April 3, 1962 O. G. LEWIS 3,027,723

INTERLOCKING CONTROL SYSTEM

Filed July 8, 1960

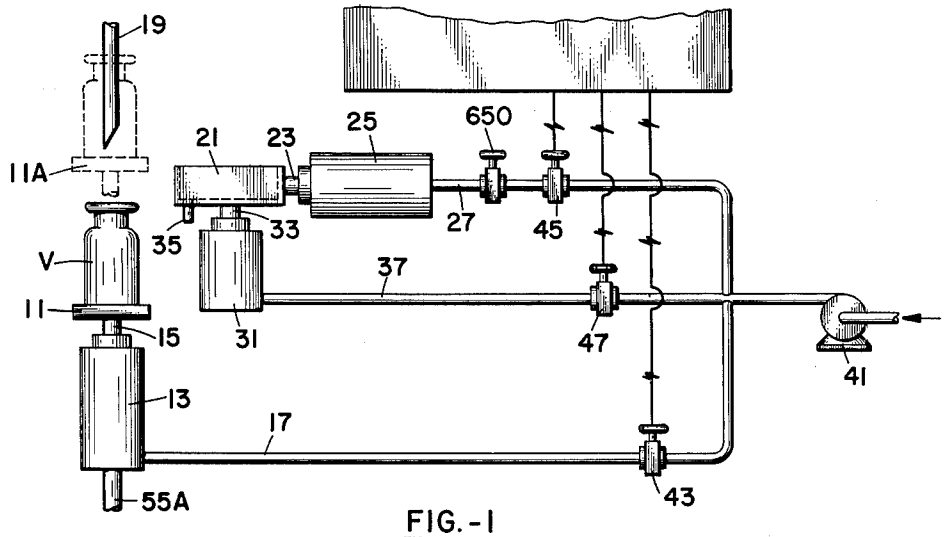


FIG.-1

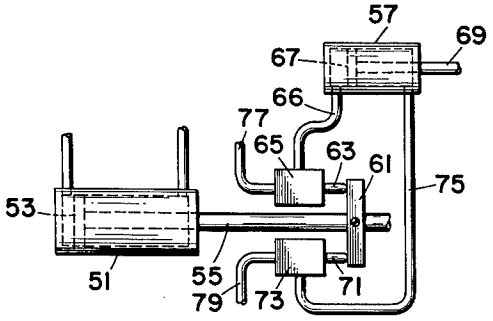


FIG.-2

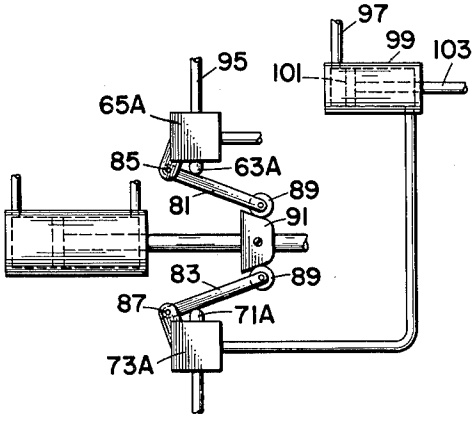


FIG.-3

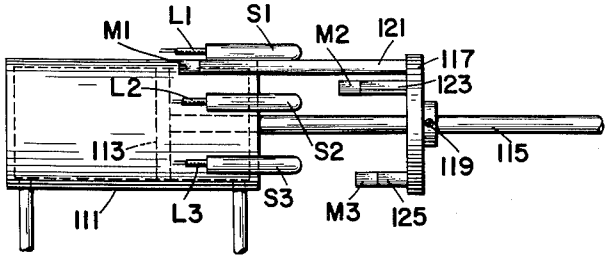


FIG.-4

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United States Patent Office 3,027,723 Patented Apr. 3, 1962

3,027,723

INTERLOCKING CONTROL SYSTEM

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Filed July 8, 1960, Ser. No. 41,646
2 Claims. (Cl. 60—97)

The present invention relates to an interlocking control system and more particularly to an apparatus for interlocking a plurality of operations to insure proper operating sequence. The invention has various applications and in general can be used in connection with a plurality of reciprocating or oscillating elements, particularly where it is desirable to prevent one operation occurring until after a related operation has been completed or has passed a critical phase. A more particular application of the present invention is related to apparatus of a general type which is used in carrying out a sequence of operations for testing or analytical purposes; for example, an apparatus which is designed to take a series of samples of lubricating oil, measure their viscosity, record the measurements and reuse the testing equipment, with appropriate washing or cleaning between operations, to repeat this type of test any desired number of times.

In one apparatus of this type, a container of the oil to be sampled is brought to a certain point in a conveyor system, is then lifted to a sampling position where a sample of oil is withdrawn therefrom by a sampling unit and tested, and after the test is completed the sample moves on down the line to a place where the analysis is recorded on the sample container. Such a system operates to prevent mis-application of data since it insures that each sample has recorded thereon its proper reading. Thereafter the sampling unit is drained into a receiver which is moved into the position just vacated by the container, the timing being such as to prevent interference but also to prevent spillage of the oil.

In a preferred type of operation, the various sequential operations are performed by fluid pressure, i.e., by hydraulically or pneumatically operated pistons with suitable control elements which may be either mechanical valves or electrical controls. The particular nature of the invention will be better understood by referring to the accompanying drawing in which:

FIG. 1 is a fragmentary view in elevation of an automatic viscometer system involving fluid pressure or hydraulically operated pistons with an interlocking control system according to the present invention;

FIG. 2 shows a preferred form of interlocking control for the assemblies of the system in FIG. 1;

FIG. 3 shows an alternative interlocking control system; and

FIG. 4 shows an electrically operated interlocking control system which can be used in place of those previously illustrated.

Referring first to FIG. 1, for background the general apparatus will first be described. A conveyor, not shown, brings an open vessel V containing oil or other material to be sampled to a position above a platform **11** which is operated through fluid pressure by a piston in cylinder **13** connected by piston rod **15** to the member **11**. Suitable pressure fluid, e.g., hydraulic, is supplied through line **17** so that at the proper instant the platform **11** is raised to bring the vessel up to a point where it encloses the sampling nozzle **19**. The latter is connected to means, not shown, for drawing a sample of the liquid upwardly, passing it through a viscosity testing operation, and thereafter returning the bulk of the sample to the vessel. The raised position of the platform is indicated in dotted lines at **11A**.

After the oil in nozzle **19** has been returned to the container except for a small dripping residue, platform **11** is lowered to its original or extreme bottom position. Thereafter a drain pan **21** is shifted about a vertical axis, moving to the left in FIG. 1, by piston rod **23** which is disposed to bear upon but is not fixedly connected to the drain pan. This piston rod is actuated by a piston in the fluid pressure cylinder **25**. The latter is supplied by suitable operating fluid which may be hydraulic, for example, through line **27**. This drain pan **21** catches the drainings from tube **19**. The height of the drain pan **21** is determined by a piston in cylinder **31** connected by piston rod **33** to the pan **21** which can rotate about this support. Thus the pan **21** may be raised and lowered as well as moved into or out of position beneath sampling device **19**. A drain **35** connected to a suitable disposal point by means of a tube, not shown, takes care of the drainings. The container is then taken on to another station, not shown.

The piston rod **33** is operated by suitable means, e.g., hydraulic fluid supplied through line **37** as will be obvious.

Means for supplying actuating fluid under pressure are indicated in the form of a pump of any suitable type at **41**, primary control being through solenoid operated valves **43**, **45** and **47** in lines **17**, **27** and **37** respectively. These valves, however, may not close completely or on exact time schedule; moreover, there is frequently a certain amount of resilience or bounce in the pressure system so that closely timed sequences are hard to achieve. However, certain safety features are required.

From the foregoing it will be clear that there must be not only proper sequential operation, but also positive prevention of untimely operation of the pistons or piston rods such as **15**, **23** and **33**.

Referring now to FIG. 2, there is shown a fluid pressure cylinder **51** having therein a movable piston **53** which operates a piston rod **55**. This cylinder **51** may correspond with cylinder **13** and may, if desired, be identical therewith so that piston rod **55** of FIG. 2 is in fact an extension **55A** of the piston rod **15** in FIG. 1. A suitable hydraulic or pneumatic motor unit indicated at **57** may be the operator for a control valve such as valve **45** in line **27** of FIG. 1. This unit **57** in one form corresponds to hydraulic cylinder **25** and its piston, FIG. 1. The rod **55** of FIG. 2 is provided with a cross-head member **61** which at the appropriate moments contacts a plurality of control plungers **63**, **71**. Plunger **63** controls a block valve **65** which is connected through line **66** to the valve or operating motor **57**. In practice, valve **65** preferably would be inserted in line **27** between electrically controlled valve **45** and hydraulic cylinder **25**, FIG. 1. This is indicated diagrammatically at **650**, FIG. 1. Now if pressure of pump **41** should inadvertently be applied to line **27** (and line **77**, (FIG. 2, which connects therewith), before piston rod **15** (and the vessel V) have reached extreme low position, valve **65** will positively block pressure to cylinder **57** and prevent movement of piston **67**. The unit comprising cylinder **57** and piston **67** has a reciprocal operating rod **69** which may be connected through means not shown to initiate opening of control valve **45** to cause the next sequential operation in the principal apparatus. At the approximate time the cross-head **61** will contact the other control plunger **71** in the second valve element **73** to permit the operating fluid to flow out of cylinder **57** through line **75** at the proper time, but prevents outflow of fluid from the cylinder prior to such proper time and cooperates with valve **65** to prevent movement of piston **67** in either direction except at the precise time desired. In these operating controls, the operating fluid is brought in through line **77** and passes out through line **79** in the sequence just described.

When the cross-head **61** moves away to the right, the

plungers 63 and 71 are moved also to the right by springs, not shown, to close valves 65 and 73 and this locks the piston 67 in a fixed position. Thus, valves 65 and 73 may be used as locks to prevent any possible misoperation of piston 67 unless and until the rod 55 has reached its proper position. The arrangement of cylinder 13 in vertical position in FIG. 1 and of cylinder 51 in horizontal position in FIG. 2 is of course optional.

A similar arrangement is shown in FIG. 3, except that the valves 65A and 73A have plungers 63A and 71A operated by rocker arms 81 and 83 respectively. Each of these arms has a pivotal mount 85 on valve 65A, or 87 on valve 73A, and each has a cam following roller 89 on its opposite end. A cross-head member 91 has suitable cam-like surfaces on its upper and lower ends which serve to operate the rollers 89 and actuate the valves in obvious manner.

Valve 65A connects through line 95 to line 97 of the master control valve operating motor 99. The latter contains a piston 101 which operates a control rod 103 and the latter is connected to a suitable valve such as 45 or 47 to control operation in the proper time sequence. The unit 99, 101 may of course replace the motor unit 25, or unit 31 of FIG. 1 if desired.

Referring now to FIG. 4, there is shown an electrical system combined with a pneumatic or hydraulic cylinder and piston for accomplishing desired sequential controls for similar purposes. Here a cylinder 111 is provided with movable piston 113 which operates piston rod 115. The latter has mounted thereon a plate or disc member 117 which may be adjustably positioned along the rod 115 by suitable fastening means such as a set screw 119. The plate or disc 117 carries a plurality of arms of different length indicated at 121, 123 and 125 respectively. Each of these carries a small active magnet M1, M2 or M3.

Mounted on the cylinder 111 in such position as to be operated by the respective magnets are a plurality of magnetically operable reed switches of known commercial type. These are spark-proof, being enclosed in glass or other suitable tubing to avoid fire or explosion hazards in the presence of highly combustible materials. Switch S1 is in position to be operated by magnet M1 as the piston 113 moves to the extreme right and the plate or disc 117 is in its farthest position from the cylinder 111. This switch S1 is connected by electrical leads L1 to a first control circuit not shown, but for example, may be the circuit which operates solenoid valve 43 in FIG. 1. Subsequently as the piston 113 moves to the left, magnet M2 approaches switch S2 and activates a second circuit which may, for example, be connected to solenoid operated valve 45 of FIG. 1 through leads L2. Finally, the switch S3 is approached by magnet M3 when piston rod 115 is fully retracted, and at the proper instant this operates the reed switch to activate a circuit through leads L3 to initiate a third operation, for example, the operation of solenoid valve 47 of FIG. 1.

Obviously by varying the lengths of the bars 121, 123 and 125 or the positioning of switches S1, S2 and S3, any desired time sequence may be obtained. The plate or disc 117 may be mounted on one of the operating piston rods of the system such as rod 55A of FIG. 1 as will be obvious to those skilled in the art.

It is realized of course that numerous interlocking control systems have been devised for many purposes in the past, but the system above described is completely safe, is very simple, and makes use of necessary operating elements of the system to be controlled so that it requires a bare minimum of additional elements to place effective interlocking controls over the whole sequence of operations. All the operations may be performed by hydraulic pressure fluid, or by pneumatic fluid, or by a combination of the two. Electrical solenoid operations, suitably dampened by fluid control means or equivalent may be substituted where appropriate.

It will also be understood that while the invention has been described in connection with a particular use or application, it also has other uses and applications of various types which will suggest themselves to those skilled in the art. It is therefore intended to cover the application broadly of this control system, as far as permissible by the prior art and the scope of the following claims.

What is claimed is:

1. In a system containing a plurality of cyclically operable fluid pressure operated pistons for performing separate operations in a desired sequence and a fluid pressure line for supplying operating hydraulic fluid to each of said pistons, the improvement which consists in (1) first actuating means moved by a first one of said pistons, (2) first control means in the path of said first actuating means to be actuated thereby in proper timed relation to the travel of said first piston, said first control means including an electric switch and magnet operating means therefor which are moved relatively to each other by movement of said first piston to cause said first control means to function at the desired time and in the desired sequence, and said first control means being connected in said fluid pressure line for positively preventing movement of at least a second piston before said first piston has reached a predetermined position in its operating cycle, and (3) second control means for operating said second piston when such predetermined position of said first piston is reached.

2. The improvement according to claim 1 in which said electric switch is a glass-enclosed reed switch, and said magnet operating means therefor is disposed to be moved back and forth with respect thereto in line with motion of said first piston.

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