Aug. 15, 1967 J. P. YELPO ETAL 3,336,490

VARIABLE-SPEED PORTABLE ELECTRIC TOOLS

Original Filed April 20, 1964 2 Sheets-Sheet 1

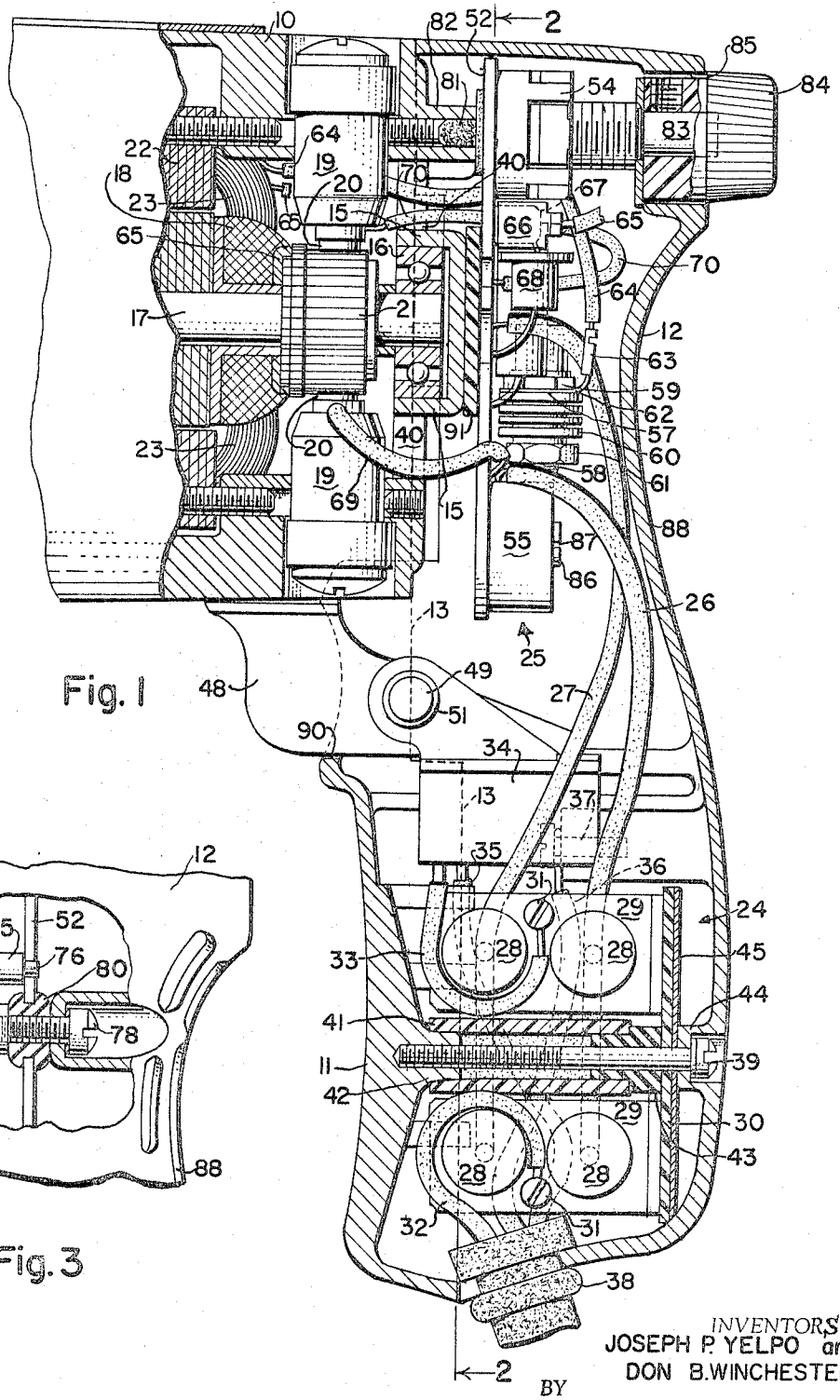

Fig. 1

Fig. 3

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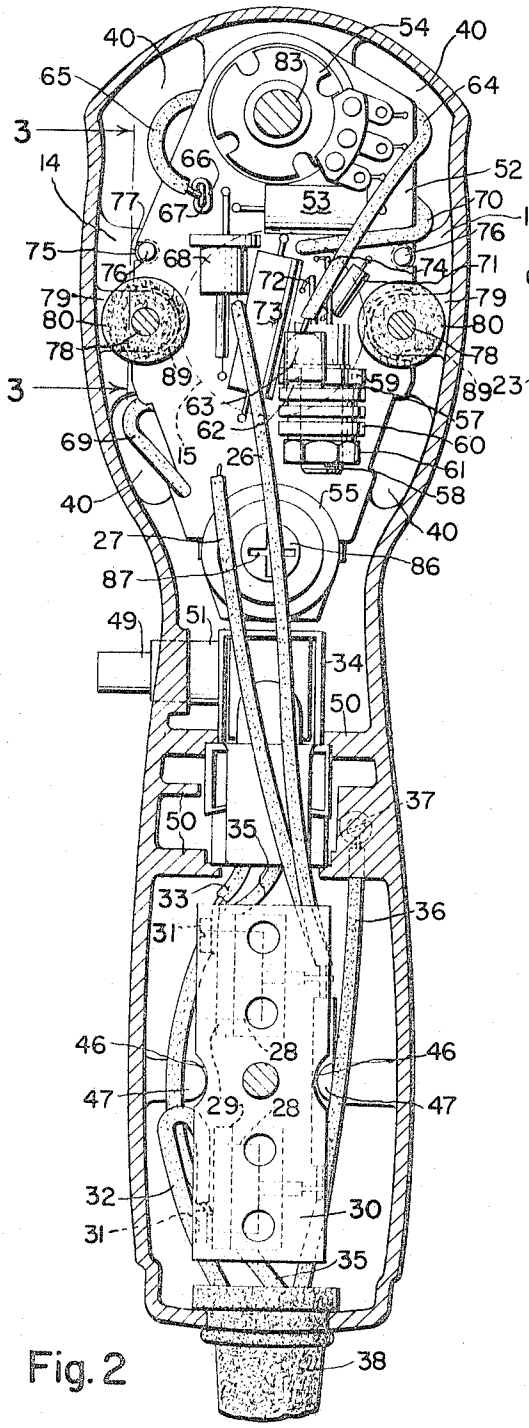

Fig. 2

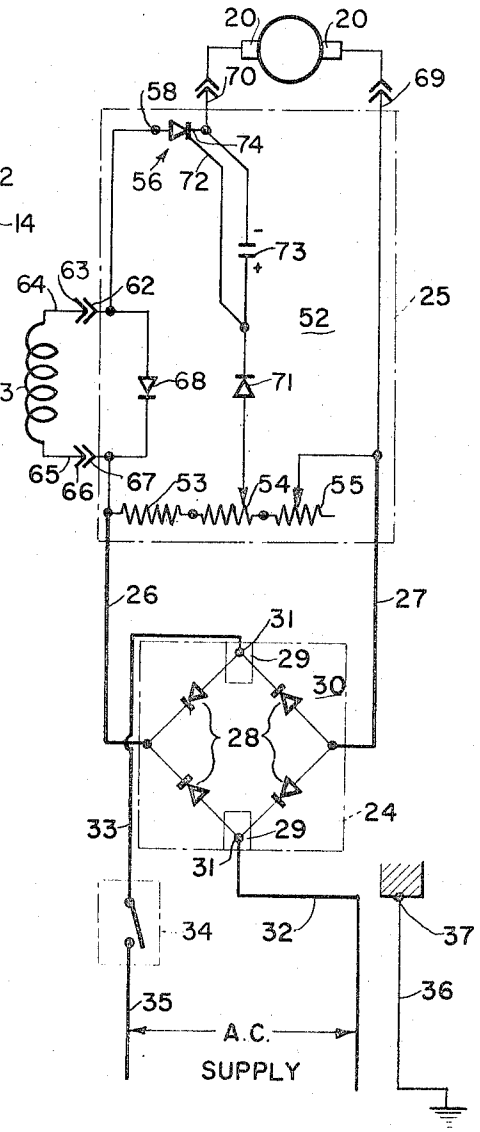

Fig. 4

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VARIABLE-SPEED PORTABLE ELECTRIC TOOLS

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Continuation of application Ser. No. 361,169, Apr. 20, 1964. This application Dec. 23, 1966, Ser. No. 604,487

1 Claim. (Cl. 310—50)

This application is a continuation of application Ser. No. 361,169, now abandoned.

This invention relates to variable-speed portable electric tools and more particularly to portable tools driven by built-in electric motors and having all-electric built-in circuitry for providing, by external manual adjustment, a plurality of selective regulated speeds for said motors.

It is a problem with portable tools of this type to provide a sufficiently compact physical arrangement of the required circuitry which is, at the same time, electrically safe and mechanically secure and which may readily be assembled within the small space available and connected to the motor and switch without interference with the other parts of the tool and without appreciably increasing the size and weight of the tool and the difficulty of assembly.

This problem has been solved according to the present invention by providing compact prewired circuit modules electrically interconnected by flexible conducting leads to form a unitary subassembly and a removable cover for the handle end of the tool, which cover, when removed, completely exposes the interior of the tool housing throughout an entire cross section thus giving open access for readily installing each of the prewired circuit modules therein in a position to be subsequently resiliently clamped in place by the cover when it is secured to the motor housing as a final assembly step.

It is therefore a primary object of this invention to provide special structure which results in a low-cost assembly of physical circuit components within the housing of a portable electric tool to adapt said tool for operation at a plurality of selected regulated operating speeds.

It is a further object of this invention to subdivide a physical circuit into separate but flexibly connected circuit modules for optimum positioning said modules in a portable electric tool in accordance with the functions of said modules thus to provide minimum space requirements consistent with adequate insulation safety.

With the above and other objects in view, as will hereinafter appear, the invention comprises the devices, combinations and arrangements of parts hereinafter set forth and illustrated in the accompanying drawings of a preferred embodiment of the invention, from which the several features of the invention and the advantages attained thereby will be readily understood by those skilled in the art.

In the drawings, FIG. 1 is a longitudinal sectional view taken through a portable electric tool showing a preferred embodiment of the invention.

FIG. 2 is a vertical transverse section taken substantially on line 2—2 of FIG. 1.

FIG. 3 is a detailed section taken substantially on line 3—3 of FIG. 2.

FIG. 4 is a schematic diagram showing the circuit configuration corresponding to the physical arrangement shown in FIGS. 1 and 2.

Referring now to FIG. 1, there is shown a portable tool, preferably an electric drill, having a motor housing **10**, a depending split handle portion **11**, and a removable cover portion **12** which when removed exposes the interior of the tool throughout preferably an entire cross section as

seen best in FIG. 2. The parting line between the cover and the remainder of the tool is indicated by line **13**.

The motor housing **10** is formed with an end bracket portion **14** having a boss **15** in which is received a ball bearing **16** for journaling a shaft **17** of a motor armature **18**. Brush boxes **19—19** are also carried by the motor housing **10** and contain brushes **20—20** which bear on a commutator **21**. A field core **22** secured in the motor housing **10** surrounds the armature **18** and is provided with field winding **23**. Apertures **40** in the housing **10** on either side of the end bracket portion **14** provide access for bringing out conducting leads from the brushes **20** and from the field windings **23** for making electrical connections to the circuit modules to be described subsequently.

Referring now to FIG. 4 the circuit configuration used to illustrate an embodiment of this invention is the full-wave version of the circuit shown and described in the Momberg et al. Reissue Patent No. 25,203 issued July 24, 1962. The circuit is physically divided into two separate circuit modules, viz a power module **24** and a control module **25**, as shown by the dot-dash lines. These modules **24**, **25** are permanently and electrically interconnected by the flexible conductors **26** and **27**. The power module consists of four silicon rectifiers **28** of the push-in type poled as shown in a conventional full-wave bridge configuration. The rectifiers **28** as seen in FIGS. 1 and 2 are mounted in pairs on two electrically conducting brackets **29—29** secured in spaced relation to an insulation board **30**. The brackets are drilled and tapped to accept screws **31** for connecting respectively to conductor **32** which connects to one side of the A.C. supply and to conductor **33** which connects to a switch **34** and thence by a conductor **35** to the other side of the A.C. supply. A third conductor **36** connects to the tool housing at screw **37** for external grounding as shown. All three conductors **32**, **35** and **36** are cabled to form a power cord and are contained within a strain-relief bushing **38**.

A single screw **39** passes through an aperture in the cover **12** and is threaded into the split handle portion **11** to secure these parts together to form a complete handle. This same screw **39** also secures the power module **24** resiliently in position within the handle by virtue of an insulated spacer bushing **41** seated in a boss **42** and surrounding the screw **39**, which bushing receives a resilient insulated plug **43** also surrounding the screw **39** and bearing against one side of the board **30**. As screw **39** is taken up to secure parts **11** and **12** together, the board **30** is resiliently clamped between the plug **43** and a boss **44** formed on the interior of cover **12**. A piece of stiff insulation **45** placed between the board **30** and the boss **44** covers any metallic elements such as rivets which may be used to secure the brackets **29** to the board **30**. The board **30** is further secured against turning by means of cut-away portions **46—46** which closely fit against bosses **47—47** formed on the interior of cover **12** as shown in FIG. 2.

The switch **34** having trigger **48** and lock button **49** is received in suitable bosses **50** in the cover **12** and is held captive by securement of the lock-button bearing element **51** of the switch **34** on the parting line **13** and clamped between the handle portion **11** and the cover **12**. The trigger **48** is slidable in a slotted aperture **90** in the handle portion **11**.

The control module **25** comprises an insulated circuit board **52** having the general configuration of the cross section of the cavity behind the motor housing **10** and mounts on one side several electrical components which are interconnected on the reverse side preferably by a conventional printed circuit which follows the diagram shown in FIG. 4.

A voltage divider is formed by the series connection

of a fixed resistor **53**, a speed setting potentiometer **54**, and a trimmer potentiometer **55**. A silicon controlled rectifier **56** is mounted on a bracket **57** which is secured to and is electrically connected to anode stud **58**. The bracket **57** is clamped between the stud flange **59** and a finned heat sink **60** surmounting the stud **58** by means of a screw **61** threaded onto the stud **58**. The bracket **57** is secured to the board **52**, makes contact with the printed circuit on the reverse side and is formed with a tab portion **62** which receives a push-on terminal **63** connected to a conducting lead **64** from the field winding **23**. The other end of the field winding **23** is connected by conducting lead **65** terminating in push-on terminal **66** which engages a tab **67** secured to the board **52**. A back rectifier diode **68** is connected across the field winding **23** and is poled as shown.

Leads **69** and **70** permanently secured to the board **52** pass through apertures **40** to connect with brushes **20—20**. A connection is made by way of the printed circuit from the slider of the speed setting potentiometer **54** through a diode **71** to the gate **72** of the controlled rectifier **56**. An electrolytic capacitor **73** is connected across the gate **72** and cathode **74** of the controlled rectifier as shown.

The end bracket portion **14** is formed with bosses **75—75** as seen best in FIG. 3. These bosses **75—75** are formed with shouldered locating pins **76—76** which receive mating cut-out portions **77—77** in the board **52** for locating said board in proper position to receive screws **78—78** which extend through the cover **12** and are threaded into bosses **79—79** formed on the bracket portion **14**. Rubber grommets **80—80** received in cut-out portions **89—89** of the board **52** are clamped between the cover **12** and the bosses **79** when the screws **78** are taken up to secure the cover **12**. A resilient bumper plug **81** may be inserted in an apertured boss **82** to provide, together with the grommets **80**, a three-point resilient suspension for the board **52**.

An insulation piece **91** is placed between the board **52** and the bearing boss **15** to protect the printed circuit against contact with tool ground.

The speed setting potentiometer **54** is secured to the board **52** and has a shaft **83** secured to which is a knob **84** which extends through an aperture **85** in the cover **12** for manipulation externally of the tool as shown best in FIG. 1.

The trimmer potentiometer **55** has a stub shaft **86** formed with a screw-driver slot **87** which shaft may be adjusted as a final factory circuit setting by a special trimming tool inserted through a ventilating slot **88** in the cover **12**. This adjustment sets the minimum motor speed.

From the above it will be perceived that there has been provided according to this invention a compact arrangement of prewired and preconnected circuit modules for simple assembly in and connection to the motor of a portable electric tool and with resilient securement of the modules being effected by the same means as used to secure the cover in the final assembly step.

It will also be perceived that, by subdividing the circuit into two separate circuit modules in accordance with the module function and by shaping each module to conform to the desired space location within the tool, the modules may then be placed in spaced positions within the tool so that the conducting leads from the power cord, the switch and the motor windings may be made short and direct so as to make optimum use of the available space and to simplify the assembly.

Having thus described the nature of the invention, what we claim herein is:

A multi-speed portable electric tool having a motor housing and a depending split handle portion comprising:

(a) a hollow cover removably secured to said motor housing and to said handle portion and providing;
(b) a first cavity located adjacent said motor housing and
(c) a second cavity interconnected with said first cavity and forming with said handle portion a hollow handle,
(d) an electric motor secured in said housing and having an armature winding and a field winding,
(e) a first circuit module including semiconductor rectifiers connected in a full-wave bridge circuit and mounted on a single insulated support clamped between the cover and the handle portion in the second cavity,
(f) a second circuit module including a semiconductor controlled rectifier connected in a speed control circuit and mounted on a single insulated support clamped between the cover and the motor housing in the first cavity,
(g) said circuit modules being electrically interconnected by flexible conductors to form a unitary subassembly,
(h) electrical conducting means for connecting said second circuit module with said armature and field windings,
(i) a switch, and
(j) a power cord secured in said hollow handle, and
(k) means for electrically connecting said first circuit module with the switch and with the power cord.

No references cited.

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