

SPECIFICATION

Multiple input, single output, modular actuator

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This invention relates to multiple input, single output, actuators which are particularly useful in connection with governors for engines or the like.

10 A variety of mechanical apparatuses utilize control mechanisms wherein a single output to the apparatus being controlled is provided by the control mechanism in response to any one or more of a plurality of input signals to the control mechanism. Such control mechanisms perform a so-called logical "OR" function and typically receive input signals of the same medium. For example, each input signal may be a pressurized air signal or a pressurized hydraulic fluid signal, but not both. The input signals may be in the form of electrical signals or in the form of movement of mechanical elements as well. Seldom, if at all, are input signals of different mediums utilized by a single, multiple input, single output actuator and, in many cases, it is required to convert an input signal from one medium to another prior to its application to the control device.

30 For example, an actuator may receive a pneumatic signal from a source of air under pressure and the apparatus controlled may also generate, as by means of a mechanically operated switch, an electrical signal. The electrical signal is converted to the air medium through the use of a solenoid operated valve prior to its application to the actuator.

Moreover, such actuators are typically designed for a predetermined number of inputs and where a particular apparatus to be controlled requires a greater or lesser number of inputs to the control device, a wholly different actuator must be employed, or input capacity wasted, or multiple actuators utilized, or combinations of the foregoing.

40 According to the present invention, a multiple input, single output, actuator comprises a plurality of modules mounted end to end in series; each module containing a signal responsive element slidable between the ends of the module, a signal input means for enabling a signal to be directed to the signal responsive element to cause the element to move towards one end of the series of modules, a link extending slidably through the signal responsive element and having an end extending out of one end of the module and stop means abutting one side of the signal responsive element, the links of adjacent modules abutting each other; and an actuator rod coupled with the link in the module at the one end of the series of modules, whereby on actuation of any of the signal responsive elements movement of the actuator rod is caused, corresponding to the displacement of the signal

responsive element having the greatest displacement.

Such an actuator has the advantage that it can readily be expanded by addition of an extra module to allow for a further input and that modules may be changed simply, to allow for changes in the type of input signals.

One example of an actuator according to the present invention will now be described with reference to the accompanying drawings in which:—

Figure 1 is a partially schematic view of one environment of use, namely, a marine propulsion unit and control system, in which a multiple input, signal output mechanical actuator of the invention may be advantageously utilized; and,

Figure 2 is a sectional view of a multiple input, signal output, mechanical actuator according to the invention.

With reference to Fig. 1, an actuator made according to the invention is utilized in a marine propulsion system and control therefor, but it is to be understood that the actuator of the invention is not restricted to use in such systems, but may find use in virtually any control system requiring a mechanical output which is responsive to plural inputs of the same or different mediums.

95 The marine drive includes an engine 10 contained in an engine room 12 in a ship. The engine 10 drives a propulsion shaft 14 connected to a propeller (not shown). The shaft 14 receives rotational power from the engine 10 via a gear unit 16.

100 The engine 10 is normally controlled from a pilot house 18 having a conventional speed control 20 connected via an air conduit 22 to a conventional air pressure controller 24 to an engine speed governor 26. The governor 26 may be, for example, a Woodward UG 8 governor manufactured by Woodward Governor Nederland B.V. of Hoofddorp, The Netherlands and forms no part of the present invention. The governor 26 may also be manually controlled within the engine room by means of a conventional mechanical actuator 28.

110 The engine 10 is provided with a hydro mechanical sensor apparatus 30 of the type available from Caterpillar Tractor Co., as part No. 3N5760. The sensor apparatus 30 will typically monitor the oil pressure of the engine 10, the water temperature in its cooling system, and sense any overspeed condition of the engine 10. When any one of the foregoing parameters reaches an undesirable level, the sensor shutoff apparatus 30 will provide to a conduit 32, a high pressure, hydraulic signal.

125 The conduit 32 extends to a multiple input, single output, mechanical actuator 34 which, as will be seen, includes a mechanical output which may bear against the conventional shutdown rod of the governor 26, when actuated, to cause the latter to shut off the engine 10.

The pilot house includes a manual control 36 which, when actuated, is adapted to send a high air pressure signal via a conduit 38 to the actuator 34 to achieve the same function.

5 In addition, electrical sensors, shown schematically at 40, may be connected to the actuator 34 and may monitor any of a variety of functions and provide an electrical signal to the actuator 34 in appropriate cases to cause
10 shutdown.

In some cases, the manual control 36, which relies upon air pressure, may be omitted entirely and, in such a case, it is desirable to provide a further manual control 42 in the
15 pilot house 18 which can be actuated to engage the shutdown rod of the governor 26 to disable the engine 10. Alternatively, the additional manual control 42 may be utilized as a backup for the manual control 36 to be
20 used in the event of loss of air pressure.

The manual control 42 is connected to the actuator 34 via a flexible cable 44 and is operative to cause engine shutdown in a manner to be described in greater detail hereinafter.

25 Within the engine room 12, there is also provided a manual actuator 46 for the actuator 34 for causing shutdown of the engine 10 via manual intervention when such shutdown is desired.

30 Turning now to Fig. 2, the actuator 34 will be described in greater detail. The governor 26 is provided with an upper cover 50 having a threaded bore 52 therein in alignment with
35 the conventional governor shutdown rod 54. A threaded collar 56 on the base of the actuator 34 is threaded into the opening 52 such that an actuator rod 58 mounted for reciprocation within a guide sleeve 59 can
40 engage the shutdown rod 54 and drive the same to cause the governor 26 to shut down the engine.

The actuator 34 is comprised of a housing defined by a plurality of cup-shaped housing
45 modules 60, 62 and 64. The housing modules 60, 62 and 64 are identical except in the respects hereinafter stated and each includes a base 66 and a peripheral, generally cylindrical wall 68 extending therefrom.

50 Each wall 68, adjacent the base 66, is provided with an external, peripheral relief 70 which will typically be cylindrical in nature and which will have a predetermined axial length. At the same time, the end of each wall
55 68 remote from the base 66 is provided with an internal, peripheral relief 72, also cylindrical, and sized to nestably receive the base 66 of the adjacent housing modules 60, 62 and 64. The axial length of each internal relief 72
60 is greater than the axial length of each external relief 70. As a consequence, at the interface of each module there is a space 74 in fluid communication with the interior of the associated module and bounded by the radially
65 outer extremity of the associated relief 72.

The walls 68 of each of the modules are provided with axially extending vent passages 76 which open to the base 66 of each module and to the internal relief 72 of the
70 same module so that the interior of each module remote from the base 66 is in fluid communication with the vent passages 76 via the spaces 74. While the vent passages 76 are shown as aligned in Fig. 2, it will be
75 appreciated that they need not be.

Each of the modules 60-64 is provided with an element 80, 82 and 84, respectively, responsive to a signal. As seen in Fig. 2, the element 80 is an electrical armature, while the
80 elements 82 and 84 are pistons. Each element 80-84 includes an axially extending projection 86 which is slidably received in a bore 88 in the base 66 of the associated module 60-64. Each bore 88 is provided
85 with an annular, radially inwardly opening groove 90 for receipt of an O-ring seal 92 which slidably engages the associated projection 86.

In the case of the module 60, a recess 100
90 is disposed in the interior surface of the wall 68 and receives an electrical coil 102 which is energizable via leads 104. When energized, it will drive the armature 80 downwardly, as seen in Fig. 2. When used in a marine
95 application, as shown in Fig. 1, the electrical leads 104 will be connected to the electrical monitors 40.

The module 62, adjacent its base, includes an inlet port 106 whereby fluid under pressure, specifically, air from the line 38, may be directed to the upper side of the piston 82.
100 The module 64 includes a similar inlet 108 which may be connected to the conduit 34 for receiving hydraulic fluid under pressure from the sensor apparatus 30. In the case of both
105 of the pistons 82 and 84, in response to the application of air pressure or hydraulic pressure, respectively, the pistons 82 and 84 will be driven downwardly, as viewed in Fig. 2.

110 Each of the elements 80, 82 and 84 and its associated projection 86 includes an axially extending through bore 110 which slidably receives a respective one of a plurality of links 112. Each of the links 112 includes an enlarged shoulder 114 which engages the underside of its associated element 80-84 so that relative slidable movement between the link 114 and its associated element 80-84 in one direction can occur, but in the opposite
115 direction is prevented. A perforated spanning washer 118 disposed on a shoulder 120 on the upper surface of the threaded collar 56 guides the rod 58 for reciprocal movement such that an end thereof extends out of the housing defined by
120 the modules and a small return coil spring 122 is interposed between the washer 118 and the underside of the lowermost shoulder 114 to urge the latter into the position illustrated in Fig. 2.

130 It will be seen that the links 112 are coaxial

with each other and in abutment with each other and further are coaxial with the actuator rod 58, with the lowermost link 112 also being in abutment therewith.

5 Each of the bases 66 of the modules 60-64 is provided with an axially opening recess 128 with the recess 128 in the modules 62 and 64 supporting respective, relatively large diameter coil springs 130 which
10 engage the underside of the elements 80 and 82 of the immediately upwardly adjacent module. A similar coil spring 132 is interposed between the washer 118 and the underside of the element 84 and the springs 130 and 132
15 normally urge the elements 80-84 to approximately the position illustrated in Fig. 2, that is, upwardly. Various other seals are employed in the assemblage where indicated and a cup-shaped cap 134 is nested in the exterior relief
20 70 of the uppermost module 60. The cap 134 includes a bore 136 which slidably receives an additional link 138. The cap 134 also mounts a yoke 140 which, in turn, pivotally supports a lever 142.

25 The lever 142 includes a nose 144 in abutment with the upper surface of the additional link 138 and further is normally biased in a clockwise direction by a coil spring 146. The end of the lever 134 remote from the
30 nose 144 is connected to the cable 44 such that when the cable 44 is operated by the control 42 (Fig. 1), the lever 142 will be pivoted in a counterclockwise direction to drive the additional link 138 downwardly into
35 the housing. Preferably, the manual actuator 46 is disposed on the lever 142 in axial alignment with the nose 144 and may be in the form of a knob which can be pushed to similarly drive the additional link 138 into the
40 housing.

Operation of the apparatus is as follows. In the event the sensor apparatus 30 senses an overspeed condition, improper oil pressure, or, undesirable water temperature, it will generate an elevated hydraulic signal which will
45 be conveyed to the module 68 and drive the element 84 downwardly against the bias of the various springs. Because the element 84 is in abutment with the shoulder 114 on its associated link 112, the latter will be moved
50 downwardly to also move the rod 58 downwardly against the shutoff rod 54 to cause the governor 26 to halt the engine 10. During such downward movement, the only force resisting the same will be that provided by the
55 return spring 122 by reason of the fact that the abutment connection between the link 112 associated with the module 64 and the link 112 associated with the module 62 will extend.
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In the case of an air pressure signal generated by the control 36, the element 82 associated with the module 62 will be driven downwardly and due to the presence of the shoulder 114 on the link 112 associated therewith,
65

that link will also be driven downwardly. Because the link 112 associated with the module 62 is in abutment with the link 112 associated with the module 64, the latter will
70 also be driven downwardly to drive the actuator rod 58 and cause shutoff.

Should there be an electrical signal from the electrical monitors 40, the resultant energization of the coil 102 will cause a similar
75 movement, but in this case, all of the links 112 will be moved to cause shutoff.

It will be noted that in none of the cases will movement of the elements 80-84 be resisted by other than their return springs 130
80 and 132 since the undersides of each such element are vented via the spaces 74 and the vent passages 76 which can be vented exteriorly of the housing, in the case illustrated, through the perforated washer 118.

85 In the event manual shutdown is required, the same may be accomplished either by pulling on the cable 44 or by pushing on the knob 46, in which case, the nose 144 of the lever 142 will drive the additional link 138
90 downwardly and that, in turn, will cause all of the links 112 to urge the rod 58 downwardly.

From the foregoing, it will be appreciated that an actuator made according to the invention can receive actuating signals from the
95 same or a variety of different mediums. In the specific form illustrated in Fig. 2, four different mediums of signals have been utilized including mechanical force applied through the lever 142, electrical signals applied
100 through the coil 102, pneumatic signals applied against the piston 82, and hydraulic signals applied against the piston 84.

It will also be appreciated that by reason of the modular construction of the actuator, as
105 many of the modules 60-64 as are required for any given number of signal inputs may be stacked in nested relation, as illustrated, so that a wide variety of actuators having different capacities can be formed of but essentially two different types of modules, one
110 electric and one fluid actuated.

Finally, it will be appreciated that in a control system such as that described, use of actuator allows shutdown of a governor in any
115 of a wide variety of different types of mechanical or electrical failure and combinations thereof, thereby providing a highly adaptable and extremely reliable control system.

120 CLAIMS

1. A multiple input, single output actuator comprising a plurality of modules mounted end to end in series; each module containing a signal responsive element slidable between
125 the ends of the module, a signal input means for enabling a signal to be directed to the signal responsive element to cause the element to move towards one end of the series of modules, a link extending slidably through
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125 the ends of the module, a signal input means for enabling a signal to be directed to the signal responsive element to cause the element to move towards one end of the series of modules, a link extending slidably through
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end extending out of one end of the module and stop means abutting one side of the signal responsive element, the links of adjacent modules abutting each other; and an actuator rod coupled with the link in the module at the one end of the series of modules, whereby on actuation of any of the signal responsive elements movement of the actuator rod is caused, corresponding to the displacement of the signal responsive element having the greatest displacement.

2. An actuator according to claim 1, wherein the housing modules are cup-shaped and the modules nest with one another.

3. An actuator according to claim 1 or claim 2, in which each module includes a biasing spring acting on the signal responsive element to bias the element to the other end of the series of modules.

4. An actuator according to any one of claims 1 to 3, wherein the signal responsive elements each comprise a piston having an extension on one side slidably received in a bore in a first end of the corresponding module, the associated link being slidably received in a bore in the piston and its extension, a seal being disposed at the interface of the first bore and the piston extension.

5. An actuator according to claims 3 and 4, wherein each biasing spring comprises at least one coil spring engaging the signal responsive element on the opposite side to the extension, the spring abutting the first end of an adjacent module.

6. An actuator according to claim 2, wherein each module has a base and a peripheral wall, the wall, adjacent the base, having an external peripheral relief of a first axial length, and remote from the base having an internal peripheral relief of a second axial length greater than the first axial length and nestably receiving the base of an adjacent module, and axially extending vent passages in the walls of the modules opening to the internal peripheral reliefs and the bases, the differing axial lengths of the reliefs establishing spaces in fluid communication with the interiors of the modules and with the vent passages.

7. An actuator according to any one of claims 1 to 6, wherein at least one of the signal responsive elements is an electro-magnetic armature and the corresponding signal input means comprises a coil.

8. An actuator according to any one of claims 1 to 7, wherein at least one of the signal responsive elements is a spring-biased piston, and the corresponding signal input means comprises a fluid receiving port in communication with the piston.

9. An actuator according to any one of claims 1 to 8, further including an additional link coaxial with the other links and extending from the other end of the series of modules, the additional link being adapted to receive an

actuating force externally of the modules to cause movement of the actuator rod.

10. An actuator according to claim 1, substantially as described with reference to the accompanying drawings.

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