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CA 2494562 A1 2004/01/08

(21) 2 494 562

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(86) Date de dépôt PCT/PCT Filing Date: 2003/06/27
(87) Date publication PCT/PCT Publication Date: 2004/01/08
(85) Entrée phase nationale/National Entry: 2004/12/23
(86) N° demande PCT/PCT Application No.: US 2003/020426
(87) N° publication PCT/PCT Publication No.: 2004/003695
(30) Priorités/Priorities: 2002/06/27 (60/392,322) US; 2002/09/27 (60/414,191) US

(51) Cl.Int.$^{7}$/Int.Cl.$^{7}$ E21B 7/00

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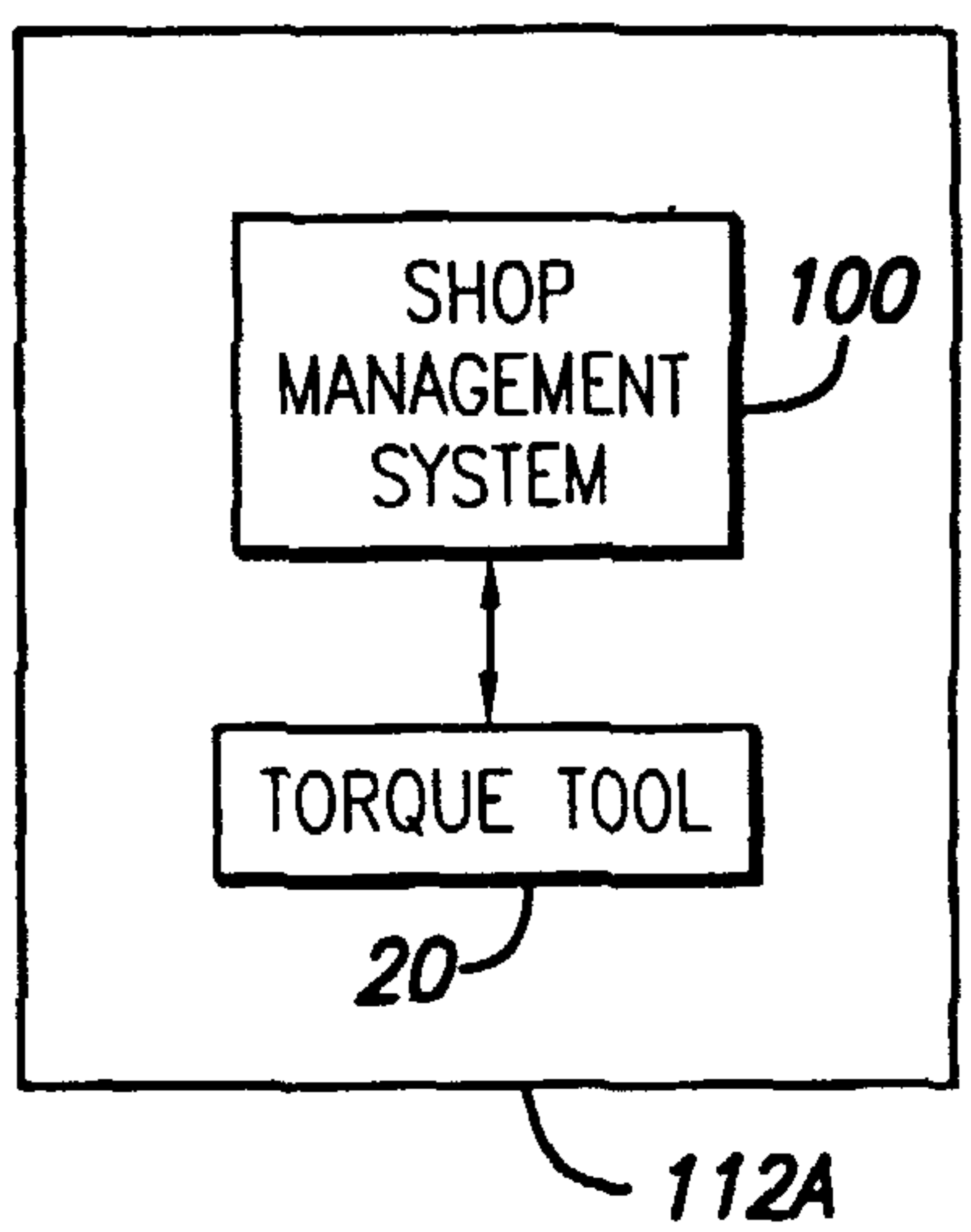
(54) Titre : OUTIL, SYSTEME D'OUTIL ET PROCEDE D'UTILISATION
(54) Title: TOOL APPARATUS, SYSTEM AND METHOD OF USE




(57) Abrégé/Abstract:
The present disclosure relates to a method, tool apparatus (20), system associated with the apparatus, and method of using the apparatus and the system for use in attaching fasteners and other operations. One application of this disclosure would be to provide a tool (20), system and method for attaching lug nuts to secure a wheel to vehicle.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
8 January 2004 (08.01.2004)

PCT

(10) International Publication Number
WO 2004/003695 A3

(51) International Patent Classification[7]: E21B 7/00

(21) International Application Number: PCT/US2003/020426

(22) International Filing Date: 27 June 2003 (27.06.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/392,322 27 June 2002 (27.06.2002) US
60/414,191 27 September 2002 (27.09.2002) US

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(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

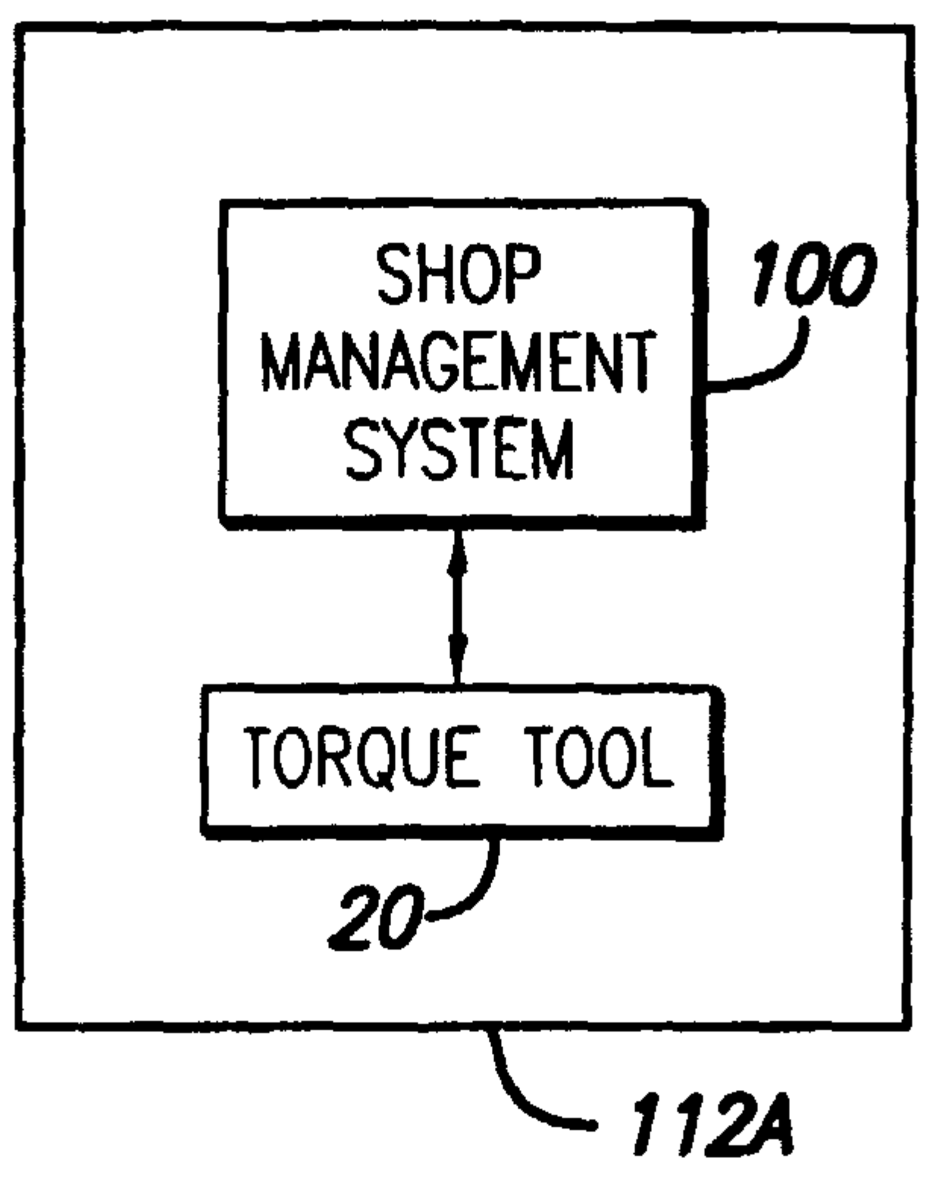
(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Published:**
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

(88) Date of publication of the international search report: 24 June 2004

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

(54) **Title:** TOOL APPARATUS, SYSTEM AND METHOD OF USE




**(57) Abstract:** The present disclosure relates to a method, tool apparatus (20), system associated with the apparatus, and method of using the apparatus and the system for use in attaching fasteners and other operations. One application of this disclosure would be to provide a tool (20), system and method for attaching lug nuts to secure a wheel to vehicle.

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# TOOL APPARATUS, SYSTEM AND METHOD OF USE

BACKGROUND

[0001] The present disclosure relates to a method, tool apparatus, system associated with the apparatus, and method of using the apparatus and the system for use in attaching fasteners and o ther tool operations. F or example, one application of this disclosure would be to provide a tool, system and method for attaching lug nuts to secure a wheel to vehicle.

[0002] By way of background, a fastening system may require tightening components such as a nut and bolt in a threaded fastening system, to a desired force or torque or within a desired torque range. Securing the fastening components at a desired torque setting allows for secure attachment of the components and any structures related thereto without under-tightening or over-tightening the components. Under-tightening the components could result in disengagement of the components. Over-tightening the components could make disengaging the components difficult or could cause damage to the components. To prevent under-tightening or over-tightening a torque measurement can be made while tightening the components, for example, a nut to bolt, to meet a target torque setting or withing a desired torque range.

[0003] With reference to a more specific example, it may be desirable to attach a lug nut to a bolt on a vehicle axle to attach the wheel to the vehicle. In this example, it is common for a vehicle such as a car to have four or five mounting bolts attaching the wheel to the car. The wheel fits over the mounting bolts and the lug nuts are attached to the mounting bolts. It is desirable to prevent under-tightening so as to prevent disengagement of the lug nuts from the bolts. It is desirable to prevent over-tightening so that the lug nuts can be disengaged at some time in the future and to prevent damage to the nut and bolt structure such as preventing "stripping" of the threads between the nut and bolt.

[0004] The present disclosure relates to a method tool apparatus, system for method of using the apparatus and system for tightening and standardizing the forces associated with a fastener system and for use in other tool systems. In one embodiment, the system includes access to a database of vehicle configuration information. Information is provided to the tool apparatus. The tool apparatus provides verification of the information and verification of application of the information. After use, the tool assembly transfers the information back to the system to provide a historical record of the event.

[0005] In another configuration, the tool assembly includes a coupling device and a tool. The coupling device receives information from the system and transfers it to the tool. Once the vehicle configuration information is received by the tool it is used to establish torque settings for use in the fastener torquing process. Verification of the tightening process is recorded at the tool and transmitted back to the coupler. The coupler then transfers the information to the system.

[0006] In yet another configuration, the system includes a shop management server which communicates with a controller. The controller is used to collect information about the subject automobile from the system. The controller delivers the information to the shop management server. The shop management server then delivers corresponding vehicle configuration information to the coupler for transfer to the tool. The tool utilizes the information in the fastener tightening process. Verification of the information can be recorded at the tool and transferred back to the coupler. Information transferred to the coupler can be

[0007] transmitted to the shop management server for verification, transaction completion and storage.

[0008] Additional features will become apparent to those skilled in the art upon consideration of the following detailed description of drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The detailed description particularly refers to the accompanying figures in which:

[00010] FIG. 1 is a perspective view of one embodiment of a tool used for a controlled tool operation;

[00011] FIG. 2 is a perspective viw of another embodiment of the tool of FIG. 1, showing a cable attachment for sending and receiving data;

[00012] FIG. 3 is a perspective view of another embodiment of the tool of FIG. 1, shown seated in a cradle for sending and receiving data;

[00013] FIG. 4 is an illustration of pneumatically driven embodiment of a tool used for controlled torque application;

[00014] FIG. 5 is a perspective view of the tool of FIG. 1 in a docking configuration with a controller;

[00015] FIG. 6 is top plan view of FIG. 5;

[00016] FIG. 7 is side perspective view of FIG. 5;

[00017] FIG. 8A and 8B are illustrations showing a front view and rear view respectively of the tool being carried on another embodiment of the controller;

[00018] FIG. 9A and 9B are illustrations showing a front view and rear view respectively of another embodiment of the controller supporting the tool;

[00019] FIG. 10 is an illustration showing a front elevational view of a pneumatically powered embodiment of the tool carried on the controller affixed to a vertical stand;

[00020] FIG. 11 is an illustration of a pneumatically powered embodiment of the tool being supported within a support structure attached to another embodiment of the controller;

[00021] FIG. 12 is a simplified diagrammatic view of a shop management system;

[00022] FIG. 13 is a simplified diagrammatic view of a torque monitoring system including shop management system and a torque tool;

[00023] FIG. 14 is a simplified diagrammatic view of another embodiment of the torque monitoring system;

[00024] FIG. 15 is a simplified diagrammatic view of another embodiment of the torque monitoring system for managing multiple torque tools;

[00025] FIG. 16 is a simplified diagrammatic view of another embodiment of the torque monitoring system for managing multiple torque tools and multiple control units;

[00026] FIG. 17 is a simplified diagrammatic view of a method of using a torque monitoring system; and

[00027] FIG. 18a-18d is a simplified illustration showing a progression of the tool display screens as seen during a torque application.

DETAILED DESCRIPTION OF THE DRAWINGS

[00028] While the present disclosure may be susceptible to embodiment in different forms, there is shown in the drawings, and herein will be described in detail, embodiments with the understanding that the present description is to be considered an exemplification of the principles of the disclosure and is not intended to limit the

disclosure to the details of construction and the arrangements of components set forth in the following description or illustrated in the drawings.

[00029] As shown in Fig. 1, a tool 20 for controlled or otherwise guided application of torque is shown in the form of a manual or pneumatic torque wrench. Although a torque wrench embodiment is shown, the present disclosure is meant to broadly cover any tool used for torque applications including but not limited to torque wrenches, torque screwdrivers, adjustable click-type torque instruments, torque reading instruments, torque drivers, open head torque wrenches, ratchets, torque calibrators, and torque measurement acquisition systems. Further, this disclosure is intended to broadly include all tools which can be configured for use in the method and system as disclosed. In the embodiment shown, the tool 20 includes a driver shown in the form of a drive head 22, and a handle 23, which includes a shaft 24, and a grip 26. Although FIG. 1 shows grip 26 at the end of handle 23, the grip may positioned at other locations along the handle 23, or alternatively, the handle 23 may be fitted with two or more grips for gripping. Tool 20 further includes a controller 28 operatively associated wit the tool, such as shown being seated in or fixedly attached to handle 23.

[00030] Preferably, controller 28 includes a display 30 for displaying information related to a torque application to be described more fully hereinafter. Controller 28 also includes one or more control buttons 32 for inputting commands or interacting with menus presented on display 30. The controller 28 also has circuitry of known construction to sense and record a magnitude of torque applied by the tool 20 during a particular torque application. The controller 28 has volatile or re-writeable memory for storing recorded torque magnitude for later retrieval and/or transmission to other devices.

[00031] Referring to FIG. 2, in applications that require the tool 28 to communicate with outside devices such as a shop management system or control unit to be described hereinafter, the controller 28 also includes an input/output connection for communicating with such devices over a communications path 34. As illustrated, the communications path may be a hard wire connection, such as an insulated copper wire or optical fiber, although it should be understood that communication paths 34 can also be a wireless communication paths such as infrared, acoustic, RF or other wireless communication techniques. The tool also can be embodied to be coupled with a cradle 36 as shown in FIG. 3 with cradle 36 and attached wired or wireless

technology acting as communications path 34. In such an embodiment, controller 28 includes a port or junction (not shown) of known construction for being removably electronically connected to cradle 36.

[00032] Referring now to FIG. 4, tool 20 may be hand powered during use or may have an attachment for being pneumatically, electrically, hydraulically or magnetically powered. As shown in FIG. 4 pneumatic line 38 is shown for connecting tool 20 to a pneumatic power source via a hose 40 and a pneumatic source coupling 42. Pneumatic pressure can be activated using trigger 43. Although a variety of pneumatic pressures may used depending on the intended torque application, a suitable range for many applications such as vehicle tire lug nut removal and/or refastening is between 85 and 120 psi line pressure at 3.0 CFM minimum air supply.

[00033] As shown in FIG. 5, tool 20 can be configured to mate with a control unit 46A. FIG. 5 also shows tool 20 including an alert indicator 44 in the form of four lights seated in handle 23 and electronically controlled by controller 28. Although visual alert indicators are shown, the alert indicator 44 may also be an auditory device for making an auditory signal, or may be a device for creating tactile sensation such as a vibration, heating, or cooling. Alert indicator 44 may also be some combination of auditory, visual, or tactile device. Although one possible positioning for alert indicator 46 is shown, other locations such as at the end or underside of the handle 33 are suitable as well.

[00034] Control unit 46A is configured to communicate with tool 20 when tool 20 is docked therein. Control unit 46A may includes control unit display 48, control unit buttons 50A used for inputting commands and interfacing with menus presented on display 48, and docking section 51. During docking, tool 20 is inserted in docking cavity 52 defined by the upright docking section wall 53 and having a width dimension 54, a length dimension 56, and a depth dimension 58 which are slightly larger than a corresponding length, width, and depth of handle 23 to allow removably secure positioning of tool 20 within the docking cavity 52. A coupling or junction (not shown) is also provided along an interior wall of docking cavity 52 for electrically connecting control unit 46A to controller 28. A top plan view and side perspective view of tool 20 docked in control unit 46A are shown in FIG. 6 and FIG. 7, respectively.

[00035] An alternative embodiment of control unit 46B is shown in FIGS. 8A and FIG. 8B. In this embodiment, tool 29 docks by hanging on support or hanger 60. Connection between the control unit 46B and tool 20 may be through hanger 60 or via wireless communication when control unit 46B and tool 20 are brought in close proximity. FIG. 9 shows another embodiment of a control unit 46C in which the drive head 22 is inserted or clicked into a hanging docking cavity 65. Control unit 46 is elevated from the floor or other support platform by pole or support 66.

[00036] FIG. 10 shows a front view of the control unit 46B with tool 20 docked therein. This embodiment also shows the positioning of the pneumatic line 38, hose 40, and pneumatic source coupling 42. Stand 66 may connected to or house a pneumatic pressure system for supplying pneumatic pressure to tool 20. To secure or balance stand 66, a floor plate 70 may be fixedly attached to the floor or other support platform.

[00037] Control units may also be commonly available portable digital assistants or PDA such as those available from Palm, or other mobile computing devices. Software configured to communicate with tool 20 may be loaded onto the PDA which can use operating systems such as Palm OS, Microsoft Windows CE, or other mobile computing device operating systems presently available or hereafter devised. The communications and operations protocols used by the tool may also be written in HTML or XML programming language, or other suitable systems presently available or hereafter devised for interoperability with a wide range of software and hardware platforms.

[00038] The control unit 46 as illustrated, can be in the form of an Ethernet cradle which is similar to the cradle bundled with most hand held devices. However, such an Ethernet cradle may be designed to include a Ethernet card and an RJ-45 connector. This connector allows the unit to connect to a local area network via a CAT5 cable attached to a hub or switch. This will allow for rapid communication (10Mbps, 100MBps, or gigabit) between the tool 20 and the shop management system 100.

[00039] FIG. 11 shows another embodiment of the control unit 46D with tool 20 docked therein. The embodiment of tool 20 shown in FIG. 11 includes a second grip 72 and extension member 76 attached to drive head 22. Control unit 46D is relatively larger than previously discussed control units and is intended to remain fixed during use. A power button 78 is shown for toggling the control unit 46D on and off. The

docking structure shown for control unit 46D is a support platform 80 including two U-shaped portions 84 connected by lateral sides 86. Tool 22 lays horizontally on the support platform 80 within the interior of the U-shaped end portions 84. Support platform 80 is connected to the stand 68 by horizontal extension member 88.

[00040] FIG. 12 is a simplified diagrammatic view of a shop management system 100. Shop management system 100 can be configured on a general purpose computer that includes a processor 102, specification database module 104 accessible by or loaded onto the system 100, a work order database module 106 accesible by or loaded onto system 100, and a communications port 108. The modules 104, 106 can be accessed by the processor locally or remotely over a communications network such as a local area network, wide area network, over an intranet, or over the Internet or another suitable communications hereafter devised and usable for this system. The term "module" referenced in this disclosure is meant to broadly cover various types of software code including but not limited to routines, functions, objects, libraries, classes, members, packages, procedures, methods, or lines of code together performing similar functionality to these types of coding, therefore one program can operate to provides the functionality, or the functionality can be divided over a number of programs, accessible either locally or remotely. The system 100 may also communicate with one or more output devices 110 such as monitors or printers. For the purposes of the present example, and as illustrated in figures, the database modules 104, 106 will be loaded on the shop management system 100.

[00041] As shown in FIGS. 13-16, shop management system 100 can communicate directly with tool 20. System 100 and tool 20 make up torque management system 112A. This connection may be via a hardwire or wireless using any of the communications protocols previously described. In the alternative, as shown in FIG. 13, the control unit 46, or alternatives embodiments 46A, 46B, 46C, 46d thereof, can also be used an intermediate interface between shop management system 100 and tool 20 these three components defining an another torque management system 112B. As shown in FIG. 14, the control unit 46 can also be used to control more than one tool 20 the group of which define torque management system 112C. Recall that tool 20 removably docks with control unit 46 so one tool can be removed and another connected so that one control unit 46 can be used to communicate with more than one tool 20. As shown in FIG. 15, shop management system 100 can be used to communicate with more than one control unit 46 which in turn can be used to

communicate with one or more tools 20. The control units can be within the same location or at different locations from the shop management system 100. The combination of the shop management system 100, multiple control units 46, and multiple tools 20 make up torque management system 100.

[00042] FIG. 16, shows the general steps by which tool operation or torque management system 112A-D is used. In a first step 200, a particular tool operation, for purposes of illustration, a torque application can be identified. A torque application can be any task or process that requires the use of a torque tool where precise tolerances, a desired range, or limits of the magnitude of the torque applied need to be monitored. Generally, a fastening or unfastening of a fastener to a member can be a torque application. One specific example of a torque application is related to changing a tire on a vehicle. In this example, a number of lug nuts need to be removed, then tire is then replaced, and in turn the lug nuts are refastened to secure the replacement tire. It is known in the automobile industry that each vehicle manufacturer offers specifications for a recommended and maximum safe amount of torque that should be applied to securely fasten lug nuts for that vehicle. While the lug nuts could be manually removed, the tool is used to at least attach the lug nuts to a desired torque range.

[00043] In step 200, the torque application such as a lug nut replacement is made to the system 100, the tool 20, or the control unit 46. That identification can be made in a number of different ways. For example, vehicle criteria or identification information such as a particular vehicle make, model, model year, as well as VIN or serial number, bar code scanning, or other identification means, can be input. The system 100 references the specifications database module 106 to find corresponding manufacturer's specifications for the identified torque application. Alternatively, a tire type can be identified. In another embodiment, a torque application code can be entered. In yet another embodiment, the vehicle can be fitted with a device to identify itself to the system 100. The identification can be made to the tool 20, system 100, or control unit 46 by any input method or device including using a keyboard, interacting with a graphical user interface that has menus or other selection protocols, scanning a barcode from a printed work order, or from import/export or other communication with work order or job database, such as a work order database used in a vehicle repair facility.

[00044] In a second step 210, the manufacturer's specifications for the identified torque application are retrieved to the tool. If the system 100 referenced the specification database in step 200, then the specification are transmitted from the system 100 to the tool 20 via a communications path 34 therebetween. Alternatively, the system 100 sends the specifications to the control unit 46 which in turn transmits the specifications to the tool 20 when the tool 20 is docked therein. If the specifications are already on tool 20, for example because the same torque application was performed prior to the current torque application, the specification can be recalled from the tool's 20 memory. Similarly, if the specifiations are already resident on the control unit 46, the specifications can be recalled and loaded onto tool 20.

[00045] In a third step 220, a user or operator, such as, for example, a mechanic or technician, uses the tool loaded with the torque application specifications to perform the torque application. The tool 20 or the tool 20-control unit 46 combination are configured to guide the user through the torque application. This guidance can come in the form of specifying a particular portion of the application and displaying a maximum allowable applied torque. The torque magnitudes displayed can be in either U.S. customary units (lbs-ft) or in S.I. units (N-m).

[00046] The guidance can also come in the form of producing an alert during torque application to notify the user that the user is approaching or has exceeded a specification. For example, if the application is re-securing lug nuts after a tire replacement, in an embodiment where the alert indicator 44 is a series of three lights, one light yellow, the second light green, and the third light red, the controller 28 may cause the yellow light to be illuminated as the desired torque is being approached, the green light to be illuminated when the desired torque is reached, and the red light to be illuminated to indicate an over torque condition.

[00047] Similarly, an audible alert indicator 44 embodiment may use different tones for an approaching limit, at limit, or over-limit condition. In yet another embodiment, the alert indicator 44 may take the form of vibration device or other tactile device vibrates at different rates or otherwise variably signals to indicate different torque conditions. The user, when being alerted by the alert indicator that the desired torque has been reached, discontinues the torque application, such as by no longer hand-actuating the tool 20 or by releasing the trigger 43 of a powered version of the tool 20, such as by pneumatics, hydraulics, electrical or magnetic.

[00048] The guidance may also come in the form of directing the user to a particular part, such as a particular tire on a vehicle. The user may then use the controls 32 to indicate that the user is about to perform a torque application on that particular part. As shown FIGS. 17A-D, the display 30 on the tool can display a tire location such as the left front tire using an abbreviated code such as LF followed by the amont of torque to be applied to fasten lug nuts for that tire, in this example 87lb-ft the user can use the controls 32, in the form of up-down buttons in this illustration to cycle between tires and/or to confirm that the selected tire torque task has been completed. FIGS. 17B-D show the display for the right front, left rear, and right rear tires respectively. Other abbreviations and other types of display protocols can be used as well, depending on the nature of the intended torque applications. In this manner, the user is stepped through each part of the torque application process.

[00049] Generally simultaneously with the guidance process described above and the various steps of the torque application, a torque sensing device within the controller 28 measures or captures data corresponding to the actual torque applied for that application. That information or data is stored in tool 20 or in a fourth step 230 immediately transmitted back to the control unit 46 or directly to the shop management system 100. The data is used to create a record of exactly how much torque was applied during the various stages of the torque application. In an embodiment where the data is not immediately transmitted from the tool 20, the data can be retrieved and sent to the control unit 46 and system 100 during docking.

[00050] The specifications and other torque-related information in the specifications database module 104 can be compiled from promulgated industry standards or from specification released by original equipment manufacturers. For example, factory torque specifications developed by the automobile manufacturer relating to the proper torque for tightening the lug nuts on the bolts of the wheel can be maintained in the database 104. The information can be modified, updated and corrected as necessary. If this system 100 is connected to a network that has access to updated specifications, this information update can occur at generally any time of the day.

[00051] In order to maintain system integrity and security. The various steps described above may include password system implementation or user authentication for added security and user accountability. For example, a technician or mechanic performing a torque application may have to enter a worker ID. As another example, specifications updates to the specification database module 104 may require manager level access.

Example 1: Vehicle Repair Center

[00052] One embodiment of the system 112 is used by the tire and wheel industry to be used in the installation of automotive wheel lug nuts. This torque management system 112 provides the user with a hand operated electronic torque measuring tool 20 with a torque limited pneumatic driven power ratchet. The user is provided with an ability to retrieve and retain required lug nut torque values from a torque value database (one embodiment of the specifications database module 104) developed to original equipment manufacturers specifications.

[00053] A service representative of the tire and wheel industry facility inputs the programmed torque settings from the database. These settings are programmable to OEM or user defined torque settings. In this embodiment, the manufacturers (OEM) specifications for torque are those published specifications from Mitchell1 (a Snap-on company). The system is advantageous for such uses because minimum technical knowledge of torque application is required by a technician to successfully apply the required torque and record torque data.

[00054] The system will reduce the possibility of the technician applying torque levels inconsistent with the torque settings by requiring the technician to only perform the sequential steps to tightening the wheel lugs, and monitoring the applied torque to each lug nut, guiding the technician to the final applied torque, and noting if an over or under torque event occurs.

[00055] During the torque application, the technician receives visual, audible, and tactile indicators when the programmed torque value is achieved. The system 112 monitors torque applied by the technician to ensure the defined specified torque has been applied to each lug nut. The defined torque setting must be properly applied before the system 112 will accept data from the next nut or wheel assembly. OEM specifications are defined as a database 104 and interfaced, or included within a service center host computer system (an embodiment of the shop management system 100).

[00056] User defined torque settings can be input by qualified and/or authorized individuals. Torque values applied to each lug nut are recorded. Recorded torque value data is sent to the host computer for record retention and customer sales order documentation. Further, the system can be configured to prevent release of the

vehicle when the tool is docked or if the torque values stored on the tool are outside of the desired torque range.

[00057] In this embodiment, the accuracy of the actual applied torque at the interface of the head of the tool and the wheel socket is +/- 3% of the applied torque.

[00058] The torque tool 20 has an air powered assist ratchet for the removal and seating of the wheel lug nuts prior to the manual application of the final torque to complete the tightening of the lug nut. The air ratchet is based on currently available air ratchet assemblies of known construction. The air ratchet is used to run the lug nut on and off the wheel stud. The air ratchet is design to purposefully not have sufficient power to be used in the breaking free of the lug nut for removal. The air ratchet used in the installation of the lug nut only has sufficient power to apply torque to seat the lug nut, but does not have sufficient power to reach the final required torque specification for the lug nut.

[00059] Construction of the hand held air ratchet / torque wrench tool is consistent with industry practice for air powered tools, and will be designed for the intended use and environment as represented as typical to a tire service centers. In this embodiment, the specifications for the tool 20 is as follows. The maximum torque capability applied through the air ratchet will be limited to an output of 50 ft.lbs. at 120 psi supplied line pressure. The level of torque output will be proportional to the supplied air pressure. The maximum achievable torque, at the defined line pressure, is at the point the ratchet stalls with no further rotation in the selected direction. The compressed air requirements for the ratchet require operation within a range of 85 to 120 psi. line pressure @ 3.0 CFM minimum air supply.

[00060] In use, the user has the ability to apply accurate torque with the tool shown in the form of a wrench. Final tightening is only performed through manually applied force and is electronically sensed and indicated to the user. The applied torque is displayed to the user by an LCD display in the tool 20 or control unit 46 indicating the target torque setting and the increasing torque values as force is applied. The display indicates the maximum torque achieved after the applied force is removed by the user.

[00061] The tool can provide one or more of the following alert indicators. When the preset torque setting is achieved from force applied to the wrench by the user the wrench provides a visual indicator. The indicator is in the form of an LED display of lights, advancing from one to three yellow torque approach indicators, a green

indicator light for reaching the target torque value, and a red indicator light indicating an over torque condition.

[00062] A second type of indicator is a tactile indicator. A tactile indicator form of vibration is used to indicate the preset torque value has been achieved and signals the user to release the force being applied to the wrench.

[00063] A third type of indicator is an audible torque set point indicator. An audible indicator is provided to indicate to the user that the preset torque value has been achieved, signaling the user to release the force being applied to the wrench.

[00064] The tool is equipped with an audio-visual feedback in the event of error conditions.

[00065] In this embodiment, the power ratchet head is a standard ½" square drive. The ratchet assembly operates under power in the clockwise and counterclockwise directions. The power driven ratchet has the capacity to sustain repeated torque loads up to 250 ft.lbs. and meet ASME Specification B 107.10-1996 for cyclical loading. The air ratchet / torque wrench can be protected from significant damage in the event that the tool is dropped from a height not exceeding three (3) feet above the shop flooring.

[00066] The tool can be covered in a protective synthetic rubber covering to assist in absorbing impact to the tool if dropped or impacted. The tool will resist the force required to break free lug nuts without damage if the required torque at the ratchet head does not exceed 250 ft.lbs. The tool will function normally in temperatures between 45 and 120 degrees F and humidity below 95%.

[00067] The handgrip will be designed to allow comfortable grasping of the tool in the right hand. The size will support the palm for application of force to achieve the desired torque. The composition of the grip is synthetic rubber to provide a tactile slip resistant grip. The trigger or button used to control the on/off air supply to the ratchet is located within easy finger reach on the handgrip. The trigger will be located as not to interfere with the hand application of force to achieve the desired torque on the lug nut.

[00068] In this embodiment, the wrench is provided with a secondary handgrip to be used to balance the tool and assist in positioning the wrench at the lug nut. The secondary grip is located immediately below to the ratchet head of the wrench. The length of the wrench will be established to provide sufficient leverage to apply

manual downward force to achieve the necessary preset torque value per ASME Specification B107.14-1994.

[00069] The control unit 46 for this embodiment provides an interface to the tool 20. An RS-485 interface that is capable of transmitting data up to several hundred feet at up to 1 megabits per second is used for communication purposes. An umbilical assembly with the RS-485 cable connection combined with the air supply line to the hand tool is used. The host computer can fully control the control unit via a two-way communication link.

[00070] The host computer formats the work order data, searches the Database for the Torque Limits and forwards relevant data to an available control unit upon request by the control unit. The control unit then indicates that it has work such as by a illuminating an LED and displaying a message on the LCD display. In the event there is no available information in the Database, an override mode is offered. The Service Representative can also select the override mode manually. The override mode allows the Service Representative to enter and confirm torque settings and other important parameters into the control unit. For safety and security the service representative may be asked for a positive ID upon confirmation of the input data.

[00071] The control unit then transfers the r elevant data to the wrench and a sks the operator for a positive verification (e.g. license plate number / VIN number, barcode scan). The control unit also maintains a clear display of all the relevant information regarding the vehicle under service in the service bay where the service is in progress.

[00072] Next, the Operator is guided by the torque wrench through the LCD messages to start applying the torque measurement/ recording within the given limits (i.e. +/- allowed tolerance). Secondary attempts at applying torque are permitted with any error/alarm condition. Alarms will trigger a recovery sequence wherein single or multiple lug nut data points, or the entire wheel pattern may be voided. A complete walk-through of each tire location and lug nut check pattern can be performed.

[00073] After completing all torque measurements, the operator commands the torque wrench to send data back to the control unit. The control unit displays both the target torque settings and the actual torque measurements received from the torque wrench. Any over or under Torque condition is indicated by a flashing message(s) on the LCD display.

[00074] The operator then commands the control unit to send all data to the host computer before closing the work order. An employee identification or personal code may be required for greater accountability.

[00075] The data that is sent from the control unit to the host computer include individual torque measurement(s) of each lug nut associated to each wheel of every vehicle under service. The host will then process the received information, store it , and print it out on the customer 's invoice.

EXAMPLE 2: Infra-red Communication Path

[00076] The hand held device 30 communicates with the shop management system 22. The technicians selects a vehicle to work on from a pick list presented at the controller 28. Upon selection from the pick list, the control unit 46 queries its internal database for the vehicle associated with the repair order, or sends a request to the system 100 to query the specification database module 104 and retrieve the lug nut torque specifications for each wheel. Once the data is displayed, the technician can then beam, via infrared communication path 34, the specifications to the infrared port on the tool 20. Upon completion of the lug nut torquing activities, the technician can beam the results of the activity back to the control unit 28 which can subsequently communicate the confirmation information and repair order number back to the shop management system 100 for storage.

[00077] While embodiments of the disclosure are shown and described, it is envisioned that those skilled in the art may devise various modifications and equivalents without departing from the spirit and scope of the disclosure as recited in the following claims.

CLAIMS:

[C1] 1. An apparatus for controlled tool operation, the apparatus comprising:

a tool;

a drive operatively associated with the tool;

a controller operatively associated with the tool; and

the controller having memory for receiving and retaining information for use in at least one tool operation.

[C2] 2. The apparatus of claim 1 further comprising a display operatively associated to the tool and communicating with the controller.

[C3] 3. The apparatus of claim 1, wherein the controller includes an Input/Output interface.

[C4] 4. The apparatus of claim 1, further comprising a sensory response device.

[C5] 5. The apparatus of claim 1, wherein the sensory response device produces at least one of a visual indication, an auditory indication, and a tactile indication.

[C6] 6. The apparatus of claim 1, wherein the tool includes a powered drive coupled with the driver for providing controllable power driving of the driver.

[C7] 7. A method for controlled application of torque, the method comprising the steps of:

providing a tool;

providing a driver operatively associated with the tool;

providing a controller operatively associated with the tool;

receiving and retaining information for use in at least one tool operation;

identifying a tool operation;

retrieving information for the tool operation;

providing information to the controller;

recording information about the tool operation; and

storing the information on the controller.

[C8] 8. The method of claim 7, wherein the tool operation is a torque application operation.

[C9] 9. The method of claim 7, further comprising the step of guiding the user through the tool operation.

[C10] 10. The method of claim 7, further comprising the step of providing a display for guiding the user through the tool operation.

[C11] 11. The method of claim 9, wherein the step of having the apparatus guide the user further comprises the step of activating an alert device when a specification is being approached.

[C12] 12. The method of claim 11, further comprises the step of: the alert device producing at lease one of a visual indication, an auditory indication, and a tactile indication.

[C13] 13. The method of claim 7, further comprising the step of: the control unit with an Input/Output interface, and using the Input/Output interface for identifying a torque application and inputting one or more tool operation characteristics to the control unit.

[C14] 14. The method of claim 7, further comprising the step of: providing the control unit further includes an Input/Output interface, using the Input/Output interface for identifying a torque application and inputting one or more vehicle characteristics to the control unit.

[C15] 15. The method of claim 14, wherein the vehicles characteristics include at least a model, a make, and a model year.

[C16] 16. The method of claim 7, wherein a specification includes at least a manufacturer's specification for a maximum allowable torque.

[C17] 17. The method of claim 7, wherein the tool further include a power drive for operating the driver wherein controller force is provided by the power drive to operate the tool.

[C18] 18. A system for providing one or more tool operations, the system comprising:

at least one apparatus for controlled application of torque, the apparatus comprising a handle, a drive head fixedly attached to an end of the handle, a programmable control unit seated in the handle, the control unit having memory for storing guided instructions for performing at least one torque application, and an alert device;

a communications path connected to the at least one apparatus; and

a computer-enabled shop management system connected to the communications path, and removably linked to the apparatus via the communications path, wherein the computer-enabled shop management system includes at least a specification database module for retrieving and retaining specifications for a plurality of tool operations.

[C19] 19. The system of claim 18, wherein the communications path is a coupler.

[C20] 20. The system of claim 18, wherein each of the at least one apparatus further includes a display.

[C21] 21. The apparatus of claim 18, the sensory device further comprising an alert device for producing at least one of a visual indication, an auditory indication, and a tactile indication.

[C22] 22. The apparatus of claim 18, wherein the tool includes a power drive for controllably powering the driver.

[C23] 23. A method of using a system used for administering at least one torque application, the system comprising at least one apparatus for guided application of torque, the apparatus comprising a handle, a drive head fixedly attached to an end of the handle, a programmable control unit seated in the handle, the control unit having memory for storing at least guided instructions for performing at least one torque application, and an alert device; at least one coupler configured to removably mate with the at least one apparatus; a communications path connected to each coupler; and a computer-enabled shop management system connected to each communications path and linking to each apparatus via the communications path, wherein the computer-enabled shop management system includes a specification database module for storing and retrieving specifications for a plurality of torque applications and a maintenance history database module for storing information about a plurality of performed torque operations, the method comprising:

identifying a torque application to the shop management system;

retrieving at least one specification for the torque application on the shop management system;

transmitting the specifications to the apparatus via the communications path;

having the apparatus guide a user through the torque application while generally simultaneously recording information about how the torque application is being performed; and

transmitting the information from the apparatus to the shop management system via the communications path.

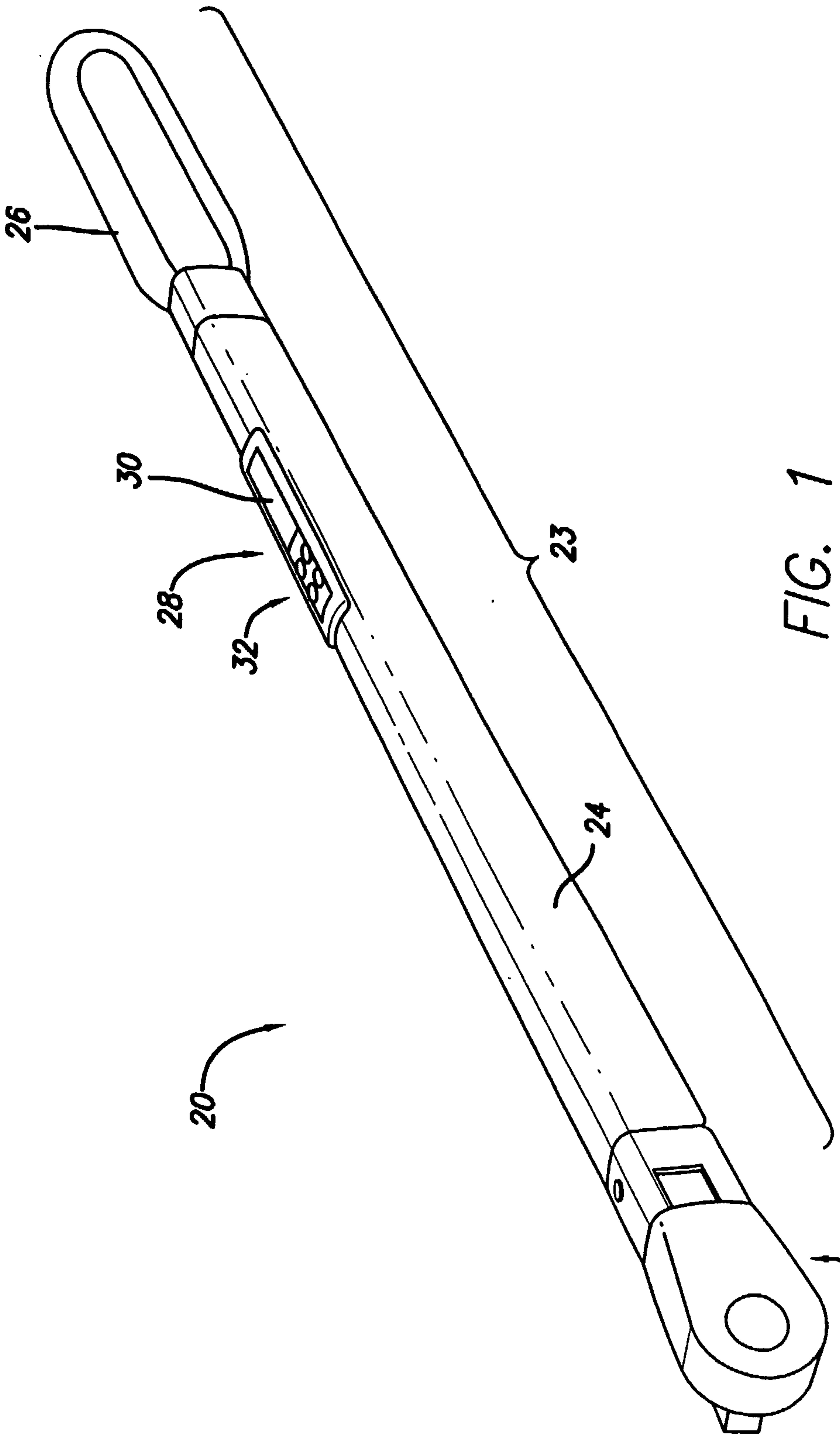



FIG. 1

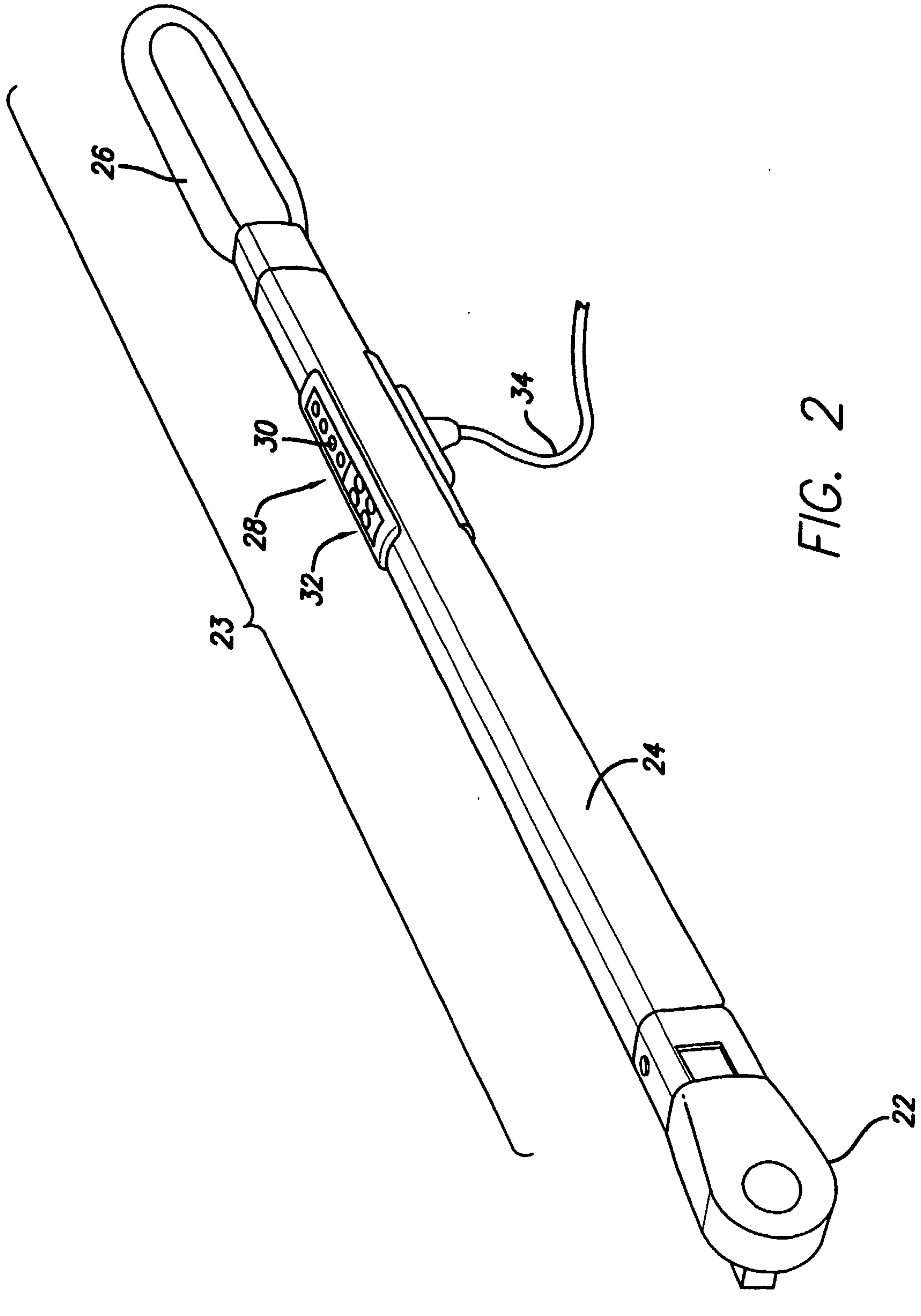



FIG. 2

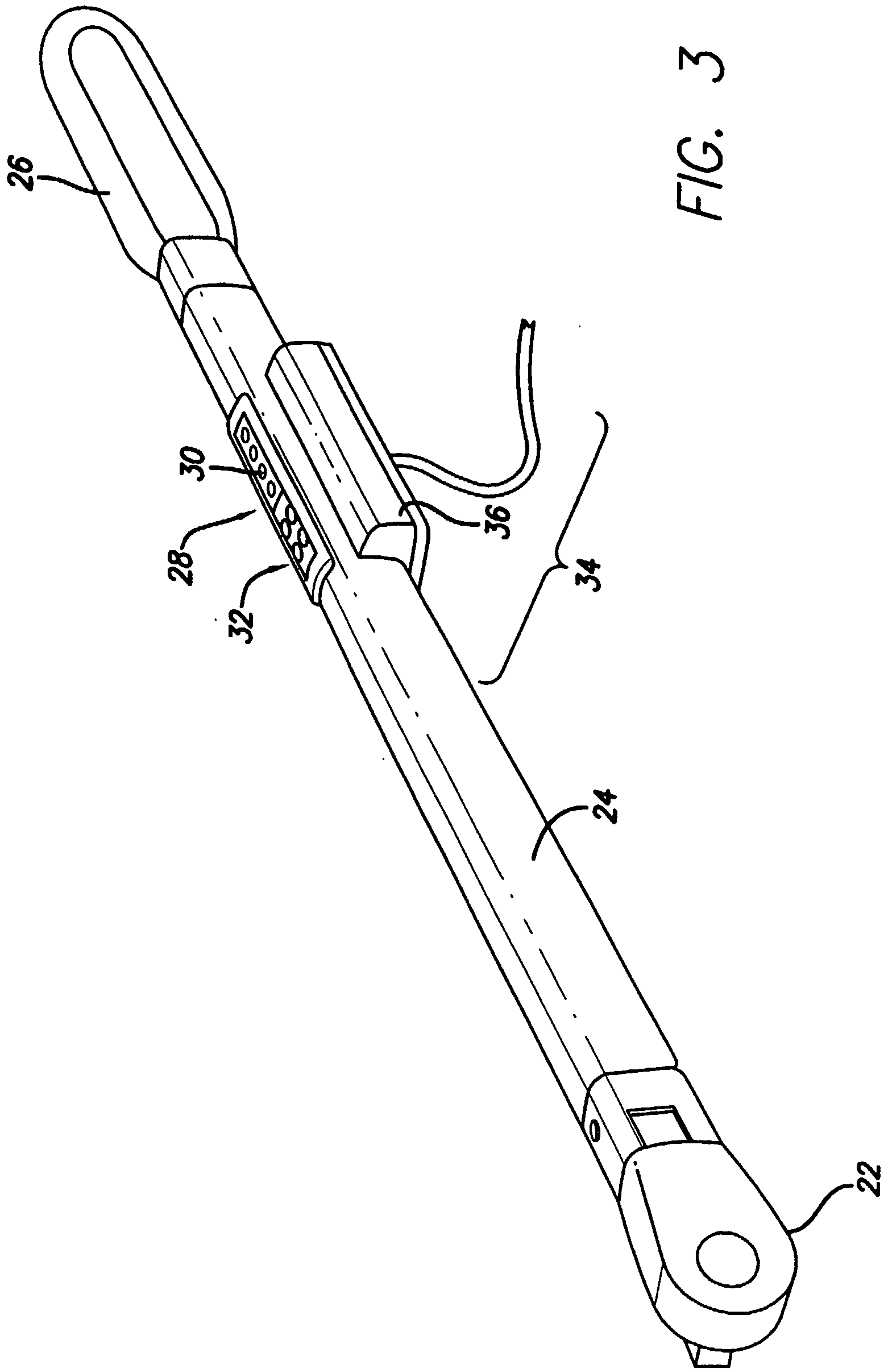



FIG. 3

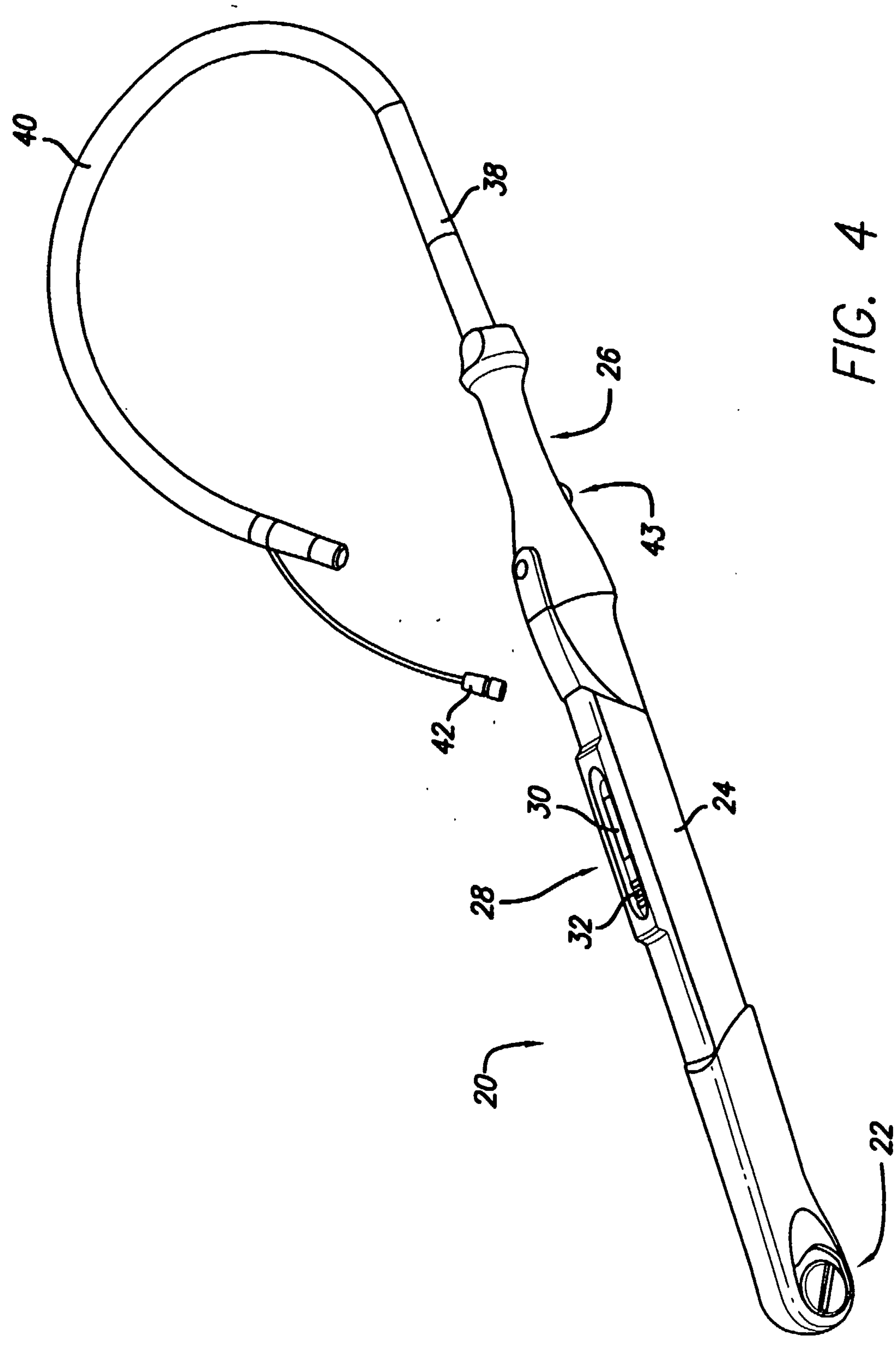



FIG. 4

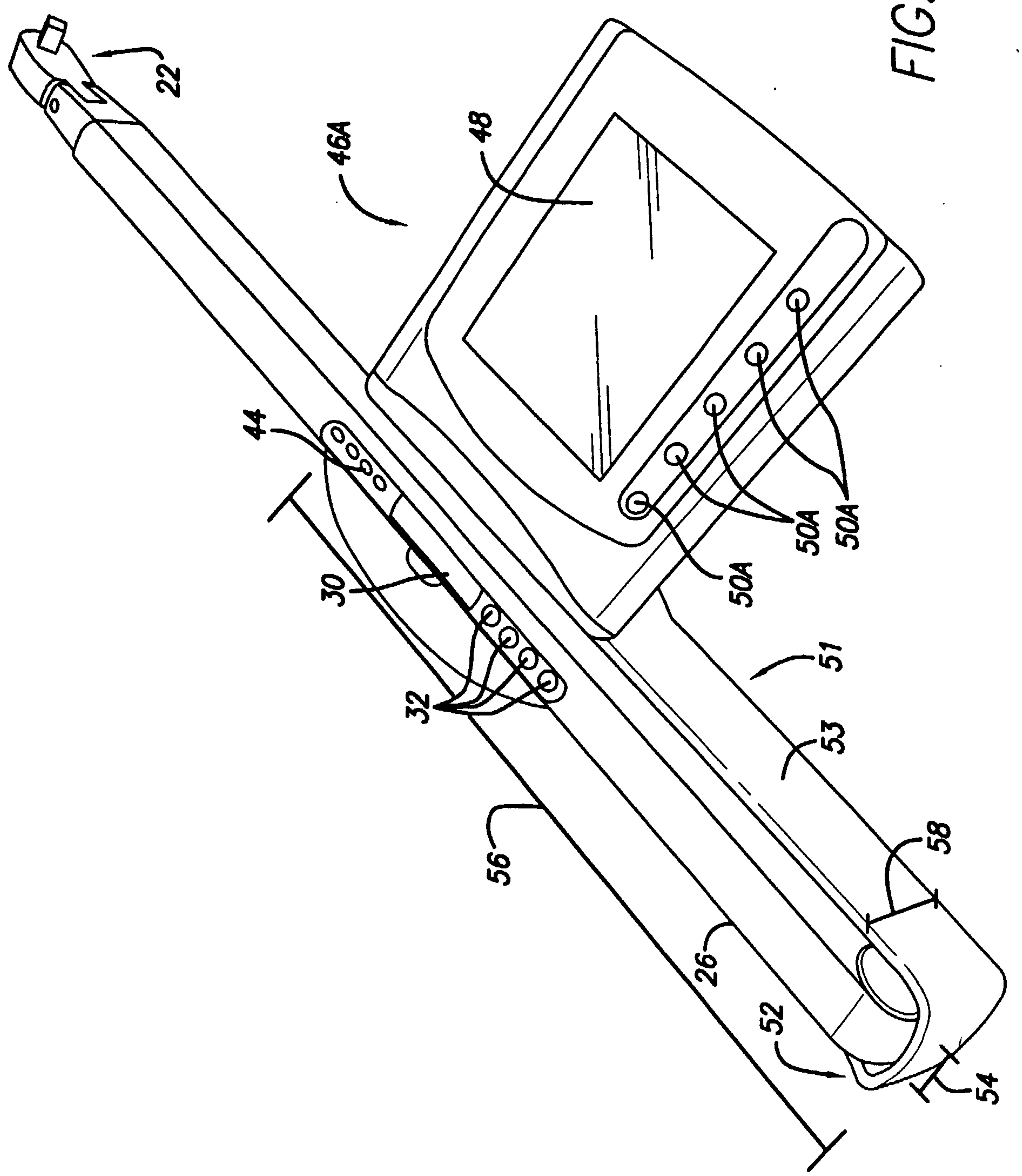



FIG. 5

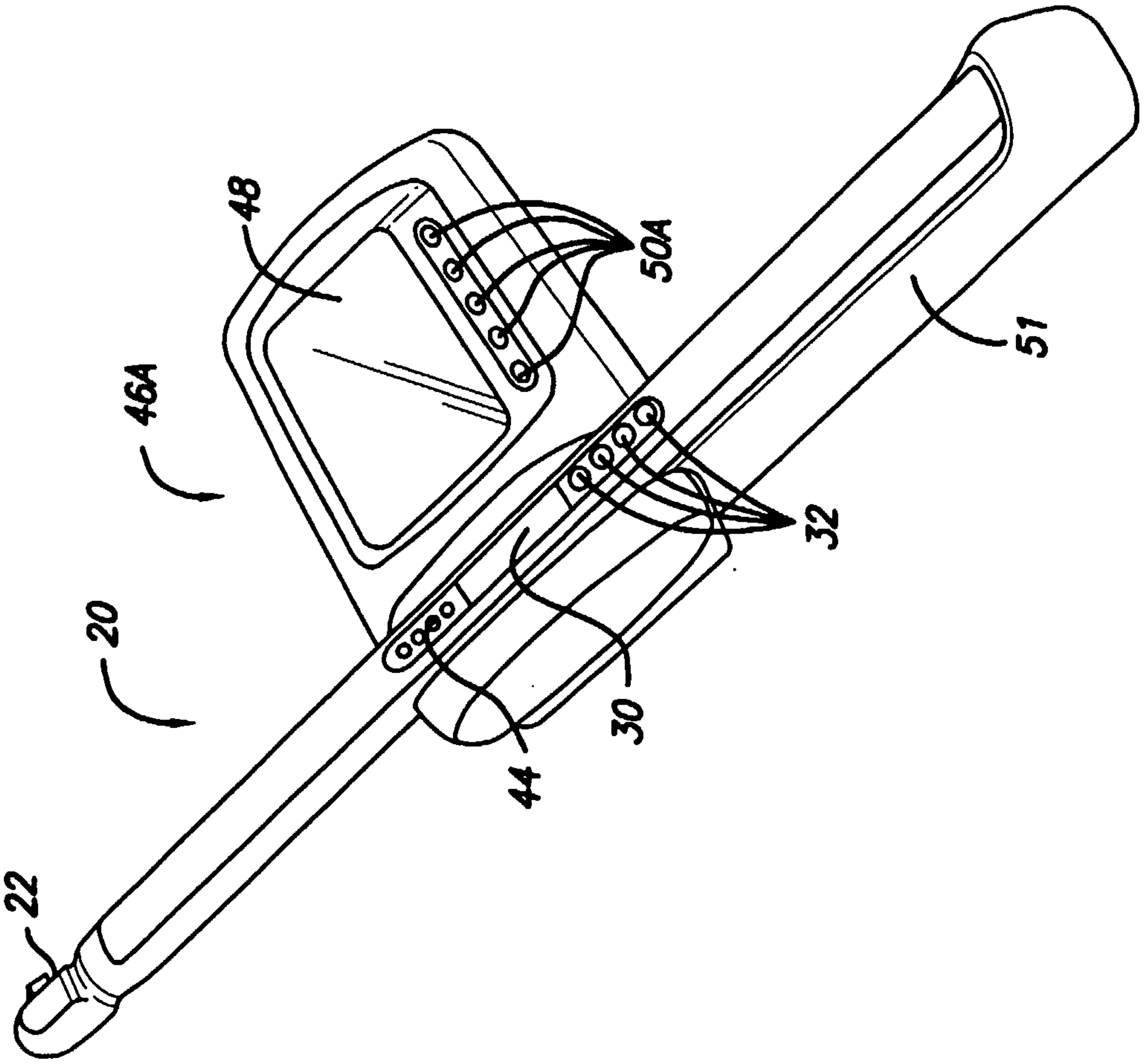



FIG. 7

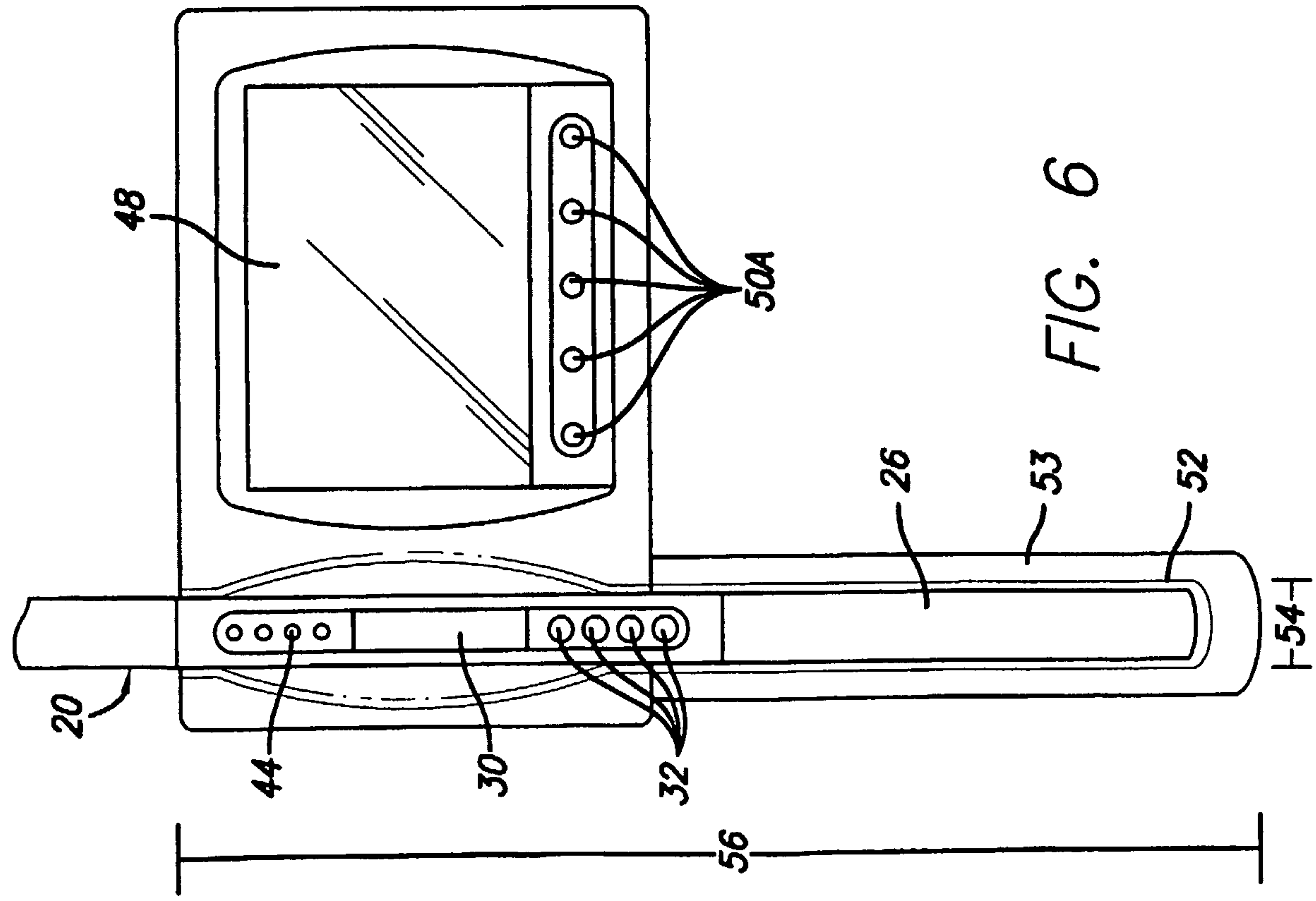



FIG. 6

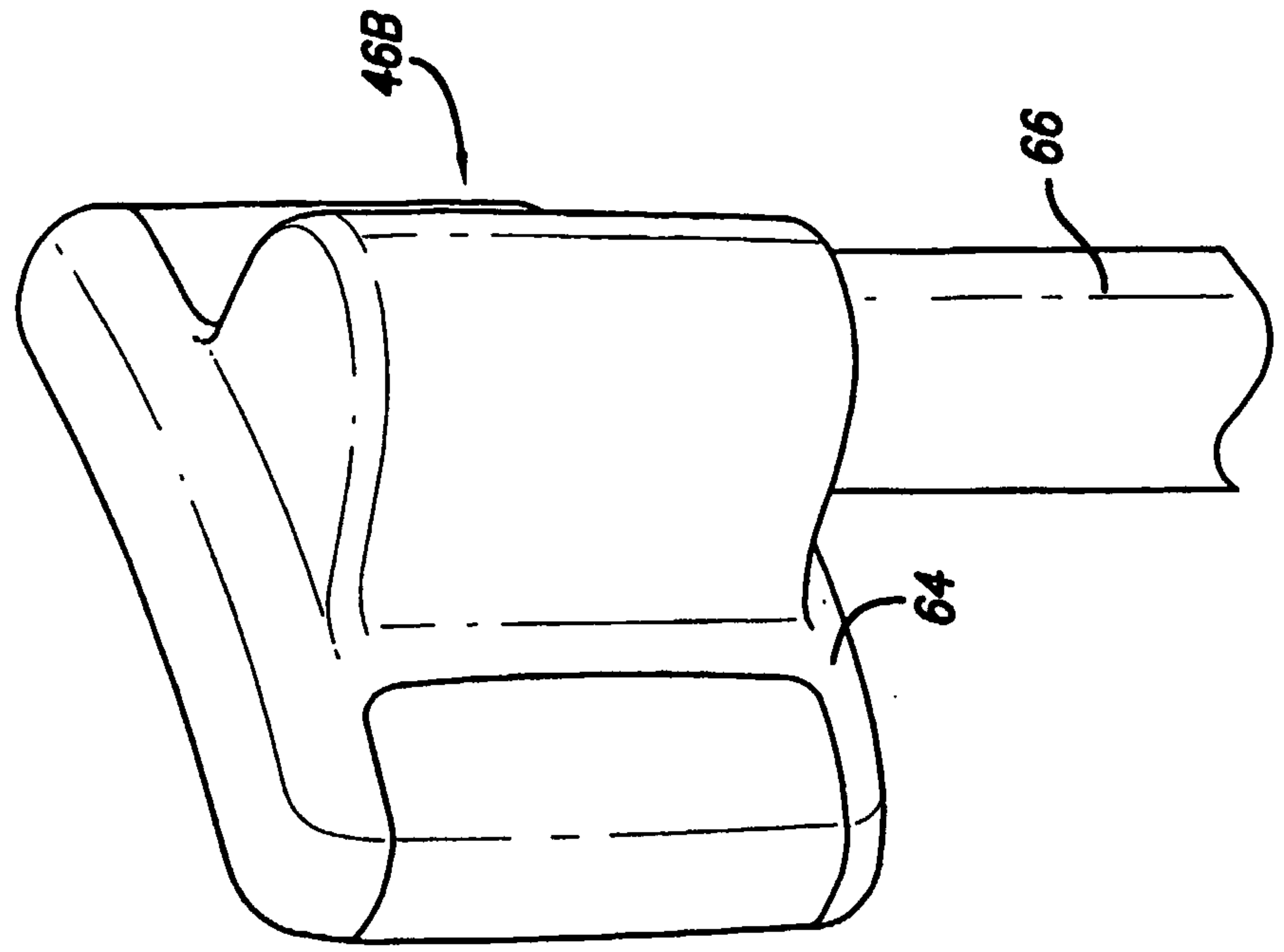



FIG. 8B

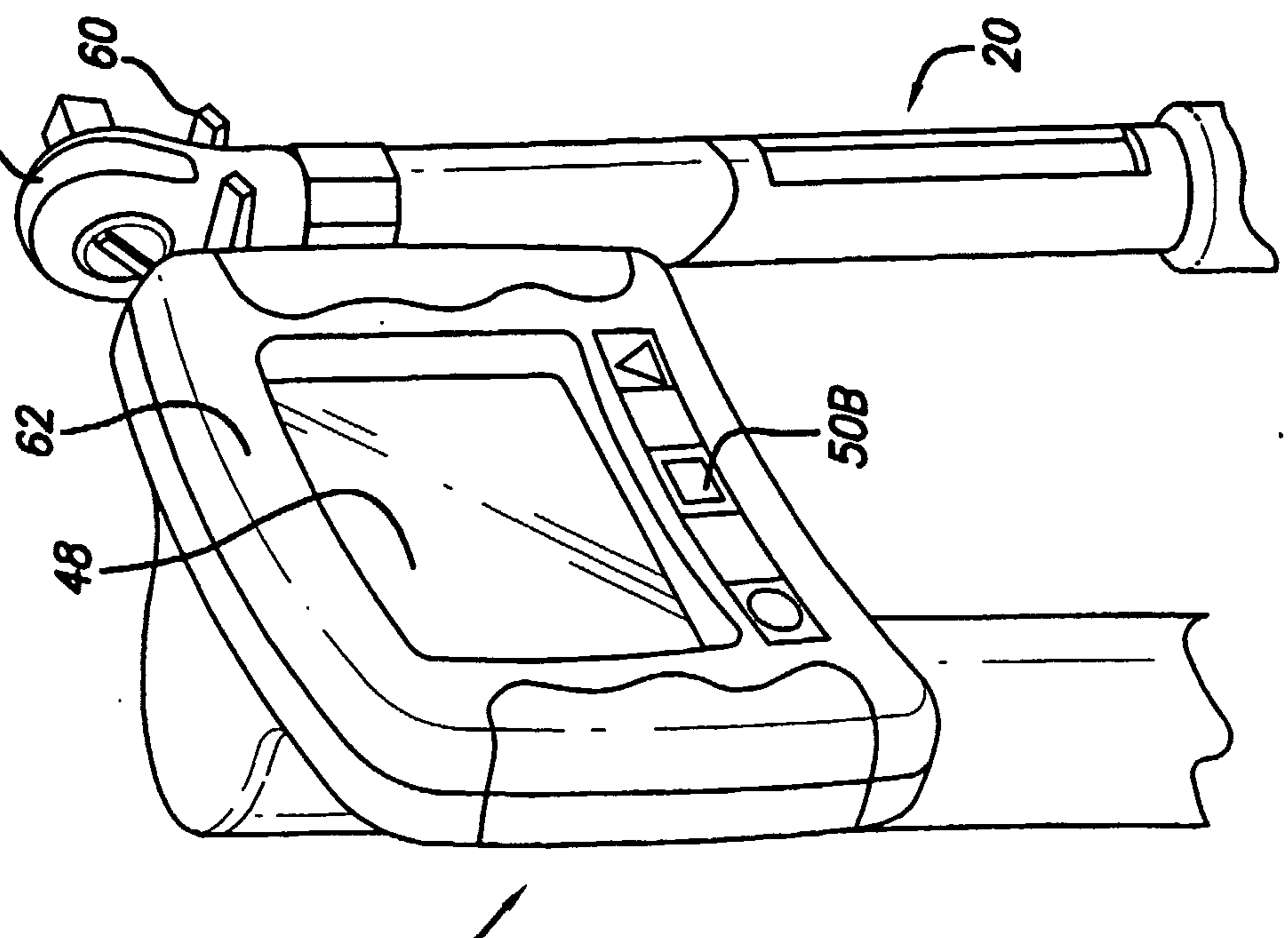



FIG. 8A

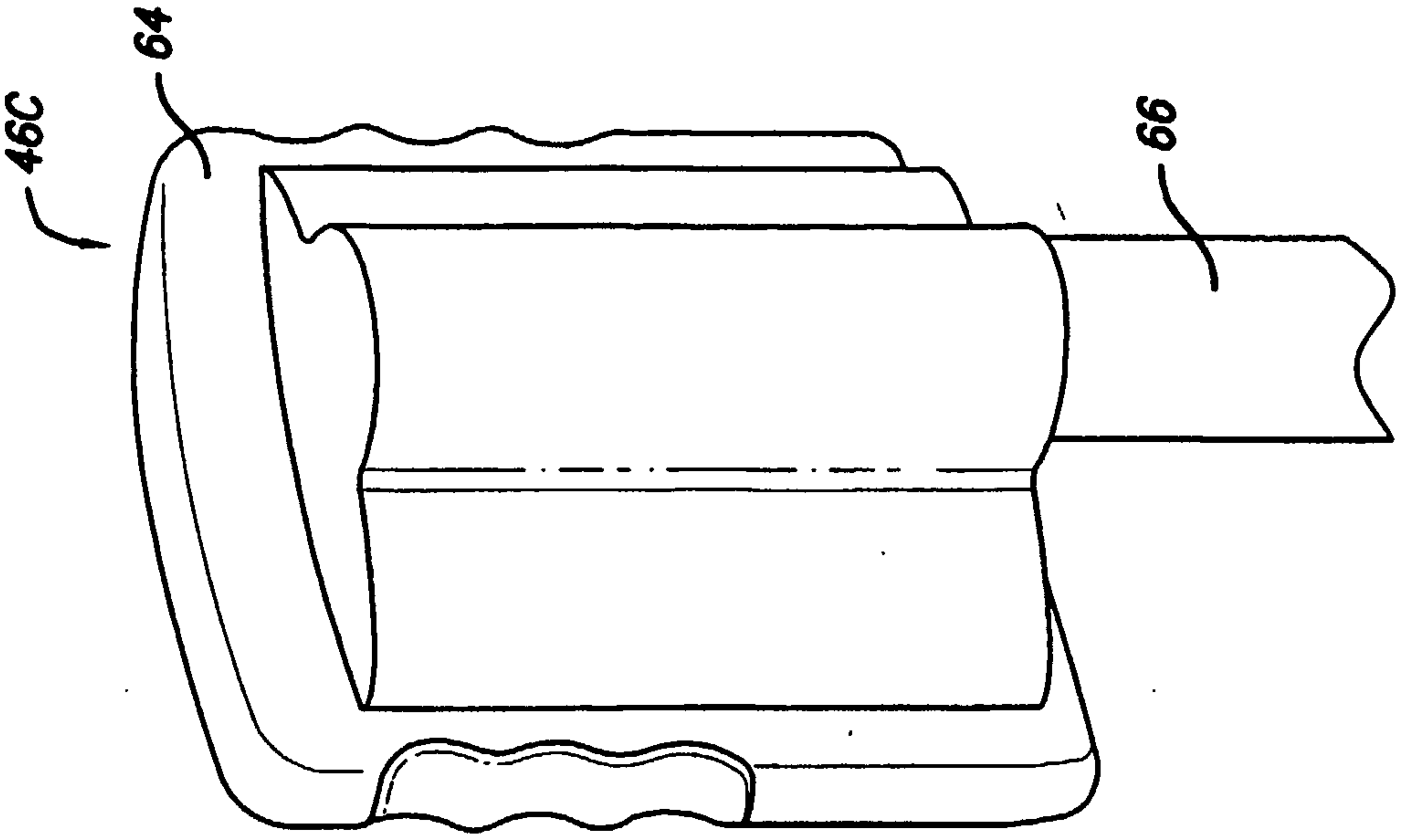



FIG. 9B

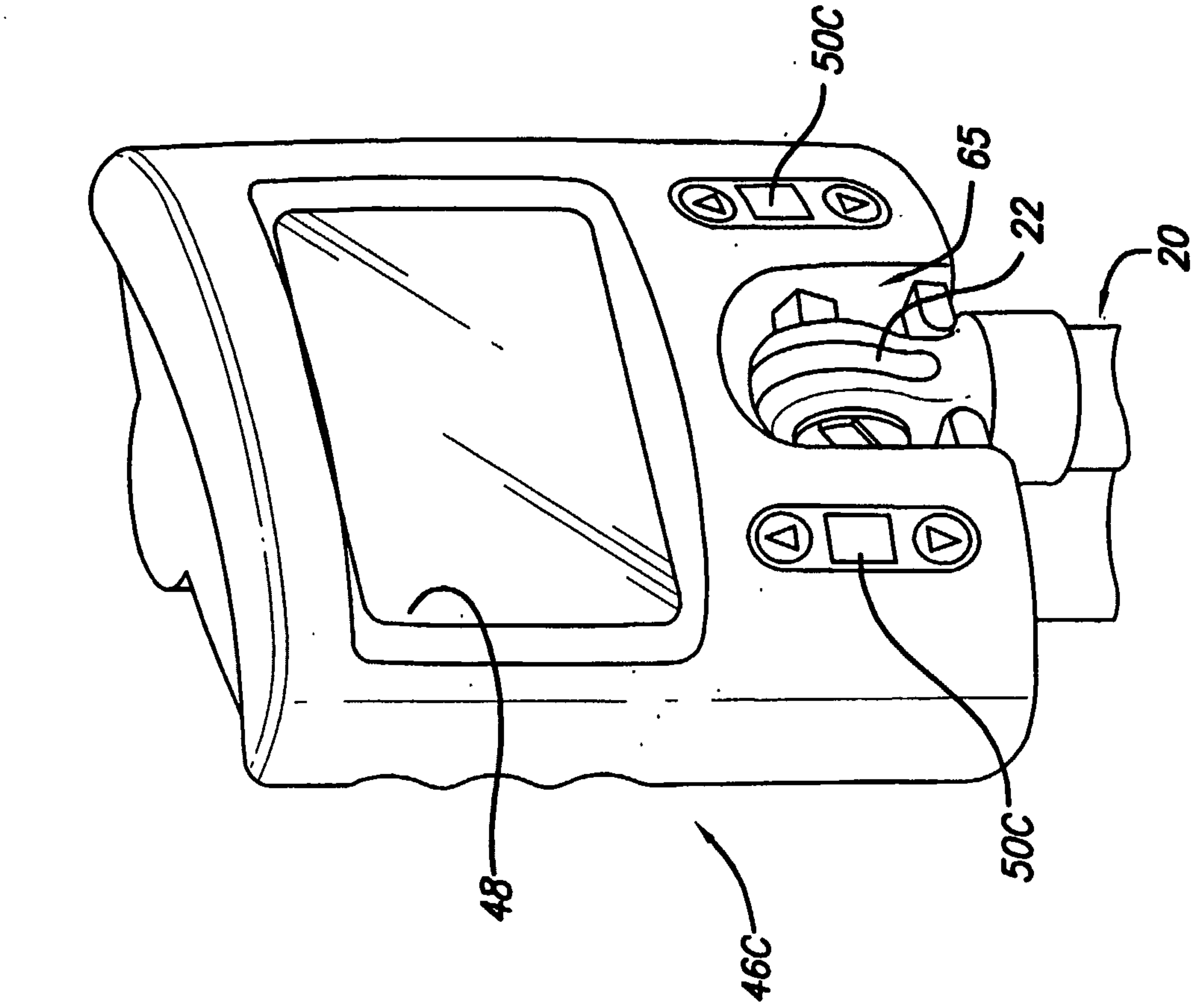



FIG. 9A

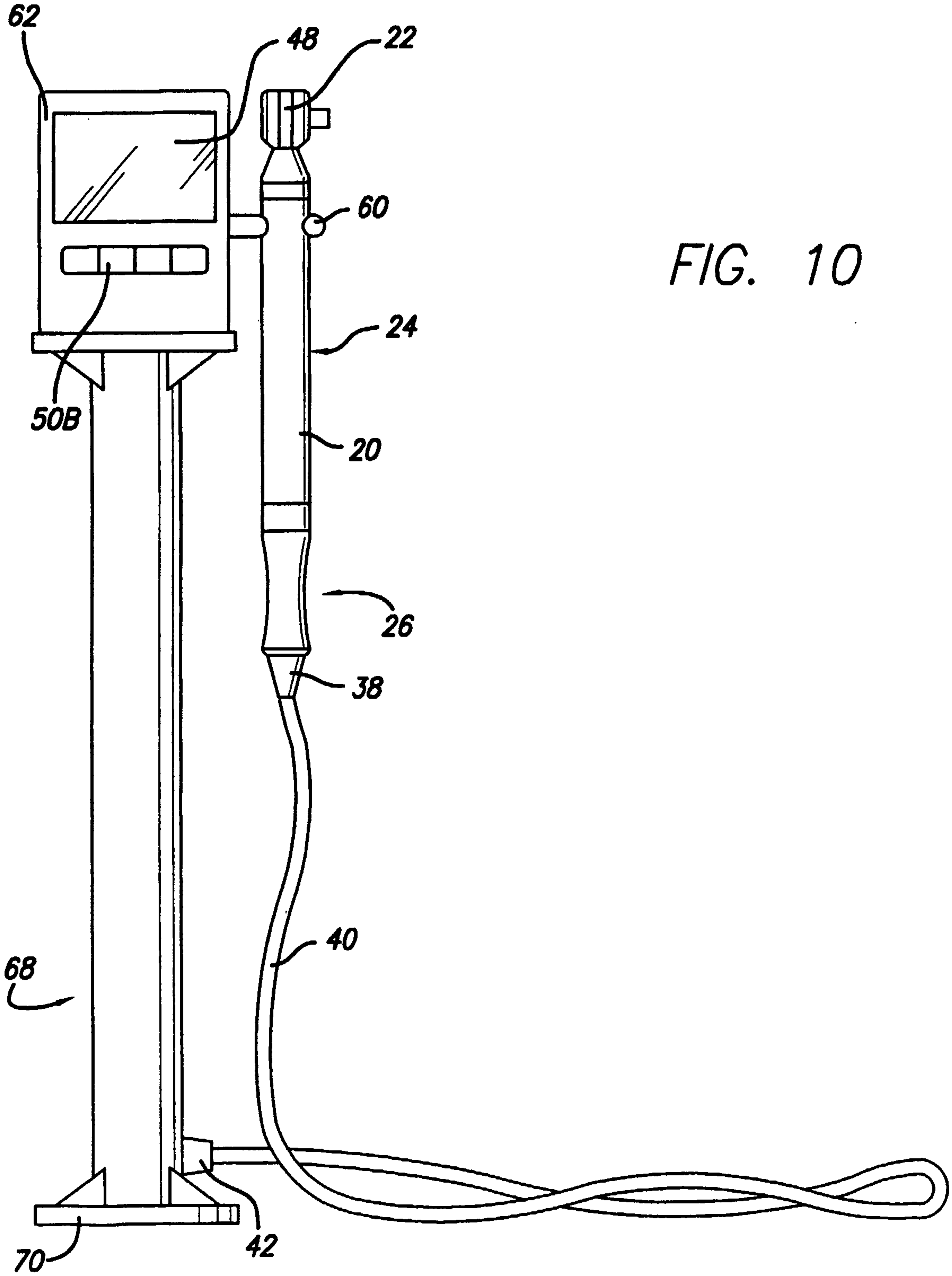



FIG. 10

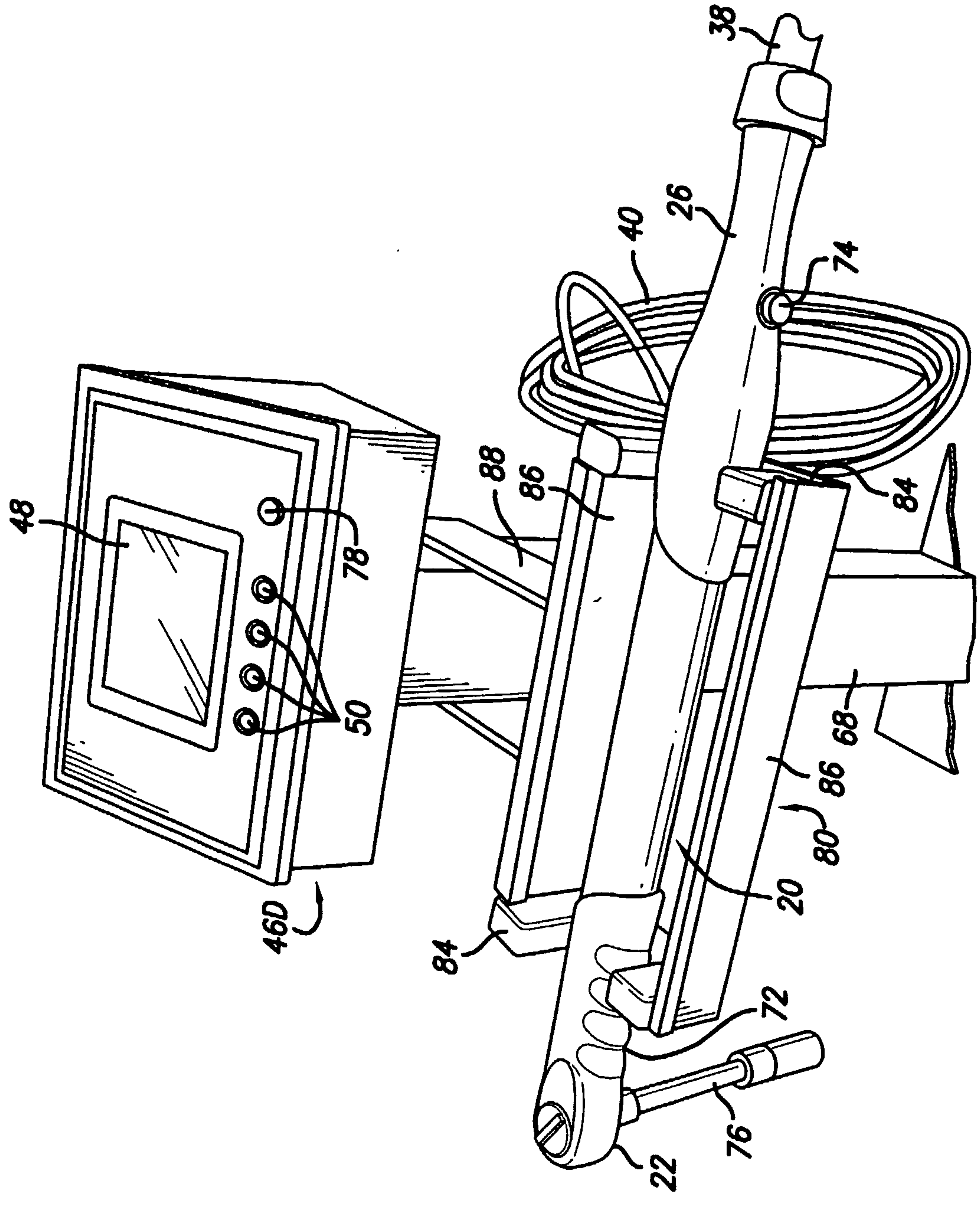



FIG. 11

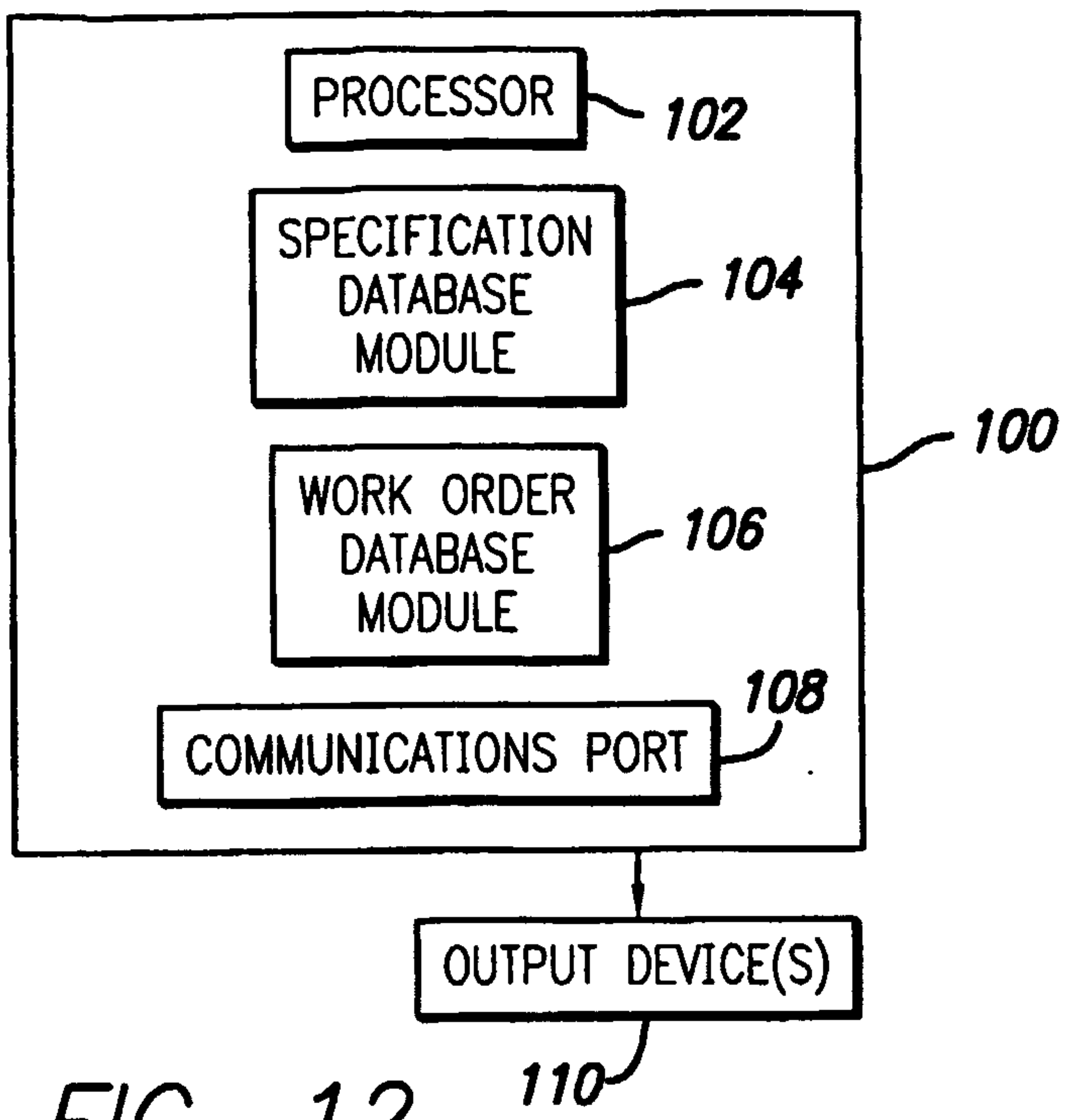



FIG. 12

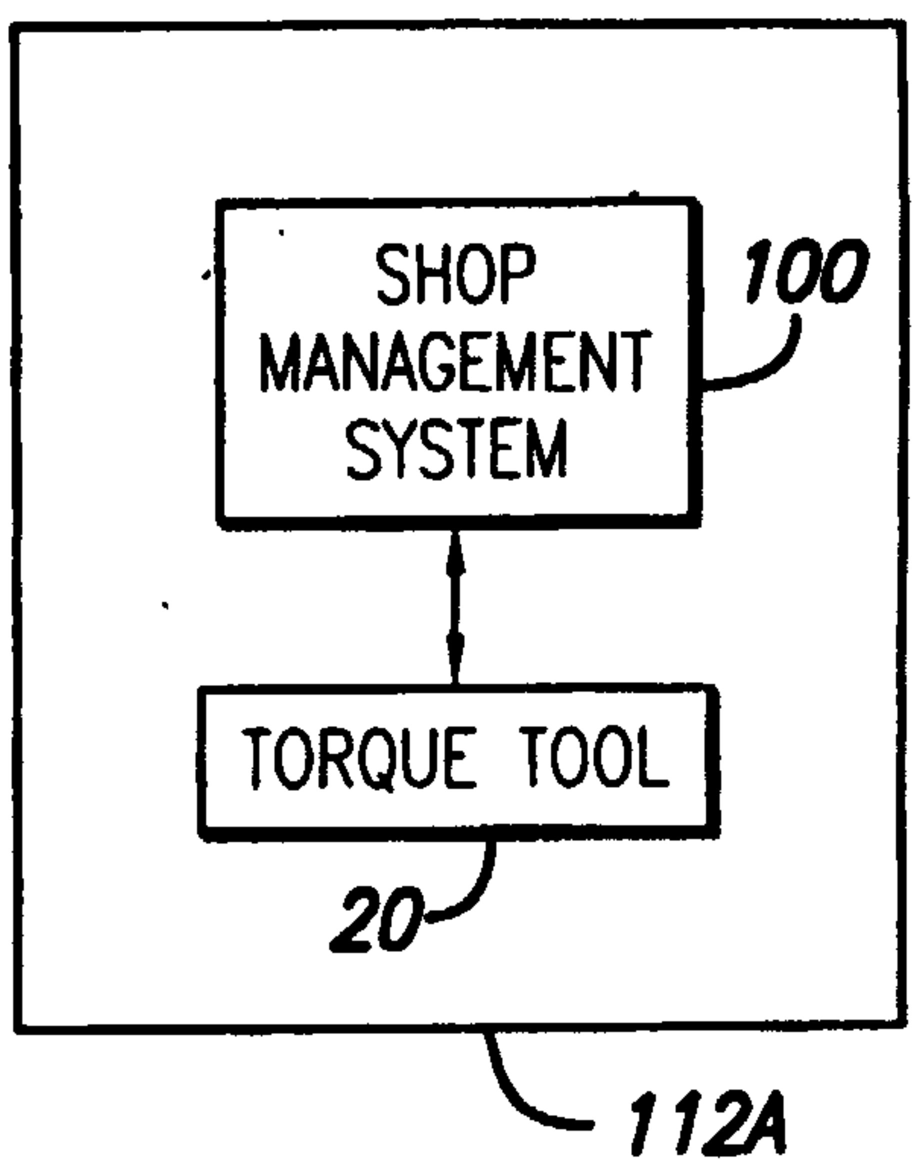



FIG. 13

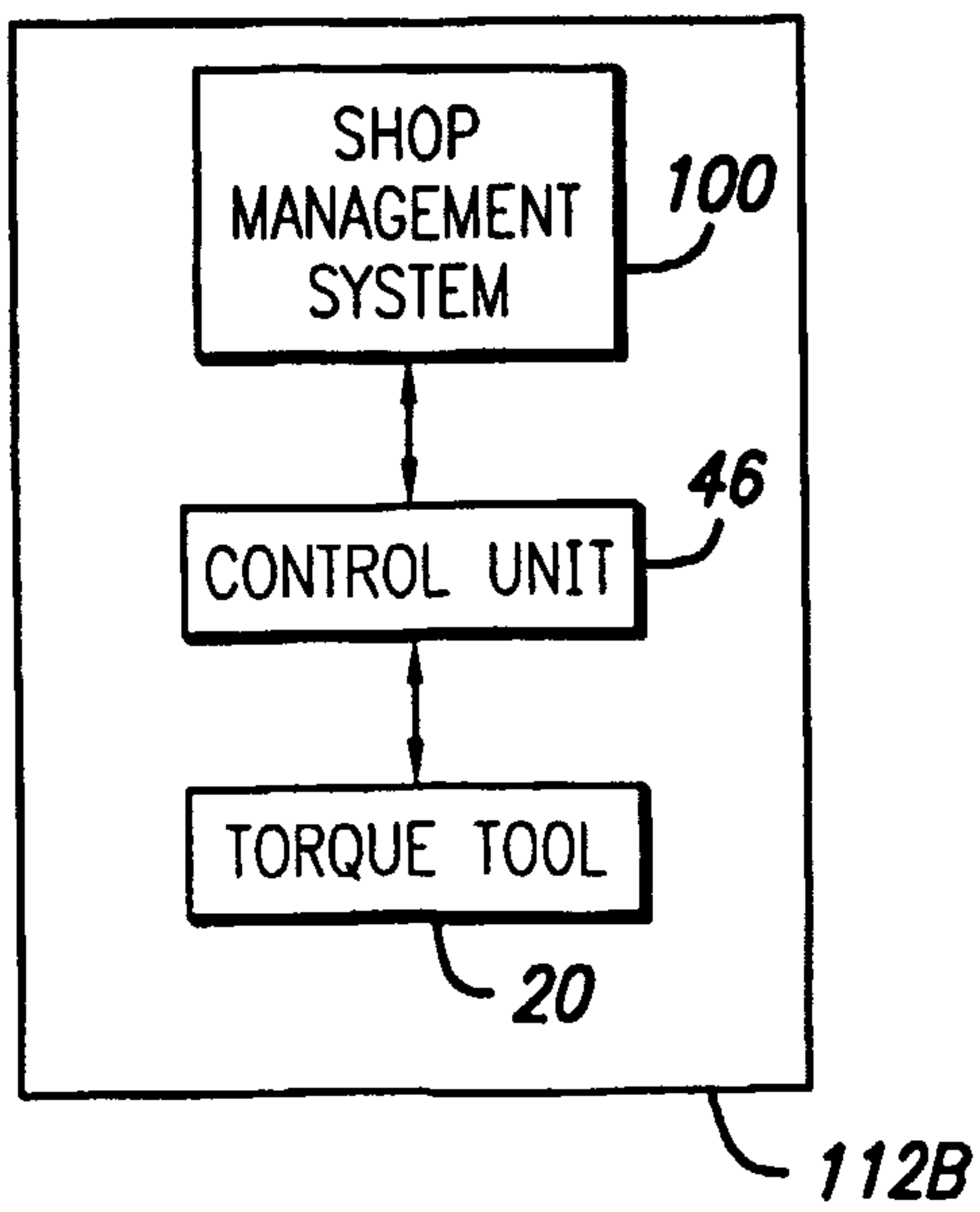



FIG. 14

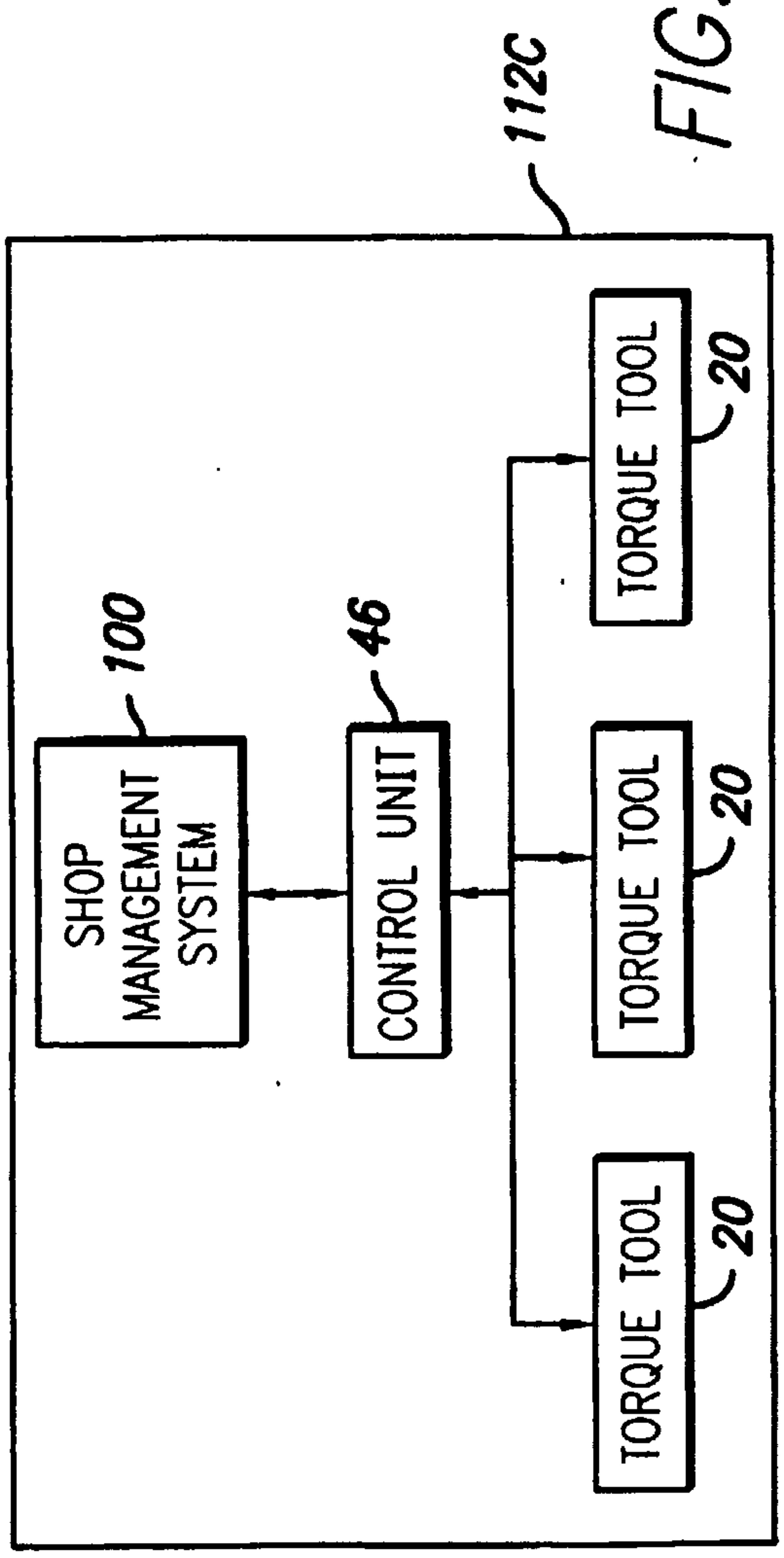
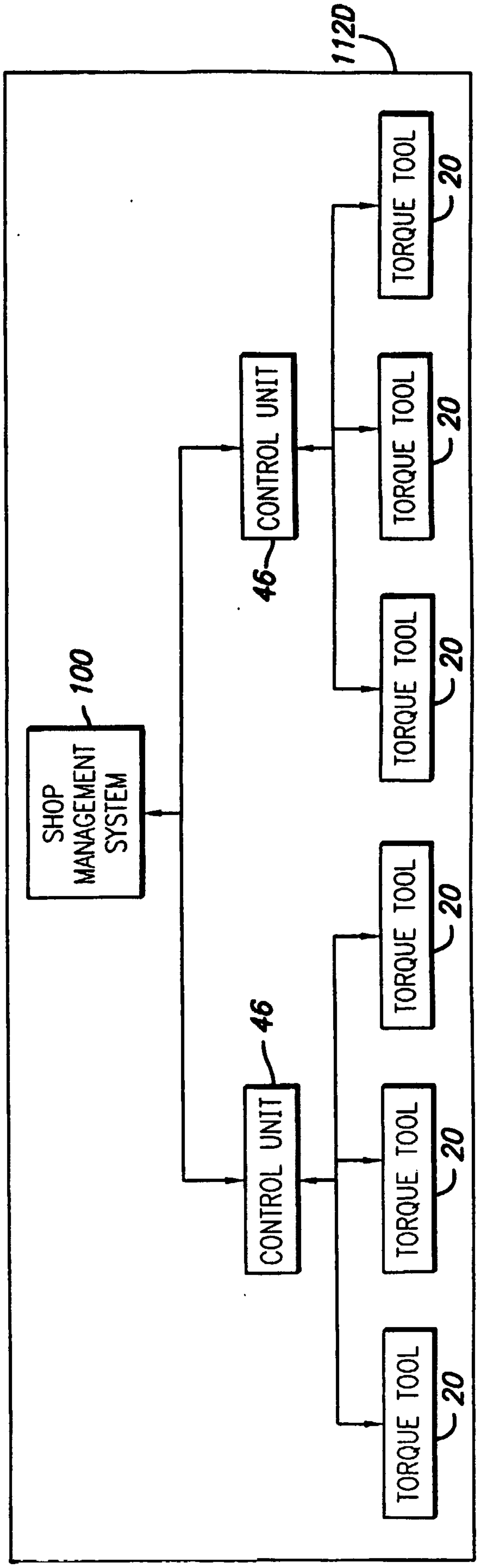

112C
SHOP MANAGEMENT SYSTEM
100
CONTROL UNIT
46
TORQUE TOOL
20
TORQUE TOOL
20
TORQUE TOOL
20

FIG. 15


112D
SHOP MANAGEMENT SYSTEM
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CONTROL UNIT
46
CONTROL UNIT
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TORQUE TOOL
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TORQUE TOOL
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TORQUE TOOL
20
TORQUE TOOL
20

FIG. 16

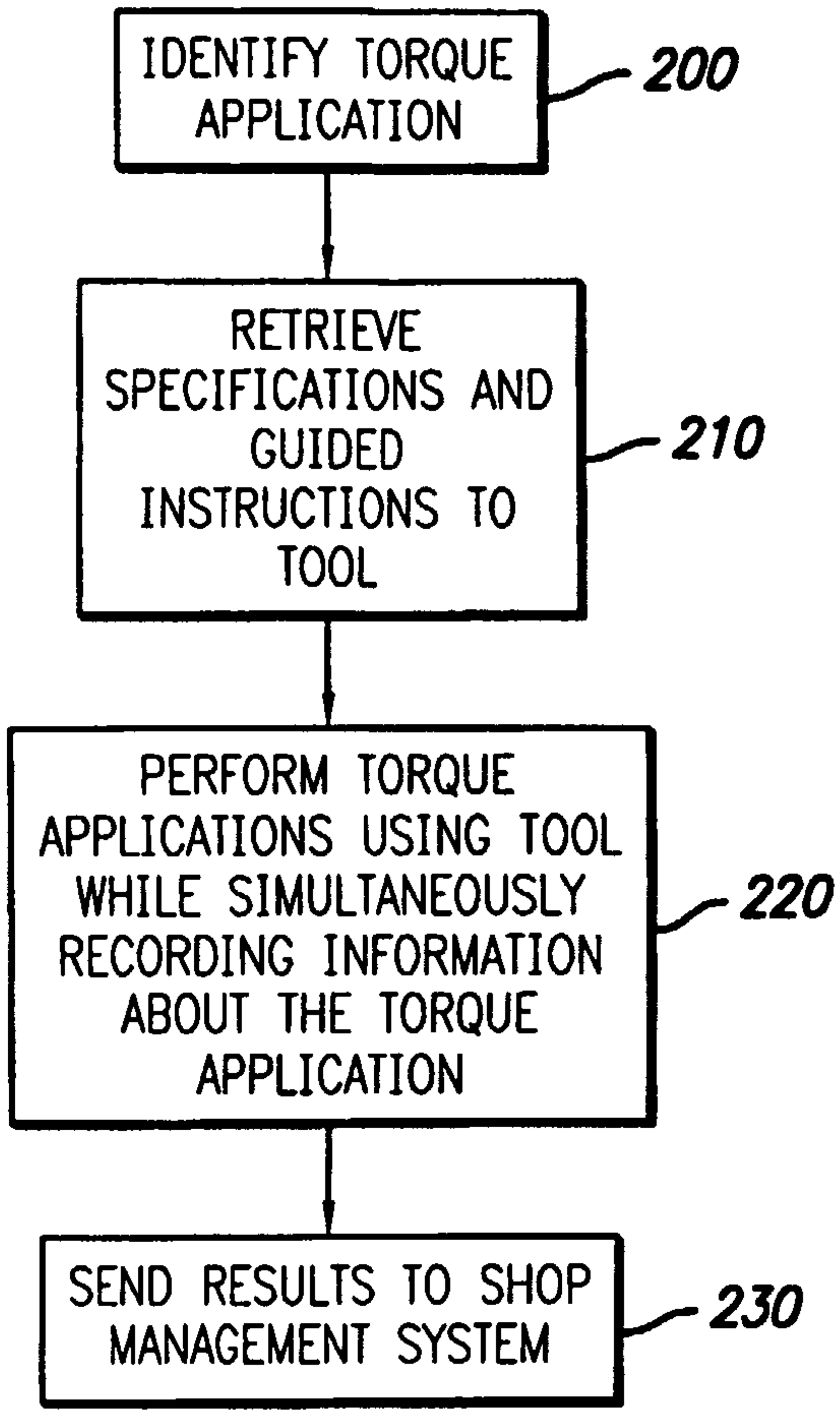



FIG. 17

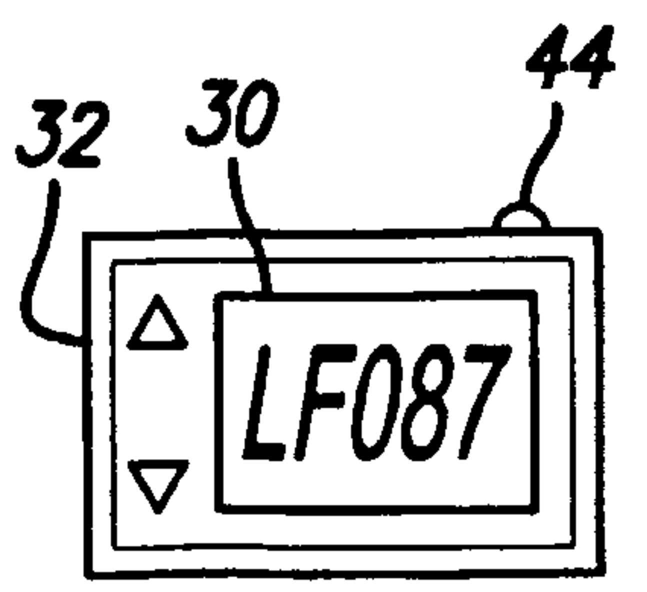



FIG. 18A

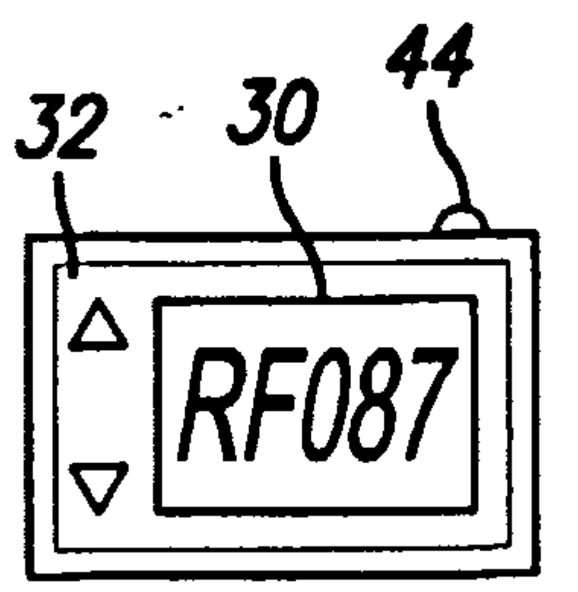



FIG. 18B

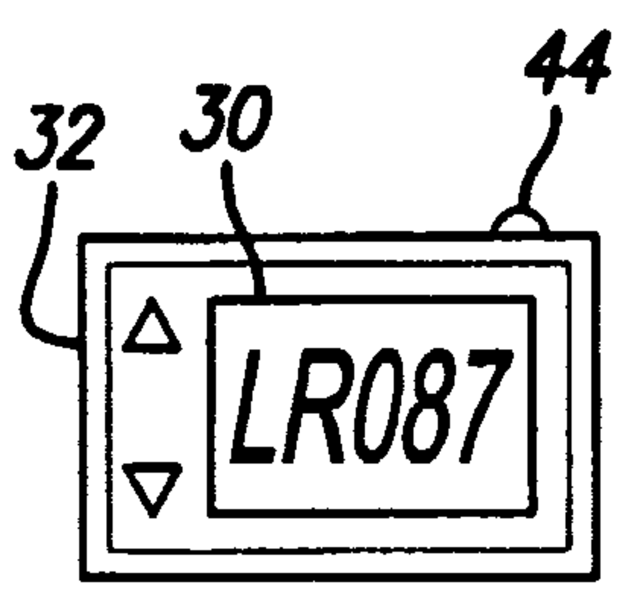



FIG. 18C

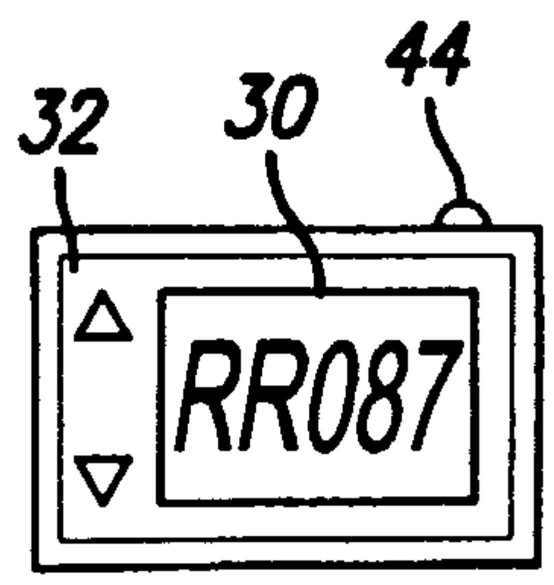
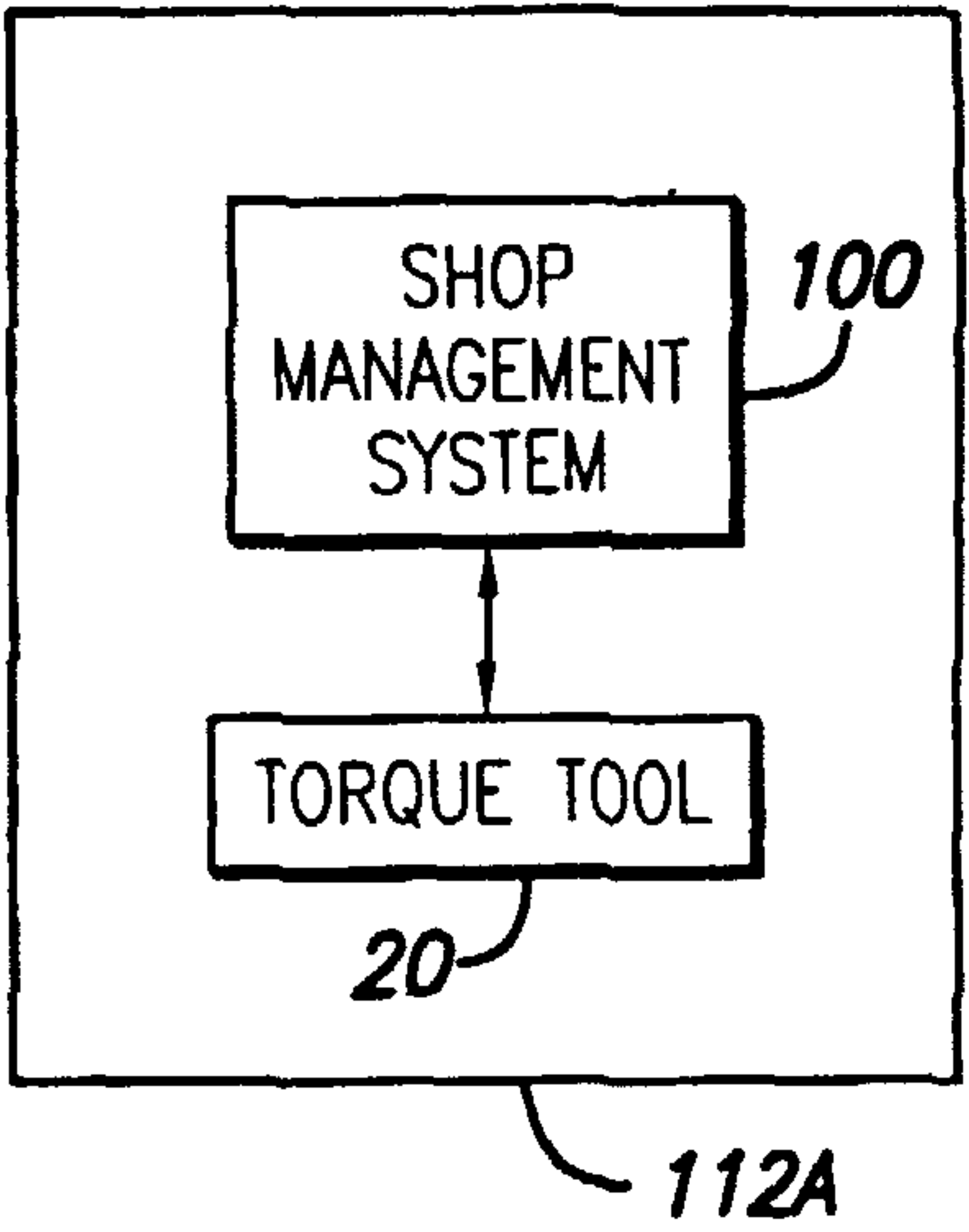



FIG. 18D


SHOP MANAGEMENT SYSTEM
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TORQUE TOOL
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