June 8, 1965 A. C. SCRIBNER 3,188,406

MULTIPLE PLUNGER ELECTRICAL SWITCH FOR SEQUENTIAL CONTACT OPERATION AND DYNAMIC BRAKING

Filed Jan. 5, 1961 4 Sheets-Sheet 1

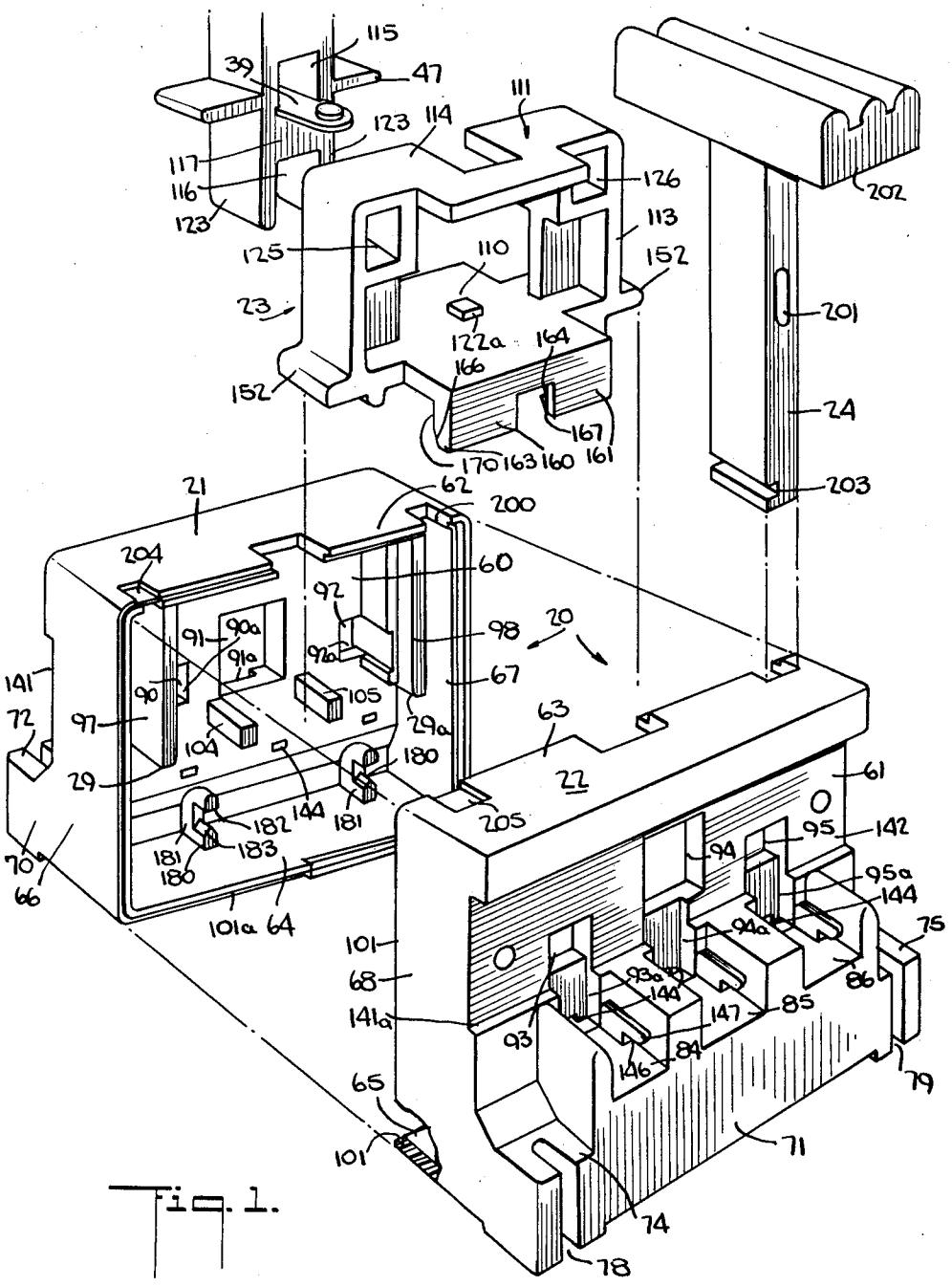


Fig. 1.

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Fig. 2.

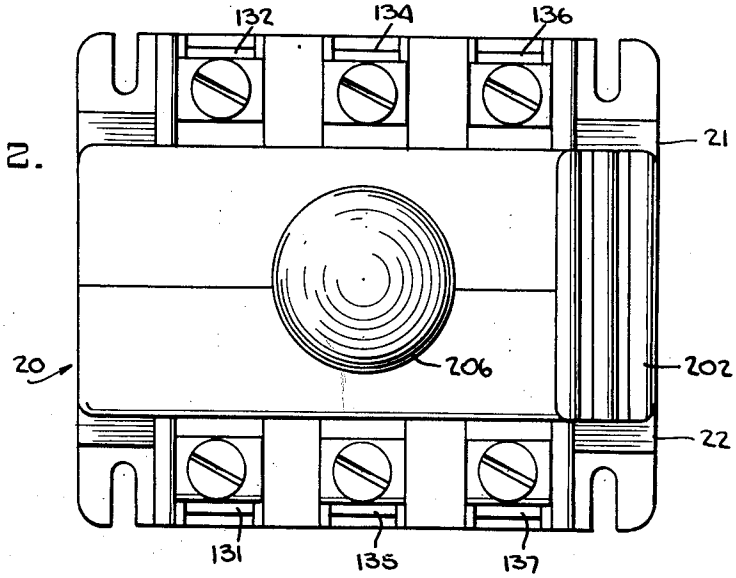


Fig. 3.

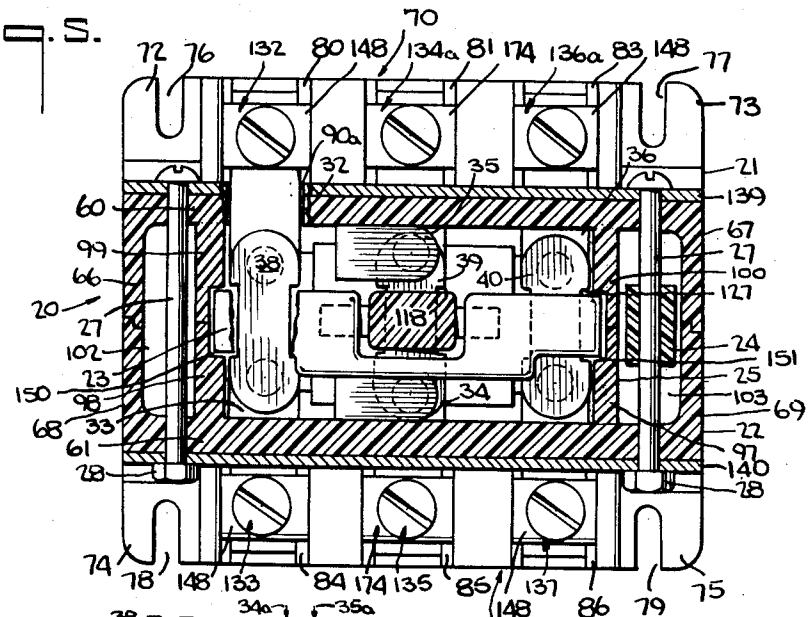


Fig. 11A.

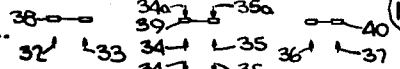


Fig. 11B.

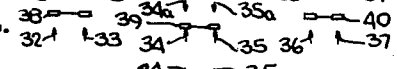


Fig. 11C.

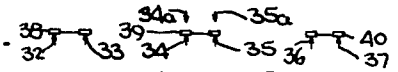


Fig. 11D.

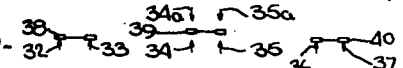
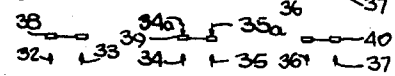


Fig. 11E.



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MULTIPLE PLUNGER ELECTRICAL SWITCH FOR SEQUENTIAL CONTACT OPERATION AND DYNAMIC BRAKING

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Fig. 3.

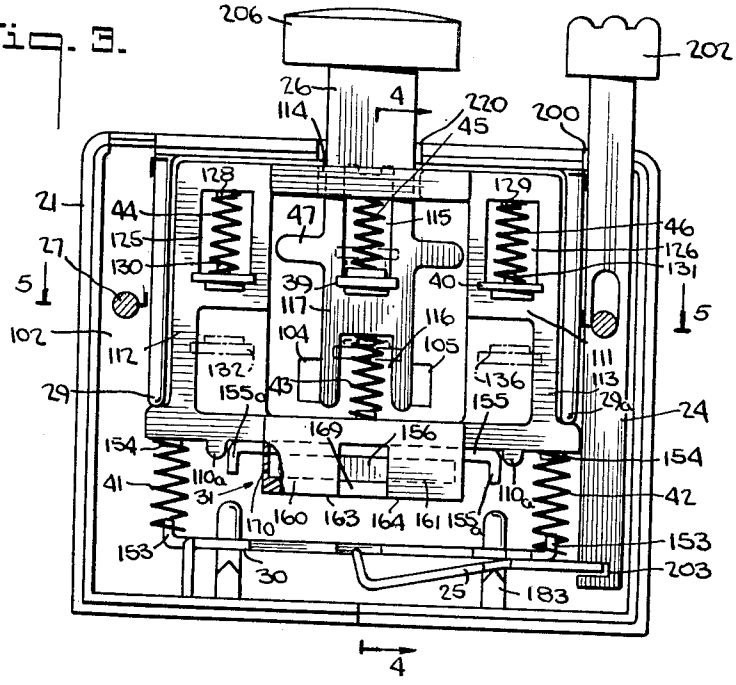
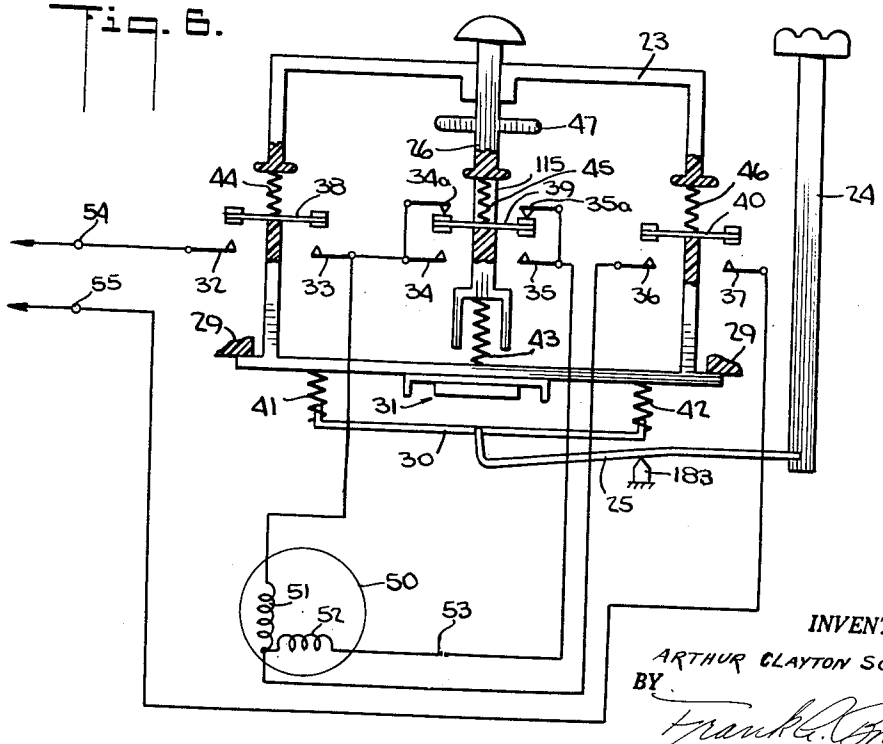


Fig. 6.



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MULTIPLE PLUNGER ELECTRICAL SWITCH FOR SEQUENTIAL CONTACT OPERATION AND DYNAMIC BRAKING

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Fig. 4.

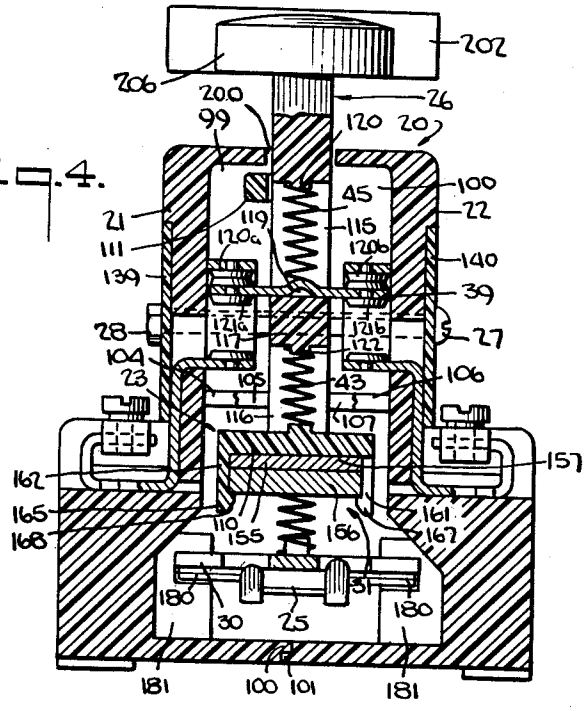


Fig. 7.

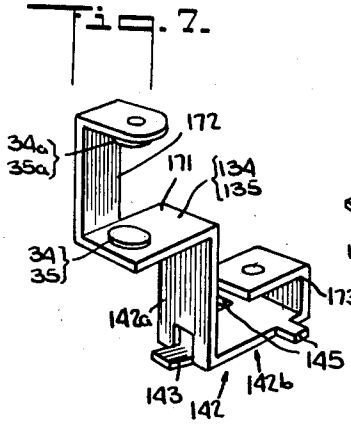


Fig. 9.

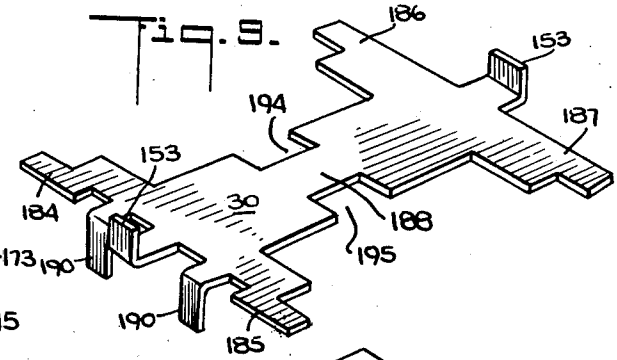


Fig. 8.

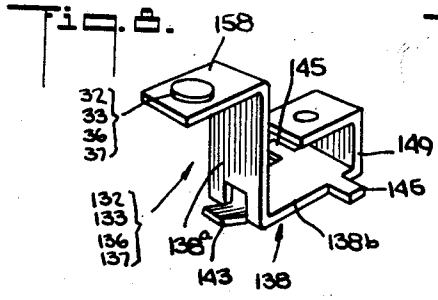
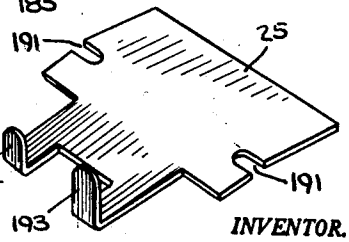


Fig. 10.



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United States Patent Office 3,188,406 Patented June 8, 1965

3,188,406

MULTIPLE PLUNGER ELECTRICAL SWITCH FOR SEQUENTIAL CONTACT OPERATION AND DYNAMIC BRAKING

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Filed Jan. 5, 1961, Ser. No. 80,862
11 Claims. (Cl. 200—17)

This invention relates to plunger operated electrical switches and particularly to switches having a plurality of sets of contacts making and breaking in a given relation.

In electrical apparatus it is often desirable to connect the elements of the apparatus in different relationships to provide for different electrical conditions. For example, in starting, running and stopping an electrical motor the windings are preferably connected in a different manner for each condition. On starting the motor the starting winding and a starting capacitor are connected between the input terminals and in parallel with the main winding. Under running conditions the starting winding is disconnected and the main winding is connected between the input terminals. In stopping the motor the main winding is disconnected from the input, and the starting winding and the capacitor are connected in series across the main winding to create a dynamic braking.

An object of this invention is to provide an electric switch with a plurality of sets of contacts that may be operated in a given relationship in response to mechanical actuation.

Another object of the invention is to provide a multicontact switch that comprises a minimum number of parts that are easily assembled.

Another object of the invention is to provide a multicontact electric switch that on starting connects the starter winding across the main winding, connects the main winding to the input terminals, disconnects the starting winding and then on stopping disconnects the main winding from the input and connects the starting winding across the main winding to apply dynamic braking.

Other and further objects and advantages will be apparent from the following description taken in connection with the drawings in which:

FIG. 1 is an exploded perspective view of the major components of the switch;

FIG. 2 is a top view of the assembled switch;

FIG. 3 is an open side view of the switch with one of the housing sections omitted;

FIG. 4 is a cross-sectional view of the assembled switch taken along lines 4—4 of FIG. 3.

FIG. 5 is a sectional view of the upper contact portion of the switch taken along line 5—5 of FIG. 3;

FIG. 6 is a schematic view of the functional portions of the switch and the circuit connections to the motor;

FIG. 7 is a perspective view of the center terminal;

FIG. 8 is a perspective view of the main terminal;

FIG. 9 is a perspective view of the armature;

FIG. 10 is a perspective view of the stop lever; and

FIGS. 11*a–e* are diagrammatic representation of the relationship of the fixed contacts and movable contacts.

Referring to the drawings, there are illustrated in FIGS. 1–5 the major components of the switch. The housing or casing **20** is formed in two identical housing sections **21, 22** and forms the major supporting and guiding means for the stationary and moving elements of the switch. The two housing sections **21, 22** are held together as an integral unitary housing **20** by means of overlapping contacting edges **100, 101** of the sections and the bolts **27** and nuts **28**. The armature **30** is held by the sections in fixed relation thereto and in a position

for engagement by the main contact carrier **23** on the starting and running of a motor. The terminals **132–137** are also held in fixed relation to the housing with the fixed contacts **32–37** within the housing for engagement by the moving contact bars **38, 39, 40** and the terminal clamps **132*a*–137*a*** exterior to the housing for securing the leads to the terminals.

The housing supports and guides the movement of the main contact carrier **23**, the trip or disconnect actuator **24** along with the stop lever **25**. In cooperation with the housing section **21** the main contact carrier supports and guides the starting and braking contact plunger **26** along the line of movement of the carrier. The movement of the main contacts is limited in the disengaged position by the stop **29** and in the engaging position by the armature **30**. The magnet means **31** on the carrier **23** holds the carrier in the engaging position by engaging the armature **30** until the magnetic linkage is disrupted by the trip actuator **24** and stop lever **25**. The contact carrier **23** is pressed upwardly against the stop means **29** by resilient means such as helical spring **41, 42**, and the starting and braking contact plunger is also urged upwardly by resilient means, such as the helical spring **43** positioned between the lower portion of the contact carrier **23** and the plunger. Stop means **47** on the plunger limits the upward movement of the starting contact plunger in relation to the main contact carrier. The contact bars **38, 39, 40** are, on the other hand, resiliently urged downward by resilient means such as the helical springs **44, 45, 56**.

Referring more particularly to FIG. 6, the connections of the switch to the motor **50** and the operation of the switch will be explained. The motor **50** is an alternating current motor having a main winding **51** and a starting winding **52**. A starting condenser **53** is connected in series with the starting winding **52**. Alternating current input terminals **54, 55** are connected to the motor windings through the contacts of the switch. The terminals **54** and **55** are connected to main fixed contacts **32** and **37** and the main winding is connected between the main fixed contacts **33** and **36** so that on bridging of contacts **32, 33** by the contact bar **38** and contacts **36, 37** by contact bar **40** current will be supplied to the main winding. The starting winding and condenser are connected across main winding to start the motor by the contact bar **39** bridging the fixed contacts **34, 35**. The auxiliary contacts **34, 34*a*** are connected to one end of the main winding and the auxiliary contacts **35** and **35*a*** are connected to the other end through the series connected starting winding and condenser. These fixed contacts form upper and lower auxiliary contact means. On the initiation of a starting procedure the contact carrier **23** and the starting contact plunger **26** are in the raised position as indicated in FIGS. 6 and 11*a*. As the starting contact plunger is depressed the contact bar **39** is disconnected from contacts **34*a*, 35*a*** and the lower end of the starting contact plunger **26** engages the contact carrier **23** to move the main contact bars **38** and **40** simultaneously with contact bar **39** which is in advance of bars **38** and **40**. The bar **39** connects the starting winding **52** and condenser **53** across the main winding **51** (FIG. 11*b*) prior to the connection of main winding **51** to the input terminals by bars **38, 40**. On the completed downward movement the bars **38** and **40** complete the circuit (FIG. 11*c*) and the main contact carrier **23** is locked in the load current supply position by the magnetic means **31** and the armature **30**. When the motor has accelerated to a speed at which the main winding **51** is able to carry the load without aid from the starting winding **52**, the pressure on the starting contact carrier is removed. The resilient means or spring **43** forces

the plunger 26 upward to disconnect the bar 39 from the contacts 34, 35 and thereby disconnecting the starting winding from input terminals. The stop means 47 limits the upward movement to prevent engagement of the contacts 34*a*, 35*a* by the bar 39. The contact bar 39 is in a neutral position (FIG. 11*d*). The motor is stopped by depressing the trip plunger 24 which pivots the stop lever 25 to separate the magnetic means 31 and armature 30. The springs 41, 42 force the contact carrier 23 and starting contact plunger 26 upward to the initial position with the bar 39 connecting the starting winding 52 and condenser 53 across the main winding 51 to apply dynamic braking and thus quickly stop the motor.

The housing sections 21 and 22 are made of plastic material and are formed by the same mold. The sections have side walls 60, 61; top walls 62, 63; bottom walls 64, 65; and end walls 66, 67 and 68, 69 respectively. On the exterior of the housing sections are terminal blocks 70 and 71 respectively formed as a single piece with a respective housing. The terminal blocks include corner bosses 72, 73 and 74, 75 for fastening the switch to an appropriate structural member. The bosses have slots 76, 77, 78 and 79 respectively for receiving bolts or other suitable fastening means. The block 70 has terminal recesses 80, 81 and 83 and block 71 has terminal recesses 84, 85 and 86. The side walls 60, 61 having openings 90 91, 92 and 93, 94, 95 respectively for passing contact arms of terminals into the interior of the housing.

The main terminals 132, 133, 136, 137 are illustrated in FIG. 8 and each comprises a contact supporting member 158, an L-shaped member 138 and a fastening member 149. The contact supporting members 158 extend through openings 90, 93, 92, 95 respectively within the housing and support the main contacts 32, 33, 36, 37 of a respective terminal. The L-shaped supporting members 138 have a portion 138*a* recessed in the grooves 90*a*, 92*a*, 93*a*, 95*a* in the side walls 60, 61 and a portion 138*b* positioned in the bottom of the recesses 80, 84, 83, 86. Plates 139, 140 fit in the side walls 60, 61 to close the openings 90–95 and cover the terminal portions 138*a*. The plates hold the terminals in position by the bolts 27 and nuts 28. Grooves 141, 141*a* are provided to recess the plates 139, 140 in the outside surface of the housing. The terminal clamps 148 are mounted on the fastening members 149 extending from the L-shaped member 138 and are located in the recesses 80, 84, 83, 86.

The terminals 134, 135 are similar to the main terminals with L-shaped members 142, fastening members 173 and contact supporting member 171 with extension member 172. The member 142 has a portion 142*a* recessed in grooves 91*a*, 94*a* and covered and retained by plates 139, 140 and a portion 142*b* recessed in the bottom of the openings 81, 85. The terminals 134, 135 have a second contact 34*a*, 35*a* extending upwardly from the contacts 34, 35 and spaced therefrom with the contact buttons facing one another for engagement by the bar 39. The fastening members 173 extend from the L-shaped member 142 and clamps 174 are mounted on the fastening members for securing leads to the terminals.

The terminals 132–137 are all mounted by sliding them into place from the outside of the housing. The contacts 32–37 pass through the openings 90–95 in the side walls. The openings 91, 94 are larger than the other four openings and are slightly off center to accommodate the contacts 34*a*, 35*a*. Each of the terminals has small tabs 143 at the inner bottom portions 138*b* and 142*b* and fits into the opening 144 in each recess through the wall. Along the side edges of the portions 138*b*, 142*b* are ears 145 which fit into slots 146 formed by the raised portions 147 on the side walls of the recesses. Thus the contacts are held firmly in place. The tabs 143 have a slight upward offset so that the distance between the contact supporting members and the tabs is slightly less than the corresponding distance between the openings 90–95 and the respective openings 144. This in combination with the ears holds the terminals snugly in place and prevents the upward displacement of the contacts. The terminals snugly fit in the openings 90 to 95, recesses 90*a* to 95*a* and recesses 80 to 86 to prevent sidewise movement of the contacts. The end cover plates 139, 140 retain the terminals in place.

Inside the housing sections 21, 22 are partitions 97, 98 and 99, 100 extending from the inside surfaces of the side walls 60, 61 and top walls 62, 63. The partitions extend to be substantially even with the edges 101 and 101*a* so that on assembly of the sections the partitions of the opposing section engage to form a contact chamber housing the contact carrier 23. The partitions are spaced from the adjacent side walls to form passages 102, 103 at each side of the housing for the trip or end plunger 24. Also projecting from and molded as a part of the side walls are guide bosses 104, 105 and 106, 107 spaced to guide the plunger 26.

The main contact carrier 23 is a single molded piece and has a flat platform 110, a generally U-shaped member 111 on one side thereof. The U-shaped member has side portions 112, 113 and a top cross member 114 having a U-shaped section forming a slot in the center of the contact carrier.

The starting and stopping contact carrying plunger 26 has an elongated shaft having a rectangular cross section and two longitudinally extending slots 115, 116 spaced by a web 117. The slot 115 carries the contact bar 39 and helical spring 45. The spring urges the bar toward the web. The spring 45 is of the helical type and is seated around the boss 120 which preferably has a rectangular shape. The boss forms a means for preventing sidewise movement of the end of the spring and for locating the spring in the slot. The contact bar 39 is a thin metal piece having a generally rectangular shape extending on opposite sides of the plunger 26 and having generally rectangular notches 118 in the side edges to retain the contact bar in the slot. In the center of the bar is an eyelet 119 punched in the contact bar to provide an attaching means for the end of the spring 45 to the contact bar for retaining the spring in place in the slot. The contact bar has two pairs of contact buttons, 120*a*, *b*, 121*a*, *b*, with one pair on the opposite side of the bar from the other pair to provide two separate contacting positions. The spring 45 normally holds the contact bar against the bottom surface of the slot. The side walls or surfaces of the slot and the notches on the contact bar provide means for guiding the bar on relative movement between the plunger and the movable contact bar.

The spring 43 is positioned between the end of the starting contact plunger 26 and the member of the contact carrier to impart a movement between the plunger 26 and carrier 23. The spring is seated on the boss 122 on the plunger and boss 122*a* on the carrier 23 to center the spring and prevent sidewise or lateral movement of the spring. The contact plunger 26 has extensions 123 on each side of the spring of equal length to limit the movement of the contact plunger 26 toward the member of the contact carrier 23. Stop means in the form of flanges 47 are provided to limit the relative movement of the plunger 26 and carrier 23 in the opposite direction. Thus the plunger 26 is movable relative to contact carrier 23 in the plane of movement of the carrier 23 with a resilient means urging the plunger 26 in the opposite direction to the resilient means engaging the contact bar 39.

The contact carrier 23 also carries the contact bars 38, 40. However, these bars have a single movement in relation to the fixed contacts as distinguished from the compound movement of the bar 39 in relation to the fixed contacts. The contact bars are mounted in slots 125, 126 formed by the partitions and the U-shaped member. The slots are positioned at opposite sides of plunger 26. The plunger 26 is thus positioned between the contact bars 38 and 40. The contact bars 38 and 40 are

similar to contact bar 39 and in this embodiment the bars are of the same length. The notches 127 in the longitudinal edges fit in the slots and provide a guide on cooperation with the surfaces of the carrier.

The springs 44, 46 are positioned within the slots 125, 126 respectively to urge the contact bars 38, 40 in the same direction as contact bar 39. The springs are seated around the rectangular bosses 128, 129 at one end and interlocked with the contact bars by the end of the springs fitting into eyelets 130, 131 stamped in the bars.

The plunger 26 is slideably mounted in the housing 20. The ribs or partitions 98, 99 and 97, 100 are formed with guide grooves 150, 151. The side walls 112, 113 of the carrier engage the groove to limit the movement to a linear action. The carrier has projecting flanges 152 on each side to engage the respective stop edges 29, 29*a* of the partitions to limit the disconnect movement of the carrier 23. The contact engaging movement is limited by the magnetic means 31 engaging the armature 30. Helical springs 41, 42 resiliently urge the contacts 38, 39 and 40 out of contact with the fixed contacts 32–37. The armature 30 is in fixed relation with the housing 20 and has projections 153 for seating the springs 41, 42 and the carrier 23 has rectangular bosses 154 for seating and holding the springs against sidewise movement.

The magnetic means 31 is mounted on the platform 110 of the carrier 23 and comprises a yoke member 155 and a rectangular wafer-shaped magnet 156. The yoke member 155 and the armature 30 are made of high permeability material and the magnet is a relatively thin section of permanent magnet material that can be readily magnetized through its thickness with north and south poles on opposite sides.

The platform 110 of the carrier 23 extends on each side of the U-shaped member to form a larger rectangular surface 157. On each side of this surface extending normally from the member are thin retaining members 160, 161, 162 with hooked shaped edges 163, 164, 165 for holding the yoke 155 and magnet 156 on the carrier to form a strong interlocking of the magnetic means 31 and the carrier 23. The carrier 23 is molded plastic material and the thin retaining members 160–162 are resilient in relation to the member to permit the yielding of the thin members so that the yoke and magnet may be snapped into place. The retaining edges have sloped surfaces 166, 167, 168 and the magnet means on being pressed against these surfaces causes the thin retaining members to separate and the magnetic means seat against the surface of the platform 110 and are held in place by the retaining edges. The retaining members 160, 161 are separated by a space 169. The retaining member 162 on the opposite side is located opposite the space 169 so that the carrier can be molded without using complex die mechanisms to form the hook-shaped edges. The opposite ends of the retaining members 160, 161 have small webs 170 to retain the magnet in place.

The yoke 155 has turned edges 155*a* which bear against the ribs 110*a* on the surface of the platform 110 to prevent endwise movement of the magnet means. Thus the magnet means is securely and fixedly fastened to the carrier 23. The retaining edges clamping the magnet means hold it from dislodgement by any force applied in a direction away from the carrier.

In the operation of the switch the magnet engages the armature forming a locking or latching means to hold the carrier 23 in the contact engaging position. The armature 30 comprises a single piece of magnetizable material and is held in a fixed position in the housing 20 by fitting in the notches 180 of the ribs 181. Two ribs 181 are molded as part of each housing section and the notches are formed with a flat surface 182 and an opposing V-shaped surface 183. The armature has four arms 184–187 positioned in the notches and spaced from the V-shaped surface 183 and bearing against the flat surface. The arms 184–187 extend from the body portion 188 having openings 194, 195. The magnet contacts the main portion of the armature and spans the openings on each side. The armature has tabs 190 extending toward and engaging the bottom wall of the housing on the edge away from the trip plunger 24. The tabs 190 firmly hold the arms 184, 185 against the flat surfaces. At the other end the stop lever 25 fits between the arms 186, 187 and the V-shaped surface 183 to firmly hold the arms 186, 187 against the flat surfaces 182. The projections 153 are positioned at opposite ends of the armature for supporting the helical springs.

An unlocking means is provided to separate the armature and magnetic means. The stop lever 25 is actuated by the trip plunger 24 and pivots or rocks on the V-shaped surface 183. The lever is slightly bent to permit the rocking action. The notches 191 fit around the ribs 181 to retain or hold the stop lever 25 in place. Two fingers or projection means 192, 193 of unequal length extend toward the armature and on pivoting of the lever fit into the openings 194, 195 to engage the magnet and separate the magnet from the fixed armature. The fingers 192, 193 are of different lengths. The finger 193 engages the magnet first and the force of the plunger raises the magnet disrupting the strong attractive force. The finger 192 then engages the magnet on the continued application of force to the plunger to raise the other side of the magnet thus separating the magnet and the armature. The plunger continues to separate the magnet and armature until the force of attraction between the magnet and the armature is less than the combined separating force of the springs 41 and 42. This spring force continues to return the main contact carrier 23 to the disconnect position and presses the flanges 152 against the stops 29, 29*a* formed by the edges of the partitions.

After the magnet is spaced from the armature the contact bars 38 and 40 disengage from the contacts 32, 33 and 36, 37 disconnecting the main motor winding from the input. The main contact carrier moves the contact bar 39 from the neutral position to engage the fixed contacts 34*a*, 35*a*. The spring 43 holds the flanges 47 against the carrier so the starting contact plunger 26 remains in fixed relation to the main contact carrier 23. After the main contacts are disconnected, the contact bar 39 closes the dynamic braking circuit by engaging the contacts 34*a*, 35*a*. This connects the main winding 50, starting winding 51 and condenser 53 in series promptly stopping the motor.

The stop lever 25 and trip plunger 24 are unbiased and the fingers are held in the recessed position by the magnetic means. The plunger 24 is slideably mounted in the passage between the partition and the end wall and extends outside of the casing through the opening 200. The plunger is provided with a slot 201 for passing the bolt 27 holding the housing section together.

The actuator 24 has a knob or head 202 on the exterior end. Pressure on the knob forces the plunger into the housing and the stop lever fitting in the groove 203 is pivoted about the fulcrum formed by the wedge shaped surface moving the fingers through the openings in contact with the magnet. The stop knob 202 is rectangular in shape and the surface engaged by the finger is ribbed. The start knob 206 is circular and has a convex upper surface. Thus the knobs may be distinguished by touching the upper surface or the shape of the knob.

The slot 200 is formed by removing the web pieces 204, 205. In order to utilize a single mold to manufacture the housing sections, the slot 200 is formed at each end of the housing with the thin web sections. The web section 204 on one section and the web section 205 on the other section are removed and the two sections fitted together. The web sections 204, 205 at the other end are intact covering the opening. Thus a single piece may be formed from a single mold to form both halves of the housing.

One of the features of the switch is the ease of assem-

bly. The fixed terminals 132–137 are slid into the recesses 80–86 inserting the contacts 32–37 through the openings 90–95 and fitting the tabs 143 in the openings 144 and the ears 145 in the slots 146. The armature 30 and stop lever 25 are fitted in the notches 180 in the ribs 181 of one of the housing sections. The helical springs are hooked into the eyelets 130, 131, the open ends of the springs are seated on the bosses 128, 129 and the contact bars 38, 40 are fitted in the openings 125, 126 by tilting the bar, inserting it in the opening and then meshing the notches 127 with the walls of the carrier. The yoke 155 and magnet 156 are snapped between retaining members 160–162. The main contact carrier is set in the housing section with the open end of the U-shaped notch in the upper cross member 114 facing the open side of the housing section. The lower platform 110 is positioned below the rectangular guide projections 104, 105 and the side members 112, 113 fitting in the grooves 150, 151 in the partitions 97, 98. The helical springs 41, 42 are fitted in place on the projection 153 of the armature and the bosses 154 of the carrier.

The starting contact carrier is preassembled by placing the contact bar 39 and spring 45 in the opening 115 in the same manner as contact bars 38 and 40 are fitted in carrier 23 and then by fitting the carrier into the notch in the cross member 114 and the opening 220 in the top wall of the housing section. The spring 43 is placed in the opening 116 and seated on the bosses 122 and 122*a*. The trip or stop plunger 24 is moved into place fitting the end of the stop lever in the groove 203 and the plunger in the slot 200 and either the passage 102 or 103.

The other housing section is positioned to mate with the partly assembled housing section completely enclosing the working parts with only the ends of the two plungers and the terminals extending through the housing walls. The cover plates 139 and 140 are fitted in the grooves 141, 142 and the bolts 27 inserted and securely held in place by the nuts 28.

To start the motor the knob 206 is pressed down which forces the starting contact carrier 23 down disconnecting the contact bar 39 from the upper fixed contacts 34*a*, 35*a* and the starting winding 52 and the condenser 53 from across the main winding. The downward movement continues and the platform 110 is engaged pressing the contact carrier 23 down with the starting contact plunger 26. The contact bar 39 engages the contacts 34 and 35 before the contact bars engage the contacts 32, 33 and 36, 37 respectively (FIG. 11*b*). Thus the starting winding 52 and condenser 53 are reconnected across the main winding before the main winding is connected to the input terminals 54, 55. The continued downward movement compresses the helical spring 43 and the contacts 38 and 40 are then moved into engagement with the fixed contacts (FIG. 11*c*). Thus the switch inherently assures by this sequential action that the capacitor 53 will be connected in series with the starting winding 52 and the series combination across the run or main winding 51 before any of the circuit elements are connected to the electrical supply.

With all the contacts bridged a circuit for the main current is provided through the fixed contact 32, contact bar 38, fixed contact 33, main winding 51, fixed contact 36, contact bar 40, fixed contact 37 to the input terminal 55. Another current path is provided from 54 through the contact 32, contact bar 38, contact 33, contact 34, contact bar 39, contact 35, capacitor 53, start winding 52, contact 36, contact bar 40, contact 37 to the terminal 55. With these two circuits completed the motor 50 develops torque and the motor increases to the desired speed.

The contact carrier 23 is moved further down to press the magnet 156 against the armature 30 to magnetically couple the two elements and hold the contact carrier in the engaged position. The attractive pull of the lines of force coupling the yoke, magnet and armature is greater than the combined force of the helical springs. The contact bars 38 and 40 are held in a firm electrical contact with the fixed contacts to transmit large amounts of current. The attractive force is sufficient to pull the carrier down when the air gap is reduced to a small space.

When the motor 50 has accelerated to a speed at which the main or run winding is able to carry the load without aid from the start winding 52, the pressure or force on the knob 206 may be removed. The starting contact carrier 23 will then move upwardly due to the compression of spring 43 and the flanges 47 engage the cross bar 114 and are firmly held there under the force of spring 43. This upward movement disengages the contact bar 39 from the fixed contacts 34, 35 (FIG. 11*d*). The main carrier 23 is retained in the depressed condition by the magnet means 31 and armature 30 and the contact bars 38 and 40 remain in engagement with the fixed contacts. This is the normal running condition.

The depressed position of the contact carrier 23 prevents the contact bar 39 from engaging the contacts 34*a*, 35*a* and holds the bar in a neutral position (FIG. 11*d*). The winding 52 and capacitor 53 are disconnected.

In order to stop the motor the stop actuator 24 is pressed down and the stop lever 25 pivoted to separate the magnet 156 and the armature 30 so that the combined forces of the helical springs 41, 42 will lift the contact carrier and disconnect the contact bars 38 and 40. The upward movement of the carrier carries the start contact carrying plunger 26 into engagement with the fixed contacts 34*a*, 35*a* (FIG. 11*e*). The contact bar is forced against the web 117 and the spring 43 is compressed pulling the flanges away from the carrier 23. The bridging of the contacts 34*a*, 35*a* applies dynamic braking to the motor by connecting the winding 52 and condenser 53 across the main winding with the main winding disconnected from the input terminals.

From the foregoing description it is seen that the switch is small, compact and self-contained. The parts are easily and inexpensively made with a sequence of action which starts and stops a motor with only two manual operations. A minimum of fastening parts are required and the operating and housing parts may be easily molded.

With this simplicity of structure the switch will accomplish the functions of connecting the start winding of a motor and its associated capacitor in parallel with the run or main winding, of connecting both the start and run windings to the electrical power supply, of disconnecting the start winding and capacitor from the power supply after the motor has accelerated to speed, of disconnecting the run winding from the power supply and of connecting the start and run windings and capacitor in series to apply dynamic braking.

It is, of course, understood that the switch may be used with other electrical devices than motors or motors having the particular arrangement of windings and capacitors. Also, various modifications may be made in the shape of the magnet and the armature, and the magnetic means and the armature may be interchanged.

The invention is set forth in the accompanying claims.

I claim:

1. In an electric switch; a casing fixedly supporting main contacts and reciprocally supporting a main contact carrier actuatable in and out of engagement with the main contacts and having a first resilient means biasing the carrier into a non-engaging position, upper and lower auxiliary contact means spaced in direction of movement of the main contact carrier, a starting and stopping contact plunger reciprocally mounted in said main contact carrier and having a contact bar resiliently urged in the direction of the engaging position of the main contact carrier and the main contacts and second resilient means between said main contact carrier and plunger urging a separation of the contact bar and lower auxiliary contact means in direction of disengagement of the main

contacts and the main contact carrier to separate said plunger contact bar from engagement to a nonengaging position of either auxiliary contact means when said main contact carrier is in a main contact engaging position and in combination with said first resilient means to move said starting and stopping contact bar on disengagement of said main contact carrier from the engaging position to move said plunger contact bar into engagement with the upper auxiliary contact means.

2. In an electrical switch; fixed main contacts, a main contact carrier reciprocally mounted to move along a line of movement in and out of engaging position with said main contacts, resilient means engaging said carrier for urging said carrier out of engaging position, a first and second pair of fixed auxiliary contacts spaced along the line of movement of said contact carrier, a contact plunger reciprocally mounted on said main contact carrier to move in the direction of said contact carrier to engage the first pair of auxiliary contacts on movement in main contact engagement and to engage the second pair of auxiliary contacts on movement from the main contact engagement, resilient means mounted between said plunger and carrier for urging said plunger out of engaging position with said first pair and said main carrier, said plunger being normally spaced from said main carrier along the line of movement to provide an initial leading advance into auxiliary contact engaging position of said plunger over main contact position of said carrier, and said plunger resilient means returning said plunger to a position out of contact with either of said pairs of said auxiliary contacts on maintained engagement of the main contact carrier and on disengagement of said contact carrier from the engaging position said main resilient means forcing said plunger in cooperation with said plunger resilient means into engagement with the second pair of auxiliary contacts.

3. For starting and stopping an electric motor having a main winding and a starter winding with one end connected to the main winding, an electric switch comprising a two-section housing having means for reciprocally guiding contact carrying members and having two sets of main fixed contacts engageable by separate bridging contact bars, a set of starting fixed contacts and a set of stopping fixed contacts, said latter two sets being electrically one piece and spaced from one another in the direction of movement of the contact carrying members, a main contact carrier reciprocally mounted in said housing sections and having two contact bars for engaging a respective set of fixed main contacts with resilient means for urging the contacts against said fixed main contacts in the direction of movement of said contact carrier, a starting and stopping contact carrying plunger reciprocally mounted in said main contact carrier and said housing sections and resilient means between said plunger and said main carrier to urge said plunger from said main contact carrier in a direction opposite to the contact engaging of said main carrier, said plunger having a starting and stopping contact bar movable between said two sets of starting and stopping fixed contacts and resiliently urged toward said starting fixed contacts in the direction of engaging movement of said main contact carrier, said resilient means between said carrier and said plunger normally spacing said carrier and plunger so that on depression of said plunger said plunger contact bar engages said starting fixed contacts in advance of said main contact bars and on release of pressure said plunger contact bar disengaging to a neutral position between said starting and stopping contacts while said main contact bars remain in engagement and on disengagement of said main contact bars said plunger contact bar engages said upper set of stopping fixed contacts to apply dynamic braking.

4. An electric switch comprising two substantially identical housing sections positioned face to face with each section formed of a single molded piece having a side wall, end walls and a top wall, said housing sections having partitions extending from a respective side wall and top wall and spaced from said end walls to form in said housing sections a contact chamber between said partitions and bound by said top wall and said side wall and guide passages between said partitions and an adjacent end wall, guide bosses spaced laterally and extending from said side wall intermediate said partitions and spaced downwardly from said top wall, openings in said side walls and main fixed contacts and upper and lower fixed auxiliary contacts extending through said walls into said chamber, a main contact carrier positioned between said partitions in said chamber and reciprocally guided by the partitions and engaging the main fixed contacts in the downward engaging position, a starting and stopping contact carrying plunger reciprocally mounted on said main carrier and between said guide bosses to reciprocate said plunger independent of said main carrier, said upper and lower auxiliary contacts being spaced in direction of movement of said plunger, latch means below said main carrier for holding said main carrier in contact engaging position, and trip means including an actuator reciprocally mounted in one of said passages and resilient means between said latch means and the main carrier to urge said main carrier into disengaging position and resilient means between said main contact carrier and said plunger to urge said plunger out of engagement with said lower auxiliary contacts and space said plunger in a neutral position between said upper and lower auxiliary contacts out of contact therewith when said main contact carrier is in engaging relation and on disengagement forcing said plunger in cooperation with said main contact carrier resilient means to raise the plunger into engagement with the upper auxiliary contacts.

5. An electric switch as set forth in claim 4 wherein said main carrier has means for engaging one of said partitions to limit the upward disengaging movement.

6. An electric switch as set forth in claim 3 wherein locking means are provided for holding said main contacts in engagement, said locking means comprising a magnetic means mounted on the bottom of the carrier and an armature fixedly mounted in said housing below said carrier and engaged by said magnetic means to hold said carrier in the engaging position.

7. An electric switch as set forth in claim 6 wherein actuating means are provided comprising a pivoted lever below said armature and having projection means for extending above said armature for engaging said magnetic means, a plunger reciprocally mounted in said housing and connected to said lever to pivot said projection means against said magnetic means to separate the magnetic means from said armature when said magnetic means is in contact therewith.

8. A locking electric switch comprising a casing having an enclosed chamber, first and second sets of fixed contacts extending through said casing into said chamber, a contact carrier reciprocally mounted in said chamber, current carrying contacts resiliently mounted in said carrier for engaging the first set of said fixed contacts, means for locking said carrier in the engaging position, a plunger reciprocally mounted in said chamber, second current carrying contacts resiliently mounted on said plunger for engaging and said second set of said fixed contacts, said plunger in an engaging and disengaging relation with said carrier to move in the engaging relation the contacts on said carrier into engaging position with said first set of fixed contacts, said contact of said plunger positioned in relation to said second set of fixed contacts to engage said second set in advance of said carrier contacts engaging said first set and in the disengaging relation said plunger contact disengaging from said second set and moving to a position out of engagement with any contacts while said carrier contacts are in engagement with said first set of fixed contacts and trip means for disengaging said carrier from said locking means.

9. An electric switch as set forth in claim 4 wherein said plunger and said actuator extend outside of said housing sections and each has knobs of different shapes and surface contour for differentiating one knob from the other solely by touch.

10. A locking electrical switch comprising a casing forming an enclosed chamber, a plurality of fixed contacts extending through said casing into said chamber, a carrier having resiliently mounted current carrying contacts for engaging said fixed contacts, means for moving said carrier into and out of contact engaging relation, magnetic means mounted on said carrier to create a magnetic field extending below said carrier and an armature fixedly mounted in said casing below said carrier magnetically coupling with said magnetic means to hold said carrier contacts in engaging relation with said fixed contacts and trip means supported by said casing for disengaging said magnetic means from said armature.

11. A locking electrical switch comprising a casing forming an enclosed chamber, a plurality of fixed contacts extending through said casing into said chamber, a carrier having resiliently mounted current carrying contacts for engaging said fixed contacts, means for moving said carrier into and out of contact engaging relation, said carrier having resilient retaining members extending below said carrier, said resilient retaining members having edge flanges with outwardly facing sloped surfaces, wafer-shaped permanent magnet means snapped between said

retaining members by pressing against said sloped surfaces and held in place by said edge flanges, a flat ferromagnetic armature plate fixedly mounted in said casing below said carrier and engaged by said permanent magnet to hold said carrier contacts in engaging relation with said fixed contacts and trip means including a reciprocally mounted actuator and a stop lever coupled to said actuator and pivotally mounted below said armature and having means extending above said armature plate for separating said magnet from said armature to permit said carrier to return to the disengaged position.

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