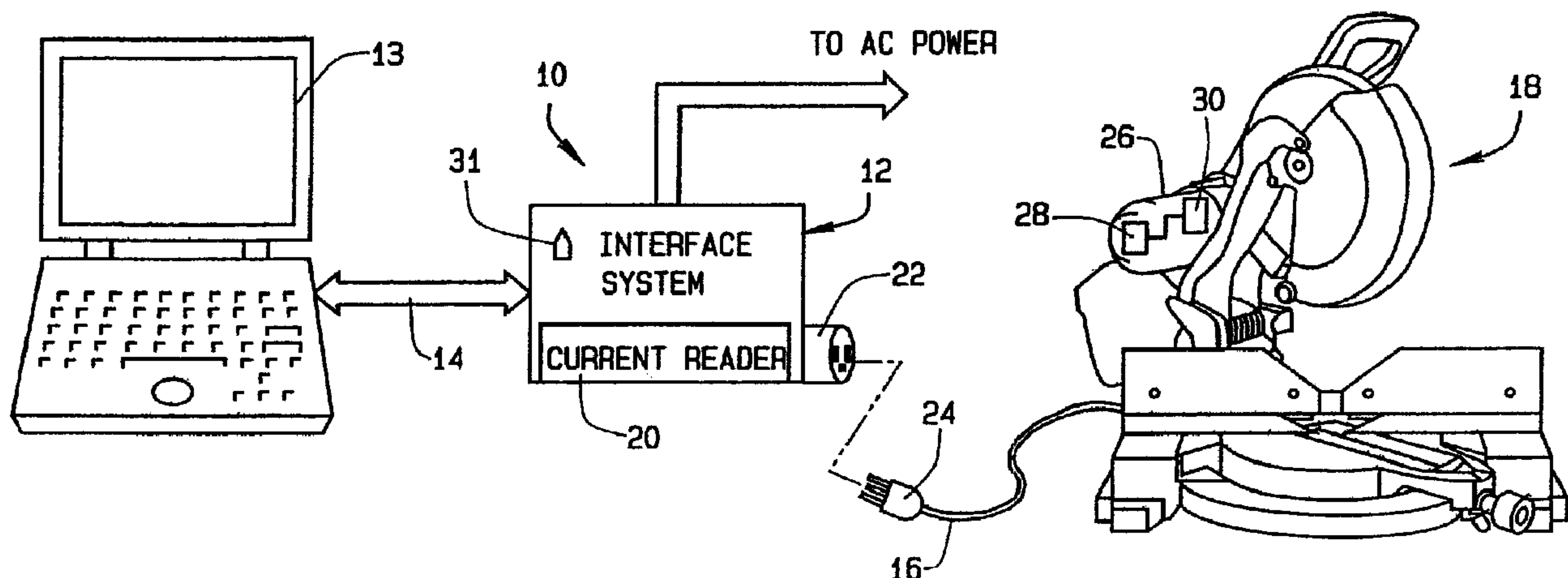




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(54) Title: SYSTEM AND METHOD FOR DATA RETRIEVAL IN AC POWER TOOLS VIA AN AC LINE CORD



(57) **Abrégé/Abstract:**

An apparatus (10) and method for obtaining data stored in an electronic module (30) within a power tool (18) over a power line cord (16) of the tool (18), and without any disassembly of the tool (18) being required. An interface subsystem (12) applies a high frequency, low power AC input signal to the power cord (16) of the tool (18). A controller (28) within the tool (18) recognizes this signal as an indication that the tool (18) is to be placed in a communications mode. The controller (28) modulates a power switching device used for turning on and off the motor of the tool (18) in such a fashion that current pulses are transmitted over the power line cord (16) back to the interface subsystem (12). The current pulses correspond to tool (18) usage/performance/identification information stored in the electronic module (30) of the tool (18). This information is interpreted by a current reader circuit of the interface subsystem (12) as binary information which is then transmitted to an external computer (13) data logging device for analysis and/or recording.

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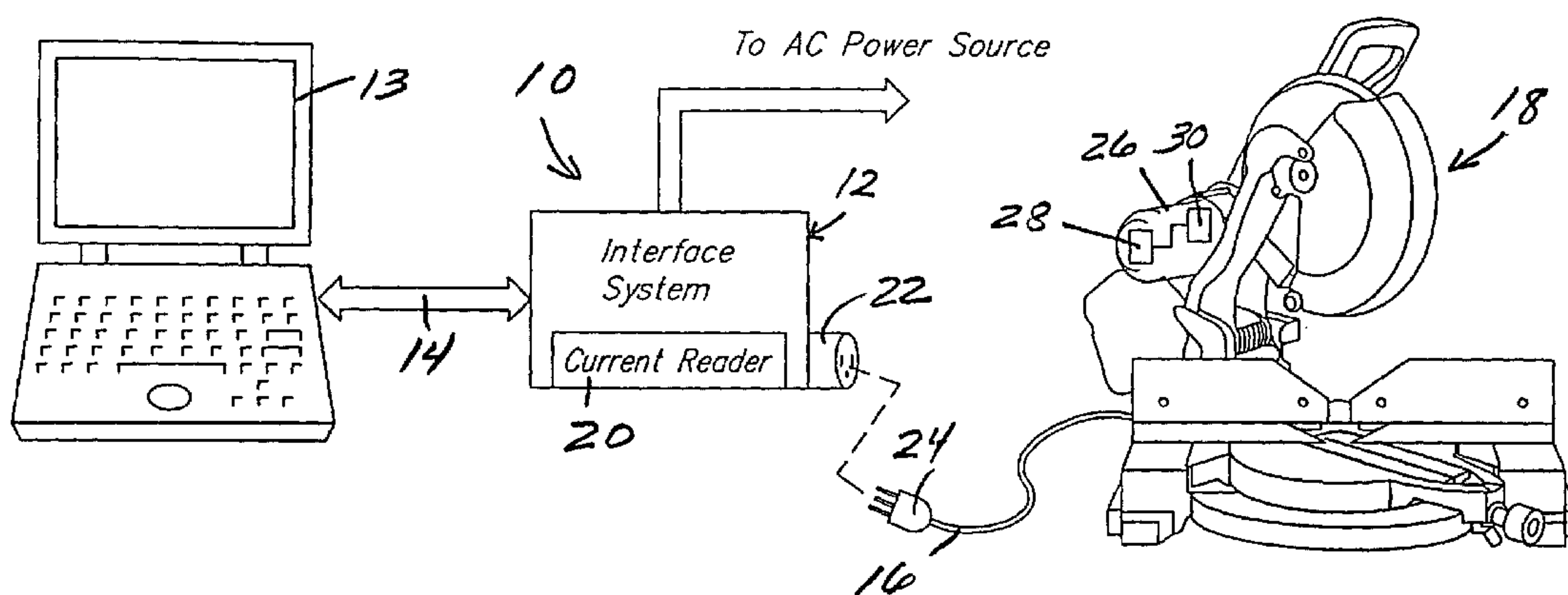
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(54) Title: SYSTEM AND METHOD FOR DATA RETRIEVAL IN AC POWER TOOLS VIA AN AC LINE CORD



(57) Abstract: An apparatus (10) and method for obtaining data stored in an electronic module (30) within a power tool (18) over a power line cord (16) of the tool (18), and without any disassembly of the tool (18) being required. An interface subsystem (12) applies a high frequency, low power AC input signal to the power cord (16) of the tool (18). A controller (28) within the tool (18) recognizes this signal as an indication that the tool (18) is to be placed in a communications mode. The controller (28) modulates a power switching device used for turning on and off the motor of the tool (18) in such a fashion that current pulses are transmitted over the power line cord (16) back to the interface subsystem (12). The current pulses correspond to tool (18) usage/performance/identification information stored in the electronic module (30) of the tool (18). This information is interpreted by a current reader circuit of the interface subsystem (12) as binary information which is then transmitted to an external computer (13) data logging device for analysis and/or recording.

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SYSTEM AND METHOD FOR DATA RETRIEVAL IN AC POWER TOOLS VIA AN AC LINE CORD

5 CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 60/396,975, filed on July 18, 2002.

FIELD OF THE INVENTION

10 [0002] This invention relates to electrically driven power tools and more particularly to an apparatus and method for communicating information over a power line cord of a power tool between an electronic module disposed within the tool and an external data logging device, to thus obtain data concerning the power tool without physically disassembling the power
15 tool.

BACKGROUND OF THE INVENTION

[0003] With present day power tools, it would be highly desirable to provide some means for obtaining usage and other pertinent information concerning the operation of the tool without the need for disassembling a
20 housing of the tool or otherwise mechanically accessing interior portions of the tool. Present day electronic components, such as controller/memory modules, are sufficiently small such that they can be easily housed within the housings of various types of power tools such as drills, saws, sanders,
25 etc. A system and/or method which allows an external device to communicate over a power cord of the power tool with an electronic module mounted within a housing of the tool to obtain usage and/or operating information concerning the power tool would be highly advantageous. Such a system would eliminate the need for a service technician to disassemble
30 the tool to gain access to the electronic module. It would allow manufacturers to quickly and easily obtain highly pertinent operating and usage information recorded by the electronic module. It would further eliminate the need to include an intercare port somewhere on the housing,

which is something that is not easily accomplished on small, hand held power tools such as drills, hand held sanders, etc.

SUMMARY OF THE INVENTION

5 **[0004]** The present invention is directed to an apparatus and method for using an external device to communicate over a power cord of a power tool with an electronic module mounted within a housing of the power tool. In one preferred form the electronic module is adapted to communicate with a controller disposed inside the power tool which recognizes signals
10 communicated over the power line of the tool that indicate that the power tool is to be placed in a communication mode.

[0005] The apparatus of the present invention includes an external interface subsystem which is coupled to a computing device, such as a personal computer or laptop computer, and also to the power cord of the
15 power tool. The interface subsystem is further coupled to an AC power source. The interface subsystem generates an AC signal that has a different frequency and/or magnitude than a standard AC mains signal, which is applied to the power cord of the tool. The controller recognizes this signal as an indication that the power tool is to be placed in a
20 communication mode. The power tool communicates information from its control module by modulating a switching device used to switch on and off the motor of the power tool. Modulating the switching device causes current pulses to be produced on the power cord that are sensed by a current reading circuit of the interface subsystem. The controller within the power
25 tool is also synchronized to the frequency of the signal applied by the interface subsystem to the power cord of the tool. The controller modulates the switching device to produce a series of current pulses over the power cord that are synchronized with the input signal applied to the power cord. These current pulses form coded information, in one preferred form binary
30 information, indicative of various types of usage or operational information recorded by the control module. These current pulses are sensed by the current reader circuit of the interface subsystem. The interface subsystem

extrapolates this usage/operational information from the coded information and transmits the usage/operational information to an external data logging device. In one implementation the external data logging device may comprise a computing device such as a personal computer, a laptop
5 computer or some other computing apparatus.

[0006] In an alternative preferred embodiment, the interface subsystem places a low power DC signal on the power cord of the power tool as an input signal. The controller within the power tool recognizes the presence of this DC signal and interprets it as a command to place the
10 power tool in a communications mode. The controller then modulates the internal switching device of the power tool as needed to produce the current pulses which represent coded signals indicative of the stored contents of the control module. These current pulses are then decoded by the interface subsystem and the decoded information is transmitted to a suitable
15 computing or data logging device.

[0007] The electronic module disposed in the power tool can be used to record and provide information to the external interface subsystem concerning the hours of use of the tool, serial number or user information related to the power tool, or any other valuable performance/operational
20 data associated with the power tool. It is a principal advantage of the present invention that the power tool does not need to be disassembled to gain access to the control module to obtain the information stored within it. By applying an appropriate signal over the power cord of the power tool and using the controller associated with the power tool to modulate a switching
25 component within the tool, signals can be sent over the tool's power cord that represent stored information from the tool's control module. Importantly, the input signal from the interface subsystem is recognized by the power tool's controller as a command that the tool be placed in a communicating mode. In the communications mode, the switching action of
30 the switching component is such that the electric motor of the power tool cannot be energized to a sufficient extent to cause operation of the motor while data from the control module is being downloaded. An additional

benefit is that the present invention does not require the use of a separate interface connector to be included on the housing.

BRIEF DESCRIPTION OF THE DRAWINGS

5 **[0008]** The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

[0009] Figure 1 is a simplified block diagram of the overall system of the present invention communicating with a laptop computer and a power cord of a power tool, and where the power tool is illustrated as a miter saw;

10 **[0010]** Figure 2 is a simplified block diagram of the coupling of the electronic control module to the controller of the power tool and to the motor of the tool;

[0011] Figure 3 is an illustration of the AC input signal waveform, the pulse train produced by the switching component within the tool, and the
15 current pulses produced on the power cord of the tool during downloading of stored information from the electronic module located in the power tool;

[0012] Figure 4 is a simplified electrical schematic diagram of the current reader of the interface subsystem;

[0013] Figure 5 is a sample waveform illustrating how current pulses
20 could be capacitively coupled onto an input waveform to transmit data stored in the electronic control module of the power tool to the interface subsystem;

[0014] Figure 6 is a waveform illustrating one preferred communication protocol for initiating communication with the electronic
25 module housed with the tool;

[0015] Figure 7 is a waveform illustrating "positive" polarity communications between the interface subsystem and the electronic module housed within the tool; and

[0016] Figure 8 is a waveform illustrating "negative" polarity
30 communications between the interface subsystem and the electronic module.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

5 **[0017]** Referring to Figure 1, there is shown a system 10 in accordance with a preferred embodiment of the present invention. The system 10 includes an interface subsystem 12 that is coupled to an AC power source. The interface system 12 is further coupled to a computing device 13 or other suitable data logging device via a suitable communications cable 14, and to a power cord 16 of an electrically driven power tool 18. The interface subsystem 12 includes a current reader circuit 20 that will be described in greater detail in the following paragraphs, and an electrical receptacle 22 for receiving a plug 24 of the power cord 16.

10 **[0018]** The power tool 18 includes a motor 26 which is controlled by a power switching device 26a in communication with a controller 28. The controller 28 is also in communication with an electronic module 30 housed within the housing of the tool 18. In actual practice, the controller 28, switch 28a and the electronic module 30 could be provided by a single electronic component.

15 **[0019]** The electronic module 30 is used to store usage information or any other form of data pertaining to the operation, ownership or performance of the power tool 18. It will be appreciated that the power tool interface subsystem 12 and electronic module 30 essentially comprise the additional components that form the system 10. The motor 26, switching device 26a and the controller 28 are components that are typically included with many present day power tools. In one preferred implementation switch 26a comprises a thyristor.

20 **[0020]** It will also be appreciated that while the power tool 18 is illustrated as a miter saw, the present invention could be used with virtually any form of electrically driven power tool. Accordingly, drills, sanders, grinders, other forms of power saws, routers, joiners, etc. could be used with the present invention. The present invention could also be employed with outdoor products such as lawn mowers, blade and string trimmers, edgers, hedge trimmers, etc.

25

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[0021] In general operation, the interface subsystem 12 is coupled to the computing device 13 and to the power tool 18 when it is desired to download stored information from or send information to the electronic module 30. Interface subsystem 12 operates to apply a low power, high frequency input signal over the power line cord 16. The controller 28 recognizes this low power, high frequency signal as a command that the power tool 18 is to be placed in a communications mode, allowing the storing and downloading of information, controlled by a set protocol. The voltage and/or frequency of the input signal applied to the power cord 16 is sufficiently different from a standard AC mains voltage such that the controller 28 immediately recognizes it as a command to enter the communications mode. The input signal is sufficiently low in magnitude, and/or high enough in frequency, that it does not cause the motor 26 of the power tool 18 to actually start rotating during the communication process with the interface subsystem 12. In one preferred form, the input signal comprises a 96 volt, 100Hz AC signal.

[0022] The controller 28 of the power tool 18 is further synchronized to the high frequency AC input signal. In a preferred embodiment, the controller 28 monitors incoming signals for a valid data-retrieval command signal, and then proceeds to pulse switching device 26a accordingly. The power switching device 26a is turned on during positive and/or negative cycles of the input signal. In one preferred embodiment a turn on, allowing current flow, would indicate a binary high (logic "1") level signal, while the absence of a current pulse during any cycle of the input signal signifies a logic "0" level signal. More specifically, in one preferred embodiment switch 26a is turned on during the negative half cycle to indicate a binary "0" and turned off to indicate a binary "1".

[0023] The current pulses during the corresponding half cycles of the input signal are detected by the current reader circuit 20 and are interpreted accordingly. In the just mentioned preferred embodiment, a current pulse would be interpreted as a logic 1. Thus, if a current pulse is not detected during a given positive half cycle of the signal input to the

power cord 16, the current reader circuit 20 interprets this absence of a current pulse as a logic 0 level signal. In this manner, the controller 28 can control the switching device 26a so that a binary stream of data is created over the power cord 16 which represents information stored in the electronic control module 30. This information is then transmitted to the computing device 12 and stored therein and/or displayed on a display thereof.

[0024] It will be appreciated that while the controller 28 may form an existing component of the power tool, it nevertheless requires suitable programming code to be able to recognize the command signal from the interface subsystem. Suitable programming code is also needed to control the switching device 26a in a manner needed to produce the current pulses on the power cord line 16.

[0025] It is a principal advantage of the present invention that the power tool 18 does not need to be disassembled to gain access to the stored information in the electronic control module 30. The power tool 18 need only be coupled to the interface subsystem 12, and the interface subsystem in turn coupled to the computing device 13, before the interface subsystem circuit can be used to download the information stored in the electronic control module 18. As will be appreciated, this significantly simplifies and expedites the downloading of the information stored in the electronic module 30. It also eliminates the possibility of accidental damage to other internal components of the power tool 18 or its housing which could occur if partial disassembly of the tool was required to obtain access to the internally mounted control module. It also significantly reduces the time needed to obtain usage/operational data, as compared to the time that would be required if manual disassembly of the power tool housing was required as part of the information gathering process.

[0026] Another important advantage of the present invention is that no interface connector(s) need to be integrated into the housing to permit the interface subsystem 12 to communicate with the controller 28. By using the power cord 16 to communicate with the controller 28, the need for a separate port or other form of electrical connector on the housing of the tool

18 is eliminated. This allows for greater flexibility in designing the housing so that maximum flexibility is afforded in positioning the controls of the tool 18. It also avoids the additional expense that would be incurred if a separate interface connector had to be integrated into the housing.

5 **[0027]** Referring to Figure 3, a typical AC input waveform 32 generated by the interface subsystem 12 is shown. The waveform is noted in Figure 3 as an AC waveform which, will be appreciated, has a frequency well above the standard 60 Hz frequency of an AC mains signal used in the United States. In one preferred implementation the frequency is 100Hz.

10 Waveform 34 is comprised of switching signals 34a-34c generated by the switching device 26a within the tool 18 while the tool 18 is in the communications mode. Switching pulses 34a, 34b and 34c represent logic 1 level signals. The absence of a switching pulse, indicated by a dash line 34d, represents a logic 0 level signal. It will be noted that pulses 34a-34c

15 are synchronized to the positive half cycles of input AC waveform 32. Waveform 36 illustrates the current pulses 36a, 36b and 36c that are produced by the switching pulse 34. Collectively, the three pulses 36a-36c and the absence of a pulse designated by dashed line 36d form a binary number of "1101". It will be noted that the current pulses 36a, 36b and 36c

20 are shifted slightly in time relative to the switch signals 34a, 34b and 34c, respectively, due to the inductance of the motor 26.

[0028] It will also be appreciated that while positive pulses are illustrated in waveform 36, the present invention is not limited to the use of only positive-going, sinusoidal pulses. Other forms of pulses such as

25 triangle or square wave pulses may be used, as well as a combination of positive-going and negative-going pulses.

[0029] Referring now to Figure 4, a preferred form of the current reader circuit 20 is illustrated. It will be appreciated immediately that the values for the electrical components shown in Figure 4 are merely shown for

30 exemplary purposes.

[0030] As explained previously, the current reader circuit 20 contains the necessary circuitry for detecting whether a current pulse exists

during any half cycle of the input sine wave 32 of Figure 3. It accomplishes this by the use of a small current shunt resistor 40 placed in series with the low side (neutral) power line 42 which couples to the power cord 16 of the power tool 18 through receptacle 22. A differential gain op-amp 44 monitors the voltage across the shunt resistor 40. The op-amp 44 amplifies the voltage to a level that the remainder of the current reader circuit 20 can use. The output of the op-amp 44 is then passed to a comparator 46 that checks to see if the voltage is above a preset threshold set by a voltage divider network 48. The voltage divider network 48 is comprised of a resistor 50 and a potentiometer 52.

[0031] When the voltage at input 54 of the comparator 46 is higher than the threshold voltage on input 56, the comparator 46 sends signals to a microcontroller 58 that there is a current present at that time. The microcontroller 58 is therefore apprised of the current pulse that is present at that given instant and is also synchronized with the input sine wave 32. The microcontroller 58 checks if the comparator 46 is indicating that current is present during a positive half wave of the input sine wave 32. It is also able to determine the length of time that the current pulse is present, if necessary. From this, the microcontroller 58 records the pulses as they occur in an internal memory. When communication is finished (i.e., once 8-bits have been received), the microcontroller 58 transmits the 8-bit data at a standard baud rate and in serial fashion, to the data logging device 13. It will be appreciated that the current reader circuit 30 can read and synchronize with virtually any frequency signal. Also, it will be appreciated that the values for the electrical components shown in Figure 4 are exemplary only.

[0032] It will also be appreciated that while the system 10 has been described in connection with the use of an alternating current signal, that a low power DC signal could also be employed instead of the AC signal. The controller 28 can be programmed to recognize this "weak" DC current as an indication that the power tool 18 is to be placed in a communications mode. The controller 28 can then pulse the power switching device 26a of the

power tool 18 to produce the coded pulse train representative of the stored information in the electronic module 30. Due to the weak DC signal, the power switching device 26a, which may comprise a thyristor or any other suitable switch, never latches. The switching device 28a can be easily and
5 very quickly switched, thus allowing a high throughput.

[0033] Still another method for transmitting information over the power line cord 16 could be formed by the use of capacitive coupling to the AC signal applied to the power cord 16. With reference to Figure 5, this method causes small pulses 60a to be superimposed on the AC signal 60
10 being input to the power cord 16. The interface subsystem 12 monitors the pulses 60a and extracts the data as needed before transmitting the data to the data logging device 13.

[0034] Referring now to Figures 6-8 an additional, specific implementation of the present invention will be described in connection with
15 the use of a switched, square wave, bipolar DC signal from the interface subsystem 12.

Interface Unit Sending Initiating Communications With The Tool

[0035] Whenever communication to the tool 18 is required, an initial passive power mode of operation is used to initiate such communication. In
20 this mode, the interface subsystem 12 simply powers the tool 18 but no actual communication of data is occurring between the tool and electronic module 30. Referring to Figure 6, in one preferred implementation a switched, bipolar DC signal 100 having a voltage of frequency of 100 Hz, a voltage of +/-96volts and a baud rate of 4800 baud is employed to initiate
25 communications. A positive voltage is present for about 5.0 milliseconds followed by a negative voltage for about 5.0 milliseconds. The duty cycle of the switched bipolar DC signal is therefore 50%. This mode is maintained for preferably at least about 100 milliseconds before communication can commence with the electronic module 30. This ensures that the power
30 supplies within the module 30 are established and stable.

Electronic module Identification and Polarity Determination

[0036] With further reference to Figure 6, once the electronic module 30 is powered up, it is necessary to establish communication with the electronic module and to determine the polarity of the connection that the module has with the interface subsystem 12. Polarity determination is necessary to ensure that whichever way the module 30 is connected to the interface subsystem 12, communication can always occur.

[0037] The identification process consists of sending a two character transmission (td) from the interface subsystem 12 to the electronic module 30, represented by portion 100a of waveform 100, and receiving a two character response, represented by portion 104. If the electronic module 30 does not respond from this "positive" polarity identification communication, the communication is repeated but with a "negative" polarity, as indicated by portion 106 of waveform 100. The response to the "negative" polarity communication is indicated by portion 108 of waveform 100. If no response is received from either identification communication (portion 110 of waveform 100), the interface subsystem 12 powers down the electronic module 30 and concludes that the tool 18 is not connected to the interface subsystem 12 or for whatever reason cannot communicate with the interface subsystem. However, if the electronic module 30 is connected and functioning properly, one of the two identification transmission will establish which polarity the electronic module 30 is connected with. From then on, all communications will be done with this polarity of communication.

Transmission Mode of Operation

[0038] Referring to waveform 112 in Figure 7, "positive" polarity communication is illustrated. The transmission of serial data to the tool 18 via the electronic module 30 consists of sending data bytes 116 consecutively with preferably about 5.0 milliseconds power supply refresh periods 114 between each character sent. The polarity of transmission is determined from the identification process described above. If the required polarity is positive, logic 0 is transmitted as a negative voltage, and a logic 1

(the same as the refresh period) is a positive voltage. Portions 118 indicate a response from the electronic module 30 back to the interface subsystem 12. Portion 120 indicates the passive powered mode where no communication is occurring between the electronic module 30 and the interface subsystem 12.

[0039] Figure 8 illustrates "negative" polarity communications via waveform 122. If the required polarity is negative, logic 0 is transmitted as a positive voltage, and a logic 1 (the same as the refresh period) is a negative voltage. This is illustrated by data bytes 124 and refresh periods 126. Portion 128 represents data being transmitted from the electronic module 30 back to the interface subsystem 12.

Reception Mode of Operation

[0040] In the reception mode of operation the interface subsystem 12 receives serial data from the electronic module 30. Immediately following the last transmission (i.e., the stop bit), reception data is expected by the interface subsystem 12 from the electronic module 30. For positive polarity, each reception bit consists of preferably a 5.6 millisecond positive voltage application 130 in Figure 7, followed by a negative polarity for preferably about 0.4 milliseconds (i.e., portions 118) where electronic switch 26a may or may not be fired. Referring again to Figure 8, for negative polarity, each reception bit consists of preferably a 5.6 millisecond negative voltage application (i.e., pulse) 132, followed by a positive polarity for 0.4 milliseconds (portions 134) where the electronic switch 26a may or may not be fired.

[0041] The current is sensed at the end of the 0.4 millisecond possible switch 26a firing period. The switch 26a current greater than 100mA corresponds to logic "0". The switch 26a current less than 100mA corresponds to logic "1". The reception mode continues until the interface subsystem has received enough bits of data to match what is expected from the electronic module 30. Once all communication is complete, the output

voltage applied to the tool from the interface subsystem 12 is set to zero. In Figure 8, communication is terminated as represented by portion 136.

5 **[0042]** It should be emphasized that each of the preferred methods for transmitting information from the electronic module 30 over the power cord 16 to the system 10 involve the application of an input signal which is of sufficiently low power (or of a predetermined frequency) that the controller 28 will not pulse the switching device 26a in a manner sufficient to cause the motor 26 to actually start to turn. Thus, the information from the electronic module 30 can be downloaded through the power cord 16 without fear of the
10 tool 18 turning on during this process.

[0043] The present invention thus forms a convenient means for obtaining information stored in an electronic module disposed within a power tool and in a manner which does not require any disassembly of the power tool. In this manner, a variety of useful information/data concerning the
15 performance, characteristics, identification or other data of the tool can be quickly accessed and recorded on a computer or other data logging device.

CLAIMS:**WHAT IS CLAIMED IS:**

1. A system for communicating information between a power tool and an independent subsystem using a power cord of the tool as a signal conducting medium, the system comprising:

a motor for driving an implement of said tool;

an independent interface subsystem adapted to be coupled to said power cord for providing an input signal to said power tool, via said power cord, that a communications mode is to be initiated between said power tool and said interface subsystem;

a controller disposed with said tool operable to recognize said input signal and to enter a communications mode of operation, said input signal being of a different frequency than an AC mains voltage normally used to power said tool so that said motor is not able to be powered on by said input signal;

an electronic module disposed within said tool for storing operational information relating to said power tool, said electronic module being in communication with said controller;

wherein said controller obtains said operational information from said electronic module and causes periodic pulses, representative of said operational information, to be transmitted over said power cord in synchronization with said input signal; and

wherein said interface system decodes said periodic pulses to obtain said operational information.

2. The system of claim 1, wherein: said periodic pulses comprise current pulses; and wherein said independent interface subsystem comprises a current reading subsystem for reading said periodic pulses and demodulating said periodic pulses.

1
2 3. The system of claim 1, wherein said interface subsystem comprises a computing
3 device.

4
5 4. The system of claim 1, wherein said input signal comprises an AC input signal
6 having a frequency of approximately 300 Hz.

7
8 5. The system of claim 1, wherein said periodic pulses comprise a DC input signal
9

10 6. The system of claim 1, wherein said periodic pulses are capacitively coupled onto
11 said AC input signal.

12
13 7. A system for communicating information between a power tool having a power cord,
14 an internal motor, a switch in communication with said power cord for switching on and
15 off said motor, and a storage module for storing operational information relating to said
16 tool, the system comprising: an independent interface subsystem adapted to be coupled to
17 said power cord for providing an input signal to said power tool, via said power cord, that
18 a communications mode is to be initiated between said power tool and said interface
19 subsystem, said input signal having a frequency greater than 60 Hz and being of
20 insufficient magnitude to cause rotation of said motor; a controller disposed with said
21 tool and operatively coupled with said switch, said controller operating to recognize said
22 input signal and to enter a communications mode of operation, said controller being in
23 communication with said storage module; wherein said controller obtains said operational
24 information from said storage module and causes periodic pulses, representative of said
25 operational information, to be transmitted over said power cord in synchronization with
26 said input signal back to said interface subsystem; and wherein said interface system
27 decodes said periodic pulses to obtain said operational information.

28
29 8. The system of claim 8, wherein said input signal comprises an AC input signal

1 having a frequency of at least about 300 Hz.

2
3 9. The system of claim 8, wherein said periodic pulses comprise pulses that are
4 synchronized in frequency with said AC input signal.

5
6 10. The system of claim 9, wherein said periodic pulses are synchronized with positive
7 going portions of said AC input signal.

8
9 11. The system of claim 7, wherein said periodic pulses comprise DC pulses.

10
11 12. The system of claim 7, wherein said periodic pulses are capacitively coupled onto
12 said input signal.

13
14 13. A system for communicating information between a power tool having a power cord,
15 an internal motor, a switch in communication with said power cord for switching on and
16 off said motor, and a storage module for storing operational information relating to said
17 tool, the system comprising: an independent interface subsystem adapted to be coupled to
18 said power cord for facilitating bi-directional communications with said power tool, via
19 said power cord; said independent interface subsystem operating to initiate a
20 communications mode between said power tool and said interface subsystem by applying
21 an input signal having a frequency greater than 60 Hz and being of insufficient magnitude
22 to cause rotation of said motor; and a controller disposed within a housing of said tool for
23 recognizing said input signal and transmitting signal pulses, via said switch,
24 corresponding to said stored operational information over said power cord back to said
25 interface subsystem for decoding by said interface subsystem.

26
27 14. The system of claim 13, wherein said signal pulses are transmitted in synchronization
28 with said input signal.

29

1 15. The system of claim 13, wherein said signal pulses are capacitively coupled onto said
2 input signal.

3
4 16. The system of claim 13, wherein said signal pulses are DC pulses transmitted in
5 synchronization with said input signal.

6
7 17. The system of claim 13, wherein said signal pulses are transmitted during
8 predetermined portions of said input signal.

9
10 18. A method for bidirectionally communicating information to and from a power tool
11 having an internally disposed module and controller the method comprising:

12 a) applying an input signal from a subsystem independent of said power tool through a
13 power cord of said tool, said input signal informing said controller to enter a
14 communications mode of operation;

15 b) causing said input signal to have a frequency higher than 60 Hz and a power that is
16 insufficient to cause normal operation of said tool;

17 c) using said controller to receive said input signal and to initiate downloading of stored
18 information from said module over said power cord via signal pulses generated in
19 synchronization with said input signal; and

20 d) demodulating said signal pulses to obtain said stored information.

21
22 19. The method of claim 18, wherein wherein step c) comprises causing said controller to
23 generate pulses that are synchronized in frequency with said input signal.

24
25 20. The method of claim 19, wherein step b) comprises causing said input signal to form
26 an AC input signal; and step c) comprises causing said controller to generate pulses that
27 are applied during positive portions of said input signal wherein said subsystem decodes
28 said periodic pulses to obtain said stored information.

29

1 21. The method of claim 18, wherein step c) comprises using the controller to control a
2 switch disposed within a housing of said tool to generate said signal pulses.

3
4 22. A system for communicating information between a power tool and an independent
5 subsystem using a power cord of the tool as a signal conducting medium, the system
6 comprising:

7 a motor for driving an implement of the tool, the motor being adapted to be
8 powered by a standard AC mains signal supplied via the power cord;

9 an independent interface subsystem adapted to be coupled to said power cord for
10 providing an input signal to said power tool in the absence of the standard AC mains
11 signal, via said power cord, to indicate that a communications mode is to be initiated
12 between said power tool and said interface subsystem;

13 a controller disposed within said tool operable to recognize said input signal and
14 to enter a communications mode of operation, said input signal having a frequency
15 sufficiently different from the standard AC mains signal to prevent operation of said
16 motor;

17 an electronic module disposed within said tool for storing operational information
18 relating to said power tool, said electronic module being in communication with said
19 controller;

20 wherein said controller obtains said operational information from said electronic
21 module and causes periodic pulses, representative of said operational information, to be
22 transmitted over said power cord in synchronization with said input signal; and
23 wherein said interface system decodes said periodic pulses to obtain said operational
24 information.

25
26 23. The system of claim 22, wherein: said periodic pulses comprise current pulses; and
27 wherein said independent interface subsystem comprises a current reading subsystem for
28 reading said periodic pulses and demodulating said periodic pulses.
29

1 24. The system of claim 22, wherein said interface subsystem comprises a computing
2 device.

3
4 25. The system of claim 22, wherein said input signal comprises an AC input signal
5 having a frequency of approximately 300 Hz.

6
7 26. The system of claim 22, wherein said periodic pulses comprise a DC input signal

8
9 27. The system of claim 22, wherein said periodic pulses are capacitively coupled onto
10 said AC input signal.

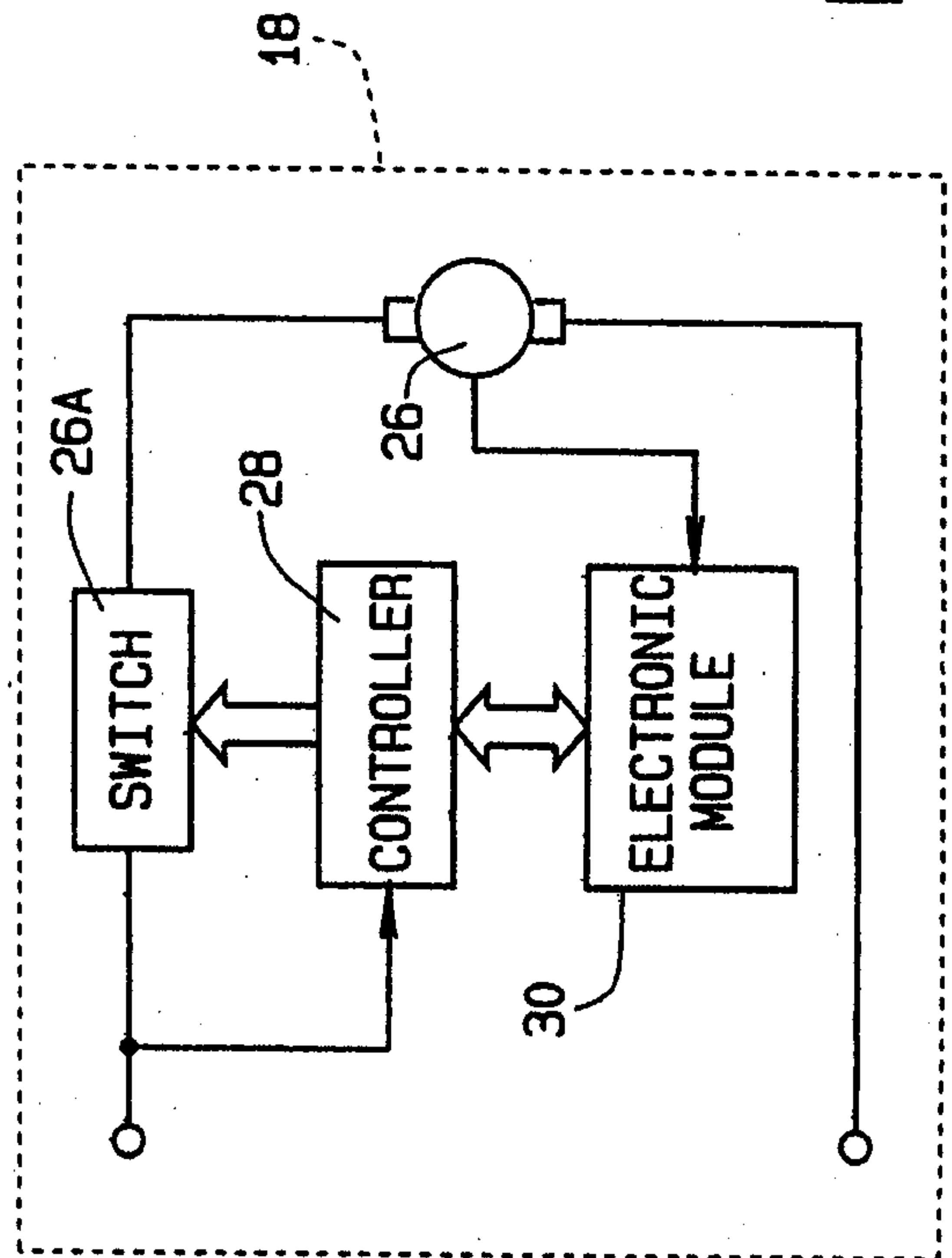
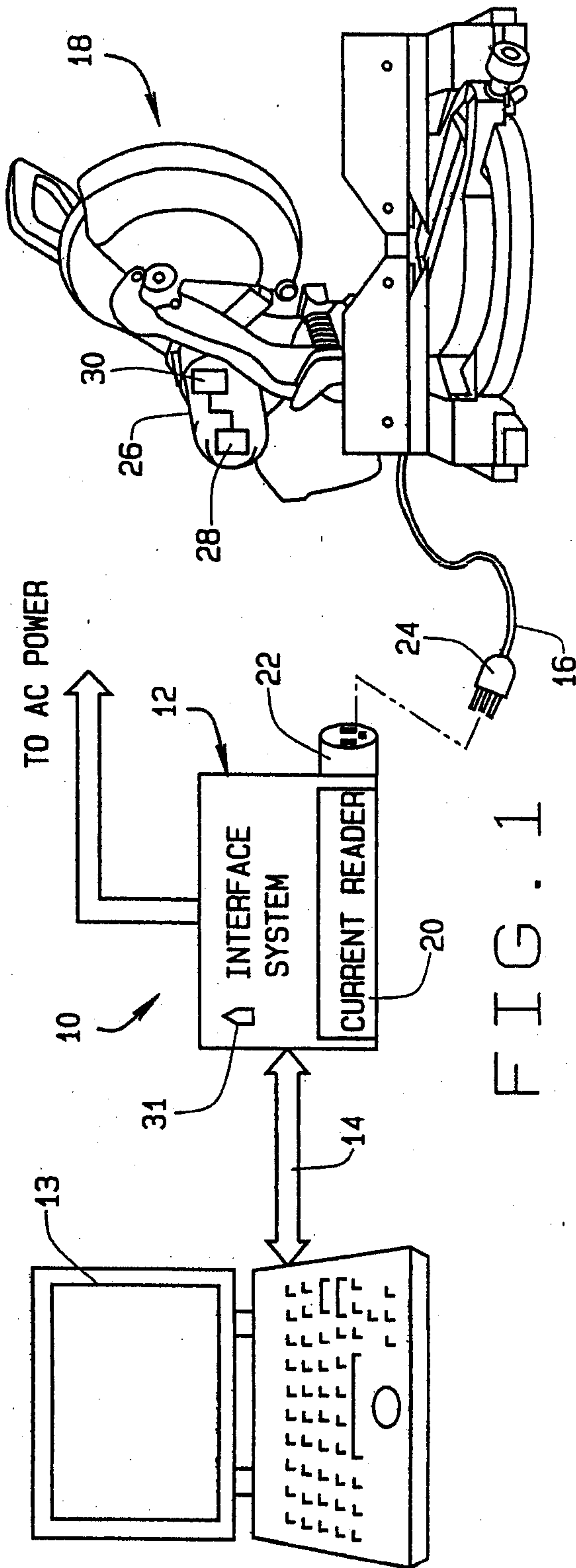
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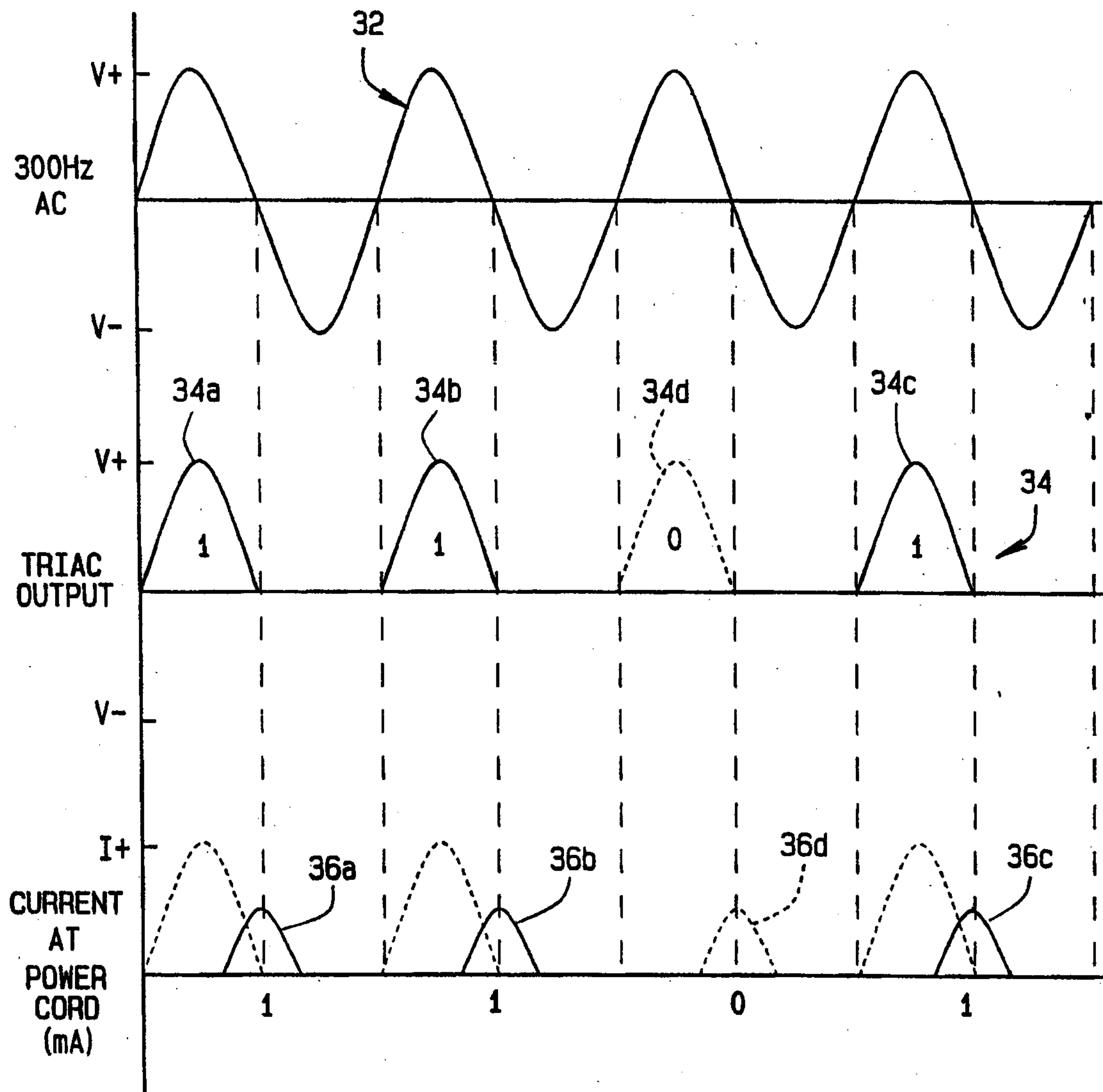


FIG. 3

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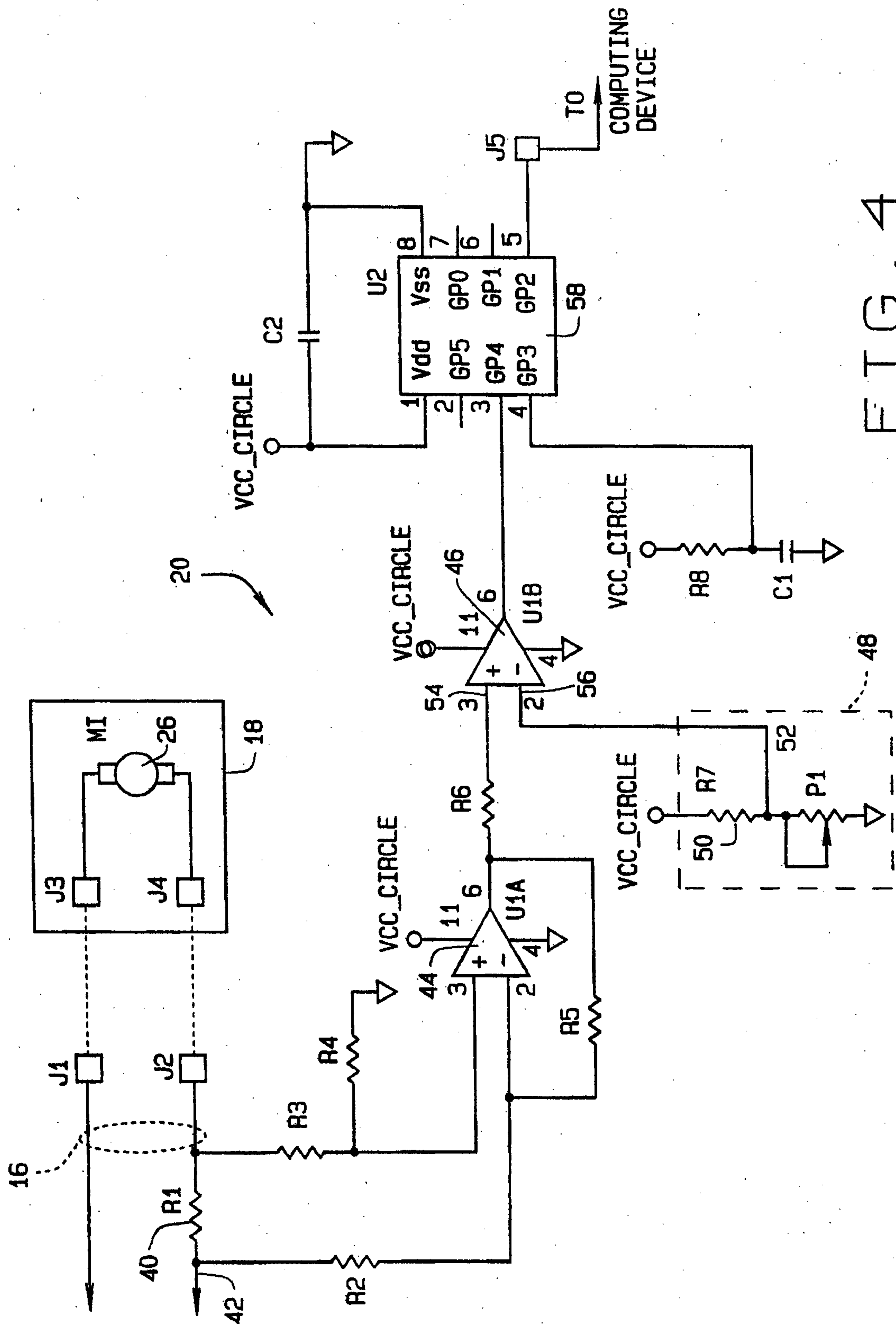


FIG. 4

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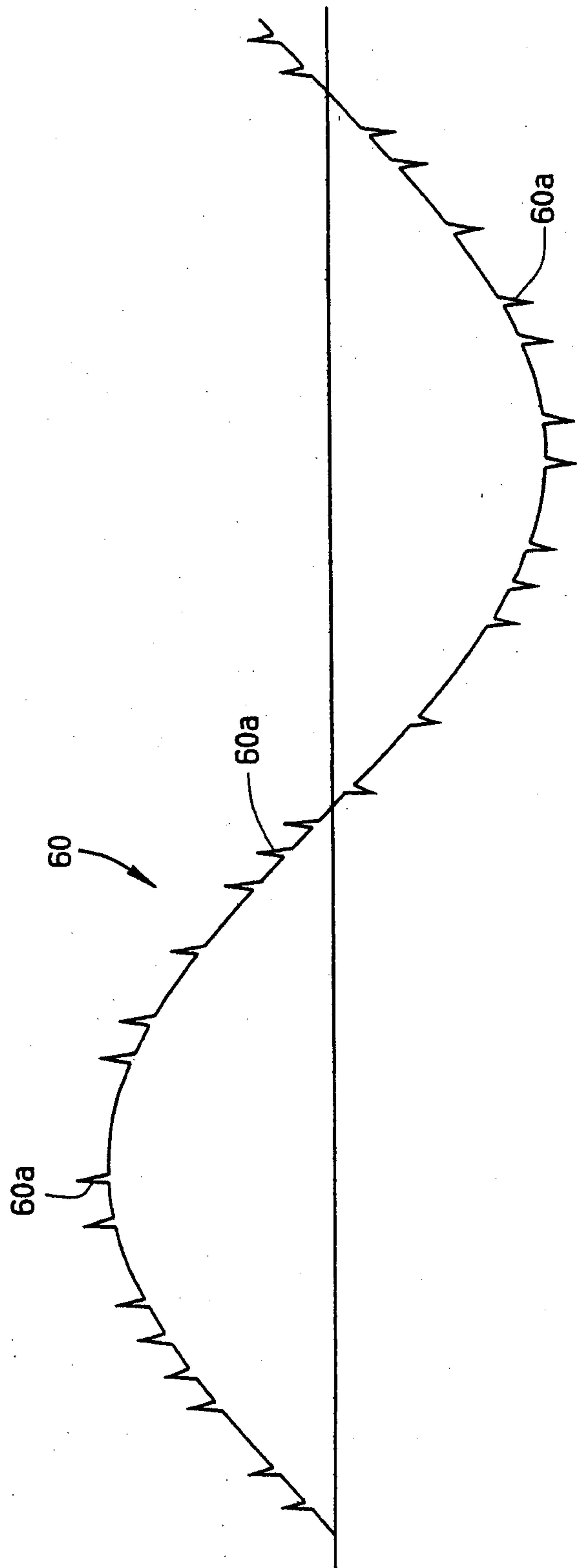


FIG. 5

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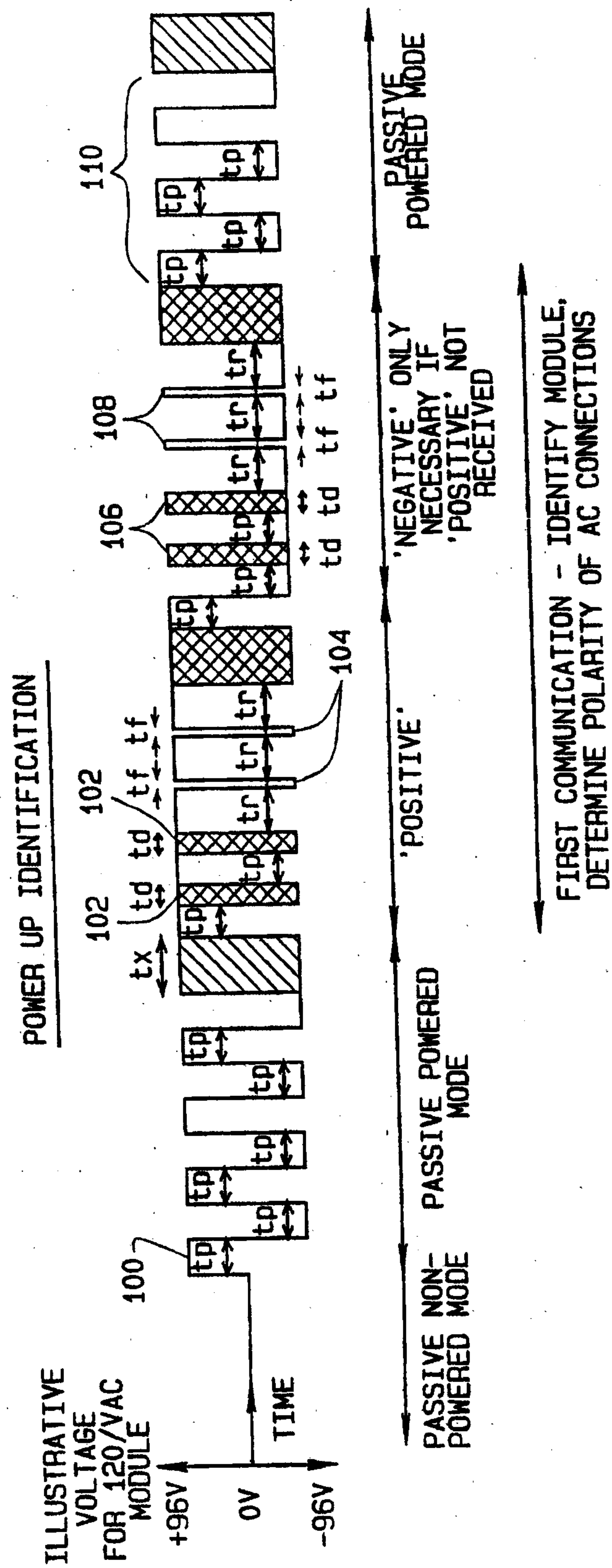
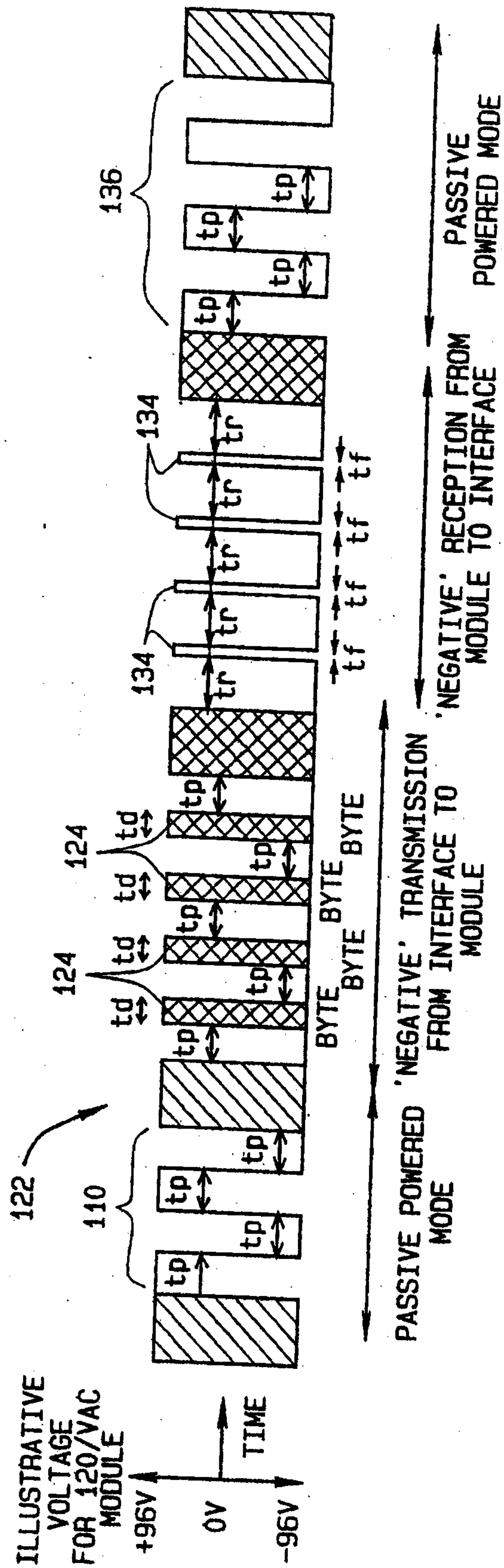


FIG. 6

'NEGATIVE' POLARITY COMMUNICATION



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