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H. E. COBB ET AL
MAGNETIC SWITCH

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2 Sheets-Sheet 1

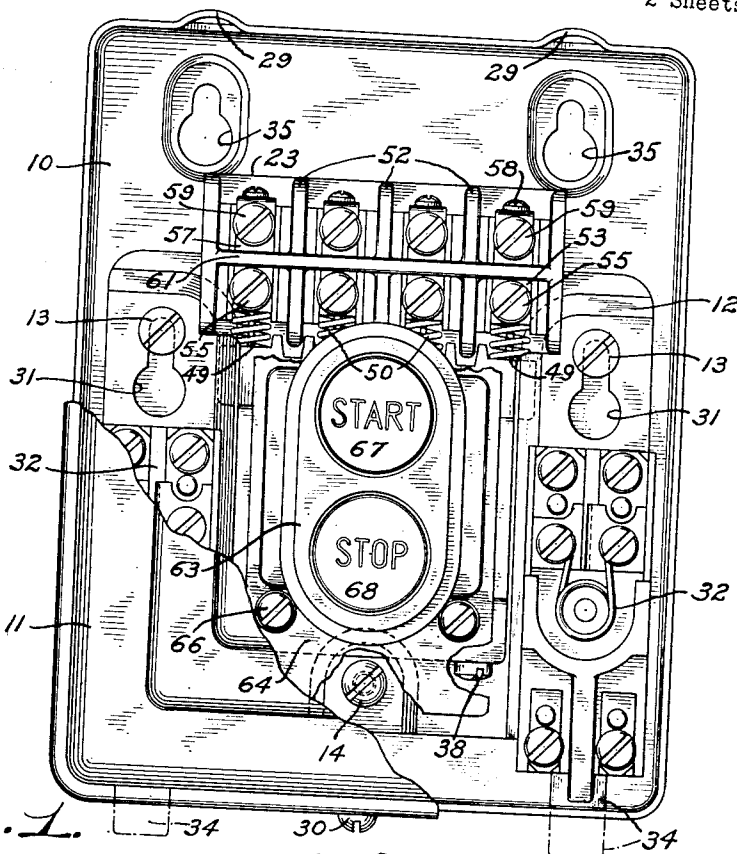


Fig. 1.

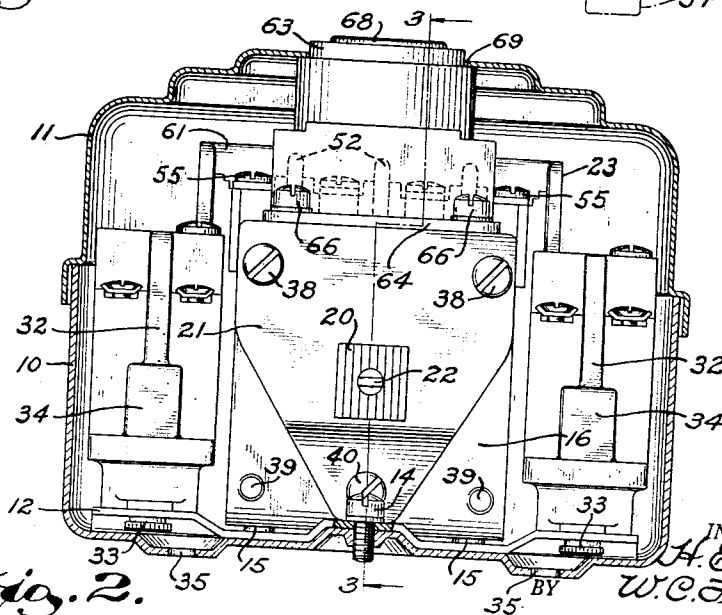


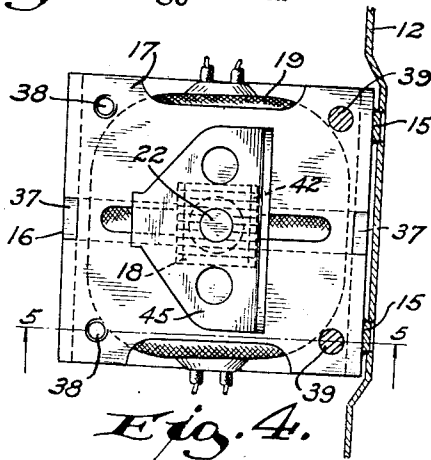
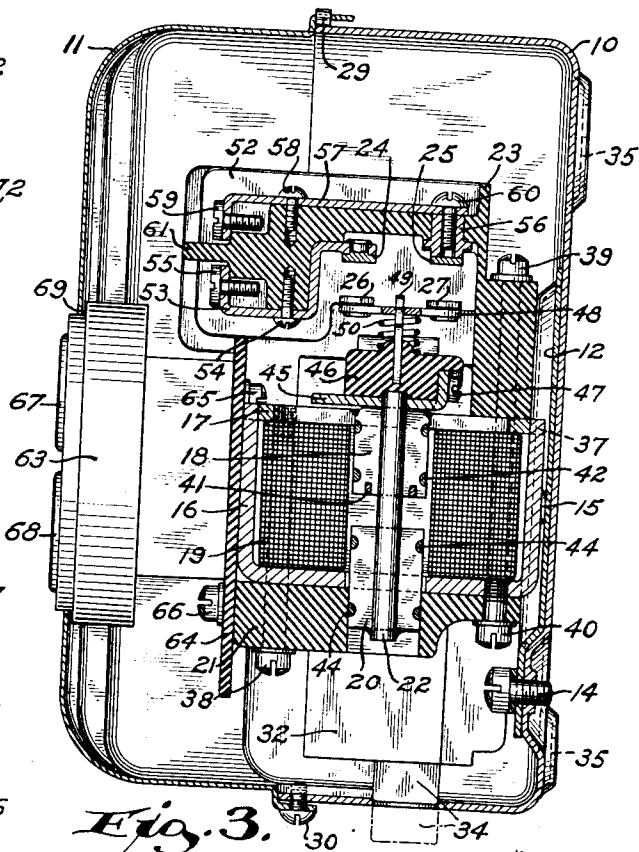
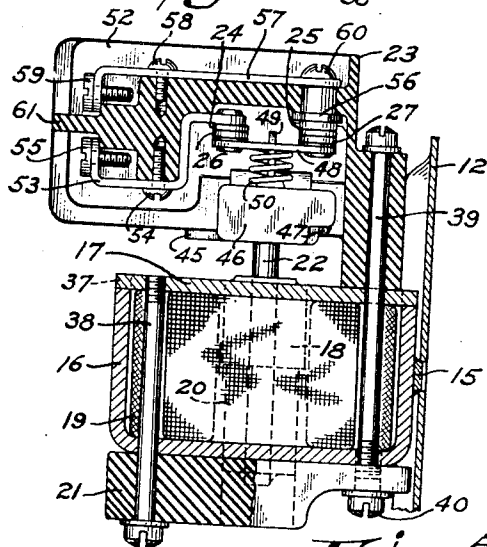
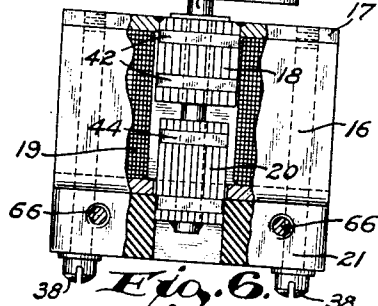
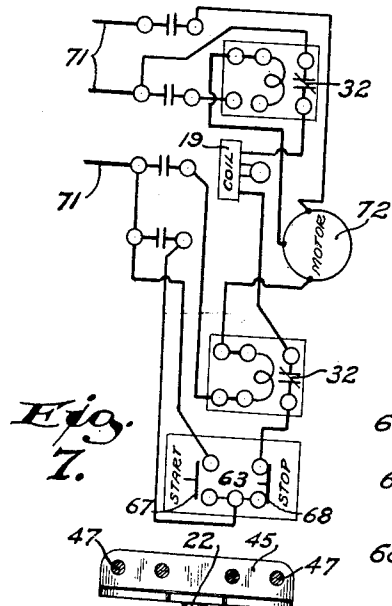
Fig. 2.

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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MAGNETIC SWITCH

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1 Claim. (Cl. 200—104)

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Our present invention relates generally to improvements in the construction and operation of magnetic switches for controlling the operation of motors and other electrical devices, and relates more particularly to improvements in the electro-magnet structure for actuating such control switches.

The primary object of the present invention is to provide an improved magnetically actuated switch unit which is simple and compact in construction, flexible in adaptation, and highly reliable and efficient in operation.

In our prior copending application Serial No. 155,651, filed April 13, 1950, now Patent No. 2,649,521, August 18, 1953, we have shown and described an improved magnetically actuated motor controller wherein the actuating magnet comprises a stationary laminated field piece of inverted U-shape having an annular energizing coil confined therein, and a reciprocable laminated armature of inverted T-shape having a cross-bar cooperable with the lower free ends of the U-piece and also having an upright central stem passing through the coil and slidably confined within the field piece while additionally providing a support for the movable switch contacts. Although this prior magnetic switch assemblage has proven highly satisfactory and successful in commercial use, it is rather expensive to manufacture and sell due primarily to the relative high cost of the laminated magnet assemblage, and it also requires considerable installation space.

It is therefore an important object of our present invention to provide an improved electromagnet assemblage for such control switches, which is simpler and less costly than that of our prior application.

Another important object of this invention is to provide an improved magnetic switch composed of relatively few simple parts which may be readily assembled or dismantled if necessary.

A further object of the invention is to provide a relatively inexpensive but effective magnetically actuated motor controller all parts of which are well insulated and protected against overloads and other damaging influences.

Still another object of our invention is to provide a very compact but durable magnetic switch unit which is sensitive and relatively silent in operation, and which may be removably confined within a housing space of comparatively small size.

An additional object of the present invention is to provide various improvements in electromagnet structures, whereby the field and armature

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cooperate with the energizing winding to insure most effective guiding and rapid reciprocation of the armature core, and in which wear on relatively movable parts is minimized.

These and other objects and advantages of the invention will be readily apparent from the following description.

A clear conception of the several features which constitute our present improvement, and of the construction and operation of a typical electro-magnetically actuated switch embodying these unique features, may be had by referring to the drawings accompanying and forming a part of this specification in which like reference characters designate the same or similar parts in the various views.

Fig. 1 is a front view of one of our improved magnetic switch units housed within a casing but having the major portion of the casing cover broken away, the unit having a push button starting and stopping switch and two thermal overload devices associated therewith;

Fig. 2 is a bottom view of the magnetic switch unit showing the same confined within its housing casing and cover both shown in section;

Fig. 3 is a vertical section through the same switch unit and housing assembly, taken along the irregular line 3—3 of Fig. 2 and showing the main switch contacts open;

Fig. 4 is a top view of the movable contact actuating magnet with the switch contacts and carrier omitted;

Fig. 5 is a transverse vertical section through the switch assembly and magnetic actuator, taken along the line 5—5 of Fig. 4, but showing the contacts in elevation and in closed position;

Fig. 6 is a part sectional front elevation of the magnet assemblage alone; and

Fig. 7 is a typical wiring diagram showing the improved switch assembly applied to a three phase electric motor starting circuit.

The gist of our present invention is the provision of an improved electro-magnetically actuated switch unit embodying a simplified actuating magnet assemblage for the movable switch contacts which is sensitive and silent in operation and can be manufactured at moderate cost, and while only a single specific embodiment of the switch has been illustrated and described herein, it is not our desire or intention to unnecessarily restrict the utility of the improvements by virtue of this limited showing. It is furthermore contemplated that specific descriptive terms used herein be given the broadest possible interpretation consistent with the actual disclosure.

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Referring to the drawings, the typical improved magnetically actuated switch unit shown therein, comprises in general, a main switch housing or casing 10 having a front closure cover 11; a mounting frame or plate 12 detachably secured to the rear wall of the casing 10 by upper and lower screws 13, 14 respectively, and having thereon a pair of partial punchings 15; a magnetic field piece consisting of a U-shaped lower section 16 rigidly attached as by welding to the plate punchings 15 and being spanned by an upper plate section 17 having a hollow laminated stop core 18 depending from its medial portion; an annular magnet energizing coil 19 confined within the field section 16 and surrounding the core 18; a laminated armature plunger 20 reciprocable within the coil 19 in alignment with the core 18 and slidably cooperating with a lower guide block 21, the plunger 20 having a central pusher rod 22 passing through and guided within the core 18; a contact carrying and housing board 23 mounted above the plate section 17 of the field piece and providing a support for front and rear fixed contacts 24, 25; and movable contacts 26, 27 resiliently supported upon the upper end of the push rod 22 and being cooperable with the fixed contacts 24, 25 to make and break electric circuits.

The casing 10 and cover 11 may be lined with insulation and formed of sheet metal, and the cover is detachably secured to the casing 10 by means of lugs 29 formed on this casing and coacting with slots in the cover 11, and by a screw 30 coacting with the lower overlapped portions of the casing and cover, see Figs. 1 and 3. The switch mounting frame plate 12 may also be formed of durable sheet metal and is provided with slots 31 at its upper side portions which are adapted to cooperate with the upper screws 13 as shown in Fig. 1, and this plate 12 also has a pair of thermal overload relays 32 secured thereto on the opposite sides of the magnetic structure by means of screws 33 shown in Fig. 2, and is normally detachably secured within the casing 10 by the single lower screw 14. Each of the overload relays 32 is provided with a reset plunger slide 34 normally concealed within the casing 10 but adapted to project through an adjacent lower casing opening as illustrated in dot-and-dash lines in Fig. 1 when the relay has sprung into circuit interrupting position; and the casing is also provided with suitable terminal outlets in a well known manner and has suspension holes or slots 35 formed in its rear wall.

The two sections 16, 17 of the field piece are formed of heavy magnetic sheet metal and have tongue and groove connections 37 at the opposite sides thereof as shown in Fig. 4, and the front portions of these sections 16, 17 are clamped together by upwardly directed long screws 38 which also clamp the block 21 to the lower U-section 16, while the rear portions of the sections 16, 17 are clamped together by downwardly directed long screws 39 which also firmly clamp the terminal board 23 to the upper plate section 17. The guide block 21 which is formed of insulation, is additionally clamped to the bottom of the U-section 16 by a single central rear short screw 40, and all of these screws 38, 39, 40 clear the annular coil 19 which is snugly confined within the lower U-section 16 by the upper plate section 17. The laminated upper stop core 18 may be swaged and welded to the top plate section 17 and is provided with shading coils 41 embedded in its lower face, and the laminations of this core 18 are formed

of magnetic material and are bound together by transverse straps 42 as clearly shown in Figs. 3 and 6.

The laminations of the reciprocable armature plunger 20 are also formed of magnetic metal and are bound together by transverse straps 44, and this plunger 20 is freely movable through a central opening in the bottom of the U-section 16 but is snugly slidable within the lower guide block 21. The plunger rod 22 is formed of non-magnetic bar stock such as stainless steel, and is likewise snugly slidable within the bore of the hollow core 18, so that the vertically movable plunger 18 cannot shift laterally. An L-shaped bracket 45 which is also formed of non-magnetic sheet metal is firmly welded or otherwise secured to the upwardly protruding end of the plunger rod 22, and a movable contact carrying cross beam 46 is rigidly attached to the bracket 45 by means of screws 47 shown in section in Fig. 6. The several sets of movable contacts 26, 27 are secured to horizontal plates 43 formed of conducting material which are slidably and tiltably but detachably mounted upon contact guides 49 firmly secured to the cross beam 46, and which are resiliently urged toward the adjacent sets of fixed contacts 24, 25 by helical compression springs 50.

The fixed contact carrying board 23 which is firmly secured to the pole piece sections 16, 17 by the rear screws 39, is also formed of insulating material and is shaped to normally conceal the fixed and movable contacts 24, 25, 26, 27. The adjacent sets of these fixed and movable contacts are segregated from each other by partitions 52 formed integral with the board 23, and the front contacts 24 are secured to lower conductor bars 53 attached to the board 23 by screws 54 and which terminate in terminal screws 55, while the rear contacts 26 are secured to polygonal mounting elements 56 fastened to upper conductor bars 57 attached to the board 23 by other screws 58, and which terminate in terminal screws 59, see Figs. 1, 3 and 5. The polygonal elements 56 are attached to the corresponding conductor bars 57 by screws 60, and coact with parallel sided recesses formed in the board 23 so as to prevent possible rotation of the contacts 25 carried thereby. The front portion of the terminal board 23 is also provided with an integral horizontal flange 61 which segregates the terminal screws 55, 59 from each other, thus effectively protecting the contacts and terminals against possible short circuiting.

In order to complete the magnetic controller unit, an auxiliary start and stop push button switch 63 may also be mounted within the casing 10 upon the front leg or wall of the field piece section 16, and this switch 63 is preferably attached to an insulating board or plate 64 by screws 65 while the plate 64 is firmly but detachably secured to the guide block 21 by screws 66 and has its upper end engaged by the contact board 23, see Figs. 1, 2 and 3. The auxiliary switch 63 is provided with an upper starting button 67 and with a lower stopping button 68 both of which are readily accessible through an opening 69 in the casing cover 11, and this push button switch assembly may be replaced by any other suitable type of start and stop switch. By mounting the switch 63 and the contact carrying board 23 upon the magnet pole piece, these elements may be rigidly suspended from the frame plate 12, and by also mounting the overload relays 32 upon the plate 12 the entire switch assemblage

may be applied or removed as a unit within the main casing 10.

While all of the electrical connections between the main switch terminal screws 55, 59 and the overload relays 32, auxiliary switch 63, and the other parts of the electric circuit have been omitted for the sake of clearness from the detail drawings of the switch unit, this unit when properly constructed and assembled may be applied to various types of circuits of which a typical control circuit is shown in Fig. 7. In this typical three phase electric motor starting and stopping diagram, current is supplied to the system through three lines 71 connected to the main switch terminals, and the thermal overload relays 32 are connected directly to the electric motor 72 while the auxiliary or starting switch 63 and the magnet energizing coil 19 may be applied to the circuit as shown. In order to start the electric motor 72 it is merely necessary to press the starting button 67 of the auxiliary switch 63, whereupon the magnet coil 19 will be energized and will cause the laminated fixed core 18 to attract and lift the likewise laminated plunger 20 thereby simultaneously elevating all of the movable contacts 26, 27 into engagement with the adjacent fixed contacts 24, 25 as illustrated in Fig. 5, and causing the motor 72 to operate normally.

If, however, the current rises abnormally, then the thermal overload relays 32 will promptly function to break the circuit and the slides 34 of these relays will be projected outwardly of the casing 11 as illustrated in dot-and-dash lines in Figs. 1 and 3. The circuit may also be interrupted at any time by merely pressing the stop button 68 of the switch 63, and when the electric circuit is broken in either manner, the coil 19 of the electro-magnet will be de-energized thereby causing the relatively heavy armature plunger 20 to promptly drop by gravity and thus lowering the movable contacts 26, 27 to open position as depicted in Fig. 3. In case the overload relays 32 have tripped, it is necessary to restore the slides 34 to active position within the casing 10 as shown in Figs. 1 and 3 before the motor 72 can be restarted. The main control switch may thus be either manually or automatically opened, but must be manually closed, and the slides 34 function to provide a plainly visible indication as to when the overload relays 32 have functioned.

From the foregoing detailed description of the construction and functioning of a typical embodiment of our invention, it will be apparent that we have provided an electro-magnetically actuated control unit which besides being simple and compact in structure, is also highly effective in operation. The improved magnet construction of the unit is composed of relatively few simple but sturdy parts which cooperate to quickly close and open the movable contacts 26, 27, and which may also be conveniently assembled or dismantled. The energizing coil 19 of this electro-magnet is effectively confined within and protected by the U-section 16 and plate section 17 of the field piece, and these field piece sections 16, 17 are firmly clamped together by the same long screws 38, 39 which also fasten the insulated block 21 and the terminal board 23 to the field piece.

The reciprocable armature plunger 20 is effectively guided by the lower block 21 and by the bore of the fixed core 18 which coacts with the plunger rod 22, thereby eliminating lost motion

and resultant noise; and the movable contacts 26, 27 are flexibly and resiliently mounted upon the transverse carrier beam 46 thereby insuring effective closing of all contacts. Both the fixed and the movable contacts are confined within and amply protected against short circuiting by the insulated terminal board 23, and the auxiliary switch 63 is also well insulated from the main switch assembly and is conveniently accessible for actuation. While the thermal overload relays 32 are normally confined within the casing 10 they give a visible indication when tripped, and may also be reset without removing the casing cover.

By forming the main casing 10 relatively shallow and the cover 11 comparatively deep, all connections may be made with ease and easy inspection of the various normally concealed parts is at all times possible. Most of the metal parts of the improved unit may be readily and accurately produced of sheet metal with the aid of punches and dies, and the main frame plate 12 which supports all of the internal switch structure may be quickly suspended within or released from the casing 10 by merely manipulating the two screws 13, 14. The improved magnetic switch unit has proven highly satisfactory in actual use and may be produced at moderate cost for diverse uses.

While the thermal overload relays 32 shown herein are of the type forming the subject of the copending application Serial No. 117,357, filed September 23, 1949 by Harold E. Cobb, and the starting and stopping push-button switch 63 is of the type forming the subject of our copending application Serial No. 120,996 filed October 12, 1949, these auxiliary devices may be replaced by other types adapted to function in a similar manner.

It should be understood that it is not desired to limit this invention to the exact details of construction and operation of the typical electro-magnetic switch unit herein shown and described, for various modifications within the scope of the appended claims may occur to persons skilled in the art.

We claim:

In a magnetic switch, a U-shaped field-piece of magnetic metal provided with upright parallel side walls interconnected at their lower ends by an integral horizontal bottom plate having therein a central rectangular opening, a horizontal top plate of magnetic metal spanning the upper ends of said side walls and also having therein a central rectangular opening disposed in vertical alignment with said bottom plate opening, a laminated core of magnetic material and of rectangular transverse cross-section secured within said top plate opening and depending from the top plate between said side walls and having therein a central vertical bore, an energizing coil for said core snugly embracing the latter within said field-piece, a guide block of insulation coacting with the lower face of said bottom plate and having therein a rectangular opening of lesser cross-section than said bottom plate opening disposed in vertical alignment with said bottom plate opening, a laminated plunger of magnetic material and of rectangular transverse cross-section slidably confined within said guide block to space said plunger from said bottom plate opening, said plunger having a cylindrical upwardly extending central rod of non-magnetic material slidably confined within said core bore and projecting upwardly beyond said top plate, a switch contact mounting board of insulation

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coacting with the upper face of said top plate and having fixed contacts mounted therein, movable switch contacts carried by the upper end of said plunger rod and being cooperable with said fixed contacts, means closely adjacent to one of said walls for detachably clamping said top plate and said guide block against said field-piece, and means closely adjacent to the other of said walls for detachably clamping said guide block and said mounting board to said field-piece and said top plate respectively.

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