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O'Brien

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[54] **MULTI-CHANNEL CONTROLLER**

[76] Inventor: **Gerard J. O'Brien,** 33 Pamrapo Ave., Jersey City, N.J.

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[52] **U.S. Cl.** **307/114,** 318/446

[51] **Int. Cl.** **H01h 19/14**

[58] **Field of Search** ..... 307/38, 114, 115, 112; 200/153 LA; 317/139; 318/446; 340/147 R

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Primary Examiner—Robert K. Schaefer
Assistant Examiner—M. Ginsburg
Attorney, Agent, or Firm—Lilling & Siegel

[57] **ABSTRACT**

A plurality of switching elements are arranged around the periphery of a rotating cam plate, slightly below the path traced out by its single lobe. A set of three solenoid coils is mounted below the rotor which is constructed from a ferromagnetic alloy and is keyed to it's shaft in such a manner that it may be translated toward the aforementioned solenoids, against the bias force of a spring. With the solenoids energized, the camplate is pulled into the plane of the switching elements and actuates any of the latter which intercept its path while in the displaced position. A remote display, visible to the operator, is driven synchronously with the cam plate and provides information on the instantaneous position of the cam lobe with respect to the several switching elements. This permits the selective actuation of any switch and, consequently, the control of the circuits of which the switching elements are parts.

10 Claims, 7 Drawing Figures

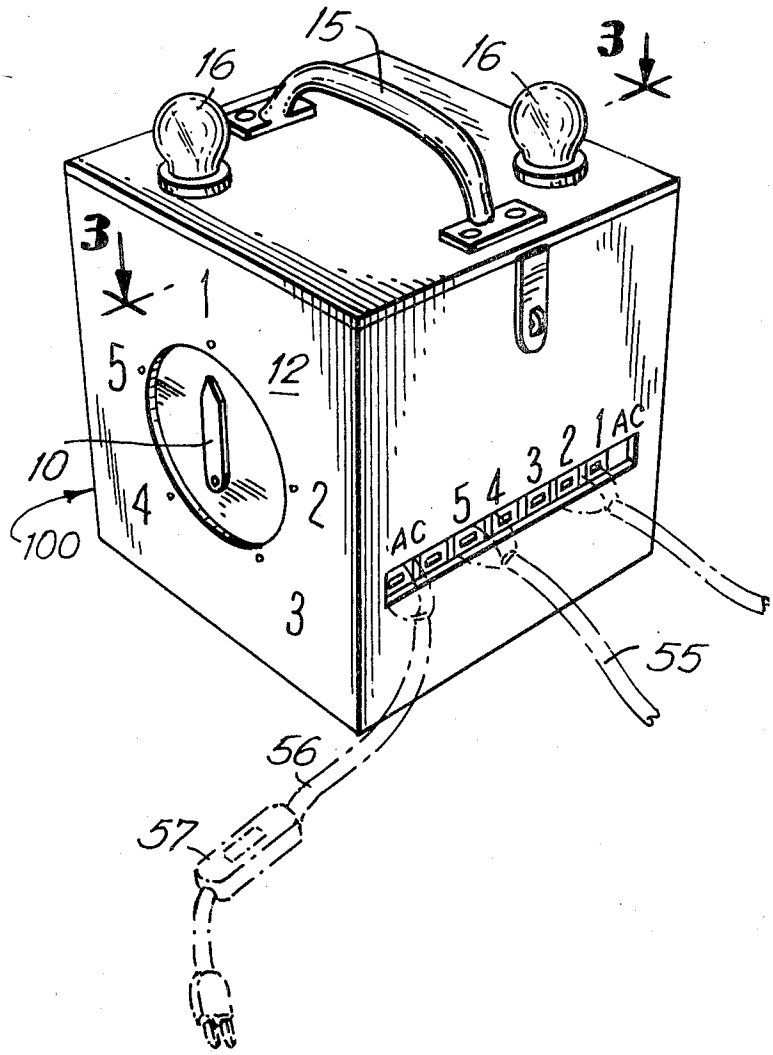


FIG.2

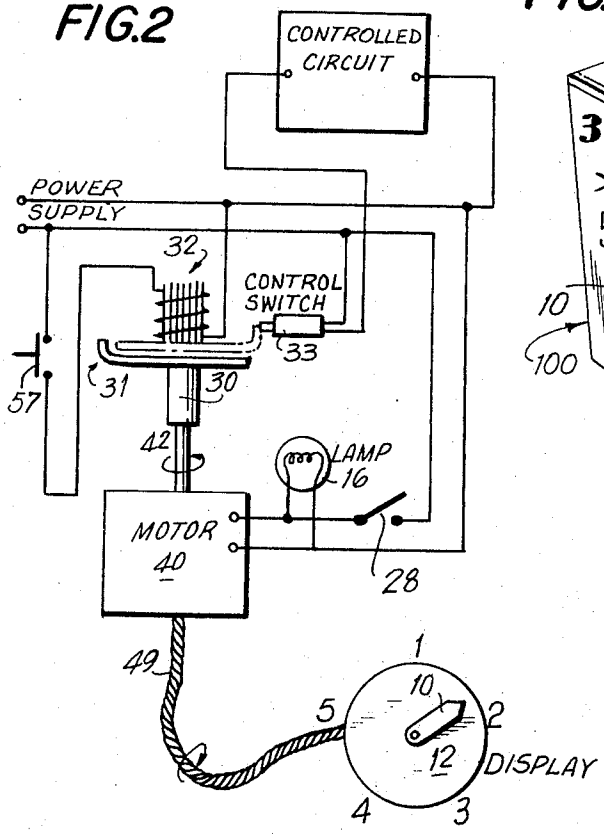


FIG.1

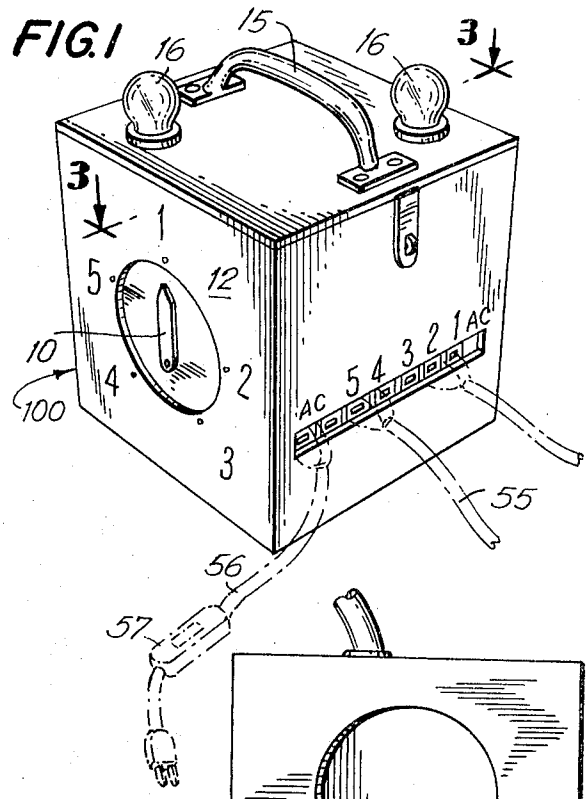


FIG.6

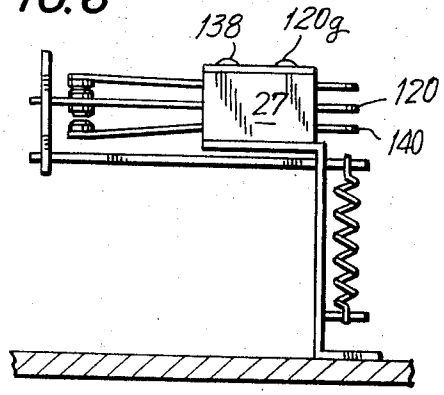
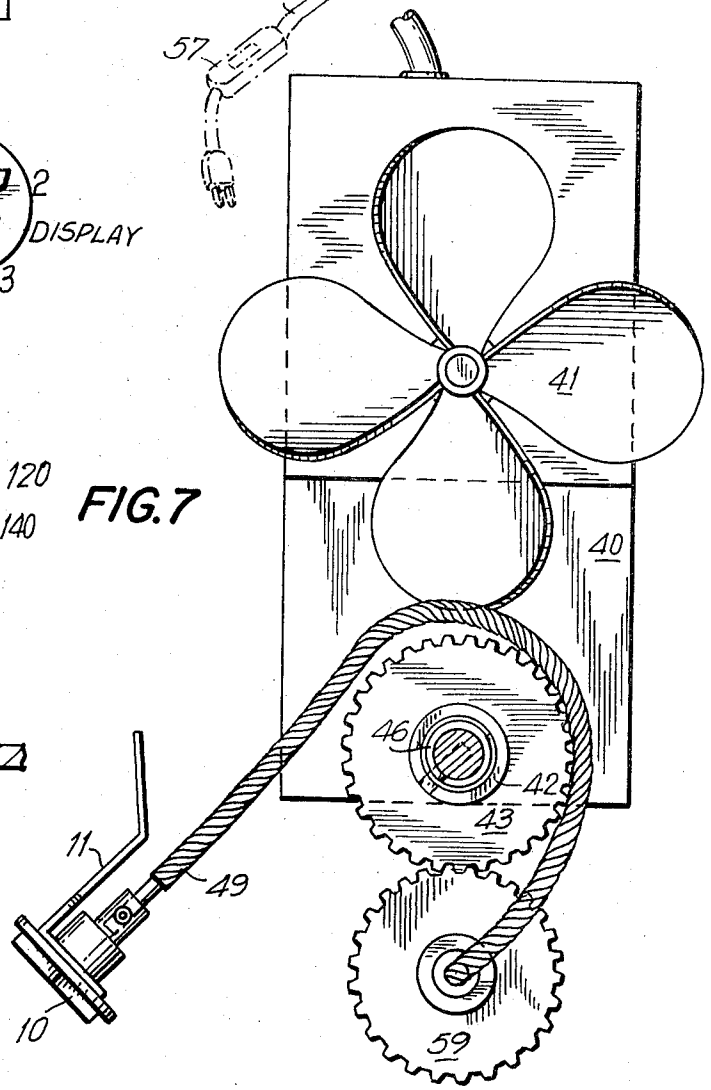


FIG.7



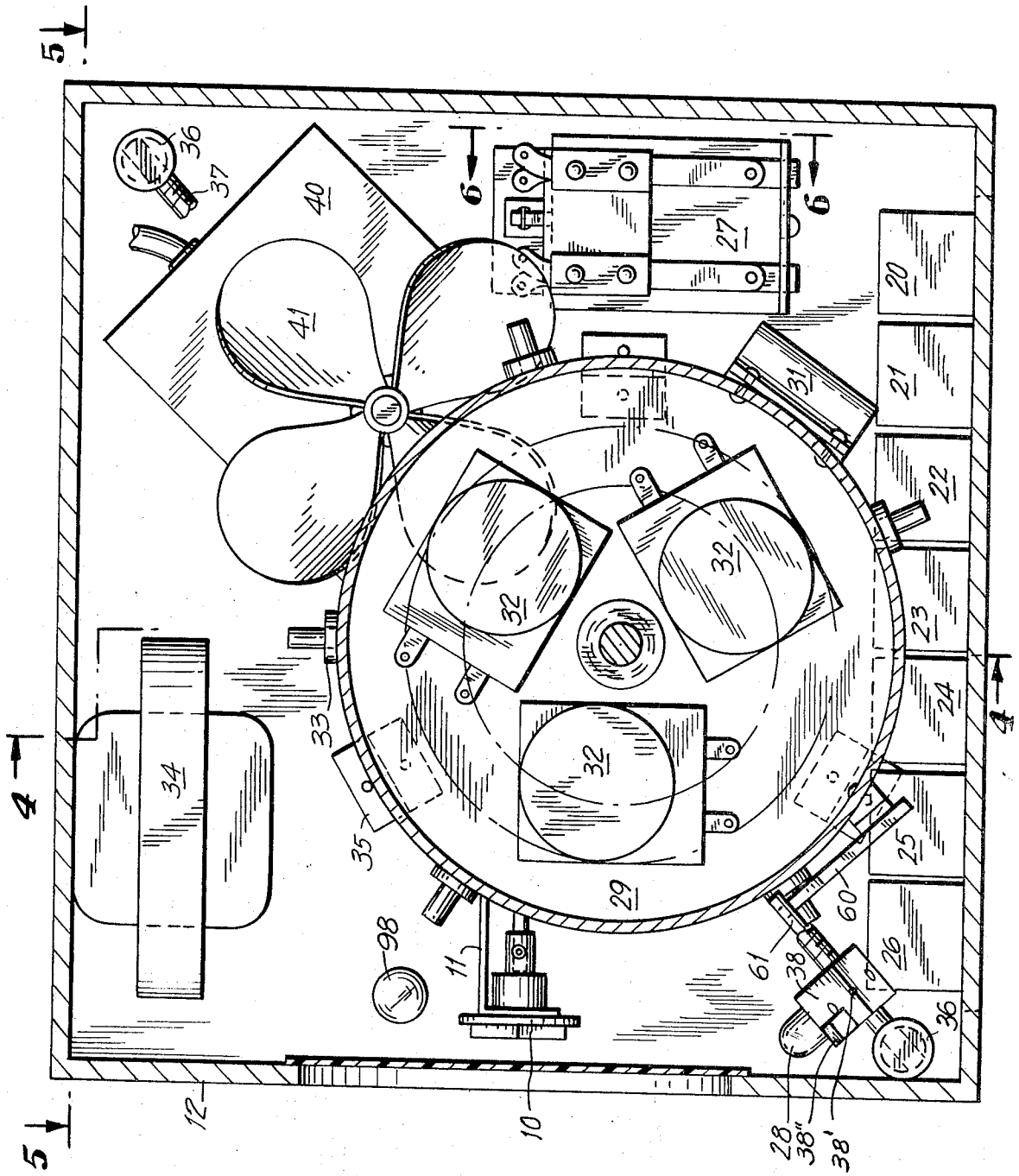

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98
11
60
61
38
36
12
10
28
38"
38'

FIG. 3

FIG. 4

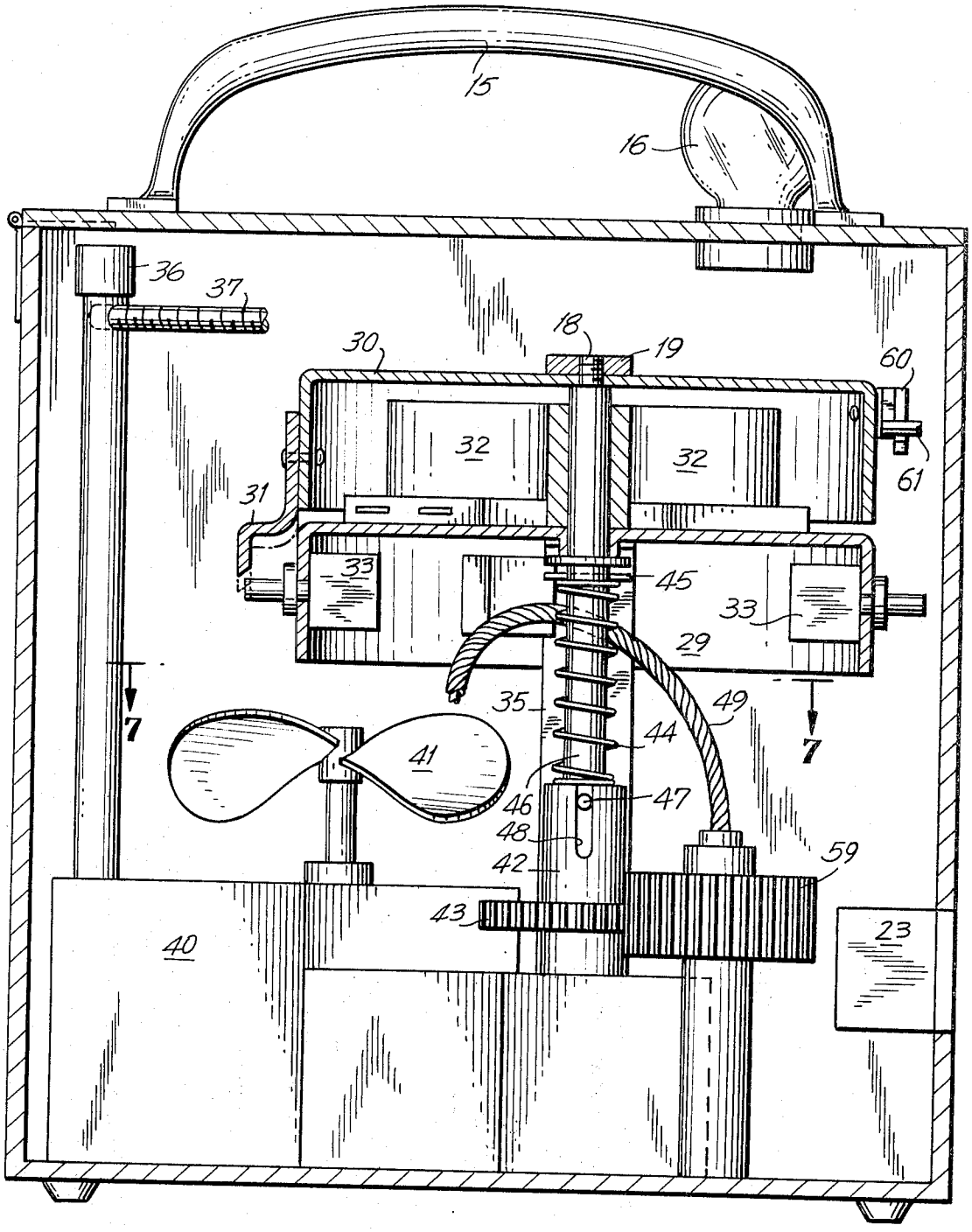
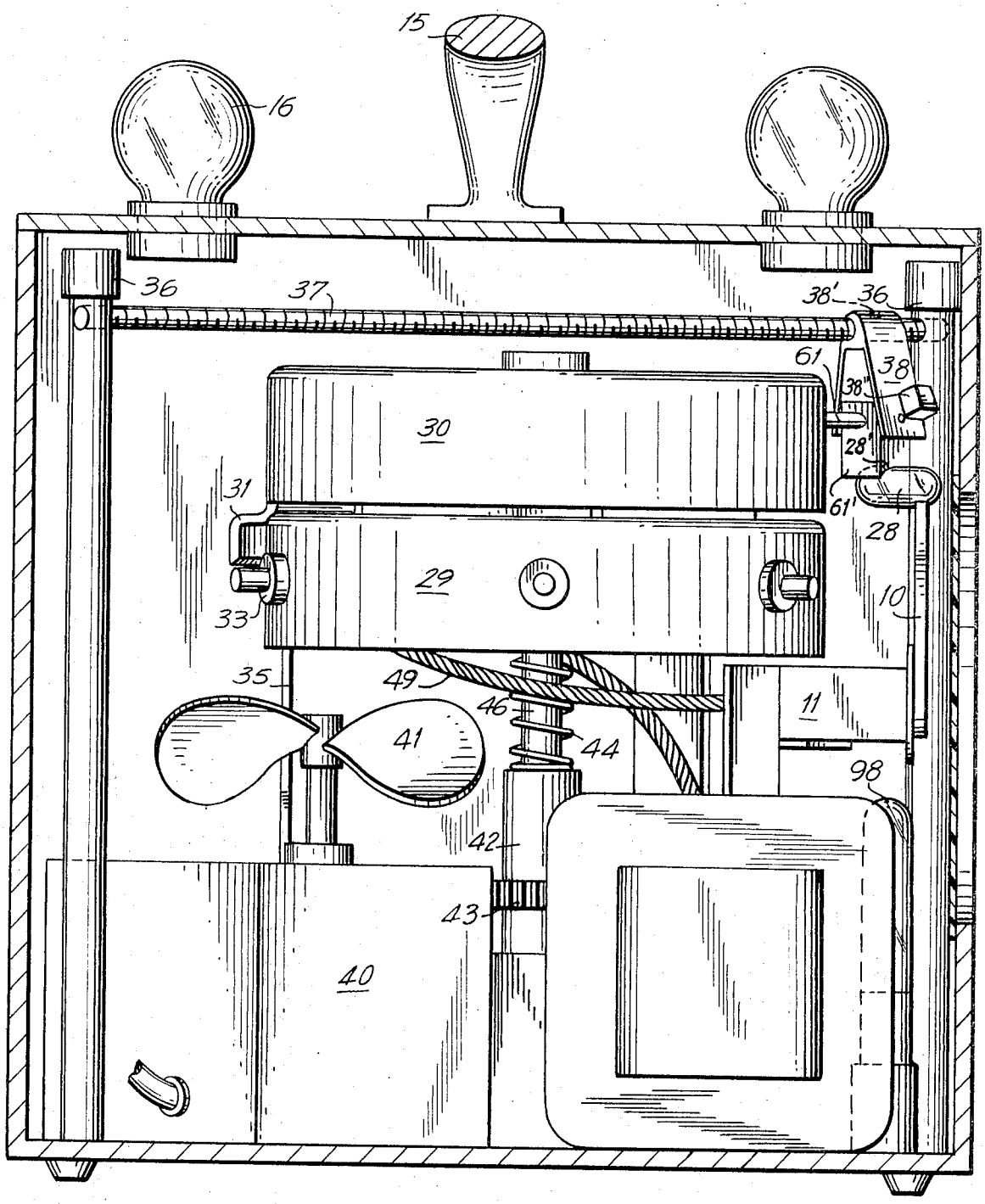

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FIG. 5


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38'
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61'
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MULTI-CHANNEL CONTROLLER

INTRODUCTION

The instant invention relates to devices which control a multiplicity of circuits by the mechanical operation of control elements, suitably on/off switches.

It relates, more particularly, to such devices which exercise control over the several circuits by means of a single controller, generally an electrical switch.

The prior art relies, in the main, on a large number of switches, or analogous devices, arranged on a control panel. One switching elements is provided for each of the controlled circuits, or functions, and the operator is required to select the appropriate switch and to move its operating handle into the desired position. Where the number of controlled circuits is large and the frequency of operation is high, the ability of an operator to select the correct switch and to reliably reposition it is severely impaired.

It is, therefore, the primary objective of the invention to provide a multi-channel controller in which the operator is provided with a single actuator and with a display panel to aid in the selection of the appropriate control circuit. The actuator is, generally, a suitable finger actuated, preferably button type, on/off switch, requiring no visual checking or great manual dexterity for operation. The display panel is, generally, in the form of a clock-face with a single pointer moving slowly around the bezel and indicating numbers, or symbols, representing the controlled circuits. The operator's attention is, therefore, uniquely focused on determining as the pointer is approaching the desired control position and briefly operating the actuating switch.

It is a further objective of the invention to teach the contruction of a multi-channel contoller; adapted to economic manufacture and reliable operation.

SUMMARY

The objectives of the invention are attained by providing a rotating cam with a single lobe and a display, synchronized with the cam and indicating the angular position of the lobe at all times. The cam is slideably arranged upon its shaft, so that it is displaced, axially, from a first position, while rotating, into a second position. The first position is the normal, inactive, one and the cam is biased toward it by a spring. The second position is the active one and movement into it is achieved by providing one, or more, electromagnets which exert a force upon the ferromagnetic cam.

In the active axial position, the operating lobe of the cam traces out a circular path which is interrupted, at arbitrary intervals, by the operating levers or plungers of several control elements. These elements may be electrical switches, or they may be hydraulic or pneumatic valves, proximity sensors or similar devices. When the lobe passes the angular position of a given control element a control signal is generated in the circuit or device to which that element is connected by an appropriate signal path. In the simplest case, where the control element is an electrical switch, the switch may be part of the controlled circuit and controls it by making or breaking the electrical conduction path.

The actuation of the control elements is, therefore, accomplished when the cam lobe is in the displaced axial position and is passing through the angular location of the selected element. The transfer of the cam into this position is readily accomplished by providing a simple momentary switch in the electrical circuit through the positioning solenoid; the operator is informed of the instantaneous position of the lobe, with respect to the control elements, by the display which may be in the form of pointer rotating in a round bezel, appropriately marked.

The multi-channel controller of the invention may be adapted to many uses, industrial or household. The principles of its operation will be described below with reference to the preferred embodiment, illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS:

In which:

FIG. **1** is an external perspective view of the preferred embodiment of the multi-channel controller of the invention, adapted to control five independent electrical circuits;

FIG. **2** is a simplified schematic diagram of the electrical circuit of the controller shown in FIG. **1**;

FIG. **3** is a section in plan, taken along line **3—3** of FIG. **1**, of the preferred embodiment;

FIG. **4** is a section in elevation, taken along line **4—4** of FIG. **3**, of the multi-channel controller;

FIG. **5** is another section of the controller shown in FIG. **1**, taken along line **5—5** of FIG. **3**;

FIG. **6** is a partial view sectional along line **6—6** of FIG. **3**, showing a control relay incorporated into the preferred embodiment; and

FIG. **7** is another partial view, sectioned along line **7—7** of FIG. **4**, illustrating the drive system of the controller cam and the synchronizing drive to the display indicator.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A multi-channel controller **100** is shown in the perspective view of FIG. **1**; one side of the controller enclosure has a circular cut-out in which an indicator arm **10** points to identifying numbers on an indicator bezel **12.** The number **1** to **5,** equidistant on the periphery of the cut-out, represent five electrical circuits whose controlling switches **33,** such as the five push button microswitches which remain either on or off are contained in the controller **100.** Connection between the individual circuits and the controller is established by plug-in cords, **55** for example, entering suitably identified sockets in the controller housing. The multi-channel controller **100** is also provided with a carrying handle **15** and external function lights **16.**

FIG. **3** is a section through the preferred embodiment, taken along line **3—3** of FIG. **1,** in which the main components of the controller are visible, including a stator **29** — with the operating plungers of the switches **33** protruding from its circumference and solenoids **32** mounted on its upper surface. Sockets **21,** 22, 23, 24 and **25** — associated with the controlled circuits **1** through **5** — and similar sockets **20** and **26** — supplying power to the drive system, including gear motor **40,** and to the solenoids **32,** respectively — are also shown.

FIG. **4** is another sectioned view of the controller mechanism, taken along line **4—4** of FIG. **3,** in which the operating components attached to the stator **29,**

and those on rotor **30**, are clearly indicated. The stator **29** and the rotor **30** are circular dished components, coaxial with one another in an axially spaced relationship. The rotor is driven by gear motor **40** via a shaft **42** in engagement with rotor shaft **46**. The shaft **46** is rigidly attached to the rotor **30** by means of a threaded extension **18** passing therethrough and a nut **19**. A rotationally rigid connection between shafts **42** and **46** is ensured by an open-ended slot **48** milled into the former and a pin **47**, pressed through the shaft **46**, riding in that slot. The two shafts are axially free to move with respect to one-another and are biased toward the relatively extended position by a spring **44**, compressed between the top surface of motor shaft **42** and a second pin **45** pressed through the rotor shaft near its upper end. The rotor shaft **46** passes through an orifice in stator **29**; the stator is rigidly held in the coaxial position by three brackets **35** attached to the base of the controller housing. The rotor **30** is made from a ferromagnetic material and is susceptible to the attractive force of solenoids **32**, attached to the stator, which may be used to move it axially downward, aganist the restraining force of spring **44**, and thereby bring a cam **31**, on the periphery of the rotor **30**, into the plane of the operating plungers of switches **33**.

The functioning of the multi-channel controller is readily described with reference to the Figures. Power from a suitable A.C. source is supplied to the switches **33** and thence to the several sockets, **21** through **25**, via jack **20**. Power to the solenoids **32** is provided by cable **56**, via a manually operated momentary switch **57** and jack **26**; it passes through transformer **34** which adjusts line voltage to the operating voltage of the solenoid windings. When the motor **40** is energized — its control will be discussed below, with reference to FIG. **5** — the shaft **42** rotates at a constant velocity, completing a revolution in a few seconds. The rotor shaft **46** carries the cam **31** around the periphery of the stator at the same angular velocity, the cam passing just above the switches **33**. The instantaneous position of the cam **31** is indicated on bezel **12** by the pointer **10** whose rotation is synchronized with the motion of the rotor by a pair of meshing gears, **43** and **59**, and a flexible shaft **49** interconnecting the gear **59** and the pointer.

The numerical markings on the face of bezel **12** are arranged slightly out of phase with the corresponding switches, in such a manner that a number is opposite the pointer **10** when the cam **31** has passed the angular position of the preceding switch and is approaching the switch in the circuit identified by that particular number. If the operator wishes to alter the status of that particular circuit — turning it on from the off condition, or vice-versa — he depresses the momentary switch **57** in the supply cord **56**. This energizes the solenoids **32** and pulls the rotor **30** toward the stator **29**, thereby altering the path of cam **31** to intercept the plunger of the indicated switch. The cam is shaped to actuate the plunger smoothly while passing over it.

This procedure may be repeated as many times as desired; the operator timing the depression of control switch **57** to the movement of the pointer **10** around the indicator dial. He may alter the condition of any circuit controlled from the device of the invention at time intervals corresponding to one complete revolution of the shaft **46**; this interval is pre-set, by choosing an appropriate output speed for gear motor **40**, according to the number of circuits to be controlled and the expected manual response of the operator.

The control of the drive motor **40** is best described with reference to FIG. **5** which is another section through the controller **100**, taken along line **5—5** of FIG. **3**. Two vertical support rods **36** are set diagonally opposite each other in corners of the controller enclosure and are connected at their upper ends by a swing pivot axis or threaded rod **37** in horizontal alignment above the rotor **30**. A mercury switch bubble **28** is suitably removably suspended from the pivot **37**, near one of the supports **36**, by means of a cradle **38**. A trip rod **61** extends from the swing cradle **38** radially inward into a close approach to the periphery of the rotor. The outer surface of the latter is provided with a trip cam **60** whose leading edge, with respect to the direction of rotation of the rotor, is appropriately shaped to perform its tripping function, for example, as an upwardly developing arc (not shown). The trip rod **61** rests on the lower edge of that arc when the controller is inoperative and balances the swing **38** in an attitude corresponding to the disconnected condition of the mercury switch **28**.

A suitable oil hole **38'** is provided in the top of the cradle **38** so as to allow oil to reach the threads of the rod **37**, thereby lubricating same and permitting the cradle **38** to swing freely about the pivot rod **37**.

Weight **38''** is secured to one side of the cradle **38** so that when the cradle **38** disengages from a trip cam **60** on the rotor **30**, the weighted side of the cradle swings back the mercury switch **28** into the "on" position.

Since the threaded shaft **37** keeps the cradle **38** in a predetermined fixed position, it can be used as a means for adjustment. Thus, the mercury switch **28** is suitably removably held in place by a spring type clamp (not shown). Upon removing the mercury switch from the cradle **38**, the cradle can then be rotated about the pivot rod **37** so that it can be positioned toward or away from the rotor **30**, whereby the trip rod **61** can be located in its desired position. Upon setting the proper position of the cradle **38**, the mercury switch **28** is then snapped back into its spring type clip or cradle clamp.

Power to the gear motor **40** is derived from the jack **20**; the connection passes through the normally open terminals of a relay-operated switch **27**; the relay coil is energized from the same source with the interposition of mercury switch **28**. It should be noted that the power supply to the motor, and to the control relay **27**, is entirely independent of the power supply to the rotor positioning solenoids **32**. The operator initiates a control cycle by the momentary actuation of the switch **57**. This causes the stationary rotor **30** to be pulled toward the stator **29**, thereby removing the support of the cam **60** from the trip rod **61** which, in turn, causes the swing cradle **38** to tip over and close the circuit to the coil of relay **27** through the mercury switch **28**. With the normally open contacts of the relay-operated switch closed, power is supplied to the motor **40** and the rotor is set into motion. At the end of the control cycle, corresponding to one revolution of the rotor **30**, the trip cam **60** re-engages the rod **61** and tips the switch bubble **28** into the off position; the relay **27** is de-energized thereby and the motor **40** stops. The angular location of the cam **60** on the rotor is aligned with the indicator position **1** on the bezel **12**, so that actuation of the switch **33** in 'circuit No. **1** ' may be obtained by continued depression of the switch **57** upon starting the mo-

tor. If circuit '1 ' is to be left unaltered during the control cycle, the switch **57** is pulsed only briefly, to initiate motor rotation.

The lamps **16** are connected in parallel with the motor **40,** so that the operator may tell at a glance if the controller is in motion or available to start a new control cycle.

FIG. **6,** a partial sectional view taken along line **6—6** in FIG. **3,** shows the control relay **27** with coil terminals **138** and **120***g* — connected to the mercury switch **28** and the ground side of jack **20,** respectively — and switch terminals **120** and **140** — connected to the power side of jack **20** and to the drive motor windings.

FIG. **7,** another partial section of FIG. **4,** shows the gear motor **40,** with cooling fan **41** attached to the armature shaft directly; the drive shaft **42** and its output gear **43**; the pointer drive-gear **59** and the flexible shaft **49** to the pointer **10.**

FIG. **2** is a slightly simplified schematic of the electrical connections in the controller **100**; the several components are identified as on the mechanical illustrations and are represented by the appropriate conventional symbols.

While the multi-channel controller has been described in detail with reference to the preferred embodiments, many changes in the arrangement of the mechanical and electrical elements are possible within the scope of the invention. In particular the arrangement of the display dial or panel; the provision of additional signal devices to acquaint the operator with the current status, on or off, of each of the controlled circuits; the substitution of hydraulic or pneumatic valves for some, or all, of the electrical switches **33**; and the specific arrangement of other parts shall not be considered without the basic invention, which is defined in the appended claims.

I claim:

1. A multi-channel control device, comprising:

drive means, including a shaft adapted to rotate at constant angular velocity;

a cam plate, rotating with said shaft and reciprocable thereon between a first axial position and a second axial position;

a projection on said cam plate;

positioning means, for translating said cam plate from said first into said second axial position;

a plurality of cam-actuated switching elements spaced around periphery of said cam plate in a plane orthogonal to axis of said shaft, said plane including said second axial position;

biasing means urging said cam plate toward said first axial position;

display means synchronized with rotation of said shaft, indicating instantaneous angular position of said projection; and

control means for energizing said positioning means, thereby translating said cam plate into said second axial position and causing said projection on the cam plate to actuate one or more of said switching elements while rotating upon its shaft, until said positioning means is de-energized and the cam plate returned to the first axial position under the influence of said biasing means.

2. The control device defined in claim **1,** said drive means including an electric motor and a gear train for reducing the rotational speed of said motor, and the output of said gear train driving said shaft.

3. The device defined in claim **2,** said positioning means including at least one electromagnet and wherein said cam plate is constructed from a ferromagnetic material.

4. The control device defined in claim **1,** wherein said switching elements break or make electrical circuits.

5. The control device defined in claim **4,** wherein said switching elements are of the maintained position type.

6. The control device defined in claim **1,** wherein said switching elements are electrical switches of the push-push, maintained position type.

7. The control device defined in claim **1,** wherein said display means include an indicator shaft rotating at the same angular velocity as said cam plate, a pointer rigidly affixed to said indicator shaft and symbols, corresponding in number to said plurality of switching elements, arranged radially spaced from said indicator shaft such that the relative location of said pointer and said symbols is indicative of relative location of said projection and said switching elements.

8. The control device defined in claim **3,** wherein said biasing means is a spring.

9. The control device defined in claim **8,** wherein said control means include electrical switching means for supplying power to said positioning means, thereby attracting said ferromagnetic cam plate into said second axial position against restraining force of said biasing means.

10. A multi-channel control device, comprising:

a shaft;

drive means, for rotating said shaft at constant angular velocity, including an electrical motor and speed-reducing gear train between said shaft and an output shaft of the motor;

a cam plate, constructed of ferromagnetic material, rotatably engaged upon said shaft and reciprocable thereon between a first axial position and a second axial position;

spring means, coaxial with said shaft, urging said cam plate into said first axial position;

a plurality of electromagnets, located along said shaft and equidistant therefrom, beyond said second axial position;

a plurality of cam-actuated electrical switches spaced around periphery of said cam plate in a plane orthogonal to axis of said shaft, said plane including said second axial position;

a cam projecting from periphery of said cam plate;

display means synchronized with rotation of said shaft, indicating instantaneous angular position of said cam with respect to angular location of said electrical switches; and

a control switch for energizing said electromagnets, thereby attracting said cam plate into said second axial position and causing said cam to trip such of said electrical switches as may be located within its arc of rotation while said electromagnets remain energized.

* * * * *