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Kaman et al.

[11] **3,755,640**

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[54] **REVERSING SWITCH FOR A POWER TOOL WITH SEPARATE SELECTIVELY MOVABLE CONTACT CARRIERS**

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[52] **U.S. Cl.** ..... **200/157,** 200/1 V, 318/292

[51] **Int. Cl.** **H01h 13/08**

[58] **Field of Search** ..... 200/157, 1 V, 61.85, 200/16 R, 5 R; 318/292; 310/68 A, 50; 173/170

[56] **References Cited**

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3,594,523	7/1971	Frenzel	200/157
3,603,757	9/1971	Sahrbacker	200/157
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3,689,715	9/1972	Glenn	200/16 R

Primary Examiner—Robert K. Schaefer
Assistant Examiner—Robert A. Vanderhye
Attorney—McDoughall, Hersh & Scott

[57] **ABSTRACT**

A common contact is arranged for connection to one of the two lines of an electric power source; a second common contact is arranged for connection to the field windings of the motor. A pair of contact strips is arranged for respective connection to the sides of a motor armature which is wound for rotation in both directions. A pair of movable contacts is mounted by a respective pair of contact carriers for slidable engagement with the contact strips. A reversing arm actuates a shuttle for connecting a selected one of the contact carriers for movement by the trigger from an "off" position wherein the associated movable contact is in engagement with the first common contact and out of engagement with the second common contact to an "on" position wherein said movable contact is in engagement with the second common contact and out of engagement with the first common contact.

10 Claims, 8 Drawing Figures

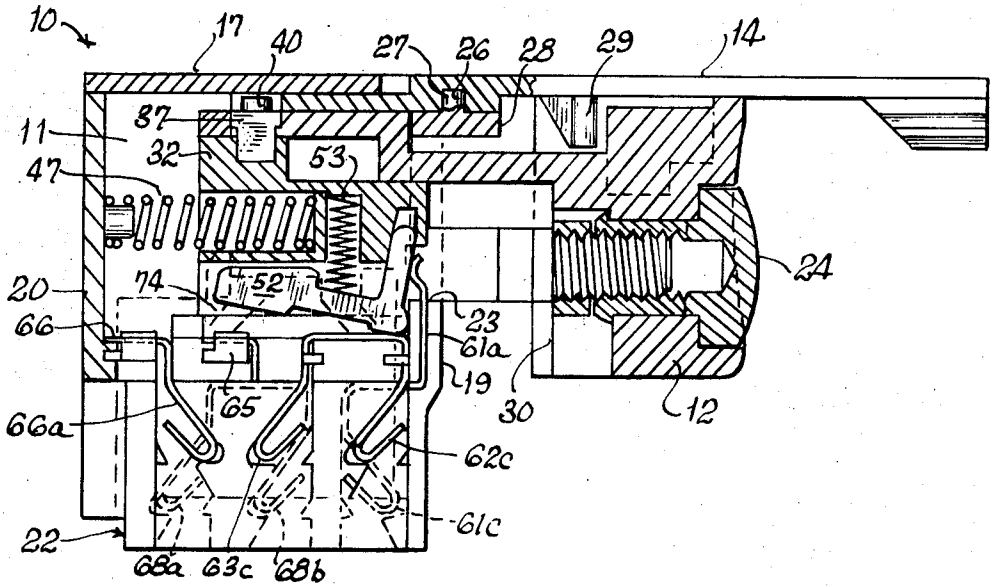


FIG. 1

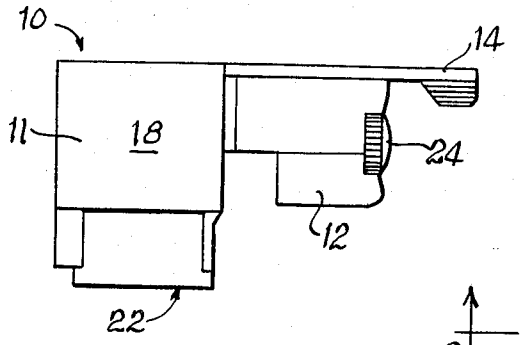


FIG. 2

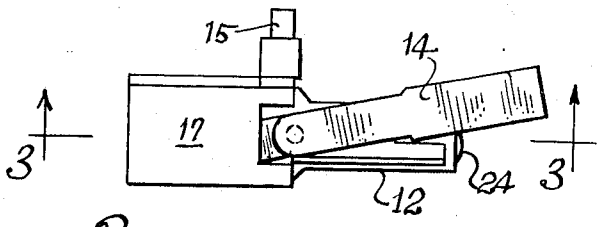
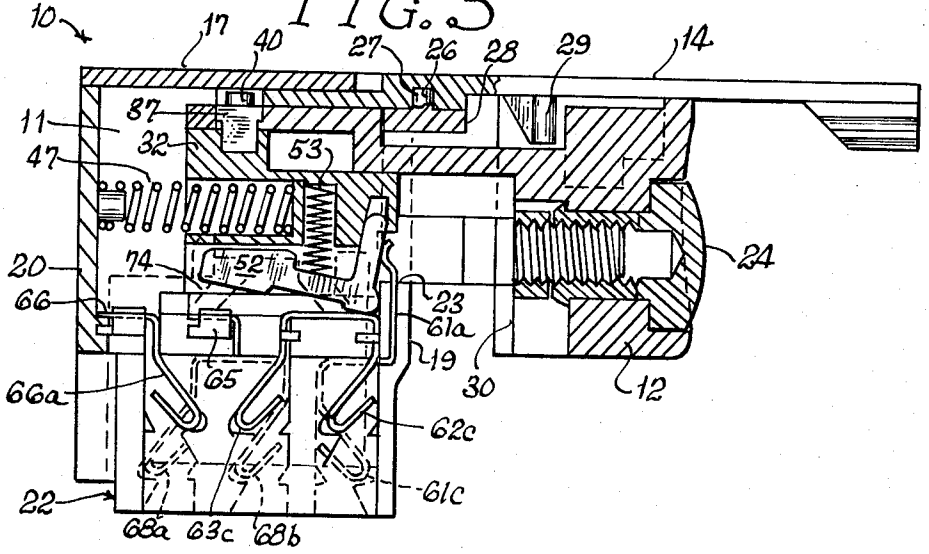


FIG. 3



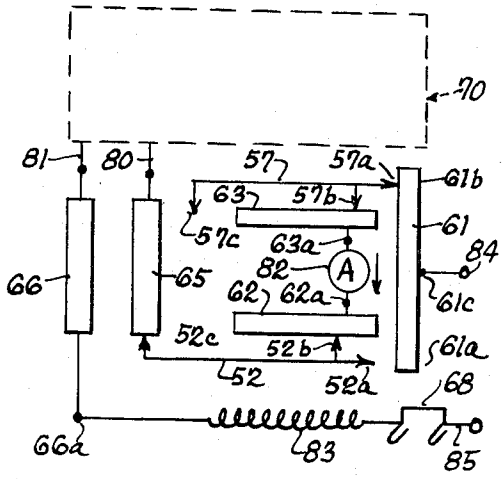


FIG. 7

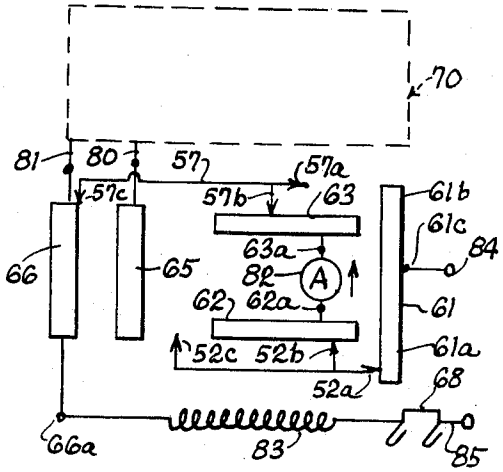


FIG. 8

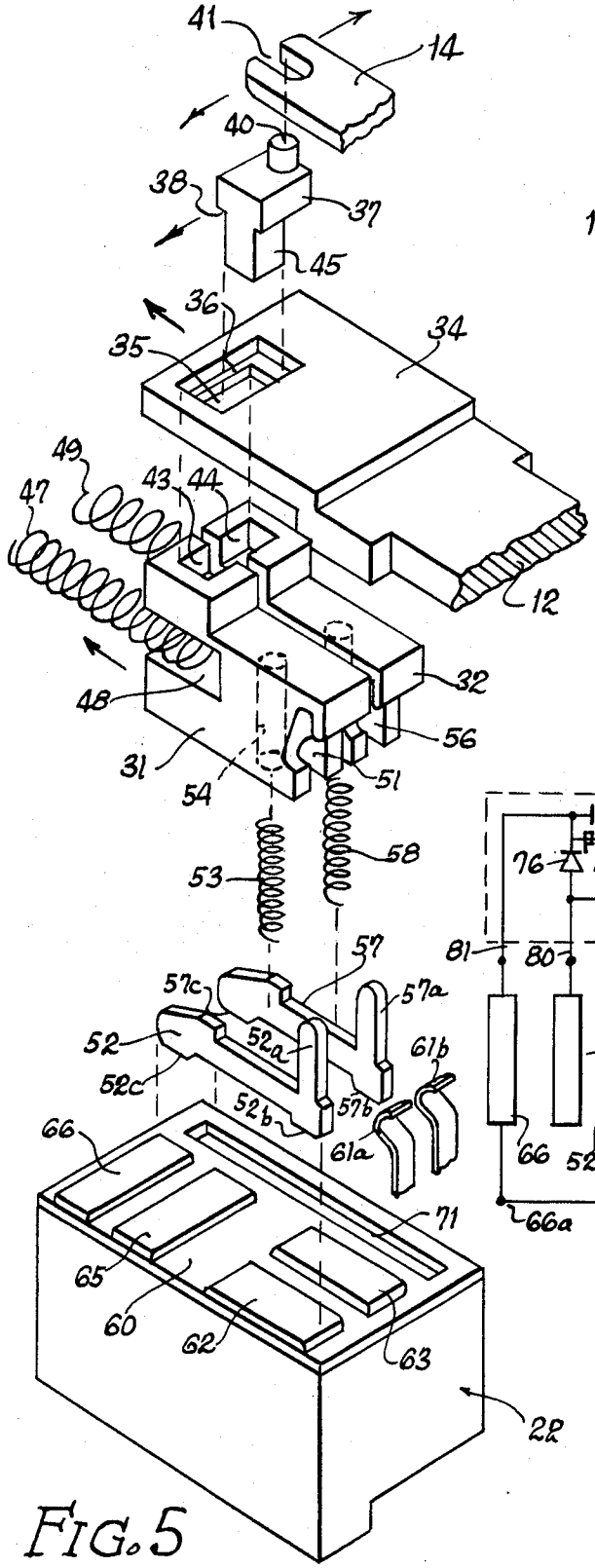


FIG. 5

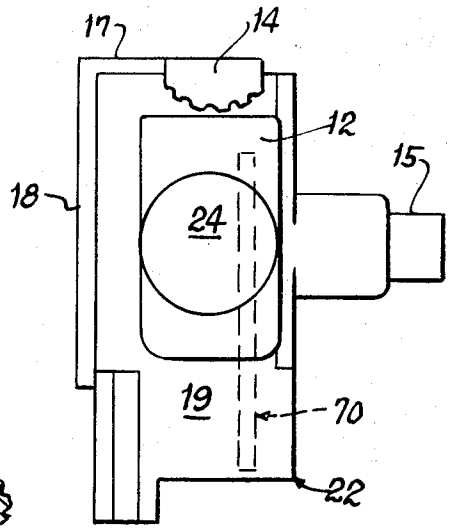


FIG. 4

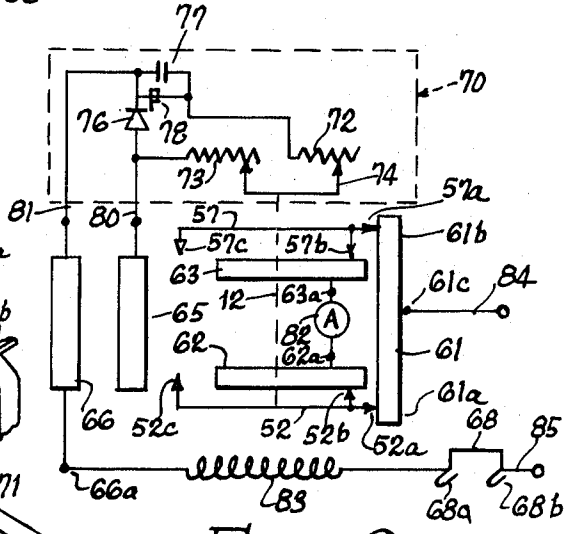


FIG. 6

REVERSING SWITCH FOR A POWER TOOL WITH SEPARATE SELECTIVELY MOVABLE CONTACT CARRIERS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a switch unit or device adapted for mounting in the housing of a portable tool, such as an electric drill, for control of the tool motor in response to movement of a trigger which forms a part of the switch unit. In particular, the present invention relates to such a switch unit having a contact arrangement for reversing the direction of current flow through the armature windings thereby to energize the associated tool in both "forward" and "reverse" directions.

2. The Prior Art

Representative prior art U.S. Pat. Nos. are Frenzel 3,260,827, Matthews 3,467,801, Braun 3,637,967 and Johnson 3,649,780. These patents show trigger operated switch devices for mounting in portable tools, such as electric drills, to energize the tool motor in both "forward" and "reverse" directions. The devices shown in these patents may also include a speed control circuit of the type disclosed and claimed in Gawron U.S. Pat. No. 3,209,228 whereby the speed of the tool motor may be varied in both directions of rotation thereof in response to the amount of trigger depression.

The prior art represented by these patents suffers from the disadvantage that the reversing contact construction is somewhat complex with the attendant disadvantage of high cost. These reversing switches which also include the speed control circuit have the reversing contacts in the form of a separate switch attached to the main body or housing which includes the speed control circuit — this results in a rather large device making assembly in a small portable tool housing difficult in some instances. The prior art reversing switch units which include speed control are also disadvantageous in that they necessarily include a duplication of contacts and are in essence two separate switches, i.e., a speed control switch and a reversing switch, connected together in one module.

SUMMARY AND OBJECTS OF THE INVENTION

The present invention relates to a reversing switch for a portable tool or the like, which switch embodies a unique arrangement of reversible contacts, which contacts permit integrating of the reversing switch with a speed control circuit.

A primary object of the present invention is the provision of a new and improved reversing switch which is simple to construct and which is highly reliable in operation.

Another object of the present invention is the provision of a reversing switch which may be readily integrated with a speed control circuit for an electric motor of a power tool.

Still another object of the present invention is the provision of the reversing switch of the type described which includes first and second common contacts, a pair of movable contacts and respective carriers therefor, whereby a selected one of the contact carriers may be connected with the trigger for movement of the associated movable contact from an "off" position wherein said movable contact is in engagement with the first common contact and out of engagement with the second contact to an "on" position wherein said movable contact is in engagement with said second common contact and out of engagement with said first common contact.

These and other objects and advantages of the present invention will become apparent from the following specification disclosing a preferred embodiment shown in the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of the switch unit or device embodying the present invention;

FIG. 2 is a top plan view of the switch device;

FIG. 3 is an enlarged section taken along the line 3—3 of FIG. 2;

FIG. 4 is a front elevation of the switch device;

FIG. 5 is a fragmentary exploded isometric, largely diagrammatic in form, primarily showing the arrangement of the contacts and the carriers for the movable contacts;

FIG. 6 is a circuit diagram, largely schematic in form, showing the reversing switch in the "off" position;

FIG. 7 is a circuit diagram, largely schematic in form, showing the reversing switch energizing the tool motor in one direction of rotation thereof through an associated speed control circuit; and

FIG. 8 is a circuit diagram, largely schematic in form, showing the reversing switch energizing the tool motor in its other direction of rotation and with the speed control circuit being bypassed.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring particularly to FIGS. **1** and **2**, the present invention is embodied in a switch unit or device, generally designated **10**, which device includes a housing **11**, generally in the form of a parallelepiped, mounting a trigger **12**, a reversing arm **14** and a locking plunger **15**. It will be understood that the switch unit **10** is adapted for mounting within the housing of a portable electric tool, such as an electric drill, which tool housing includes suitable apertures for exposing the trigger **12**, the reversing arm **14** and the plunger **15** for manipulation by the operator of the tool. It will also be understood that the associated portable tool includes a motor having an armature wound for rotation in both directions, which directions will be referred to as "forward" and "reverse." The trigger **12** and reversing arm **14** are preferably juxtaposed for convenient operation as disclosed and claimed in Frenzel U.S. Pat. No. 3,260,827, assigned to the assignee of the present application.

The housing **11** includes a top wall **17**, side walls **18**, a front wall **19** and a rear wall **20**, the housing being open at the bottom thereof for reception of a housing subassembly, generally designated **22**. The front wall **19** includes an aperture **23** for receiving the trigger **12**. It will be understood that the trigger is suitably mounted, as by guideways or the like, for reciprocal movement relative to the housing. The trigger **12** may include adjustment mechanism as disclosed and claimed in Frenzel Reissue U.S. Pat. No. Re. 26,781, assigned to the assignee of the present application, which mechanism is operated by an adjustment button **24** to vary the stroke of the trigger. Since such adjustment mechanism forms no part of the present invention, no further reference herein will be made thereto.

The opening **23** in the front housing wall **19** also receives the reversing arm **14**. This arm includes a blind

bore 26 on its underside and intermediate its ends for receiving a pin 27 formed on a member 28, the latter being a part of the housing 11. It will be apparent the reversing arm 14 is mounted for pivoting or swinging movement in a horizontal plane about an axis defined by the pin 27. The reversing arm 14 preferably includes a pin 29 to prevent movement of the reversing arm unless the trigger is in its extended position, all as fully described in the aforesaid Frenzel U.S. Pat. No. 3,260,827.

The trigger 12 includes a cavity 30 in the underside thereof for receiving a pair of contact carriers 31, 32. The trigger 12 also includes a rearwardly extending tongue portion 34 having a transversely extending opening 35, the walls of which are stepped to form slideways 36. A shuttle 37 is slidably mounted in the opening 35, which shuttle has shoulders 38 in sliding engagement with the slideways 36. The shuttle 37 includes an upwardly extending pin 40 received within a cutout 41 in the inner end of the reversing arm 14. It should be apparent that swinging movement of the reversing arm will result in sliding movement of the shuttle from one end of the opening 35 to the other end thereof.

The contact carrier 31 includes a pocket 43 opening at the top of the contact carrier and at one side thereof. Similarly, the contact carrier 32, which is of identical but opposite hand construction with the carrier 31, includes a pocket 44. These pockets are adapted for alternately receiving the depending portion 45 of the shuttle 37 and for permitting sliding movement of the shuttle fron one pocket to the other when the contact carriers are in side-by-side alignment as shown in FIG. 5. When the shuttle is received in the pocket 43, the contact carrier 31 is connected with the trigger 12 for movement in unison with the latter, the contact carrier 32 at such time being disconnected from the trigger. When the shuttle 37 is received within the pocket 44, the contact carrier 32 is connected with the trigger 12 and the contact carrier 31 disconnected from the trigger.

A coil spring 47 has one end thereof received within an opening 48 formed in the contact carrier 31, the other end of this spring being in abutting engagement with the inside surface of the rear housing wall 20. Another spring 49 abuts the rear housing wall 29 and is also received within an opening (not shown) in the contact carrier 32. The springs 47, 49 urge the contact carriers to the right as seen in FIG. 3.

The contact carrier 31 includes a longitudinally extending slot 51 for reception of a bridging contact 52, which bridging contact includes an upstanding ear 52*a* and contact faces 52*b*, 52*c*. The carrier 31 includes a pocket for receiving the ear 52*a*. A coil spring 53 has its upper end received within a blind bore 54 formed in the contact carrier 31, the lower end of this spring bearing downwardly against the bridging contact 52 for urging the same into engagement with fixed contacts to be described hereinbelow. Similarly, the contact carrier 32 includes a slot 56 for reception of a bridging contact 57, the latter being urged downwardly by a coil spring 58. The bridging contact 57, which is identical with the bridging contact 52, includes an upstanding ear 57*a* and contact faces 57*b*, 57*c*.

The subassembly 22 is generally in the form of a parallelepiped having its top defined by a dielectric contact mounting board 60. The board 60 mounts a common contact 61 including contact formations 61*a*, 61*b* as well as a depending terminal 61*c*. The contact board 60 also mounts a pair of parallel spaced contact strips 62, 63 having respective depending terminals 62*a*, 63*a*. A common contact bar 65 is mounted on the board 60 in perpendicular spaced relationship with the strips 62, 63. Finally, the board 60 mounts another common contact bar 66 having a depending terminal portion 66*a*. At this time it should be mentioned that the subassembly 22 includes a contact 68 having a first terminal 68*a* and a second terminal 68*b*. This contact serves only as a convenient means for making the connection between the field windings of the motor and the source of alternating current; the contact 68 serves no function as far as the switching operation is concerned. It will also be noted that the six contact terminals 61*c*, 62*a*, 63*a*, 66*a*, 68*a* and 68*b* are in the form of "push-in" terminals and are received in respective cavities opening at the base of the subassembly 22 thereby to facilitate connection with the various lead wires.

The subassembly 22 includes a compartment (not shown) for reception of a vertically disposed ceramic circuit board, generally designated 70 (FIG. 4). It will be understood that this circuit board, which is of the type disclosed and claimed in Robertson U.S. Pat. No. 3,543,120, mounts the various electronic components constituting a speed control circuit of the type disclosed and claimed in Gawron U.S. Pat. No. 3,209,228, each of these patents being assigned to the assignee of the present invention. The contact board 60 includes an elongated slot 71 for receiving the upper portion of the circuit board 70, which upper portion mounts resistance strips forming part of the variable resistor of the speed control circuit, as fully explained in the aforesaid Robertson patent.

Referring now to FIG. 6, the circuit board 70 includes a pair of colinear resistance strips 72, 73 adapted to be slidably engaged by the contact slider 74. It will be understood that the trigger 12 includes a cavity for receiving the slider 74 thereby to impart sliding movement to the latter along the resistance strips 72, 73 in response to reciprocal movement of the trigger. The circuit board 70 further includes a controllable semiconductor 76, which may be a silicon controlled rectifier, for example. The board 70 mounts a capacitor 77 and a suitable triggering device 78. The circuit board 70 includes a pair of contact strips 80 and 81 which are bent over horizontally and connected to the respective contact bars 65, 66, as by soldering. Reference should be had to the aforementioned Robertson and Gawron patents for a detailed description of the speed control circuit.

As seen in FIG. 6, the contact strip terminals 62*a* and 63*a* are respectively connected to the sides of an armature 82, which armature is wound for rotation in both forward and reverse directions. The field windings 83 of the motor are connected to the terminal 66*a* of the contact bar 66 and to the terminal 68*a* of the contact 68. The two lines 84, 85 from the source of alternating current are respectively connected to the terminals 61*c* and 68*b*.

The operation of the reversing switch according to the present invention is as follows:

The switch unit is shown in the "off" position in FIG. 3. In such position the contact face 52*b* is engaged with the contact strip 62 and the ear 52*a* is in engagement with the contact formations 61*a*. It is noted that the

contact face **52***c* is out of engagement with the contacts on the board **60**. Similarly, in the "off" position, the contact face **57***b* is in engagement with the contact strip **63**, the ear **57***a* is in engagement with the contact formation **61***b*, and the contact face **57***c* is out of engagement with the contacts on the board **60**.

Assume it is desired to energize the motor in the "forward" direction. The reversing arm **14** is swung to the position shown in FIG. **3** thereby positioning the shuttle **37** in the pocket **43** of the contact carrier **31**. When the trigger is depressed, corresponding movement will be imparted to the contact carrier **31** as such carrier is now connected to the trigger for movement therewith by means of the shuttle; the contact carrier **32** will not be moved at this time as the same is disengaged from the trigger.

Initial movement of the contact carrier **31** will cause the ear **52***a* to be separated from the contact formation **61***a* followed by snapping of the contact face **52***c* into engagement with the contact bar **65** as the bridging contact **52** pivots about the point of engagement between the contact face **52***b* and the strip **62**. At this time it should be mentioned that the bridging contacts **52, 57** are preferably mounted and independently snapped into engagement with the bar **65** and separated from the bar **65** in the manner disclosed and claimed in Frenzel U.S. Pat. No. 3,594,523, assigned to the assignee of the present invention.

The arrangement of the contacts as just described is schematically represented in FIG. **7**. The circuit through the motor is as follows: terminal **61***c*, contact formation **61***b*, contact ear **57***a*, contact strip **63**, terminal **63***a*, armature **82**, terminal **62***a*, contact strip **62**, contact faces **52***b*, **52***c*, bar **65**, contact strip **80**, the speed control circuit on the ceramic circuit board **70**, contact strip **81**, bar **66**, terminal **66***a*, field windings **83**, and contact **68**.

Accordingly, the motor is energized in the forward direction and at a speed proportional to the amount the trigger is depressed. As the trigger is continued to be squeezed, the contact faces **52***b*, **52***c* slide along the respective contacts **62, 65**. Such movement of the trigger causes corresponding movement of the slider **74** along the resistance strips **72, 73** progressively increasing the speed of the motor as more fully explained in the aforementioned Robertson and Gawron patents.

Continued squeezing of the trigger will cause the contact face **52***c* to separate from the contact bar **65** and come into engagement with the contact bar **66**. This movement of the trigger will result in energization of the motor in the forward direction at full speed independently of the speed control circuit as follows: terminal **61***c*, contact formation **61***b*, contact ear **57***a*, contact face **57***b*, contact strip **63**, terminal **63***a*, armature **82**, terminal **62***a*, contact strip **62**, contact faces **52***b*, **52** *c*, bar **66**, terminal **66***a*, field windings **83**, and contact **68**.

As the trigger is released, the motor will again be energized in the forward direction through the speed control circuit from the high speed mode of operation and to low speed as the trigger is progressively extended. When the trigger is fully extended, the bridging contact **52** will be rocked to the position shown in FIG. **3** thereby again establishing the "off" position as seen in FIG. **6**.

Now assume it is desired to energize the motor in the other or reverse direction. The reversing arm **14** is swung to its other position thereby sliding the shuttle from the pocket **43** to the pocket **44**. This will result in disconnecting the contact carrier **31** from the trigger **12** and connecting the contact carrier **32** to the trigger for movement therewith. Now, when the trigger is depressed, the contact face **57***c* will be snapped into engagement with the contact bar **66** after separation of the contact ear **57***a* from the contact formation **61***b*. The circuit through the armature is as follows: terminal **61***c*, contact formation **61***a*, contact ear **52***a*, contact face **52***b*, contact strip **62**, terminal **62***a*, armature **82**, terminal **63***a*, contact bar **65**. The circuit path from the contact bar **65** to the other terminal **85** in the reverse direction is the same as described above in connection iwth the forward direction of rotation.

FIG. **8** illustrates the arrangement of contacts when the reversing arm **14** is in the reverse position and when the trigger is fully depressed. It will be apparent that in such position of the reversing arm and trigger, the motor will be energized in the reverse direction of rotation at full speed independently of the speed control circuit.

It will be appreciated that the present invention provides a new and improved arrangement of contacts for reversing the direction of rotation of an electric motor. The present invention has particular applicability in a reversing switch of the trigger actuated type adapted for mounting within the housing of a portable electric tool. The arrangement of contacts according to the present invention may be readily integrated with a contact arrangement forming part of a speed control circuit of the type which includes a variable resistor for varying the speed of the motor in response to the amount of trigger movement. However, it will be understood the present invention is not to be limited for use in association with a speed control circuit.

We claim:

1. A reversing switch for an electric motor comprising:

a. first common contact means arranged for connection to one of the two lines of an electric power source;

b. second common contact means arranged for connection to the field windings of said motor;

c. a pair of movable contacts and a pair of respective carriers therefor;

d. means respectively connecting said movable contacts to a pair of terminals arranged for connection to the respective sides of a motor armature of the type wound for rotation in both directions;

e. first actuator means for moving a selected one of said contact carriers from an "off" position wherein the associated movable contact is in engagement with said first common contact means and out of engagement with said second common contact means to an "on" position wherein said movable contact is in engagement with said second common contact means and out of engagement with said first common contact means; and

f. second actuator means for alternately connecting one or the other of said contact carriers for movement by said first actuator means.

2. The reversing switch according to claim **1** wherein said means connecting said movable contacts to said armature comprise a pair of contact strips respectively slidably engaged by said movable contacts.

3. The reversing switch according to claim 2 further defined by:

a. means defining a speed control circuit of the type including a variable resistor, which circuit is connected to said second common contact means;

b. a contact slider forming part of said variable resistor; and

c. means connecting said contact slider with said first actuator means for movement of the former in response to movement of the latter.

4. The reversing switch according to claim 3 further defined by third common contact means connected with said speed control circuit and arranged for connection within the field windings of said motor, said first actuator means being adapted to move a selected one of said contact carriers from said "on" position to a "bypass" position wherein the associated movable contact is in engagement with said third common contact means and out of engagement with said first and second common contact means.

5. A reversing switch for a portable tool of the type powered by an electric motor of the reversible type comprising:

a. a switch housing adapted for mounting within the housing of a power tool;

b. a trigger and a reversing member mounted by said housing for independent movement relative thereto;

c. first common contact means mounted in said housing and connected with a first terminal arranged for connection to one of the two lines of an electric power source;

d. second common contact means mounted in said housing and connected with a second terminal arranged for connection to the field windings of said motor;

e. said housing containing a pair of movable contacts and a pair of respective carriers therefor;

f. first means in said housing respectively connecting said movable contacts to third and fourth terminals which third and fourth terminals are arranged for connection to the respective sides of a motor armature of the type wound for rotation in both directions; and

g. second means in said housing movable, in response to movement of said reversing member back and forth between forward and reverse positions, for connecting a selected one of said contact carriers with said trigger for movement of the former, in response to movement of the latter, from an "off" position wherein the associated movable contact is in engagement with said first common contact means and out of engagement with said second common contact means to an "on" position wherein said movable contact is in engagement with said second common contact means and out of engagement with said first common contact means.

6. The reversing switch according to claim 5 wherein said first means includes a pair of contact strips respectively slidably engaged by said movable contacts.

7. The reversing switch according to claim 6 further defined by:

a. means in said housing defining a speed control circuit of the type including a variable resistor, which circuit is connected between said second common contact means and said second terminal;

b. a contact slider forming part of said variable resistor; and

c. third means connecting said contact slider with said trigger for movement of the former in response to movement of the latter.

8. The reversing switch according to claim 7 further defined by, third common contact means connected between said speed control circuit and said second terminal said trigger being adapted to move a selected one of said contact carriers from said "on" position to a "bypass" position wherein the associated movable contact is in engagement with said third common contact means and out of engagement with said first and second common contact means.

9. The reversing switch according to claim 5 further defined by:

a. said first means including a pair of contact strips extending in parallel spaced relation with each other and also being parallel with the direction of trigger movement, which strips are respectively slidably engaged by said movable contacts;

b. a pair of springs respectively engaged with said contact carriers for yieldably holding said movable contacts in said "off" position;

c. said contact carriers each having a pocket; and

d. said second means including a shuttle engaged with said reversing member and movably mounted by said trigger, said shuttle being alternately received in said pockets for establishing the connection between said trigger and the selected one of said contact carriers.

10. The reversing switch according to claim 9 further defined by, means defining a speed control circuit of the type including a variable resistor, which circuit is connected between said second common contact means and said second terminal;

b. a contact slider forming part of said variable resistor; and

c. third means connecting said contact slider with said trigger for movement of the former in response to movement of the latter.

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