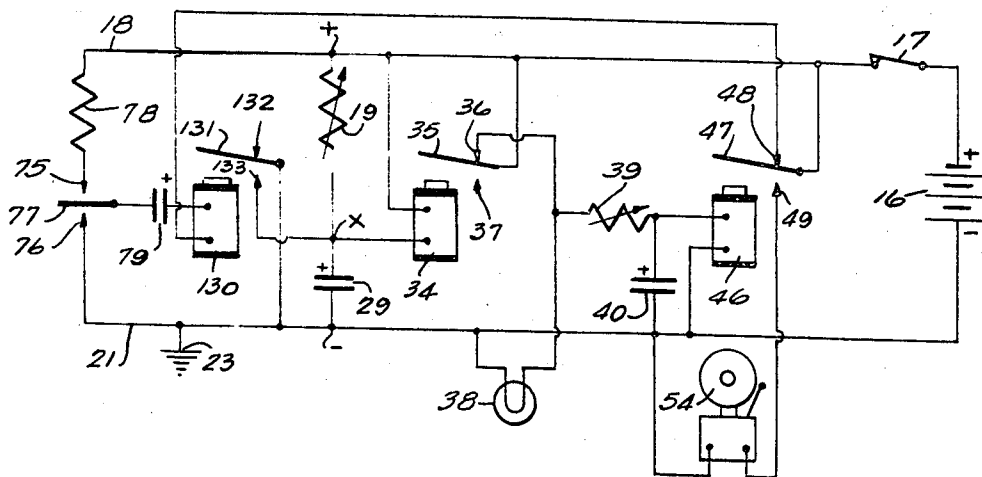


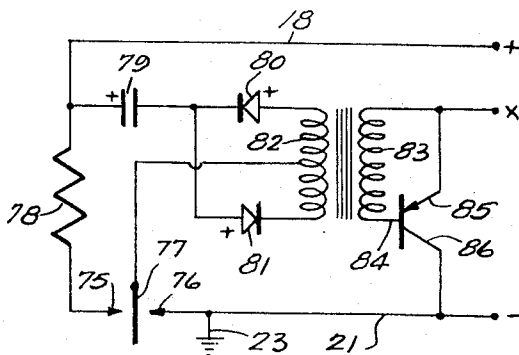
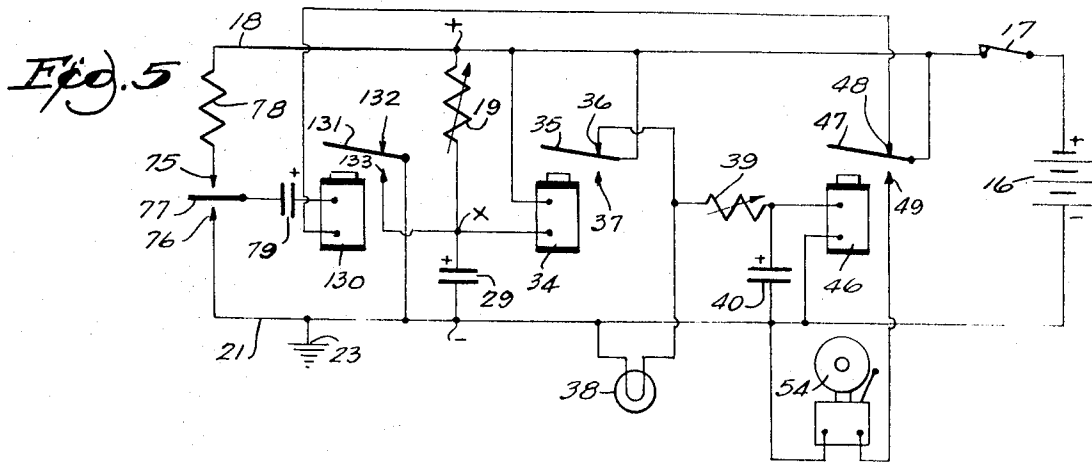
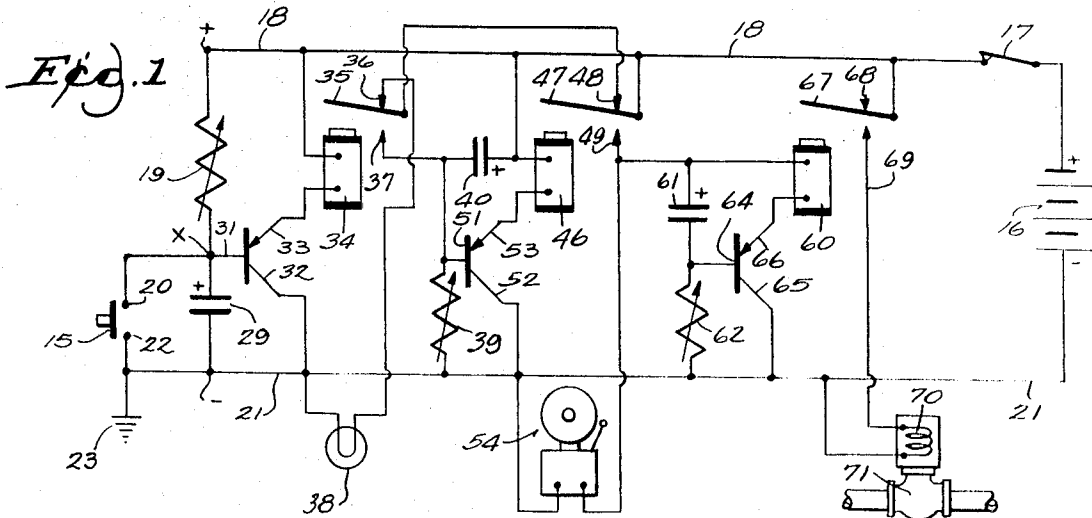
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 [21] Appl. No. **845,654**
 [22] Filed **July 9, 1969**
 [45] Patented **June 28, 1971**
 Continuation of application Ser. No.
 477,115, Aug. 10, 1965, now abandoned.

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 Primary Examiner—John W. Caldwell
 Assistant Examiner—David L. Trafton
 Attorney—Wheeler, House & Wheeler

[54] **SYSTEM FOR SUPERVISION OF OPERATION OF A MACHINE**
 11 Claims, 13 Drawing Figs.
 [52] U.S. Cl. 340/267,
 200/61.54, 317/141, 340/271, 340/279
 [51] Int. Cl. G08b 21/00
 [50] Field of Search 340/271,
 279, 213, 267, 309.4; 317/141 (X), 142

ABSTRACT: A switch comprising a center contact frictionally carried on a reversibly moving part and a pair of spaced side contacts is connected to a capacitor to produce a charging or discharging pulse only upon reversal of the part. Circuits actuated by the pulse include various signalling and control functions and may include transistor amplifiers, timing circuits, relays, and a diode network feeding a transformer with the base-emitter circuit of a transistor across the secondary.





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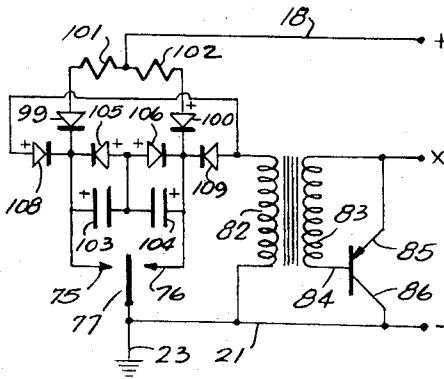


Fig. 3

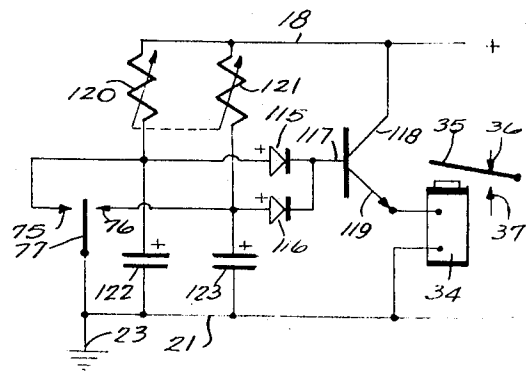


Fig. 4

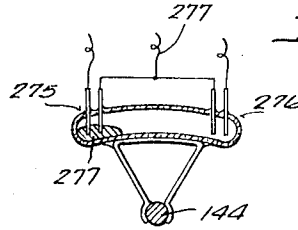


Fig. 13

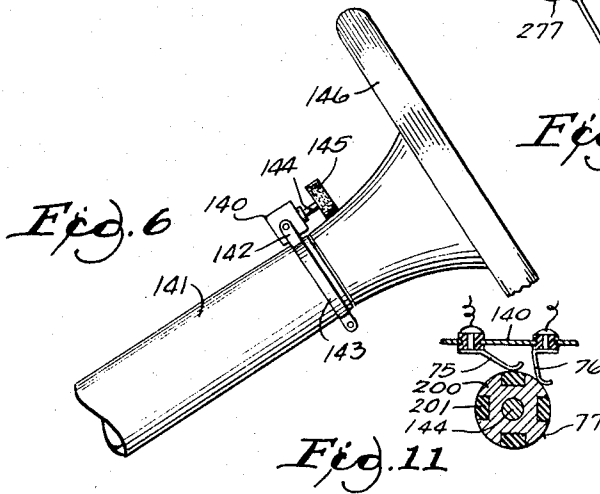


Fig. 6

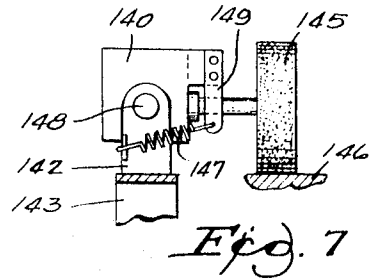


Fig. 7

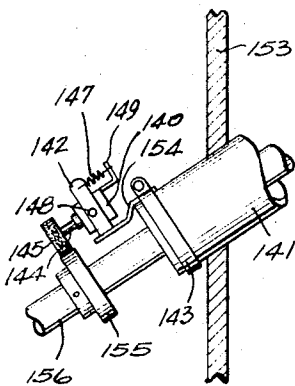


Fig. 9

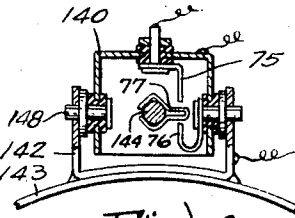


Fig. 8

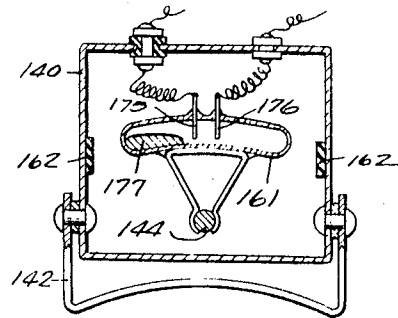


Fig. 12

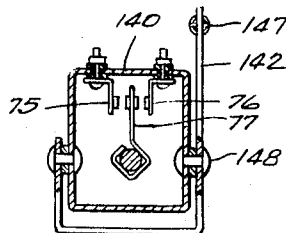


Fig. 10

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SYSTEM FOR SUPERVISION OF OPERATION OF A MACHINE

This application is a continuation of Ser. No. 477,115 filed Aug. 10, 1965.

This invention relates to means for insuring alertness of the operator of any machine requiring constant supervision to assure proper operation of the machine.

Various machines must be voluntarily controlled under monotonous conditions, for extended lengths of time or under other conditions militating against alertness of the operator, and failure of the operator to remain alert may be dangerous to him or to the machine or both. Other machines must operate in an invariable rhythm not subject to the will of a person, e.g. a heart pacemaker, or a lung assistance machine, and with the least possibility of change in rhythm. If a system is provided which requires the machine operator to perform some action within a given time and at intervals to avoid operation of a signal, alarm or means for stopping or otherwise affecting the machine, the repetition of such act will aid in keeping the operator alert. In the case of a machine requiring constant voluntary correction of some machine function such as the steering of an automobile, the operation of the system can be made automatically responsive to such function. The sequence of operations which should be followed by the machine, whether the control is voluntary or involuntary, is referred to as the program.

More persons are concerned with driving an automobile than operation of any other single machine and the invention will therefore be described in connection therewith. In driving an automobile it is found that there are few lengths of highway or street where it is unnecessary to turn the steering wheel voluntarily to the right or the left by small amounts to keep in the desired path of the automobile movement. It has been found that there is enough alternation in direction of turning the steering wheel so that a system as described below, can be made responsive to the turning of such wheel.

In its simplest form, the system comprises a first subcircuit which includes a source of direct electric current, a capacitor and a variable resistor for adjusting the rate of charging of the capacitor from said source, a control or sensing switch in parallel with the capacitor for voluntary charge or discharge of the same, and electrical means for operating a signal or otherwise affecting operation of the machine unless the capacitor is periodically charged or discharged by operation of the control switch. Such electrical means may be devices controlling the voltage in a relay coil and having a movable contact controlling relay closure of a current supply circuit to the signal or to brake operating means or the like. The switching portion for the control circuit may be under the action of a manually operated switch, a switch automatically responsive to voluntary action of the operator in correcting some function of the device, or a switch automatically responsive to some involuntary action such as a heart beat when the device is used, for example, in operating a pacemaker controlling the rhythm of a heart beat.

Such control subcircuit is in command of one or more subcircuits by which a signal or means affecting some function of the machine are actuated. Whenever it is possible to use semiconductor devices such as transistors and diodes in the control circuit to determine the flow of current in the second or actuating subcircuits it is desirable to do so because of increased reliability. Each actuating subcircuit includes a variable resistor controlling the rate of charge and discharge of a capacitor which in turn controls the flow of current through the semiconductor device to the coil of a relay. The relay controls a signal, or an alarm, or some other means affecting the machine, and all of which are herein considered equivalents, and may include a second contact which controls another actuating circuit by controlling the flow of current through semiconductor devices in such other circuit. FIG. 1 shows a control circuit and three actuating subcircuits respectively causing actuation of a visible signal, an audible alarm, and a valve controlling fluid pressure operated braking or other equipment on an automobile.

For making the present system automatically responsive to some voluntarily corrected action as in the case of steering an automobile, the manually operable switch is replaced by a sensing switch producing current impulses as steering action swings a movable switch contact between two fixed contacts. Such current impulses replace the periodic pushbutton actuation previously required. Security against malfunction of the sensing switch is provided if the fixed contacts of the sensing switch are connected to a current-impulse energized transformer primary winding through circuits controlling the flow of current to such winding (or the transformer may be entirely eliminated). When the control circuit is to be made as reliable as possible, diodes are used in the circuits of the transistors and the transformer primary winding to control direction of flow of current impulses. Although the single capacitors cause flow of current in a transistor as shown in FIG. 1 or a combination of a capacitor and transformer as shown in FIG. 2, there is more reliability if two capacitors are provided with a number of diodes in circuit with a midtapped fixed resistor or in circuit with two capacitors and two mechanically interconnected resistors as shown in FIG. 4. If conditions of use prevent employment of semiconductors such as transistors and diodes, the sensing switch may directly control actuation of the relay for the signals as shown in FIG. 5.

In the drawings:

FIG. 1 is a diagram showing the present system adapted for operator actuation of a pushbutton completing a control circuit and with three actuating subcircuits severally including a visible signal, an audible alarm and a fluid pressure control valve as equivalent machine control means.

FIG. 2 is a diagram showing a control subcircuit substituted for the pushbutton when a condition of the machine automatically controls the system, and in which current impulses are generated in a transformer and diodes are used in the transformer primary winding lead.

FIG. 3 is a control circuit using a midtapped fixed resistor to charge plural capacitors having plural diodes in their leads to control current flow.

FIG. 4 is a control circuit diagram of means employing variable resistors and plural capacitors and plural diodes to reduce the possibility of malfunction of the transformer shown in FIG. 2.

FIG. 5 is a circuit diagram eliminating the transformer of FIGS. 2 and 3 and all semiconductor devices, if the system is to be used beyond the range of conditions suitable for semiconductors.

FIG. 6 is a side elevation of a sensing switch coacting with the steering wheel of an automobile.

FIG. 7 is an enlarged elevational view of the sensing switch shown in FIG. 6.

FIG. 8 is a transverse cross section of the sensing switch shown in FIGS. 6 and 7.

FIG. 9 is a side elevation of a sensing switch mounted on the steering column and coacting with the steering post in an automobile.

FIG. 10 is a transverse cross section of the sensing switch shown in FIG. 9.

FIG. 11 is an end view of a segmented rotor-type of movable contact and leaf spring fixed contacts as a substitute for the contacts of FIGS. 8 and 10.

FIG. 12 is a transverse cross section of a mercury-type switch which may be mounted as shown in FIGS. 6—10, but will perform like the pushbutton of FIG. 1, and

FIG. 13 is a fragment of a mercury-type switch similar to FIG. 11, but with contacts similar to those of FIGS. 6—10.

Referring to the drawings by numbered parts, in FIG. 1 a control switch 15 is shown as being a manually operated pushbutton but such switch may be of any type actuated responsive to elapsed time, direction of rotation of a vehicle steering wheel or direction of movement of a vehicle as a whole or any other factor related to the control and operation of any machine which must be kept under constant supervision by an attendant. A source of direct current electric power is shown

as a storage battery 16 with its positive terminal connected by way of a disconnecting switch 17 with a positive power line 18 connected by a control circuit resistor 19 with one terminal 20 of the switch. The negative terminal of the battery 16 is connected by negative power line 21 with the negative terminal 22 of the switch and the negative power line is grounded at 23. Three terminals adjacent switch 15 are marked plus, X and minus and substitute control as shown in FIGS. 2-4 are to be connected at such terminals in place of pushbutton 15, 29, 22. A control circuit electrical capacitor 29 is connected in parallel with the switch 15, the capacitor positive plate being connected between the switch terminal 20 and resistor 19 and the negative plate of the capacitor 29 is being connected with negative power line 21. A modified control circuit is shown in FIG. 5 in which the resistor is fixed and numbered 19 while the capacitor is numbered 29. In both instances, however, the resistor regulates the rate of charging of the capacitor and the capacitor is discharged by the use of a switch.

The positive plate of capacitor 29 is also connected in parallel with the base terminal 31 of a first transistor which is part of a first signal actuating subcircuit. The transistor collector terminal 32 is connected with the negative power line 21 and the transistor emitter terminal 33 is connected with the coil 34 of a first relay having its other coil terminal connected with the positive power line 18. Relay coil 34 actuates a movable contact 35 normally biased against a fixed contact 36 of the relay and such movable contact 35 swings against a relay fixed contact 37 when the relay coil is energized. Relay fixed contact 37 is connected through a resistor and a capacitor with another relay and controls energization of a second signal actuating subcircuit to be described. As many actuating circuits may be used in sequence as desired, up to the limit of power available in battery 16.

Relay fixed contact 36 is connected with one terminal of a visual signal 38 and through the signal to the negative power line 21, and relay fixed contact 37 is connected through second variable resistor 39 with the negative power line 21. Parts 31-36 and 37 form a first signal actuating unit in which the signal 38 is energized so long as the first relay coil 34 is not energized sufficiently to draw movable contact 35 away from the fixed contact 36.

Relay fixed contact 37 is also connected through a second electrical capacitor 40 with one terminal of the coil 46 of a second relay, the positive plate of the capacitor 40 being connected to one terminal of the relay coil 46 and with the positive power line 18. The second relay also includes a movable contact 47 connected with positive power line 18 and a fixed contact 48 connected with the first relay movable contact 35, and a fixed contact 49. The base terminal 51 of a second transistor is connected between the first relay fixed contact 37 and second variable resistor 39 and the second transistor collector terminal 52 is connected to the negative power line 21. The second transistor emitter terminal 53 is connected with the other terminal of the second relay coil 46. The second fixed relay contact 49 is also connected with one terminal of an audible signal 54 having its other terminal connected with the negative power line 21 and contact 49 is also connected with one terminal of the coil 60 of a third relay. Parts 39-46 and 51-53 provide a second actuating subcircuit for audible signal 54 which is energized only as visible signal 38 is deenergized.

A third signal actuating subcircuit in which a third electrical capacitor 61 is connected with the second relay fixed terminal 49 and with a third variable resistor 62 having its other terminal connected to the negative power line 21. The base terminal 64 of a third transistor is connected between capacitor 61 and resistor 62, while the collector terminal 65 of such transistor is connected with the negative power line 21, and the emitter terminal 66 is connected with one terminal of a third relay coil 60. The third relay movable contact 67 is biased against fixed stop 68, and is connected with the positive power line 18. A fixed contact 69 of the third relay is connected with one terminal of a solenoid 70 for opening a valve

indicated at 71. The valve is used in controlling fluid pressure to operate means such as the braking system of an automobile. It will be obvious that the present system includes subcircuit units severally operating visual and audible signals and a fluid pressure control valve and that all of them may be used in combinations of all three or any two of the three devices, and that any one of such devices may be used alone.

In use, the visible signal 38 of FIG. 1 is deenergized so long as the machine operator is fully alert and periodically presses the pushbutton, and is energized if the operator fails to press button 15 at given time intervals. Thus it will be apparent to both the machine operator and his passengers that the operator has failed to carry out his instructions. The invention has been applied to automobiles but could be used equally well with any machine requiring constant supervision and therefore alertness of the operator. Assuming that disconnect switch 17 is closed, the circuit is controlled by operator pressure on pushbutton 15, which periodically discharges capacitor 29 so that the capacitor momentarily energizes relay coil 34. The above condition is attained because transistor 31-33 is connected in a known "common collector configuration" so that, even though there is large current gain, the voltage at the transistor base terminal 31 and the emitter terminal 33 remain substantially equal to that on the positive plate of the capacitor 29. However, when the pushbutton 15 engages its contacts 20-22; it discharges capacitor 29 and the full supply source voltage is applied through transistor 31-33 to first relay coil 34 which draws movable relay contact 35 against contact 37 and cuts off visual signal 38.

When pushbutton 15 is released, the capacitor 29 recharges from lines 18, 21 at a rate controlled by the variable resistor 19. Transistor 31-33 also has voltage applied to the base terminal 31 which causes the emitter terminal 33 to become more positive and decreases the voltage across the relay coil 34. Current flow through the coil is now not sufficient to hold the relay movable contact 35 on fixed contact 37 and movable contact 35 reengages fixed contact 36. A circuit is then completed through the first relay fixed contact 36 and the first relay movable contact 35 to a second relay movable contact 47 and fixed contact 48 from the positive power line 21.

When the first movable contact 35 engages fixed contact 37, capacitor 40 can discharge (to the circuit 47, 48, 35, 37) to bring the second transistor base terminal 51 and the emitter terminal 53 to substantially equal voltage on the terminals of the relay coil 46 and such relay does not swing its movable contact 47 from the position shown. As relay contact 35 is now off contact 37, the negative plate of capacitor 40 now becomes increasingly negative through resistor 39. Both the transistor base terminal 51 and the emitter terminal 53 become more negative and the voltage across the relay coil 46 increases until such coil swings its movable contact 47 onto its fixed contact 49 which completes a circuit to the audible signal 54. There is now no circuit through capacitor 40 even if pushbutton 50 is again actuated and there can be no unintentional resetting of the circuit for the audible signal 51 after it has commenced operation.

Closure of contact 47 on contact 49, has also applied power to coil 60 of a third relay, but the voltage at the third transistor base terminal 64 at the instant of circuit energization is equal to the voltage at the second relay contact 49, because capacitor 61 has discharged and the third relay 60, 67-69 is now inoperative. Such inoperativeness continues until capacitor 61 has become sufficiently negative to make the voltage of third transistor base terminal 64 and its emitter terminal 66 sufficiently negative to cause flow of current across the relay coil 60, which draws its movable contact 67 against fixed contact 69 to close a circuit for energizing the solenoid 70 and opening the valve 71. Thus a third actuating circuit unit is provided and it will be obvious from above that any number of actuating circuits may be used dependent on the power furnished by battery 16.

FIG. 2 illustrates a control circuit portion replacing the manual control switch 15 by a switch for automatically sensing

the direction of movement of an object such as an automobile steering wheel or its post, which is constantly turned left or right by small amounts to correct the course of an automobile. The subcircuit of FIG. 2 may replace that portion of the circuit of FIG. 1 to the left of circuit junctions marked plus, X and minus in FIG. 1, by connection at such circuit junctions, as marked in FIG. 2 by the above symbols. The sensing switch comprises two fixed contacts 75, 76 and a movable contact 77, the mechanical structure of the switch being described below. Fixed contact 75 is connected through a first fixed resistor 78 with positive power line 18 and with fourth capacitor 79 having one plate connected with diode 80 and diode 81 in series as shown to control direction of current flow, with the ends of the primary winding 82 of a transformer having a secondary winding designated 83. The sensing switch has its movable contact 77 connected with the midtap of the transformer primary winding 82. The transformer secondary winding 83 is connected at one end to the circuit junction X and at the other end with base terminal 84 of a fourth transistor. The fourth transistor has its emitter terminal 85 connected to the other end of the transformer secondary winding 83 and its collector terminal 86 connected with the negative power line 21. The transistor 84-86 is normally biased to charge the signal capacitor 29. Upon the occurrence of an impulse in the transformer secondary winding 83, the impulse is transmitted to the base terminal of the transistor and causes the transistor to discharge the signal capacitor 29. Diodes 80 and 81 direct current flow into the transformer primary winding 82 so that both charge and discharge of capacitor 79 generates impulses of proper polarity to operate the transistor.

When the subcircuit of FIG. 2 is substituted in FIG. 1, the chief effect is to substitute for manual switch 15, a sensing switch actuated by some part of the machine which is constantly in motion one way or another as the machine operates. Referring to FIG. 2, the transistor 84-86 discharges first capacitor 29 only when a current impulse acts in the transformer secondary winding 83 between the transistor base terminal 84 and the emitter terminal 85, to cause conduction of current through the transistor for discharging the capacitor. Whenever there is no current pulsation in the transformer secondary winding 83, the voltage between transistor base terminal 84 and emitter terminal 85 are equal and no current can flow through the transistor. A current impulse is produced in the transformer secondary winding 84 only when current flows in either half of the primary winding 82. Such current flow occurs whenever the switch movable contact 77 swings to or from one of fixed contact 75 or 76 to the other. The current impulse in the transformer secondary winding 83 results from steering wheel position changes and the resistor 78 prevents successive current flows if the fixed contacts 75, 76 should be accidentally brought against one another.

In FIG. 3, sensing switch 75-77 and transformer 82, 83 and transistor 84-86 are identical to those shown in FIG. 2, the transformer secondary winding and the transistor connections also being identical with those of FIG. 2 while the transformer primary winding 82 is now connected at one end to the negative power line 21 as is true also of the sensing switch movable contact 77. Sensing switch fixed contacts 75, 76 are now respectively connected through first pair of diodes 99, 100 to the ends of a fixed resistor 101, 102 having its midtap connected with the positive power line 18.

The capacitance required in the control circuit may be provided by two capacitors as shown in FIGS. 3 and 4. A pair of capacitors 103 and 104 are connected across fixed contacts 75, 76 as shown. A second pair of diodes 105, 106 (with their terminals reversed) are also connected between the switch fixed contacts 75, 76 in parallel with capacitors 103, 104 and diodes 105, 106 (or a nonpolarized capacitor of suitable value may be connected across contacts 75, 76 to replace capacitors 103, 104 and diodes 105, 106). Another pair of diodes 108, 109 (with their terminals reversed) is connected by way of diodes 105, 106 to the other end of the transformer primary winding 82.

The control circuit shown in FIG. 3 is connected at the circuit junctions plus, X and minus in place of pushbutton 15 of FIG. 1. Transistor 84-86 discharges the first capacitor 29 only when a current pulse in the transformer secondary winding 83 between transistor terminals 84, 85 causes such transistor to be conductive, the secondary winding 83 otherwise maintaining the transistor base terminal 84 and emitter terminal 85 at substantially the same potential and preventing flow of current through the transistor. The current impulses are generated by current flow through the transformer primary winding 82 when the sensing switch movable contact 77 swings from the fixed contact 75 to the contact 76 or vice versa.

When movable contact 77 touches fixed contact 75, capacitor 104 is charged through resistor 102 and diodes 100, 105. An inconsequential current also flows through resistor 101 and diode 99. When movable contact 77 bears on contact 76, capacitor 103 is charged through resistor 101, and diodes 99, 106 and is thus prepared for recycling while an inconsequential current now also flows through resistor 102 and diode 100. When movable sensing switch contact 77 returns to the fixed contact 75, an impulse is generated as capacitor 103 discharges through contact 75, 77, transformer primary winding 82, diode 109 and capacitor 104. At that time capacitor 104 is recharged through resistor 102, diodes 100 and 105, and contacts 75, 77. Thus a current pulse is produced each time the sensing switch movable contact swings from one fixed contact to another as one or the other of capacitors 103, 104 is always ready to discharge. Between reversals of such switch, diodes 99 and 100 prevent discharge of capacitors 103 and 104 through resistors 101 and 102.

In FIG. 4, sensing switch movable contact 77 is again connected with negative power line 21, but movable contacts 75, 76 are in parallel and are connected through diodes 115 and 116 with base terminal 117 of a transistor of which collector terminal 118 is connected with positive power line 18 and emitter terminal 119 is connected with one terminal of relay coil 34 (also shown in FIG. 1), the relay coil having its other terminal now connected with the negative power line 21. The connections of discharged, the base terminal 117 and emitter terminal 119 are at the potential of the negative power line 21 and the relay coil 34 cannot operate. When either capacitor 122 or 123 is charged positively, diode 115 or 116 will conduct positive potential to the base terminal 117 and the emitter terminal 119, and a voltage difference develops across relay coil 34 equal to the charge of the one of capacitors 122 and 123 which is then more positively charged. Diodes 115 and 116 prevent interaction of capacitors 122 and 123 and also select the more positive of the capacitors for controlling the voltage across the relay coil 34. Relay fixed contacts 46, 47 are now reversed and the subcircuit of FIG. 4 is especially suited for monitoring rapid reversals of the sensing switch.

FIG. 5 shows a system in which reference numerals corresponding to those in FIG. 1 where applicable in FIG. 5. The sensing switch 75-77 has its fixed contact 75 connected through resistor 78 with the positive supply line 18 and its fixed contact 76 connected directly with the negative supply line 21. Movable contact 77 is connected through capacitor 129 with one terminal of relay coil 130 which is connected through relay contacts 47, 48 at its other terminal to line 18. The relay 130 includes movable contact 131 biased against fixed contact 133 when the coil is energized. Movable contact 131 is connected with the negative supply line 21 and the fixed contact 133 is connected between resistor 19 and capacitor 29.

When the movable contact 77 swings to engaged fixed contacts 75, or 76, capacitor 79 is charged or discharged and a current surge occurs in the relay coil 130. If the surge draws movable contacts 131 against fixed contact 133, connection is made from the negative supply line through contacts 131, 133 to resistor 19 and capacitor 29. A capacitor 29 charges, current flows in relay coil 34 and the coil draws its movable contact 35 away from the fixed contact 36 and interrupts the cir-

cuit to visual signal 38. Resistor 39 is connected with fixed relay contact 36 and with one terminal of relay 46, the other terminal of the relay being connected to the negative supply line. Capacitor 40 is connected between the negative supply line and a terminal of the resistor 39. When relay coil 46 is energized it draws movable contact 47 against fixed contact 49 and thus closes circuit of audible signal 54 between positive supply line 18 and negative supply line 21. Thus both signal 38 and alarm 54 are actuated in sequence dependent upon the setting of resistors 19 and 39 and the circuit can not be reset until the disconnecting switch 17 is opened and reclosed again.

FIGS. 6, 7 and 8 show mounting of the sensing switch 75—77 in a case 140 on the steering column 141 or other stationary part of an automobile, by way of a yoke 142 and an adjustable mounting ring 143. An axle 144 is rotatably mounted in the switch casing and has a wheel 145 frictionally engageable with a movable portion of the steering wheel 146 or other automobile part responsive to steering action, for oscillating the sensing switch movable contact 77, frictionally mounted on axle 144, as the steering wheel is oscillated in making minor steering corrections. A spring 147 (see FIG. 7) is connected between one of the pivots 148 of yoke 142 and a bracket 149 on the switch housing 140 for pressing a friction wheel the right and left partial rotations of the steering wheel. Movable contact 77 slips on axle 144 when more force is applied than necessary to make conductive contact with a fixed contact.

FIGS. 9 and 10 show the sensing switch 75—77 mounted ahead of the firewall 153 separating the engine and passenger space of an automobile. The mounting ring 143 now has a bracket 154 integral with yoke 142 and pivots 148 on which switch housing 140 is mounted. A flange 155 is now formed on or fixed to the steering post 156 to transmit steering corrections through the friction wheel 145 to the sensing switch movable contact 77. In FIG. 11, fixed contacts 75, 76 are shown as spring members mounted in insulated relation on housing 140 while movable contact 77 is a conductive rotor 200 with spaced insulation segments 201 for alternate engagement with contacts 75, 76. FIG. 12 shows a sensing switch comprising an arcuate insulation tube 161 mounted on the switch axle 144 to be rocked about the axle centerline as the switch wheel 145 oscillates. Fixed contacts 75 and 76 are now conductors 175, 176 extending into the tube and movable contact 77 is a globule of mercury 177 which rolls from end to end in the tube, and momentarily makes and breaks contact with each of the movable contacts 75 and 76 upon each movement of the mercury from end to end of the tube. Resilient pads 162 are placed on opposite walls on the switch housing 140 to cushion impact of the tube thereof thereon. A conductor from contact 175 is to be connected to the circuit terminal X and a conductor from contact 176 is to be connected to the negative supply line 21. The remaining structure of the switch may be as described in either FIGS. 6, 7 and 8 or 9 and 10. FIG. 13 shows a mercury type of sensing switch frictionally mounted on axle 144 and in which contacts 275 and 276 are at the end of an arcuate-shaped tube with contacts 277 being formed by two members extending into the tube and in the open position being bridged by a globule of mercury. When contact is to be made, for example, by the conductors 275 and 277, the tube is tilted and the mercury flows to engage the ends of contact 275 and the end of the left-hand portion of contact 277.

Generally, the present system indicates or controls the action of a machine by way of a control circuit including a source of direct current with a switch operated manually or automatically responsive to a condition imposed on the machine by the operator's voluntary or involuntary acts in operating the machine. A capacitor, or pair of capacitors, is charged through a resistor which may be variable, and upon discharge the capacitor produces a current impulse in the control circuit. A relay with a coil normally having no voltage difference between its terminals, is activated by the current im-

pulse to energize a circuit actuating a signal, an alarm, means for directly affecting a machine operation or the like.

In FIG. 1, the simplest form of control switch is shown and together with a source of direct current constitutes the whole of the control circuit. Each of the plural signal (alarm or machine control) means has a capacitor charged at a rate dependent on adjustment of the current flow control means herein shown as a variable resistor. Because the plural signals are to be operated in sequence, a relay in each signal circuit coacts with a transistor in determining when potential is to be applied to its associated capacitor. The transistors allow increase of 50—100 times in the period required for charging the respective capacitors, the total elapsed time amounting to as much as 10 minutes. The control switch herein is to be intermittently closed by the operator within a time interval determined by the setting of the first variable resistor.

In FIG. 5, the transistors of FIG. 1 are omitted and the control circuit employs a switch having intermittent reversing movement and connected by way of a capacitor to a relay winding. Each reversal of the control switch charges or discharges the capacitor and momentarily activates the relay. However, when the capacitor is fully charged or discharged, it cannot activate the relay so that vibration of the machine cannot improperly discharge the signal circuit capacitor.

In FIG. 2, the control circuit includes a diode-transformer transistor combination in which the transistor normally charges the first signal circuit capacitor and an impulse in the transformer secondary causes the transistor to discharge the signal capacitor. The diodes so direct current through the transformer primary winding that both charging and discharging impulses from the control circuit capacitor are in proper polarity to actuate the transformer.

In FIG. 3, further current limiting resistors control current flow to individual diodes. Capacitors with a pair of diodes connected therebetween form a nonpolarized capacitor (referred to sometimes herein as 103—106) in place of relatively high capacitance single polarized capacitors previously shown, the diodes bypass all reverse currents around the capacitors. When the control switch closes one of the fixed contacts the nonpolarized capacitor is charged through the respective resistor and diode. When another control switch fixed contact is in use the nonpolarized capacitor discharges through a diode into the primary winding of a transformer. An impulse is thus generated in the transformer secondary winding that causes a transistor associated therewith to discharge the first signal circuit capacitor as previously described. Now another resistor and diode and another fixed contact of the switch come into action and the nonpolarized capacitor is recharged in the reverse polarity, whereupon the above cycle is repeated in a reverse manner. The polarity of the nonpolarized capacitor reverses continuously as above described during the entire operation of the present control system. Two of the diodes employed prevent undesired discharges of the nonpolarized capacitor between resistors of the control switch.

In FIG. 4, a relay is used in the control circuit as shown in FIG. 5, in combination with a transistor control and current flow from the positive pole of the current source through the relay coil to the negative pole, the relay contacts being normally open. The transistor connects the relay coil between the terminals of the direct current source and the base terminal of the transistor is connected by way of diodes to a looped circuit including the two fixed contacts of the control switch and the more positive one of the diodes controls the pairs put on the transformer. A pair of capacitors is connected in parallel between the terminals of the direct current source, through variable current limiting resistors having their adjustable arms connected for simultaneously movement. A signal circuit is again activated by charge to a given level of either one of the capacitors.

The above specific description is an illustration and is not intended to limit the scope of the claims.

I claim:

1. In a system for assuring operation of a machine according to a predetermined program, a control circuit comprising a source of direct current and control switch means operable to a first closed position as long as a part of said machine goes in a first direction and to a second closed position only when said part goes in a second direction, and a signal circuit comprising signal means to be energized, a variable current flow control device connected at one terminal with the current source, a capacitor connected with the other terminal of the current flow device for charging of the capacitor and connected with the control switch means for discharging the capacitor, and means transmitting current flow to the signal means when the capacitor charge reaches a given value, the control switch means being actuated to discharge the capacitor only if a part of the machine reverses direction before the charge reaches a given value, and thus prevent energization of the signal means only if a reversal of said part occurs prior to completion of the predetermined charging time of said capacitor.

2. The system of claim 1 in which the signal circuit has a relay coil and a transistor in circuit with the signal means, the transistor being connected with the capacitor for current flow to the signal means upon charge of the capacitor above a given value.

3. The system of claim 1 in which a switch is placed in the control circuit for opening and reclosing to reset the entire system to an initial condition.

4. The system of claim 1 in which plural signal circuits with separate signal means each have a separate capacitor and a relay for sequential energization of successive signal means with the current source, and means connected with the capacitor and the relay for transmitting current flow to the signal means upon charge of the capacitor above a given value.

5. In a system for assuring operation of a machine according to a predetermined program, a control circuit comprising a source of direct current, a switch intermittently moved to engage different contacts during operation of the machine for opening and closing the control circuit, said switch being adapted to move whenever, and only whenever, a part of the machine reverses direction, a capacitor alternately charged and discharged as the control switch moves, a relay connected with and activated by discharge thereinto of the control circuit capacitor, and a signal circuit comprising signal means to be energized, a capacitor, a variable current flow control device for the capacitor and a relay for energization upon discharge of the control capacitor thereinto and controlling energization of the signal means.

6. The system of claim 5 provided with plural signal circuits each comprising signal means, a capacitor variable current flow means controlling the flow of current to the capacitor and a relay energized upon discharge of the control capacitor thereinto and energizing the signal means, the energization of the relays following in sequence upon discharge of the signal circuit capacitor into the signal circuit relay.

7. In a system for signalling operation of a machine according to a given program, a signal circuit for signalling deviation of machine operation from the given program, and a circuit controlling the signal circuit and comprising a source of direct current, a control switch comprising a pair of alternate circuits, respective control switch actuating means responsive to respective conditions of machine operation to close respective circuits of said alternate circuits through said control switch during operation of the machine, a capacitor connected to be charged by one said alternate circuit and discharged by another said circuit as said control switch actuating means closes the respective circuits of said pair, a transformer having a primary winding connected with a capacitor terminal for receiving an impulse upon capacitor discharging, a pair of oppositely conducting diodes in series with respective ends of the transformer primary winding to limit said impulses to one polarity, and a transistor having two terminals connected respectively with the ends of the transformer secondary winding and a third terminal connected with a pole of the current

source, the said terminals of said transistor comprising a collector, a base, and an emitter, and means effective to actuate said signal circuit upon flow of a predetermined current through said collector and said emitter.

8. In a system for signalling operation of a machine according to a given program, a signal circuit for signalling deviation of machine operation from the given program, and a circuit controlling the signal circuit and comprising a source of direct current, a control switch having fixed contacts and movable contacts and comprising a pair of alternate circuits, respective control switch actuating means responsive to respective conditions of machine operation to close respective circuits of said alternate circuits through said control switch operable intermittently for opening and reclosing different circuits, a nonpolarized capacitor comprising a pair of capacitors, one plate of each capacitor being connected to a plate of like polarity in the other capacitor of said pair and each capacitor having another plate connected with the fixed contacts of the switch and connected through a diode with a current limiting resistor and with a first pole of the current source, a transformer having first and second primary winding terminals, the first primary winding terminal connected with a second pole of the current source, a circuit including a rectifier bridge connecting the second primary winding terminal to said capacitor and said first pole of the current source, and a transistor having two terminals connected respectively with the transformer secondary winding and a third terminal connected with the second pole of the current source, the said terminals of said transistor comprising a collector, a base, and an emitter, and means effective to actuate said signal circuit upon flow of a predetermined current through said collector and said emitter.

9. In a system for signalling operation of a machine according to a given program, a signal circuit for signalling deviation of machine operation from the given program, and a circuit controlling the signal circuit and comprising a source of direct current, a switch intermittently moved during operation of the machine for engaging different contacts upon each switch movement, the switch having plural fixed contacts and a contact movable from one fixed contact to another, a capacitor alternately charged and discharged responsive to control switch movement, plural variable resistors severally connected with the positive pole of the current source, plural capacitors severally connected with the resistors and with the negative pole of the current source, a circuit connected at the ends with the fixed switch contact, a diode in said circuit adjacent each fixed switch contact, a transistor having a base terminal connected with a terminal of each diode and one terminal connected with the positive pole of the current source and with one terminal of the transistor whereby the relay is energized for movement of its contacts upon reaching a given charge by either capacitor.

10. The control circuit of claim 10 in which the variable resistors are simultaneously adjustable and the diodes are similarly connected to the capacitors and to the transistor whereby the more positive of the diodes controls the current flow through the transistor.

11. For use with a device having a part normally movable in opposite directions, a reversal detection means comprising a pair of contacts spaced from each other in the direction of a component of movement of said part and a center contact movable between said pair of contacts, said center contact being carried upon means solely in surface frictional engagement with said movable part, said frictional engagement being effective to carry said center contact against a first contact of said pair of contacts whenever a movement of said movable part is in the direction of said first contact and to carry said center contact against said second contact of said pair of contacts whenever a component of movement of said movable part is in the direction of said second contact, a pulse forming circuit effective to produce only one pulse each time said movable part reverses direction without producing a pulse for continued movement of said part in the same direction, re-

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regardless of interruption of said movement, said pulse forming circuit comprising a direct current source and a capacitor, said capacitor having a plate electrically connected to said center terminal, and a plate electrically connected to a terminal of said pair of terminals and to one pole of said direct current source, said other terminal of said pair of terminals

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being electrically connected to said other terminal of said direct current source whereby said capacitor will produce a pulse only when said center contact moves from one contact of said pair of contacts to the other contact of said pair of contacts.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,588,864 Dated June 28, 1971

Inventor(s) Wallace E. Gaulke

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 10, Line 53, "claim 10" should read---claim 9---

Signed and sealed this 2nd day of November 1971.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Patents