June 18, 1968 B. H. MATTHEWS ET AL 3,389,365

VARIABLE RESISTOR WITH SWITCH

Filed Aug. 23, 1965 3 Sheets-Sheet 1

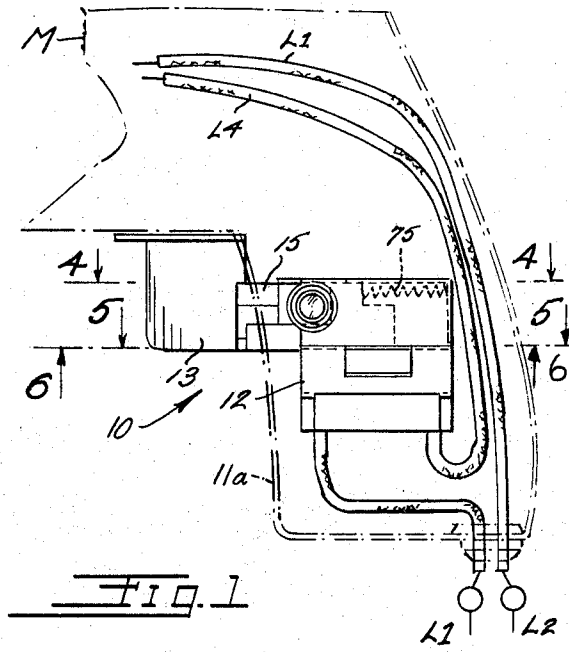


FIG. 1

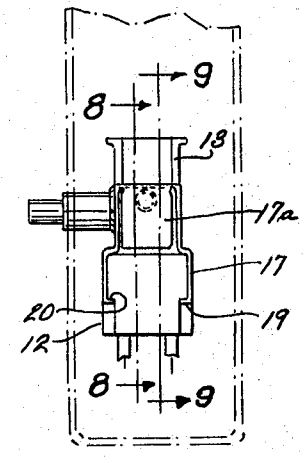


FIG. 2

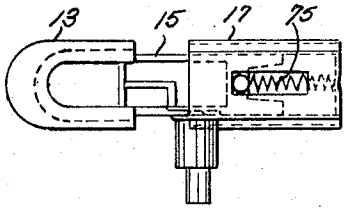


FIG. 3

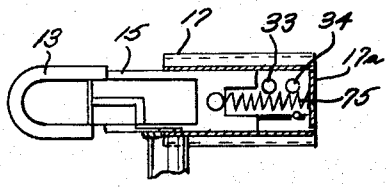


FIG. 4

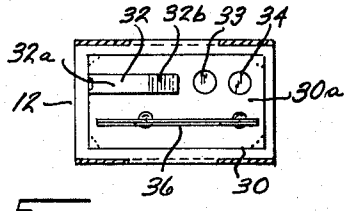


FIG. 5

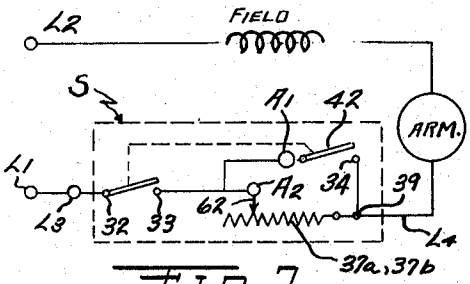


FIG. 7

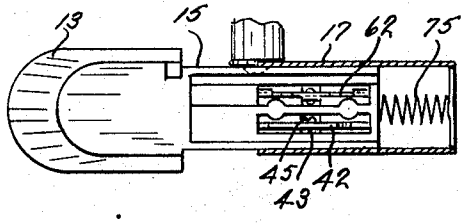


FIG. 6

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VARIABLE RESISTOR WITH SWITCH

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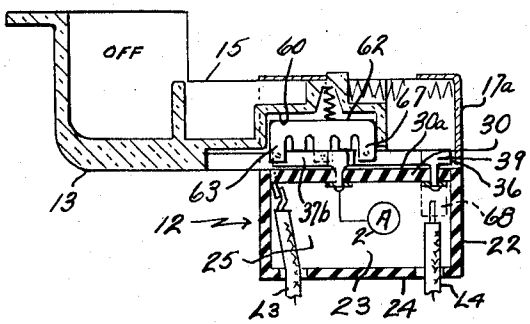


FIG. 8

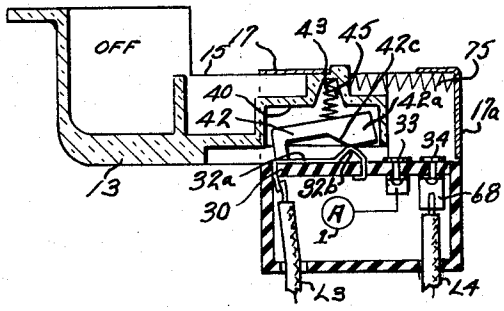


FIG. 9

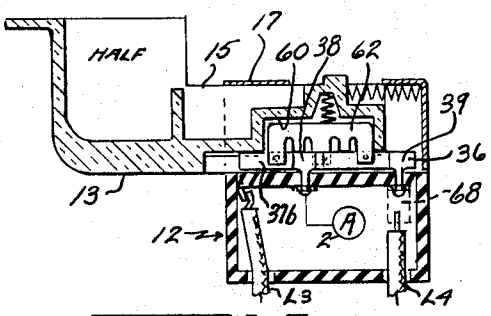


FIG. 10

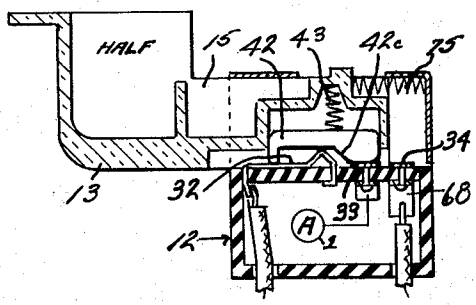


FIG. 11

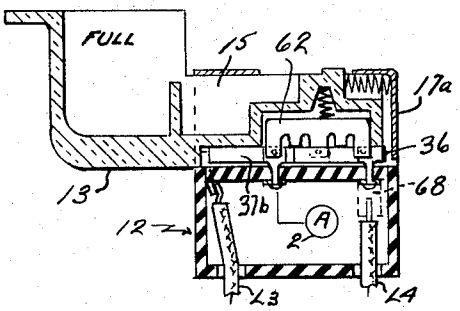


FIG. 12

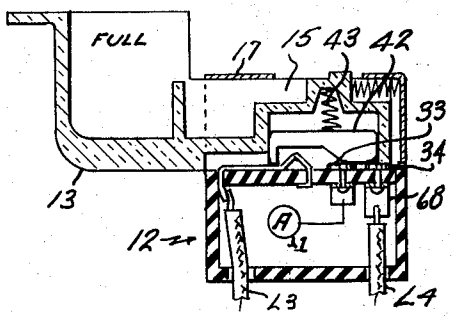


FIG. 13

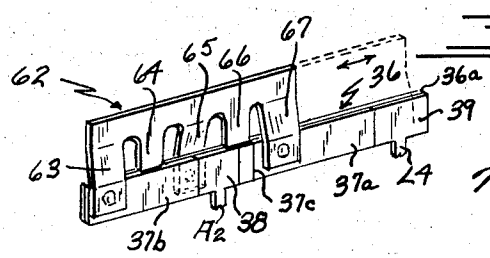


FIG. 14

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VARIABLE RESISTOR WITH SWITCH

Filed Aug. 23, 1965 3 Sheets-Sheet 3

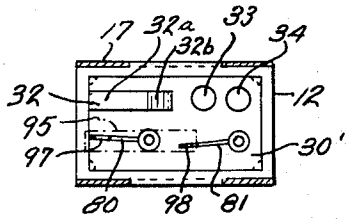


Fig. 15

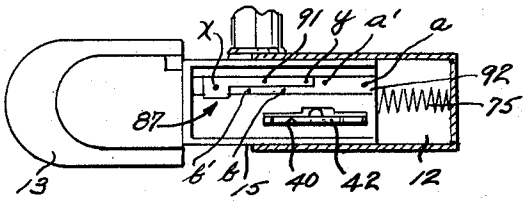


Fig. 16

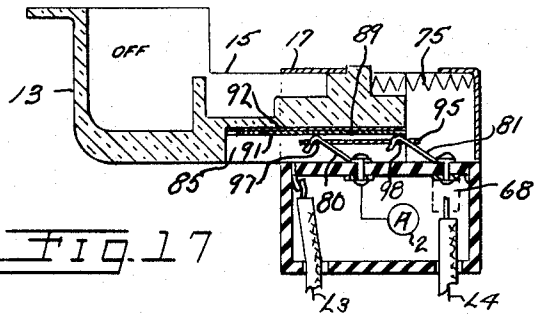


Fig. 17

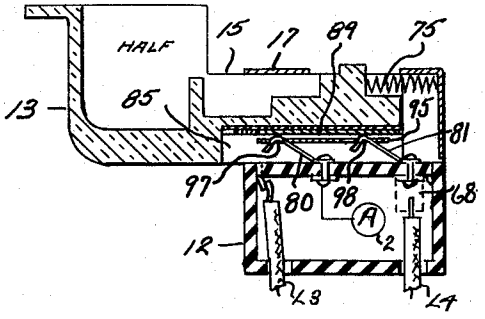


Fig. 18

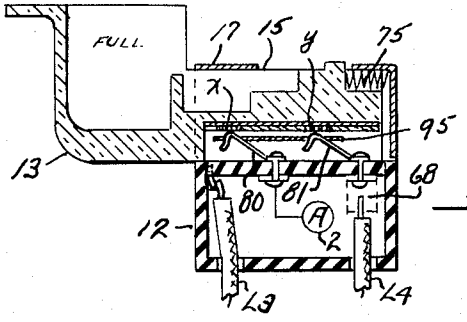


Fig. 19

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United States Patent Office 3,389,365 Patented June 18, 1968

3,389,365

VARIABLE RESISTOR WITH SWITCH

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Filed Aug. 23, 1965, Ser. No. 481,564
7 Claims. (Cl. 338—200)

ABSTRACT OF THE DISCLOSURE

A combination electric switch and resistor speed control is used to regulate the speed of a power tool. An activating trigger is slidable on an insulative base for switching a resistor in circuit with the tool motor and selectively decreasing the amount of resistance in circuit as the trigger is depressed. The resistance element and switching contacts are located on a support fixed to the base and a wiper means is slidably received by the support and positioned to be moved with the trigger. Alternatively, the resistance element and switching contacts are fixed to a surface of the trigger and the wiper means is fixed to the support.

This invention relates to electrical switch apparatus which has a movable switch contact assembly that includes a slidable bridging switch contact operable between bridging and non-bridging positions to connect and disconnect respectively, a source of electrical energy to a circuit input, and a second contact assembly which includes a rheostat assembly having a slidably actuated rheostat element operable to adjust said rheostat and regulate the magnitude of electrical energy to said circuit input.

It is therefore one of the objects of the present invention to provide electrical switch apparatus of the type above defined, and further which can be miniaturized in its structure so that it can be readily inserted into the housing of a portable tool such as an electric drill, saw or the like and which may be operable by the conventional finger actuated trigger of said tool to control the speed of the drive motor of said tool.

Additional objects and advantages of the electrical switch apparatus of the present invention will be apparent to one skilled in the art to which it pertains and upon reference to several preferred embodiments thereof as are described herein and illustrated in the accompanying drawings wherein:

FIG. 1 is a side view of the electrical switch apparatus of the present invention disposed in its operative position within the handle of a portable electric tool or the like;

FIG. 2 is an end view looking in the direction generally indicated by the arrows **2—2** shown in FIG. 1;

FIG. 3 is a plan view of the electrical switch apparatus removed from its tool housing;

FIG. 4 is a plan view taken approximately on the line **4—4** shown in FIG. 1;

FIG. 5 is a sectional view taken approximately on the plane as indicated by the lines **5—5** shown in FIG. 1;

FIG. 6 is a sectional view taken approximately on the line **6—6**, as shown in FIG. 1;

FIG. 7 is a schematic wiring diagram of a typical electrical control circuit of an electrical portable tool or the like and incorporating the switch apparatus of the present invention;

FIG. 8 is a longitudinal sectional view taken approximately on the line **8—8** shown in FIG. 2;

FIG. 9 is a similar longitudinal section taken on line **9—9** of FIG. 2;

FIG. 10 is a longitudinal sectional view similar to FIG. 8 but with the movable rheostat actuating element shown

in an intermediate position with respect to the fixed or stationary rheostat element;

FIG. 11 is a longitudinal sectional view similar to FIG. 9 and showing the electrical switch bridging member in a first bridging position with respect to the fixed or stationary switch contacts ant occurring at the instant the rheostat actuating element is moved to the FIG. 10 position;

FIGS. 12 and 13 are longitudinal sectional views similar respectively to FIGS. 10 and 11, but with the rheostat actuating element and bridging switch contact of the movable contact assembly in their fully actuated position;

FIG. 14 is a fragmentary perspective view of the rheostat assembly;

FIG. 15 is a plan view of a second embodiment of switch housing assembly and showing the stationary or fixed switch and rheostat elements of said assembly;

FIG. 16 is a plan view of the movable switch contact assembly incorporated in the second embodiment of switch apparatus of the present invention;

FIG. 17 is a longitudinal sectional view of the modified rheostat assembly shown in its off position;

FIG. 18 is a view similar to FIG. 17 but with the movable rheostat element moved to an intermediate position; and

FIG. 19 is a view also similar to FIG. 17 but with the movable rheostat element moved to its full on position.

The electrical switch apparatus as herein disclosed is especially designed to be utilized with a motor control circuit for varying the speed of an electrical series motor of the type used in a portable electrical tool such as a drill, saw or the like and is operable to provide a variable magnitude of electrical energy to said motor.

Referring momentarily to FIG. 7, a typical motor control circuit is schematically illustrated and shows a series motor with its armature and field connected in series with each other and across line conductors L_1 and L_2 to which is applied a source of alternating current voltage such as 110 v. A.C.

The electrical switch apparatus of the present invention as shown in its entirety at S is connected in series in either line L_1 or L_2. For purposes of identification the switch assembly is provided with a pair of output leads L_3, L_4 which connect respectively to line conductor L_1 and to one side of the motor armature.

Likewise, as will be hereinafter more clearly described, the switch assembly is of such electrical configuration as to be incorporated into a plurality of motor control circuits. For example, as shown in FIG. 7 herein the bridging contact **33** may be connected to the movable rheostat element **62** by connecting terminal points A_1 and A_2 together to enable the instant switch assembly to be used in the FIG. 7 configuration of motor control circuit. Likewise, by connecting terminal points A_1 and A_2 together in the manner shown in FIG. 7 the movable bridging contact **42** is also connected serially into the circuit effective to control the application of electrical energy to said circuit and motor. Likewise, for use of the instant switch assembly in a motor control circuit of the type that is disclosed in copending application Ser. No. 354,957, the terminal points A_1 and A_2 are connected respectively to the base *c* of the SCR **15** and to the conductor **22** of the circuit disclosed therein. As will be also obvious hereinafter, the electrical switch apparatus may be readily applicable to other configurations of motor control circuitry not herein specifically referred to.

With reference now directed to FIG. 1, the electrical switch apparatus of the present invention, as identified at **10**, is sufficiently miniaturized so as to enable the same to be readily inserted into the housing of a portable hand tool **11** such as an electric drill, saw or the like, said

apparatus having a somewhat rectangular housing **12** formed preferably of a plastic material or the like in which the switch elements are disposed. The housing **12** is seen to be suitably mounted in the handle part **11***a* of the tool housing, the usual trigger **13** extending outwardly therefrom and actuatable by the finger of the operator in the normal manner. By squeezing the trigger **13**, the movable actuator **15** of the switch apparatus is slidably actuated as will be hereinafter described so as to connect and vary simultaneously the magnitude of electrical energy to the tool motor effective to vary its speed.

One embodiment of switch apparatus of the present invention is illustrated in FIGS. 1–6 and 8–14 and is seen to include the aforementioned housing **12** of rectangular configuration upon which is slidably mounted the movable actuator **15** which is in the form of a bar and which may be preferably integrally formed with the aforementioned tool trigger **13**.

As best seen in FIG. 1, the slide bar **15** is mounted on top of the housing **12**, being secured to the latter as to be reversibly slidably movable longitudinally thereover by an inverted U-shaped clamp **17** which as seen in FIG. 2 has inwardly opposed fingers **19** provided at the ends thereof and which engage the switch housing **12** at recesses **20** located at the ends thereof being thus effective to securely fasten said slide bar **15** thereto.

As seen in FIG. 8, the housing **12** is of rectangular configuration having upstanding end and side walls **22** and **23** respectively, preferably integrally formed with the housing base **24** to thereby define an open-ended box-shaped container having a chamber **25** of similar configuration formed therein.

A switch plate identified at **30** is disposed within the upper open end of the housing **12** being preferably slightly smaller in its dimensions so as to substantially completely close the housing chamber **25**. The switch plate **30**, as best seen in FIG. 5, has a set of fixed or stationary switch contacts **32**, **33** and **34** mounted on its upper surface **30***a* which are secured to said plate in longitudinally spaced relation to each other. Spaced laterally therefrom a narrow elongated rheostat bar as identified at **36** is mounted on its one longitudinal edge on said plate and extends longitudinally therealong in parallel spaced relation to said contacts.

As seen in FIGS. 5 and 9, the set of switch contacts **32**, **33** and **34** project upwardly above the surface **30***a* of the switch plate **30**, fixed contact **32** having a rectangular flat portion as indicated at **32***a* and an upwardly projecting nipple-shaped camming portion **32***b* integrally formed on its end closely adjacent to contact **33**. Switch contacts **33** and **34** in turn are each preferably circular in configuration.

As seen in FIGS. 5, 8 and 14, the upright rheostat bar **36** is composed of a suitable non-conducting base, as indicated at **36***a*, such as bakelite and which is covered on its one side surface with two carbon tracks **37***a* and **37***b* forming a preselected value of resistance for example on the order of 100,000 ohms, the value depending upon the value of the components in the motor circuit to which it is connected. Track **37***b* on the inner end thereof connects to an intermediate metallic conductor plate **38**. The opposite or remote end of the carbon track **37***a* is seen to connect with a similar metallic conductor plate **39**. As best seen in FIGS. 10 and 14, the carbon track **37***a* is terminated at its inner end at **37***c* to space said track from the conductor plate **38**.

The slide bar **15**, which is slidably mounted on top of the switch housing **12**, carries a pair of contacts which are movable therewith into selective engagement with the stationary contacts **32**, **33**, **34** and the rheostat bar **36**.

As best seen in FIG. 9, the slide bar **15** is formed with a recess as indicated at **40** into which is disposed a metallic contact **42** being somewhat of inverted U-shaped configuration, coil spring **43** being disposed in blind hole **45** formed in said bar **15** and effective to bias said contact **42** toward the switch plate **30**.

Referring now to FIGS. 9, 11, and 13, by pressing the trigger **13** the slide bar **15** is slidable over the housing **12** from left to right causing the contact **42** to move from its FIG. 9 position thence to a plurality of intermediate positions as represented in its FIG. 11 position and finally to its FIG. 13 position.

As shown in FIG. 9, the contact **42** has a contacting end portion thereof as shown at **42***a* which, in the FIG. 9 or off position of the switch assembly has its bottom edge riding upon the top of the camming portion **32***b* of the fixed contact **32**, being urged into contact therewith by the coil spring **43**.

Said end portion **42***a* is formed with an angular wall **42***c* which extends outwardly and rearwardly therefrom to terminate with the main stem portion of the body of the contact **42**.

The angular wall **42***c* of said movable contact **42** and the upwardly extending camming portion **32***a* of contact **32** are each of such related configuration that as the switch bar **15** is moved from its FIG. 9 position toward its FIG. 11 position, said contact **42** is cammed so that its forward contact portion **42***a* is dropped directly onto the fixed contact **33** prior to and without any initial wiping action occurring between the said contacts **42** and **33**.

With the slide bar **15** moved toward its FIG. 11 position contacts **32** and **33** are connected to each other by movable contact **42**, said switch elements thus defining a closed contact or switch position for said assembly.

The closing of switch contacts **32**, **33** by contact **42** is shown schematically in FIG. 7 to connect line conductor L_1 to the switch apparatus S, and with the conductors A_1 and A_2 connected together, said line conductor L_1 is also connected to the adjustable element of the rheostat.

Thereafter, with the trigger **13** being additionally moved to the right to its FIG. 13 position, the contact **42** is moved therewith, its tail portion sliding along the rectangular flat section **32***a* of the contact **32**, whereupon its forward portion **42***a* rides over and partially onto the top of contact **34** thus bridging said contacts **33**, **34** and connecting the same with contact **32**.

The contacts **33**, **34** being connected to each other and to the contact **32** by movable contact **42** is also shown schematically in FIG. 7 to connect line conductor L_1 directly to the armature of the motor thus bypassing the rheostat assembly.

With reference directed now to FIGS. 8, 10 and 12, the slide bar **15** is also formed with a second rectangular-shaped recess **60** which is spaced laterally from the recess **40**. A contact **62** is disposed in said recess **60** and is formed of a suitable conductive material and has a plurality of depending fingers **63–67** disposed as best seen in FIG. 14 in longitudinal spaced relation along and projecting outwardly from the base of said contact.

The contact **62** is intended to engage the rheostat bar **36** being slidably actuated therealong so as to connect predetermined portions of the carbon tracks **37***a* and **37***b* thereof to the energy source being thereby operable as a variable resistance connected in series with the line conductor L_1 effective to vary the magnitude of electrical energy delivered to the connected motor.

As seen in FIG. 14, the contact **62** is mounted on the top longitudinal edge **36***a* of the rheostat bar **36** whereby the end fingers **63** and **67** extend over and engage the carbon tracks **37***b* and **37***a* respectively, the centrally disposed finger **65** extending over and engaging the opposite side surface of said rheostat bar, the material forming said contact **62** being preferably resilient in characteristic whereby said engaging fingers act to resiliently hold the contact **62** thereon.

To provide additional stability to the movable contact **62** as it slides along the upper edge **36***a* of the bar **36**, the intermediate fingers **64**, **66** of said contact are seen to

be shorter in their respective length so as to slidably engage the upper edge **36***a* of said bar.

As best seen in FIGS. 8 and 9, a connector bar **68** extends transversely across the underside of switch plate **30** and connects contact **34** and conductor plate **39** together.

With the slide bar **15** disposed in its FIG. 8 position corresponding to the off position for said switch the contact fingers **63** and **67** are in engagement with the carbon tracks **37***a* and **37***b* whereby a predetermined maximum value of resistance of said rheostat is connected serially in circuit with the terminal point A_2 and line conductor L_4.

As the slide bar **15** is thereafter moved to the right by pressing upon the trigger **13** the contact **62** is slidably moved along the carbon tracks **37***a* and **37***b* simultaneously with the movement of bridging contact **42**. As the slide bar **15** is moved to the right progressively toward its FIG. 10 and 12 positions, the value of the rheostat resistance is likewise progressively reduced until said slide bar is moved to its FIG. 12 position at which the contact fingers **63** and **67** engage the conductor plates **38** and **39** respectively, thus, connecting contacts **62** directly across the terminal point A_2 and line conductor L_4 to thereby short out the carbon tracks **37***b*, **37***a* whereby line conductor L_1 of the motor circuit may be connected directly to the one side of the motor armature.

At this instant, as is aforementioned and as seen in FIG. 13, the trailing end of bridging contact **42** is in engagement with the fixed contact **32** and its opposite end is in engagement with both contacts **33** and **34** thereby connecting the line conductor L_1 through closed switch contacts **42**, **34** to conductor L_4 and to said one side of the motor armature to provide a second conductor path to said armature.

Upon the operator releasing the trigger **13**, the coil spring **75** interposed between the slide bar **15** and the end wall **17***a* of the bracket **17** as seen in FIG. 9 is operative to spring said bar and trigger to its off position as shown in FIGS. 8 and 9. The instant switch apparatus is therefore seen to provide a first bridging switch assembly **32**, **33**, **34** and **42** which is operable to connect and disconnect respectively a source of electrical energy L_1 to a circuit input (motor circuit) and a second variable rheostat assembly operable to vary the magnitude of electrical energy to said circuit input.

Further, in the instant switch assembly the actuation of the bridging switch (movable contact **42**) and rheostat (rheostat contact **62**) are carried by the slide bar **15** and slidably actuated simultaneously.

In FIGS. 15–19 a second embodiment of switch apparatus of the present invention is herein disclosed, and differs from the previous switch structure in the rheostat assembly.

With reference directed particularly to FIGS. 15 and 17, the switch plate **30'** has the fixed or stationary contacts **32**, **33** and **34** mounted therein and which function with the bridging or movable switch contact **42** in the same manner as in the previous switch assembly.

The modified rheostat assembly comprises a pair of metallic spring-like fingers **80**, **81** securely fastened at one end to the switch plate **30'** in longitudinal spaced relation to each other and extending angularly upwardly therefrom. Finger **80** is connected to one end of conductor A_2 and finger **81** is attached to bracket **68** to which is connected one end of conductor L_4.

As in the previous switch assembly, when using the switch apparatus in the motor control circuit as shown in FIG. 7, conductors A_1 and A_2 are connected together to thereby connect the stationary contact **33**, the movable bridging contact **42** and finger **80** to each other.

Likewise, when using the switch apparatus in conjunction with the motor control circuit of the type disclosed in the aforesaid copending application Ser. No. 354,957 the conductors A_1 and A_2 are connected to fixed contact point *d* and to conductor **22**, respectively.

The slide bar **15** is formed with a recess **85** spaced laterally from the recess **40** and extending generally longitudinally along said bar in parallel spaced relation to said recess **40**.

A rheostat bar **87** is disposed in the recess **85**, being secured by any suitable means such as adhesive to the top wall **89** thereof.

As seen in FIG. 16, the underside of the rheostat bar **87** is provided with a somewhat L-shaped copper bus bar **91** which is disposed adjacent a somewhat similarly shaped carbon track **92** the surfaces of said bus bar and carbon track being preferably coplanar.

A flat spacer member **95** is seen to have a pair of slots **97** and **98** formed on opposite ends and adjacent the opposed longitudinal edges thereof and into which the curved ends of the fingers **80** and **81** are disposed.

The spacer member **95** is preferably of such width as to enable it to be inserted into the recess **85** and freely movable therethrough.

With the slide bar **15** mounted over the switch plate **30'**, the fingers **80** and **81** project upwardly into recess **85** and are pressed against the rheostat bar **87**.

As seen in FIGS. 16 and 17, with the slide bar **15** and trigger **13** in the off position for the switch apparatus, the curved end of finger **80** is intended to engage the carbon track **92** at approximately point *a* and in like manner at point *b* by finger **81**. At this switch position the resistance of the carbon track **92** between points *a* and *b* represents the rheostat resistance connected between line conductors L_3 and L_4 in the motor control circuit shown in FIG. 7.

With the trigger **13** further depressed to a position such as illustrated in FIG. 18, whereby the fingers **80** and **81** engage the carbon track **92** at points *a'* and *b'* respectively the resistance between said points *a'* and *b'* has been progressively reduced to thereby provide a larger magnitude of electrical energy to the motor effective to increase the speed thereof to, for example, half speed.

As the trigger **13** is moved to its FIG. 19 position, the fingers **80** and **81** engage the copper bus par **91** at points *x* and *y* respectively, whereby the rheostat resistance is zero and maximum energy is available to the motor to enable the same to attain full speed.

Having thus described several preferred embodiments of switch apparatus of the present invention it will be realized that the same is susceptible to various modifications, combinations and arrangements of parts thereof without departing from the inventive concepts as are defined in the claims.

What is claimed is:

1. In an electric switch, in combination, a switch base, at least a pair of stationary contacts mounted on said base in spaced relation to each other, an electrically conductive bridging contact having contacting ends, actuator means supporting said bridging contact and mounted for sliding movement over said base between a non-bridging position where said bridging contact is out of engagement with at least one of said stationary contacts and a bridging position where the contacting ends of said bridging contact engage said stationary contacts, respectively, a rheostat assembly comprising bar means supported on said base and having a surface disposed generally perpendicular to said base, resistor means on said surface connected to conductive terminal means, a second contact operatively connected to said actuator and having contacting means engageable with said resistor means, said second contact being movable with said actuator to selective positions along said resistor means to provide a plurality of resistance values between said terminal means, and said second contact being movable to a position to connect across said terminal means effective to provide a second conductive path through said second contact and between said terminal means short-circuiting at least a part of said resistor means therebetween.

2. In an electric switch, in combination, a switch base, at least a pair of stationary contacts mounted on said base in spaced relation to each other, an electrically conductive bridging contact having contacting ends, actuator means supporting said bridging contact and mounted for sliding movement over said base between a non-bridging position where said bridging contact is out of engagement with at least one of said stationary contacts and a bridging position where the contacting ends of said bridging contact engage said stationary contacts, respectively, a rheostat assembly comprising a pair of conductive terminals spaced along said base, an elongate bar supported on said base having a surface disposed generally perpendicular to said base and extending longitudinally therealong in parallel spaced relation to said stationary contacts, a pair of resistor tracks carried on said surface and disposed in longitudinal spaced relation to each other, one of said terminals connecting with adjacent ends of said resistor tracks, the other of said terminals connecting with the opposite end of one of said resistor tracks, a second conductive contact operatively connected to said actuator and formed with at least two contact fingers each of which engages one of said resistor tracks, said second contact being slidably movable by said actuator along said bar to move said contact fingers along said resistor tracks and provide a plurality of resistance values between said terminals, and said second contact being movable by said actuator to bring said contact fingers into engagement wi.h said terminals effective to provide a second conductive path between said terminals and short-circuit at least a part of said resistor tracks therebetween.

3. In an electric switch, in combination, a switch base, at least a pair of stationary contacts mounted on said base in spaced relation to each other, an electrically conductive bridging contact having contacting ends, actuator means supporting said bridging contact and mounted for sliding movement over said base between a non-bridging position where said bridging contact is out of engagement with at least one of said stationary contacts and a bridging position where the contacting ends of said bridging contact engage said stationary contacts, respectively, a rheostat assembly comprising a pair of terminals carried on said base, bar means supported on said base and having a surface disposed generally perpendicular to said base, a pair of resistor elements mounted on said surface each connected to said terminals, a second contact operatively connected to said actuator and having contacting means engageable with each said resistor element, and said second contact being slidably movable with said actuator to selective positions along said resistor elements to provide a plurality of resistance values between said terminals.

4. In an electric switch as defined in claim 1 and wherein the conductive terminal means are spaced along said base of said switch, said bar means includes an elongate bar supported on said base which extends longitudinally therealong and having a surface disposed generally perpendicular to said base and said resistor means includes a pair of resistor tracks on said surface connecting to said terminal means, and wherein said second conductive contact includes a pair of fingers each engaging one of said resistor tracks, said second contact being slidably movable by said actuator along said bar to slide said contact fingers along said resistor tracks and provide a plurality of resistance values between said terminal means.

5. A rheostat assembly as is defined in claim 4 and which includes at least one additional finger on said second contact engaging said elongate bar effective to stabilize said second contact on said bar.

6. A rheostat assembly as is defined in claim 1 and wherein the second contact is disposed in approximate parallel spaced relation to said bridging contact.

7. A rheostat assembly as is defined in claim 4 and wherein the elongate bar is spaced transversely from said stationary contacts and extends generally parallel therewith along said base.

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