stop surface is defined by the end portion of a stop arm on the stop lever and the solenoid is releasably secured to

the governor by means of a mounting bracket screw fastened to the governor.

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