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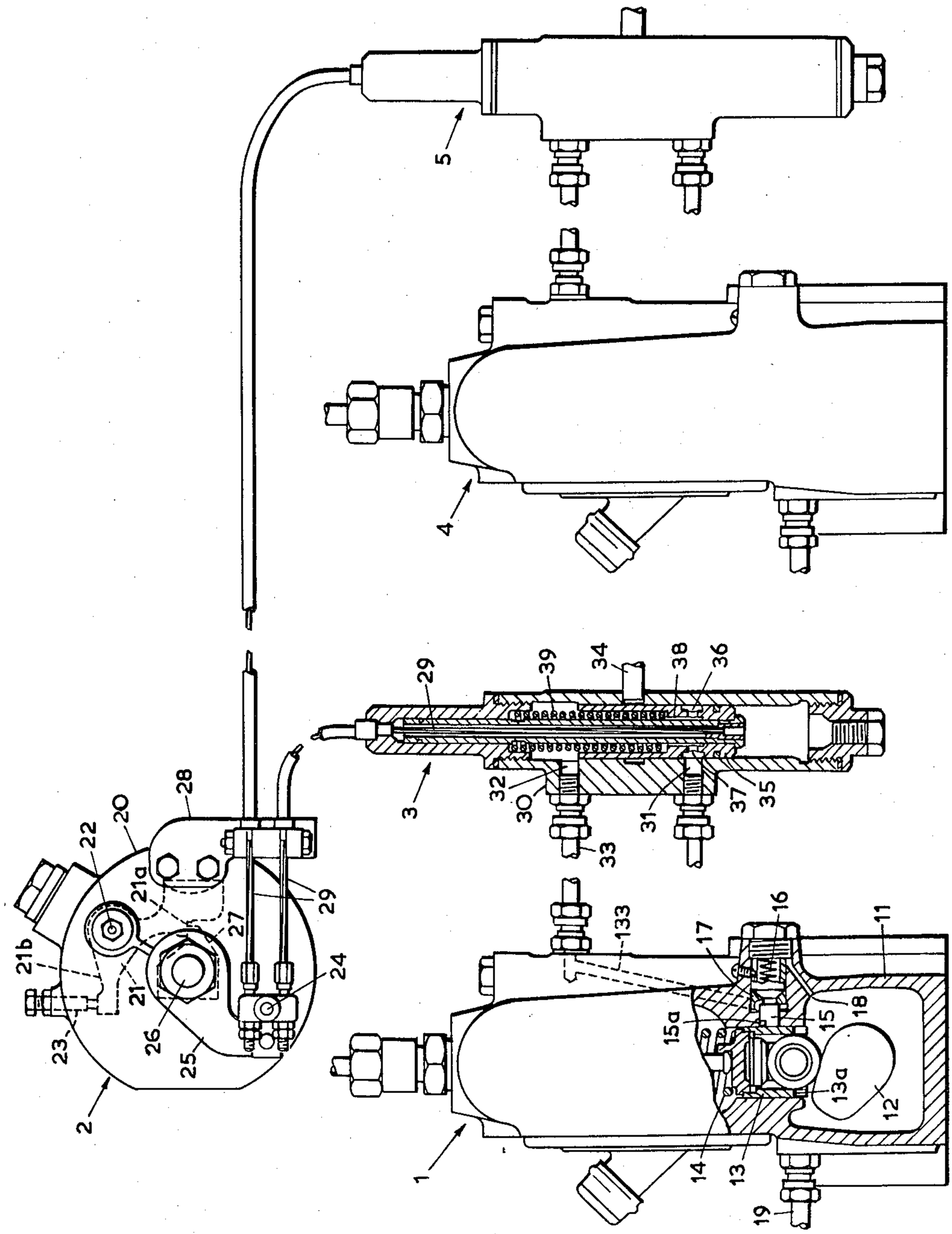

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EMERGENCY SHUT-DOWN GEAR FOR MULTI-CYLINDER COMPRESSION IGNITION ENGINES

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The present invention relates to an emergency shut-down gear for a multi-cylinder compression ignition engine.

According to the invention, emergency shut-down gear for a multi-cylinder compression-ignition engine comprises a source of hydraulic pressure; a single speed-responsive tripping device driven by the engine; at least two fuel-injection pumps driven by said engine and delivering fuel to the cylinders thereof; at least two hydraulic control valves each comprising a valve body having an inlet port, an outlet port, and a drain port, said inlet port being connected to said source of hydraulic pressure, a piston mounted to slide in said body between a first position, in which the inlet port is connected to the outlet port and the drain port is blocked, and a second position, in which the drain port is connected to the outlet port and the inlet port is blocked, and resilient means to bias said piston towards said second position; tension means connecting the piston of each said hydraulic control valve to said tripping device to oppose movement of said piston due to said resilient means; each said fuel-injection pump comprising a spragging pin housing having a bore, a spragging pin slidable in said bore, spring means to bias the spragging pin to lock the fuel pump, and the spragging pin having a surface acted on by the pressure in said bore in the sense to over-ride said spring means; and duct means connecting said bore to the outlet port of a hydraulic control valve, whereby on operation of said tripping device the pistons of said hydraulic control valves move substantially simultaneously under the influence of the resilient means to their second positions, so that said bore of each fuel-injection pump is connected through the outlet port of a hydraulic control valve to the drain port thereof and the spragging pins of said fuel-injection pumps move substantially simultaneously, under the influence of the corresponding spring means, to lock the corresponding fuel-injection pumps, and thus to cause the delivery of fuel to the cylinders of the engine to be terminated substantially simultaneously.

This arrangement is particularly suited to multi-cylinder engines where more than one multi-element fuel pump is fitted, and where these pumps are arranged remote from one another, for instance on a V-engine with the pumps outboard. The emergency gear according to the invention ensures complete synchronisation of operation in such an engine.

The source of hydraulic pressure controlling the spragging pin may be derived from the engine lubricating oil pressure system or from an independent closed hydraulic circuit.

The emergency shut-down gear according to the inpention "fails safe" in the failure of hydraulic pressure caused by leakage or any other breakdown will lock the fuel pump, and accordingly bring the internal combustion engine to a standstill, the same way as the action of the overspeed tripping device upon overspeeding.

An embodiment of the invention will now be described with reference to the accompanying drawing, which shows a diagrammatic arrangement of emergency shut-down gear according to the invention.

In the drawing, the fuel pumps **1**, **4**, are controlled

by an overspeed tripping device **2** by means of piston valves **3**, **5**. The piston valve **3** is connected to fuel pump **1** and piston valve **5** to pump **4**.

Each fuel pump comprises a camshaft housing **11** wherein the engine-driven cam **12** is journalled, and the tappet assembly **13** of the pump plunger is mounted to slide perpendicularly to the axis of the camshaft, by which the plunger is reciprocated against the bias of a spring **14**. A spragging pin **15** slidable in a bore in its housing **17** is biased by a spring **16** towards the tappet assembly **13** in a direction perpendicular to both the axis of said assembly and that of the cam shaft. This spragging pin has a shoulder **15***a* capable of engaging in a recess **13***a* of the tappet assembly **13** in the uppermost or near uppermost position of the latter, but is normally held back by hydraulic pressure applied to the surface on its left-hand side (as seen in the drawing) as will be explained hereinafter. The space behind the spragging pin **15** is connected to the camshaft housing **11** by a relief bore **18**, and the camshaft housing is connected to drain by a pipe **19**.

The overspeed tripping device **2** comprises a casing **20** wherein a trip latch **21** is pivotally mounted at **22**. A lever **25** is mounted outside the casing **20** to rotate with a shaft **26**, on which inside the casing a cam **27** is mounted which cooperates with a shoulder **21***a* of the trip latch **21**. Normally the trip latch is biased clockwise and its arm **21***b* abuts a stop **23** adjustably fitted to the casing **20**. In the event of overspeeding the trip latch **21** is swung anti-clockwise by conventional overspeed tripping means (not shown) and its shoulder **21***a* clears the cam **27**. A bracket **28** attached outside the casing **20** holds the sheaths of tension cables **29** attached by a swivel joint **24** to the free end of the lever **25**.

Each piston valve **3**, **5** comprises a casing **30** having an inlet port **31** connected to a supply of hydraulic pressure, an outlet port **32** connected by a pipe **33** to the pump **1**, and a drain port **34**. A piston **35**, having an annular groove **36** connected by radial ports **37** to an inner bore **38**, is mounted to slide in the casing **30**, and is biased downward (as shown in the drawing) by a powerful pre-loaded compression spring **39**.

The tension cables **29** are attached to the pistons **35**, and while the trip latch **21** keeps the lever **25** locked, these cables **29** hold the pistons **35** in a first position as shown, in which the inlet port **31** is connecten to the outlet port **32**, and the drain port **34** is blocked. Hence hydraulic pressure is transmitted through the pipe **33** and the duct **133** is the casing of each fuel pump **1**, **4** and acts on the surface of the spragging pin **15** to hold it back against the bias of spring **16**.

However, when the trip latch **21** releases the cam **27**, the spring **39** of each piston valve pushes the piston **35** downward to a second position, in which it blocks the inlet port **31**, and connects the outlet port **32** to the drain port **34**.

Following the closing of the inlet port **31** and before the opening of the drain port **34**, the piston **35**, which has the form of a hollow plunger, displaces a fixed volume of liquid which is equivalent to the volume of liquid in the bore of the spragging pin housing **17** of the corresponding fuel pump. Accordingly the hydraulic pressure inside the bore of the housing **17** of the fuel pump drops at once, and the spragging pin **15** is pushed to the left by spring **16** and engages with its shoulder **15***a* in a recess **13***a* of the respective tappet assembly **13** when the latter is in its maximum or near maximum lift position, and prevents it from following the cam **12** downward under the bias of spring **14**.

The fuel pumps **1**, **4** are thus put out of action immediately and substantially simultaneously and the in-

ternal combustion engine supplied by them is brought to a standstill at once.

When the overspeed trip device 2 is reset—by hand or otherwise—the piston 35 is returned to its first position (as illustrated), hydraulic pressure is re-established in the bore of the housing 17 of the pumps 1, 4, the spragging pin 15 is thereby withdrawn from the tappet assembly 13 against the bias of spring 16, and the fuel pumps 1, 4 are ready to resume operation.

The "fail-safe" effect of the arrangement will be noted: failure of hydraulic pressure for any reason will stop the fuel pumps 1, 4 in the manner described, and they cannot then be restarted before the hydraulic pressure is restored.

Owing to the fact that the tappet assembly 13 is locked by the spragging pin 15 at or near the maximum lift position, the cam 12 of each fuel pump 1, 4 is free to rotate clear of the tappet assembly until the associated spragging pin 15 is retracted under re-established hydraulic pressure, this action being independent for each fuel pump.

What we claim as our invention and desire to secure by Letters Patent is:

1. Emergency shut-down gear for a multi-cylinder compression-ignition engine, comprising a source of hydraulic pressure; a single speed-responsive tripping device driven by the engine; at least two fuel-injection pumps driven by said engine and delivering fuel to the cylinders thereof; at least two hydraulic control valves each comprising a valve body having an inlet port, an outlet port, and a drain port, said inlet port being connected to said source of hydraulic pressure, a piston mounted to slide in said body between a first position, in which the inlet port is connected to the outlet port and the drain port is blocked, and a second position, in which the drain port is connected to the outlet port and the inlet port is blocked, and resilient means to bias said piston towards said second position; tension means connecting the piston of each said hydraulic control valve to said tripping device to oppose movement of said piston due to said resilient means; each said fuel-injection pump comprising a spragging pin housing having a bore, a spragging pin slidable in said bore, spring means to bias the spragging pin to lock the fuel pump, and the spragging pin having a surface acted on by the pressure in said bore in the sense to over-ride said spring means; and duct means connecting said bore to the outlet port of a hydraulic control valve, whereby on operation of said tripping device the pistons of said hydraulic control valves move substantially simultaneously under the influence of the resilient means to their second positions, so that said bore of each fuel-injection pump is connected through the outlet port of a hydraulic control valve to the drain port thereof and the spragging pins of said fuel-injection pumps move substantially simultaneously, under the influence of the corresponding spring means, to lock the corresponding fuel-injection pumps, and thus to cause the delivery of fuel to the cylinders of the engine to be terminated substantially simultaneously.

2. Emergency shut-down gear as claimed in claim 1 wherein each said piston has the form of a hollow plunger, the interior of which is in constant communication through said outlet port and said duct means with said bore wherein the pressure acts on the surface of the spragging pin in the sense to over-ride the spring means, whereby on movement of said piston from said first piston to said second position, resulting from operation of said overspeed trip device, a substantial volume of liquid is displaced from said bore along said duct means towards said hollow plunger, thereby facilitating movement of said spragging pin under the influence of its spring.

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