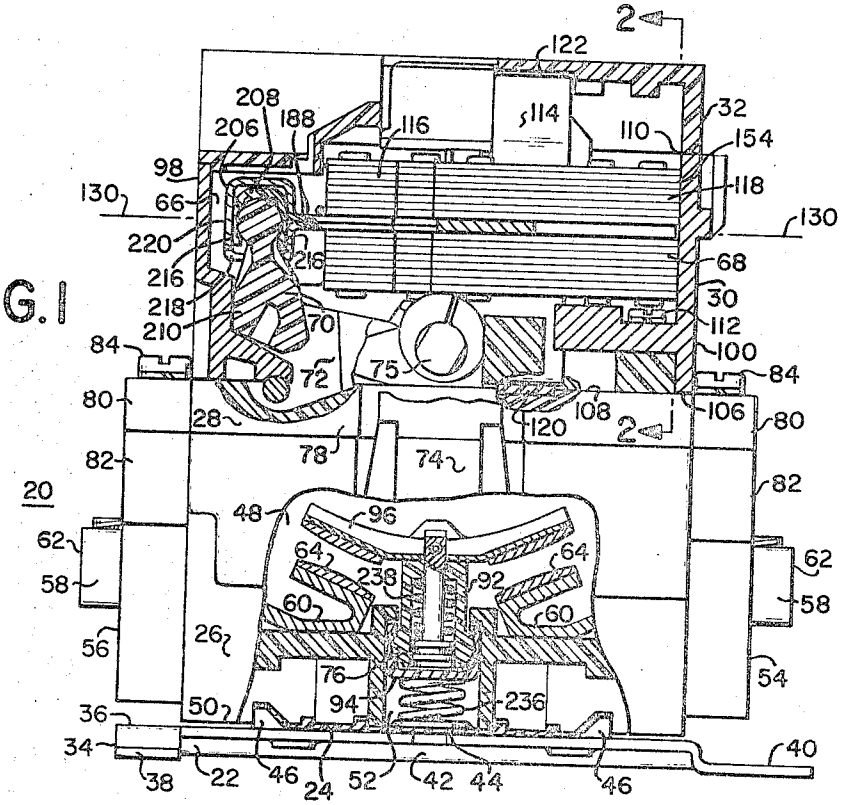
Jan. 5, 1971 M. Y. TURNBULL ET AL 3,553,617

MAGNET STRUCTURE AND MAGNET SUPPORT STRUCTURE IN AN ELECTROMAGNETICALLY OPERATED SWITCH

Filed July 23, 1969

2 Sheets-Sheet 1

FIG. 1



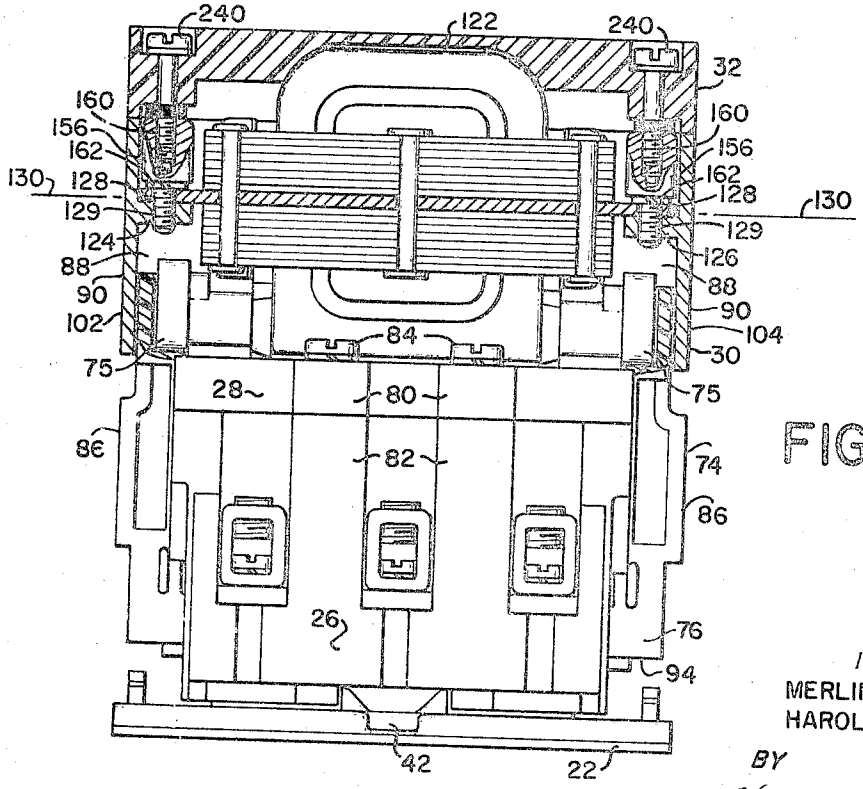


FIG. 2

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MAGNET STRUCTURE AND MAGNET SUPPORT STRUCTURE IN AN ELECTROMAGNETICALLY OPERATED SWITCH

Filed July 23, 1969 2 Sheets-Sheet 2

FIG. 3

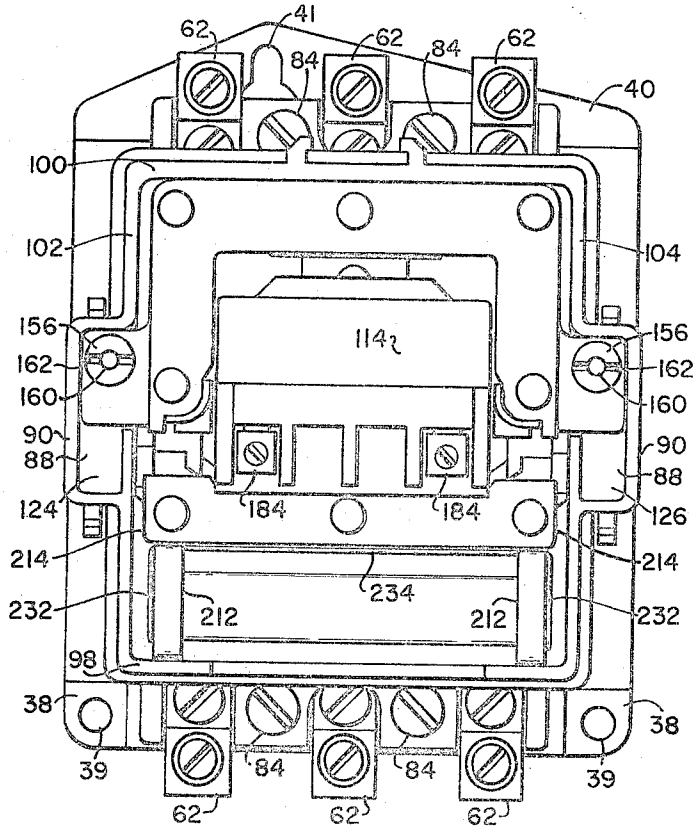
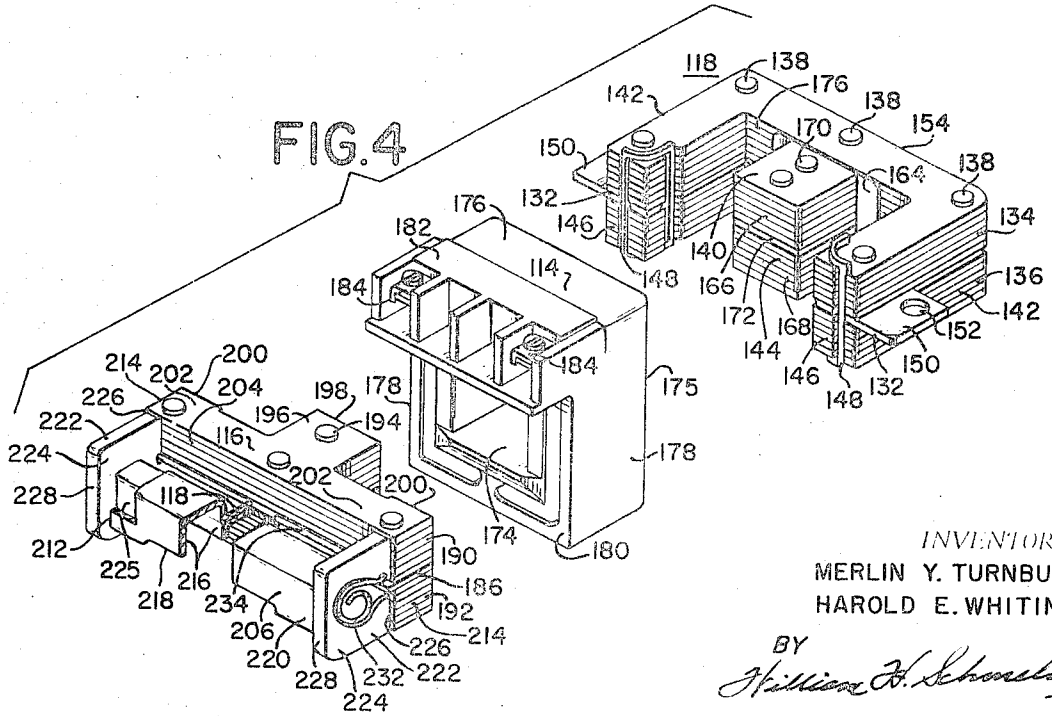


FIG. 4



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United States Patent Office 3,553,617 Patented Jan. 5, 1971

3,553,617

MAGNET STRUCTURE AND MAGNET SUPPORT STRUCTURE IN AN ELECTROMAGNETICALLY OPERATED SWITCH

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Filed July 23, 1969, Ser. No. 844,034
Int. Cl. H01h 45/04
U.S. Cl. 335—202 10 Claims

ABSTRACT OF THE DISCLOSURE

A multiple contact electromagnetically operated switch having a housing that provides an enclosure for the electromagnet operator of the switch. The housing includes at least one metal part that has a high coefficient of thermal conductivity so the housing acts as a heat sink and a radiator for heat generated within the electromagnet when a magnet coil of the electromagnet is energized. The heat sinking capability is accomplished by supporting a portion of a magnet core for the electromagnet of the metal housing by a pair of ears that are located adjacent the pole faces of the magnet core to maximize the transfer of heat between the magnet core and the housing. The ears extend from a member that is centrally located in the stack of laminated pieces of magnetic iron forming the magnet core. A member providing the connection between the armature and a bell crank lever extends centrally in the stack of laminated pieces of magnetic iron forming the armature so the support for the magnet core and the output of the armature are coplanar with resilient members carried by the member providing the connection between the amature and bell crank absorbing the shock when the electromagnet is de-energized.

The present invention relates to electromagnetic type switching devices and more particularly to the constructional details and the arrangement of the components of a multiple contact electromagnetically operated switching device.

Electromagnetic switching devices of the type with which the present invention is concerned are commonly known as contactors and are furnished as devices of varying sizes having ratings in accordance with standards promulgated by the National Electric Manufacturers Association, commonly known as NEMA. An example of a contactor construction which is particularly suited to control loads of 50 amperes or less, which corresponds to a NEMA Size 2 device, is disclosed in United States Patent No. 3,354,415, which was granted on Nov. 21, 1967 to the inventors Joseph J. Gribble, Kenneth J. Marien and Harold E. Whiting.

While the proportions of the device shown in the Gribble et al. patent may be increased to control currents greater than 50 amperes, economic and physical size limitations dictate that additional features should be incorporated therein if currents having a magnitude two or three times 50 amperes are to be controlled by the device. The stucture according to the present invention provides increased pressures between the switching contacts and a greater contact mass to enable the device to conduct the higher current values without overheating and without increasing the contact bounce characteristics of the device than was included in the structure disclosed in the Gribble et al patent. Thus while the device according to the present invention incorporates the desirable features and advantages included in the device as disclosed in the Gribble et al. patent, it additionally includes a novel support arrangement for supporting the magnet

core portion of the electromagnet which will cause the heat generated within the electromagnet to be more readily dissipated and reduce the impact shock which is imparted to the heat dissipating portion of the housing when the electromagnet is de-energized.

It is an object of the present invention to provide an electromagnetically operated switch with a magnet structure which will reduce the shock when the electromagnet is de-energized and to support the magnet core on a housing part for the switch so the housing will act as a heat sink and dissipate heat generated within the electromagnet when the electromagnet is energized.

Another object is to support a magnet core of an electromagnet on portions of a metal part of a housing in an electromagnetically operated switch structure so the metal part will act as a heat sink and aid in dissipating the heat generated within the electromagnet when the electromagnet is energized and to reduce the shock to the metal part when the armature moves to a de-energized position when the electromagnet is de-energized.

A further object of the present invention is to provide an electromagnetically operated switch with a housing that has one metal part formed of a material that has a high degree of thermal conductivity and forms the external walls and the internal walls of a cavity within the housing and to support a magnet core and provide a connection between the armature and a bell crank lever in the switch by members which extend in a common plane centrally in a stack of laminated magnet metal pieces that form the magnet core and the armature so that the forces between the magnet core, the armature and the bell crank lever react along a linear plane to minimize wear of the parts and provide an efficient magnet structure and connection between the armature and the bell crank lever and to support the magnet core on a pair of ears that are formed on the magnet core member to extend laterally at the pole face portions of the magnet core which ears are arranged to rest on ledges formed on the walls of the housing part so that an efficient heat transfer path is provided between the magnet core and housing part whereby the heat generated within the electromagnet will be efficiently dissipated by the housing part when the electromagnet is energized.

A further object of the present invention is to provide an electromagnetically operated switch with a housing that has one metal part formed of a material that has a high degree of thermal conductivity and forms the external walls and the internal walls of a cavity within the housing and to support a magnet core and provide a connection between the armature and a bell crank lever in the switch by members which extend in a common plane centrally in a stack of laminated magnet metal pieces that form the magnet core and the armature so that the forces between the magnet core, the armature and the bell crank lever react along a linear plane to minimize wear of the parts and provide an efficient magnet structure and connection between the armature and the bell crank lever and to support the magnet core on a pair of ears that are formed on the magnet core member to extend laterally at the pole face portions of the magnet core which ears are arranged to rest on ledges formed on the walls of the housing part so that an efficient heat transfer path is provided between the magnet core and housing part whereby the heat generated within the electromagnet will be efficiently dissipated by the housing part when the electromagnet is energized and to position a pair of elastomeric members at a surface on the armature that is remote from the pole faces on the armature by the member which provides the connection with the bell crank lever to absorb the shock which occurs when the

electromagnet is de-energized and the armature moves to a de-energized position as the elastomeric members are compressed between the armature and a wall of the housing part.

Further objects and features of the invention will be readily apparent to those skilled in the art from the specification and appended drawings illustrating certain preferred embodiments in which:

FIG. 1 is a side view partly in section of an electric switch incorporating an electromagnet structure and support therefor according to the present invention.

FIG. 2 is an end view partly in section of the switch in FIG. 1 taken in the direction of arrows 2—2 in FIG. 1.

FIG. 3 is a top view of the switch in FIG. 1 with a cover removed.

FIG. 4 is an exploded view showing in perspective the components of an electromagnet as used in the switch shown in FIG. 1 with a portion of the armature structure broken away to illustrate the connection of a shock absorbing member with the remainder of the armature.

Referring to the drawing, and particularly to FIG. 1, there is shown an electromagnet switch assembly **20** having a plurality of components that are stacked one upon the other. The components of the assembly include a metal mounting plate **22**, an insulating sheet-like member **24**, an insulating base **26**, an insulation barrier **28**, a metal housing **30**, and a cover **32**, each of which is disclosed and described in an application for U.S. Pat. Ser. No. 844,148, which was filed concurrently herewith.

The metal mounting plate **22** is formed of a stamped metal part and provides a means to secure the switch assembly **20** to a vertical panel and the like, not shown. When the plate **22** is secured to a panel, an edge **34** becomes a bottom edge of the plate **22** and a surface **36** the front surface of the plate **22**. The plate **22** has a pair of rearwardly extending indentations **38** along its bottom edge **34**, providing a pair of spaced mounting feet having openings **39** therein. The plate **22** also has an identation **40** extending across its top edge which provides an elongated mounting foot having an opening **41** therein. The mounting feet **38** and **40** with the openings **39** and **41** therein are provided for the purpose of securing the plate **22** to a vertical panel. The plate **22** also includes an indentation **42** which extends from the bottom edge **34** rearwardly in the front surface **36** to the indentation **40**. The indentation **42** is provided to permit passage of control wires, not shown, from the upper to the lower ends of the switch **20** in the space provided by the indentation. The control wires may be connected in circuit with the switching contacts of a device known as an overload relay, in a manner well known to those skilled in the art. The plate **22** also is provided with suitably located threaded openings which act as mounting holes which are used to secure the insulating sheet-like member **24** and base **26** to the plate **22**.

The sheet **24** is preferably formed as a molded insulating part having a relatively thin cross section having a flat rear surface engaging the front surface **36** to cover a central portion of the indentation **42** so as to act as a cover for the wire trough. The sheet **24** is provided with a pair of circular ribs **44** which are raised on the front surface of the sheet **24** on opposite sides of a vertical center of the plate **22**. The ribs **44** act as spring seats, as will be later described. The sheet **24** also is provided with portions **46** which are formed along the top and bottom edges of the sheet **24** in alignment with the indentation **42**. The portions **46** act as scoops and aid in directing the wires in the portion of the wire trough disposed between the sheet **24** and the plate **22**.

As disclosed in the application for United States Patent, Serial No. 844,148, the base **26** and the barrier **28** are formed of a molded insulating material having arc suppressing capabilities and cooperate with each other to provide a cavity which is divided into three compartments **48** having equal widths. The base **26** has a rear surface **50** positioned on the insulating sheet **24** and the plate **22** in a secured position by suitable screws which pass through openings in the base **26** and the sheet **24** and are threadedly received in the housing holes in the plate **22**. Extending into the material of the base **26** forwardly of the rear surface **50** and through the side walls of the base **26** is a slot **52**. The slot **52** is centered on a center-line equidistant between a top wall **54** and a bottom wall **56** of the base **26** and is exposed to each of the compartments **48** by an opening. The compartments **48** each extend between the top wall **54** and the bottom wall **56** and each have a pair of terminal and stationary contact assemblies secured therein.

The terminal and stationary contact assemblies in each of the compartments **48** are arranged so that the contact assemblies of each pair are spaced equidistantly on opposite sides of the slot **52** and face in opposite directions. Each of the contact assemblies includes a terminal member **58** and a contact member **60**. When the pairs of terminal and contact assemblies are secured at the opposite ends of the compartments **48**, the terminal members **58** will have a wire connecting portion **62** extending external of the top wall **54** and the bottom wall **56** and the contact members **60** will have an inclined stationary contact surface **64** positioned on opposite sides of the slot **52**.

As disclosed in an application for United States Patent, Ser. No. 844,148, the barrier **28**, the metal housing **30** and cover **32** define an internal closed cavity **66** wherein an electromagnet **68** is included. The electromagnet **68** operates a bell crank lever **70** which has a pair of arms **72** connected to a movable U-shaped contact carrier **74** that has a bight portion indicated by the numeral **76** in the drawings. The bight portion **76** is movable forwardly and rearwardly in the slot **52**. The movable contact carrier **74** including the bight portion **76** is most clearly disclosed in an application for United States Patent, Ser. No. 844,100, concurrently filed herewith which has been assigned by the inventors Merlin Y. Turnbull and Harold E. Whiting to the assignee of the present invention. The barrier **28** has a body portion **78** which provides a front wall for the compartments **48** and suitable ribs, not shown provide side walls for the compartments. Extending from the body portion **78** are ears **80** that are arranged to seat upon the forward ends of a pair of posts **82** at the top and bottom walls **54** and **56**. The posts **82** each have a threaded insert molded therein and each of the ears **80** has an opening therein which permits the barrier **28** to be removably secured to the front surface of the base **26** by screws **84** which pass through the openings in the ears **80** into the threaded inserts in the posts **82**. It is readily apparent that the removal of the screws **84** will permit the assembly including the barrier **28**, the housing **30** and the cover **32** to be detached from the base **26** to permit access to the stationary and the movable contacts within the compartments **48** in the event the contacts require inspection or replacement.

The movable contact carrier **74** which is partly shown in FIG. 2, is preferably formed as a U-shaped molded part that includes the bight portion **76**. The bight portion **76** is received in the slot **52** while arms, **86**, which extend from opposite ends of the bight portion **76**, extend externally of the side walls of the base **26** have free ends received in channels **88** in the housing **30** defined by portions **90** on the housing **30**. The free ends of the arms **86** each receive a bearing **75** on a terminal end on an arm **72** of the bell crank lever **70**. Extending forwardly of the bight portion **76** are a plurality of spaced projections **92** each of which extends into one of the compartments **48**. The bight portion **76** has a rear surface **94** and each of the projections **92** has a front surface whereon a movable contact member **96** is positioned, in a manner disclosed in an application for United States Patent, Ser. No. 844,151, which has been filed by the inventor Merlin Y. Turnbull concurrently herewith.

The housing **30** preferably is formed as a cast metal part which has a high thermal conductivity. While aluminum may be used to form the housing **30**, in that it posesses high thermal conductivity and is light weight, because of its resistance to impact, the housing part **30** is preferably formed of a zinc die cast material to have a bottom wall **98**, a top wall **100** and a pair of side walls **102** and **104** which have a rear edge **106** resting on a front surface **108** of the barrier **28** and an open front wall **110** which is closed by the cover **32**. The front surface **108** and the walls **98**, **100**, **102** and **104** define the cavity **66** which has a front side closed by the cover **32**. The cover **32**, when removed, provides access to the electromagnet **68** that is positioned within the cavity **66** for inspection and for service purposes. Extending inwardly at each of the four corners of the housing **30** into the cavity **66** are suitably located ledges each of which has an opening therein and is arranged to rest upon the front surface **108** while the openings therein provide a passage for screws **112**, one of which is illustrated in FIG. 1, which are threaded into suitably located threaded inserts that are embedded in the barrier **28** to secure the housing **30** to the barrier **28**.

The electromagnet **68** which is positioned within the cavity **66** includes a magnet coil **114**, an armature **116** and a magnet core **118**. The magnet coil **114** preferably is formed as a molded encapsulated coil body as is well known to those skilled in the art and has a rear end positioned against an elastomeric sheet-like member **120** that is positioned in a socket in the front surface **108** and its front end positioned against an elastomeric member **122** on an inner face of the cover **32** so as to be positioned within the cavity **66** by the cover **32** and the barrier **28** when the cover **32** is secured to the housing **30**.

Extending inwardly along the opposite side walls **102**, **104** are a pair of ledges **124** and **126**. The ledges **124** and **126** each extend from the portions **90** into the channels **88** so as to present a forward facing surface **128** that is exposed to the cavity **66** and have a threaded opening **129** therein. The surfaces **128** are disposed to be adjacent and extend parallel to a center line indicated by a numeral **130** in FIGS. 1 and 2.

The magnet core **118** has an E-shape and includes an E-shaped central member **132** with an equal number of E-shaped magnet iron pieces stacked on the opposite sides of the central member **132**. The E-shaped central member **132** and the stacked E-shaped magnet iron pieces, which are indicated by the numerals **134** and **136**, are laminated together and secured by rivets **138**. The E-shaped central member and the E-shaped iron pieces provide the magnet core **118** with a central leg **140** and a pair of outer legs **142** with the leg **140** presenting a pole face **144** and the legs **142** presenting pole faces **146**. The pole faces **142** and **144** all face in the same direction with the pole faces **146** having shading coils **148** that are shaped and sized and secured therein in a manner well known to those skilled in the art. Extending outwardly of the outer legs **142** adjacent the pole faces **146**, and integrally formed on the central member **132** are a pair of ears **150**, each of which has an opening **152** therein. The ledges **124** and **126**, the surfaces **128**, the openings **129**, the ears **150** and the openings **152** are arranged so that when the magnet core **118** is positioned within the cavity **66**, the ears **150** will rest upon the surfaces **128**, with the openings **129** and **152** in alignment with each other with the central member **132** centered on the center line **130** and extending in a plane defined by the center line **130** that is perpendicular to the bottom wall **98** and the top wall **100**. Further, when the magnet core **118** is thus positioned in the cavity **66**, a top wall **154** of the E-shaped magnet core **118** including the E-shaped member **132** and the E-shaped magnet iron pieces **134** and **136**, will engage the portions of the top wall **100** facing the cavity **66**. When the magnet core **118** is thus positioned within the cavity **66**, the pole faces **144** and **146** will face the bottom wall **98**. The magnet core **118** is maintained in the cavity **66** in the position described by a pair of fastening members **156**, each of which has a portion extending through the openings **152** and threaded into the opening **129**. The fastening members each have a head portion that tightly engages the ears **150** and a threaded bore **160** extending from a free end thereof. The free end may be provided with a suitable slot **162** which receives a top of a screw driver for the purpose of tightening the members **156** in the openings **129**. As in conventional practice, a lock washer **162** may be positioned between the head portion and the ears **150**.

If desired, the portions of the magnet iron pieces **134** and **136** which define the central leg **140** may be formed as separate parts which are spaced from the remainder of the magnet core by a sheet **164** of a non-magnetic metal, such as brass, to provide the magnet core with a permanent air gap, as is well known to those skilled in the art. When the magnet core **118** is provided with a permanent air gap, the portions **166** and **168** providing the central leg **140** are maintained in position by rivets **170** and a leg portion **172** formed integrally with the remainder of the central member **132**.

The magnet coil **114**, when positioned within the cavity **66** by the elastomeric members **120** and **122** after the cover **32** is secured to the housing **30**, will present a rectangularly shaped opening **174** into which the leg **140** extends while a top wall **175** of the coil is positioned adjacent a wall **176** on the magnet core **118** from which the leg **140** extends. The coil **114** further has a pair of side walls **178** positioned adjacent the inner faces of the outer legs **142**, a bottom wall **180** facing the bottom wall **98** and a portion **182** extending through a suitable opening in the cover **32** carrying terminals **184** for the windings within the coil. The armature **116** in the form shown in FIGS. 1 and 4, has a T-shape and includes a central member **186** that is preerably formed of a single metal piece to have a pair of T-shaped portions **188** in face-to-face engagement with each other with the interface therebetween extending in the plane defined by the center line **130** and an equal number of T-shaped magnet iron pieces stacked on the opposite sides of the T-shaped portions **188**. The T-shaped portions **188** and the stacked T-shaped magnet iron pieces, which are indicated by the numerals **190** and **192** are laminated together and secured by rivets **194**. The T-shaped central portion and the T-shaped stacks of iron pieces **190** and **192** provide the armature **116** with a central leg or stem **196** having a pole face **198** at its free end and a pair of pole faces **200** at the ends of the arms **202** which face and are arranged to engage the pole faces **146**. The stem **196** extends into and is movable in the opening **174** when the armature **116** is positioned in the cavity **66**. The armature **116** has a bottom wall **204** facing in the opposite direction from the pole faces **200**. Extending downwardly from the wall **204** and spaced therefrom, the member **186** is provided with a portion **206** that is shaped to provide an operative connection with a bearing **208** that is mounted on an operating arm **210** of the bell crank lever **70**. The portion **206** has a box-like cross section and has its opposite ends **212** spaced inwardly of the ends **214** of the armature **116**. The box-like cross section provides a pair of spaced inner walls **216** and an opening **218** is provided in portions of the inner walls **126** and the rear wall **220** of the portion **206**. The opening **218** is sized so an end portion of the operating arm **210** on the bell crank lever **70** may extend into the space between the walls **216**. The arm portion **210** carries the bearing member **208** which is positioned between the walls **216** and is more clearly described in the application for United States Patent, Serial No. 844,100, supra. When the armature **116** is positioned within the cavity **66**, the bearing member **208** will be positioned between the walls **216** while the central leg **196** of the

armature **116** is received in and partly extends into the opening **174** of the coil **114**.

Positioned at the opposite ends **212** of the box-like portion **206** are a pair of elastomeric members **222** which are preferably formed by butyl rubber, which is a material well known for its ability to absorb shock without instantly rebounding. Each of the members **222** includies a shock absorbing portion **224** which is substantially rectangular in shape, having a flat surface **226** positioned on the rear wall **204** and a flat surface **228** remote from the wall **204** extending downwardly beyond the square shaped portion **206** so as to engage the bottom wall **98** when the armature is in its de-activated position. The members **222** also include a portion **225** which is formed integrally with the portions **224** and is received within the interior of the square shaped portion **206** to position the shock absorbing portion **224** on the ends **212**. A spring member having its opposite ends **232** formed to engage the outer surfaces of the shock absorbing portion **224** and a portion **234** connecting the ends **232** passing adjacent the wall **204** maintains the members **222** in position on the ends **212**. The switch assembly also includes a pair of springs **236** which are positioned by the ribs **44** and engage the bight portion **76** to constantly urge the movable contact carrier **74** forwardly in the slot **52** and a spring **238** which is compressed as the movable contact **96** engages the stationary contact surfaces **64**.

The mounting plate **22**, the insulating member **24**, the base **26**, the stationary contacts assemblies, the movable contact carrier **74** with the movable contacts **96** thereon, the barrier **28**, the housing **30** and the bell crank lever **72** which is positioned within the cavity **66** are all assembled in a manner disclosed in the application for United States Patent Serial No. 844,148, supra. After the foregoing mentioned parts are assembled, the electromagnet **68** is installed in the cavity **66** by assembling the armature **116**, coil **114** and the magnet core **118** so that the stem **196** extends into the opening **174** from one side of the coil **114** and the central leg **140** of the E-shaped magnetic core **118** extends into the opening **174** from the other end of the coil **114**. The electromagnet **68** is then installed within the cavity **66** by aligning the armature **116**, the coil **114** and the magnet coil **118** so that the coil **114** is seated on the elastomeric member **120**, the opening **218** permits the bearing **208** to be received between the walls **216** and the openings **152** on the ears **150** are aligned with the openings **129** so that the fastening members **156** may secure the electromagnet **68** in the cavity **66** as previously described with the shock absorbing portions **224** in engagement with the bottom wall **98**. The cover **32** is then secured on the housing **30** by positioning the cover **32** on the open front **110** and tightening screws **240**, which extend through suitably located openings in the cover **32**, into the threaded bores **160**. The cover **32**, when secured to the housing **30**, will cause the coil **114** to be properly positioned in the cavity **66** as the elastomeric member **122** is compressed against the front surface of the coil **114**.

The operation of the switching device **20** is as follows. While the switch **20** will operate when mounted on a horizontal support, it is particularly suited to be mounted on a vertical panel, not shown, so that the armature **116** will be moved by the combined forces furnished by gravity and the springs **236** to a position whereat the pole faces **200** of the armature **116** are separated from the pole faces **146** of the magnet core **118**. The energization of the coil **114** through suitable wires connected to terminals **184** causes a mutual magnetic attraction to be generated between the armature **116** and the magnet core **118**. The armature **116** is connected to the rotatable bell crank lever **70**. The magnet core **118** is maintained in engagement with the top wall **110** by the ears **150** which are secured on the ledges **124** and **126**. It is well known that the magnetic attraction between the armature **116** and the magnet

core **118** increases exponentially with the decrease in the distance between the pole faces of the armature **116** and the magnet core **118** and the magnet attraction increases to a maximum when the pole faces engage each other. The magnetic attraction between the armature **116** and the magnet core **118** causes the armature **116** to move upwardly toward the magnet core **118** and the bell crank lever **70** to rotate about its pivot. The rotating bell crank lever **70** causes the movable contact carrier **74** to move toward the plate **22** to a position wherein the movable contacts **96** engage the contact surfaces **64**. The initial movement of the contact carrier **74** is opopsed by the force of gravity on the armature **116** and by the springs **236**. The subsequent movement of the contact carrier **74** which occurs after the movablee contacts **96** engage the contact surfaces **64**, is opposed by the force of gravity on the armature **116** and the springs **236** as well as the springs **238** which are associated with the movable contact member **96**. Thus. the resistance to the movement of the armature **116** toward the magnet core **118** progressively increases as the springs **236** are compressed and markedly increases as the force required to compress the springs **238** is added to the force required to compress the springs **236**. The magnet core **118** is rigidly supported in the cavity **66** by the ears **150** to have its upper wall **154** tightly pressed against the top wall **110**. It is well known that when an electromagnet is energized, the area of the magnet core which includes the shading coil operates at a higher temperature than the remainder of the magnet core. Thus the heat generated within the electromagnet **68** when the coil **114** is energized will be readily transmitted by the ears **150** which are located on the magnet core adjacent the shading coils **148** and the wall **154** to the metal housing **30** so the metal housing may serve as an efficient heat sink and dissipate the heat energy generated within the electromagnet **68**. When the coil **114** is de-energized, the combined forces of the springs **236** and **238** as well as the force of gravity on the armature **116** will cause the armature **116** to move downwardly toward the bottom wall **98**. After the movable contact members **96** separate from the contact surfaces **64**, the force of gravity on the armature **116** and the springs **236** causes the armature **116** to continue its movement toward the bottom wall **98** to a position wherein the elastomeric members **222** engage the bottom wall **98** and limit further movement of the armature **116**. The members **222** each have a flat surface **226** resting on the rear wall **204** of the aramature **116** and a surface **228** arranged to engage the bottom wall **98**. Thus as the armature **116** moves to its de-activated position, the members **222** will be compressed and absorb the shock which could otherwise damage the housing **30**. Further, as disclosed in the Gribble et al. patent No. 3,354,415, supra, and in patent application Ser. No. 844,151, supra, as well as an application for U.S. Pat. Ser. No. 843,994, concurrently filed herewith, the movable contact and its supporting structure provides an arrangement will considerably reduce the bounce which accompanies the engagement between the movable contacts **96** and the stationary contact members **60**.

While certain preferred embodiments of the invention have been specifically disclosed, it is understood that the invention is not limited thereto, as many variations will be readily apparent to those skilled in the art and the invention is to be given its broadest possible interpretation within the terms of the following claims.

What is claimed is:

1. In an electromagnetically operated switch, the combination comprising: a housing including at least one metal part having a high coefficient of thermal conductivity, said part having a top wall, a bottom wall and a pair of side walls defining an internal cavity within the housing and providing at least a portion of the external walls of the housing and a pair of support ledges along side wall portions of the cavity, an E-shaped magnet core having a plate-like member and an equal number of E-shaped lam-

inated magnet metal pieces stacked on opposite sides of the plate-like member to provide a pole face at the terminal end of each outer leg of the core, a shading coil secured adjacent the pole face on each outer leg and a pair of ears extending from the plate-like member at the pole face portions of the core, said ears being secured to the support ledges for mounting the core within the cavity so the plate-like member extends in a plane perpendicular to the top and the bottom walls and providing a path for conducting heat generated within the core to the metal housing part, an armature movably mounted in the cavity and having a central member extending in the plane of the plate-like member and an equal number of laminated magnet metal pieces stacked on opposite sides of the central member to provide a pair of pole faces on the armature that are engageable with the pole faces on the magnet core, and a magnet coil having an opening extending therethrough centered in the plane of the plate-like member and surrounding at least a portion of the middle leg of the E-shaped magnet core for inducing a magnetic flux in the core and causing the pole faces of the armature to engage the pole faces of the core when the coil is energized.

2. The electromagnetically operated switch in accordance with claim 1 including a bell crank lever having an actuating arm portion movable in the cavity and a box-like portion on the central member centered in said plane and extending from a side of the armature remote from the pole faces on the armature, said box-like portion providing a connection between the armature and the actuating arm portion of the bell crank lever.

3. The electromagnetically operated switch in accordance with claim 2 wherein the armature is movable along said plane between two positions in the cavity and a yieldable means including a spring force reacting on the bell crank lever constantly urges the armature to a first of the said two positions and maintains the armature in the first position when the electromagnet is de-energized and the armature is moved against the force provided by the yieldable means to a second of the said two positions whereat the pole faces of the armature and the magnet core engage each other when the electromagnet is energized and wherein the switch includes a pair of resilient elastomeric members positioned at opposite ends of the box-like portion to engage the bottom wall of the metal part of the housing to reduce the shock to the housing when the armature moves from the second position to the first position.

4. The electromagnetically operated switch in accordance with claim 3 wherein the armature, the magnet coil and the magnet core are positioned within the cavity so that the force of gravity acts on the armature and provides at least a portion of the force which constantly urges the armature toward the first position.

5. The electromagnetically operated switch in accordance with claim 3 wherein the armature is connected to a movable contact carrier through the bell-crank lever and springs reacting on the movable contact carrier provides a portion of the force which constantly urges the armature toward the first position.

6. The electromagnetically operated switch in accordance with claim 1 wherein the magnet core is E-shaped and the armature is T-shaped.

7. The electromagnetically operated switch in accordance with claim 1 wherein the central portion of the box-like portion has spaced inner walls and an opening therein receiving a portion of the actuating arm portion of the bell crank lever so that a bearing member that is rotatable on a terminal end of the actuating arm is positioned between the inner walls of the box-like portion.

8. The electromagnetically operated switch in accordance with claim 3 wherein the elastomeric members each includes a shock absorbing portion that is positioned by the box-like portion to have surface portions engaging the side of the armature from which the box-like portion extends and surface portions extending from the box-like portion engageable with the bottom wall of the housing so that the elastomeric members are compressed between the bottom wall of the housing and the armature as the resilient members absorb the shock when the armature moves to the first position.

9. The electromagnetically operated switch in accordance with claim 8 wherein the box-like portion has an opening at each of its ends and each of the elastomeric members includes a portion extending from a side of the shock absorbing portion into the opening on the ends of the box-like portion for positioning the shock absorbing portion on the side of the armature.

10. The electromagnetically operated switch in accordance with claim 9 wherein a single spring-like member that has opposite ends engaging a side of the shock absorbing portion on each elastomeric member that is remote from the box-like portion maintains the position of the elastomeric members on the ends of the box-like portion.

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