

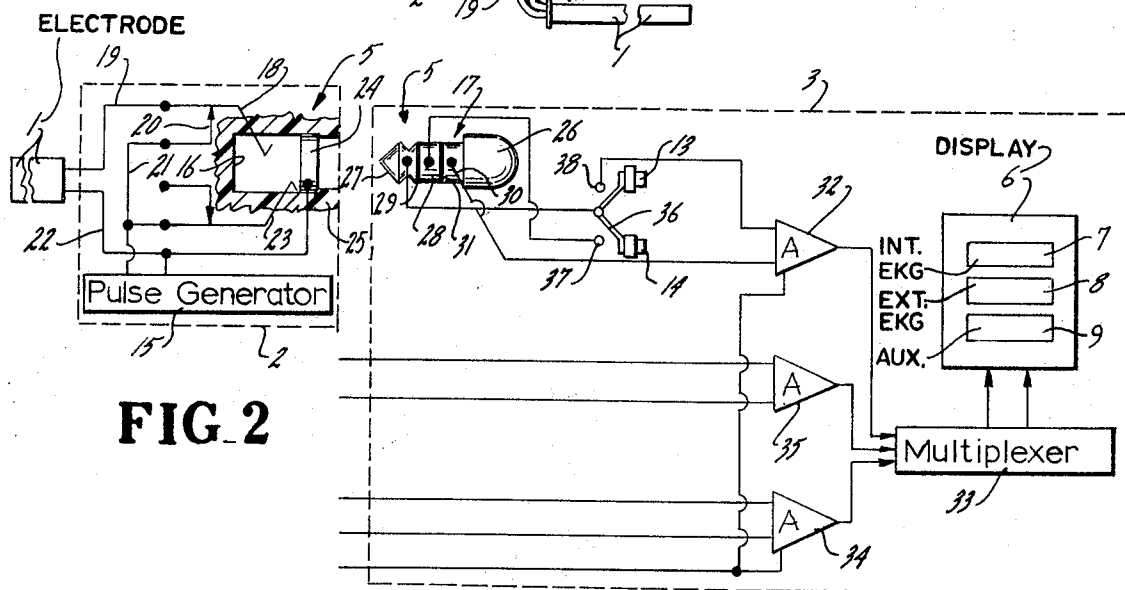
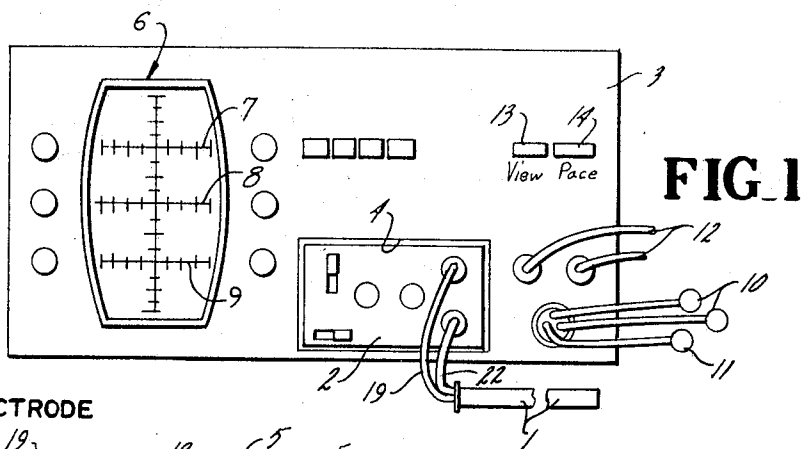
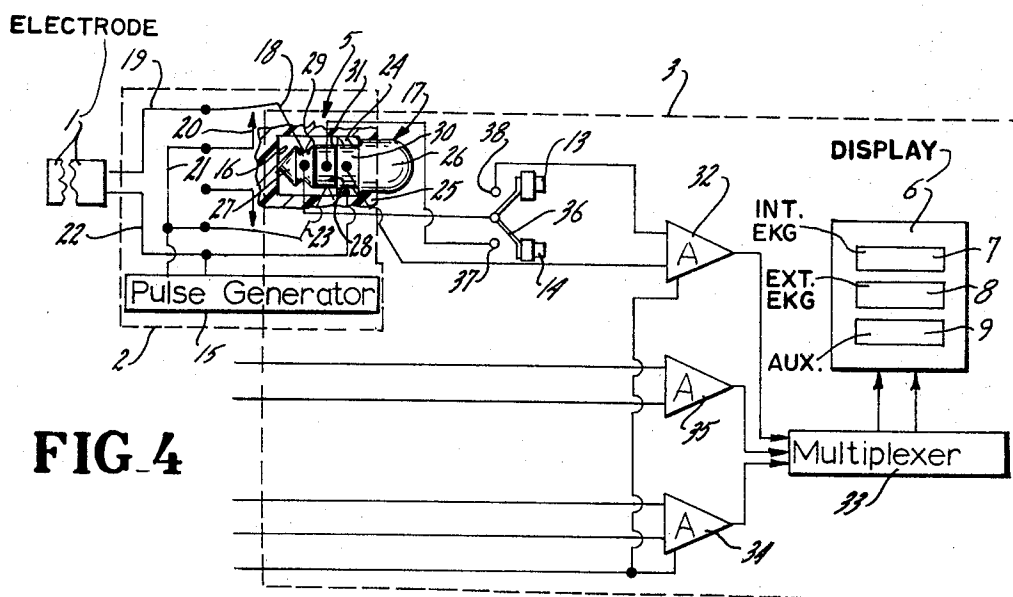


FIG. 3



ELECTRODE PLACEMENT APPARATUS AND PACER

BACKGROUND OF THE INVENTION

This invention relates to an electrode placement apparatus which is particularly constructed for intercardial electrographic insertion of a catheter for heart pacing.

The human heart automatically contracts and relaxes in a periodic manner, functioning as a pump to circulate the blood through the body. The heart contractions, or beats, are generally controlled by specialized tissues of the heart. Damage to one or more components of the heart structure may result in either a permanent or temporary malfunctioning and in particular a disruption of the regular rhythm of the heart. In such cases, it is important to provide artificial means, which have been developed, for stimulating the heart action and thereby establishing and maintaining the regular heart beat. In a significant number of cases, heart malfunction creates an emergency condition where time is of the essence and the immediate stimulation of the heart is required.

Generally, artificial heart stimulating means includes a thin, plastic coated wire, known as an electrode or, previously, as a catheter, having a metal contact at its distal end. The electrode is introduced through a large vein into the heart and particularly through the right auricle and into the apex of the right ventricle. An external electronic pulsing means, generally identified by the term pulse generator, is interconnected to the proximal end of the electrode and establishes a series of electrical pulses into the heart. The heart condition may require temporary pacing or the damage may be such that a permanent pacing is required.

Generally, permanent pacing is provided by implanting a small electronic Pacemaker within the fatty tissue overlying the pectoralis major. The electronic pacer is, of course, connected directly to the electrode which was implanted via the large vein in the neck and which is run subdermally from the site of the venipuncture to the Pacemaker.

The Pacemaker can be constructed to establish a continuous fixed beat or through suitable constructions to provide a demand pacing function.

The standard method of introducing the electrode into the heart has been a generally surgical operation wherein the movement of an electrode through the vein and into the heart is followed with the aid of a fluoroscopic device. The physician through visual analysis can properly manipulate an electrode into the desired position within the heart.

Although fluoroscopic insertion has been highly satisfactory, there are certain distinct disadvantages associated with its use. In many instances, the pacing requirement arises under emergency conditions with insufficient time to transport the patient to a medical center where the majority of Pacemaker insertions are performed or even to the necessary fluoroscopic facilities, when otherwise available. Further, the patient may be so ill that even movement from a bed to the fluoroscopic facilities within a center may be extremely hazardous. Fluoroscopic insertion subjects both the patient and the performing physician to radiation. Although this is not particularly severe from the standpoint of the patient, as he will not normally be subjected to more than a single operation, or a couple of

operations spaced by one or more years, the attending physicians, particularly if they specialize in the operation and thus perform a substantial number of such operations in a short period, are exposed repeatedly to the x-rays and are thus subject to accumulated radiation exposure which may be in excess of that considered safe or desirable.

Further, because the visual insertion is a relatively delicate procedure, the physician and assistants may tend to reject the usual heavy lead protective clothing which is routinely recommended in connection with fluoroscopic procedures. The x-ray room in which the procedure is necessarily performed under the visual insertion method is not normally a surgical facility, notwithstanding, the procedure is basically a surgical procedure.

Additionally, the equipment employed must minimize to the greatest possible extent the accidental impressing of an extraneous electrical signal on the patient. Thus, the surgeon and/or associates may accidentally form a circuit connection from the equipment to the patient. The leakage current characteristic of the equipment is such as to impress a current as low as the order of ten microamperes on the patient, serious if not fatal, injury to the patient may result. Generally, fluoroscopes are not designed with the desirable low leakage current characteristic to establish highly safe condition.

Although under emergency conditions it is possible and when absolutely required, the physician will insert the alone and without auxiliary fluoroscopic aid, this procedure cannot be reliably employed. As an alternative to the fluoroscopic insertion method and a blind feel method, research has indicated that the catheter can be reliably and properly passed through the vein and implanted in the heart through intracardiac electrographic processes. Various articles have suggested such a procedure. For example, an article in the American Journal of Medicine in the Apr., 1959 issue, pages 494 through 542, includes a report by a Charles A. Bartran et al. on Intracardiac Electrography In Man. As more fully disclosed therein, under this procedure the proximal end of the catheter is interconnected to an electrocardiogram apparatus with the reading providing the basis of determining the position of the catheter. Generally, the author concluded that the electrocardiogram obtained is sufficiently characteristic of the location of the catheter within the chambers and vessels of the heart to permit accurate localization of the catheter tip during cardiac catheterization. The article also notes the advantages of this system in reducing exposure to radiation of both the patient and the physician and further that the electrocardiogram facilitated the detection of phenomena which would not be readily apparent by the more conventional electrocardiogram taken with surface attached electrodes. More recent articles have also indicated the advantage of this system for emergency insertion of a catheter at the bedside of the patient. An article entitled "Simple Bedside Method for Travenous Intracardiac Pacing" by Kimball et al. appeared in the July, 1965 issue of American Heart Journal, page 35 through 39, wherein an emergency temporary catheter pacing procedure is disclosed.

A relatively flexible Teflon coated stainless steel wire was introduced into a vein and connected to the precordial lead of a direct-writers electrocardiograph machine through suitable interconnecting clip adapters. In addition, external limb leads were attached in the stan-

dard manner. The wire is then readily advanced into the heart and in particular to the right atrium. Once located, a characteristic atrial pattern was recorded on the electrocardiograph machine. It was found that with minimal manipulation the electrode could be properly advanced through the heart with the platinum reading tip resting on the proper surface within the right ventricle. The electrocardiogram from that point was readily recognized. After proper implantation the external ends of the intercardiac electrodes were connected to the Pacemaker and pacing was established. The system there employed is primarily for interim intracardiac pacing with use of a relatively flexible wire to avoid the possible potential hazard of puncture associated with a more conventional stiff cardiac catheter. This system has the advantage of permitting bedside catheter insertion or any other situation where it is possible to perform a venipuncture or cutdown on a vein. A more recent article entitled "Bedside Transvenous Cardiac Pacing" was written by Rosenberg et al. and appears in the May, 1969 issue of the American Heart Journal identified, at Vol. 77, No. 5, at pages 697-703. This article reports on the bedside insertion of a soft flexible catheter in a number of patients over a period of time under a similar procedure, with simultaneous electrocardiograms of the intracardiac trace and a limb trace provided by the inserted electrode and an external limb electrode. Both articles particularly suggest the procedure as satisfactory for temporary catheter insertion which may be employed to pace the heart during the insertion of a permanent transvenous Pacemaker catheter. After the insertion of a permanent electrode, the temporary electrode is removed of course.

Notwithstanding the apparent distinct advantages of the intracardiac electrograph method of electrode insertion it has not been widely adopted. Generally, the apparatus employed is the conventional electrocardiographic apparatus which is interconnected through auxiliary connectors and the like when employed. Applicant has realized that one of the problems presented is the lack of special instrumentation providing for convenient and standard operating use in the electrographic insertion process.

SUMMARY OF THE INVENTION

The present invention is particularly directed to a novel, special electrode placement apparatus for intracardiac electrographic procedures and which will contribute to rapid and accurate implanting of a pacing electrode.

Generally, in accordance with a particularly novel aspect of the present invention, an electrode pacing means having a pulsing means and electrode connection circuit means is connected to a first connector means for selective interconnection with a second connector means of a complementing multiple part connection means. The latter forms a part of an electrode placement means which includes means for visually displaying electrocardiograph traces and the like. A selection switch is coupled to the multiple part connection means for selectively setting and interconnecting of the pacing means to transmit pacing pulse energy to the electrode or to transmit the detected signal on the electrode to the display means. When the pacing means is disconnected from the electrode placement means, the pacing is automatically connected to establish and

maintain pacing signals to the electrode and thence to the patient's heart.

During an implanting operation, the electrode is inserted with an intracardiac electrocardiogram taken from the electrode tip. When the desired placement has been achieved, the selection switch means is actuated to establish pacing. An externally derived electrocardiogram indicates whether or not proper capture has been made. If an improper capture has been made, the surgeon merely reverses the position of the switch means to again establish the intracardiac trace. Once stable pacing is established, the pacing means is separated from the electrode placement means to permit transfer of the patient, if required.

The external and internal electrocardiogram traces are preferably displayed in side-by-side relationship to provide for direct comparison in determining proper placement. The simultaneous display of the internal and external traces is important because a damaged heart displays bizarre complexes which are not easily recognizable without comparison to a known (external) signal. Further, when proper placement is considered to have been made, the selection switch means is actuated to a pacing position. The pulse means will then provide the desired pacing while anticipating pacing action which is compared with the trace provided by the external electrocardiogram. As previously noted, of relocation of the catheter electrode appears necessary, the switch means is actuated to the display mode and the traces again compared during the necessary movement for repositioning of the electrode.

After stable pacing has been established, the pacing means is disconnected from the electrode placement means to automatically establish heart pacing. Under emergency operating conditions or the like, the patient can be moved to the desired facilities without interruption of the pacing. There is virtually no interruption of the pacing nor is any further action required because the separation of the pacing means automatically establishes the desired pacing interconnection.

This provides a very simple and reliable apparatus which is especially constructed for electrode implanting and provides an apparatus which can be readily transported to the bedside of a patient or other location for immediate electrode and pacer insertion. The present invention thus provides a means for permitting emergency implanting with the same precision normally obtained under controlled conditions. Further, the invention completely eliminates the necessity of fluoroscopic procedures with the attendant radiation exposures and also permits the implanting in the usual surgical room and under controlled, electrically safe conditions.

In accordance with a particularly practical and novel construction of the present invention, the electrode placement means is provided with a plurality of visual display means having individual and related inputs. The one input is adapted to display the intracardiac electrocardiogram and a second display provides a simultaneous external electrode sensed electrocardiogram. One or more auxiliary inputs can be provided with pressure sensing means to establish a pressure signal display or other physiological conditions. The pacing means and the electrode placement means include complementing connecting components having interrelated and complementing plug-in type contact members. The pacing means connector component includes

a switch normally providing for interconnection of a pulse source to the electrode leads. When the pacing means is attached to the electrode placement means, the switch is automatically actuated to disconnect the pulse means from the electrode leads through the complementing contact members and a selection switch of the placement means. The pacing means contact member includes a first contact connected to the pulse source and a second contact connected to the electrode leads. In addition, a common contact is selectively interconnected to the electrode leads and to the pulse source. The contact member of the electrode placement means includes three interrelated contacts which are interconnected to the selection switch means and to the display means. The selection switch means includes a movable contact means connected to a first contact of the second contact member which in the assembled relation is connected directly to the electrode contact of the first contact member. The switch means includes an input contact for the display means and a pacing contact which, in turn, is connected to a second contact of the second contact member. The third contact of the electrode placement contact member is connected to the third common contact of the first contact member. Thus, in the assembled relation, the switch may be set to connect the electrode directly to the input of the oscilloscope display means and provide a corresponding visual display of the heart action as sensed by the electrode. When the switch means is connected to the pacer contact, it automatically provides a reconnection of the electrode contact and the Pacemaker contact of the first contact member and thereby reinterconnects the pacemaker to the electrode. When the connector is open, as by removing of the pacing means from the electrode placement means, the contact members are separated and simultaneously the switch means of the pacing means automatically closes to reconnect the pulse generator directly to the electrode and maintain the pacing connection.

The releasable connector is conveniently a jack-type unit with the socket mounted and formed as a part of the pacing means. The contact members include resiliently loaded contacts.

The invention thus provides a new and novel apparatus which is particularly adapted for the reliable and rapid implanting of an electrode unit based on the intracardiac electrographic procedures and provides an apparatus which can be readily and conveniently operated without interfering with the physician's normal implanting procedures.

BRIEF DESCRIPTION OF THE DRAWING

The drawing furnished herewith illustrates the best mode presently contemplated by the inventor for carrying out the invention in which the above advantages and features are clearly disclosed as well as others which will be readily understood from the following description.

In the drawing:

FIG. 1 is a pictorial illustration of an electrode placement apparatus constructed in accordance with the present invention;

FIG. 2 is a schematic illustration of the pacing means shown in FIG. 1;

FIG. 3 is a schematic view of the pacing means shown in FIG. 1 schematically illustrating the switching cir-

cuitry of the pacing means separated from the electrode placement means; and

FIG. 4 is a similar schematic view of FIGS. 2 and 3 showing the pacing means interconnected to the electrode placements means.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

Referring to the drawing and particularly to FIG. 1, an electrode 1 is illustrated connected through a suitable connecting means to a special pacing unit 2 which is adapted to provide automatic timed pulses through the electrode 1 to the heart, not shown, for pacing of the heart. The special pacing unit 2 is releasably attached and interconnected to an intracardiac electrode placement unit 3 for initial insertion of the electrode 1 into the patient. The electrode placement unit 3 is formed with a supporting recess 4 within which the pacing unit 2 is attached with a releasable two-piece connector means 5, as shown in FIGS. 2 - 4, providing an electrical circuit connection between the pacing unit 2 and the placement unit 3. The pacing unit 2 is preferably constructed in accordance with the known functional capability of producing electrical impulses for heart pacing. Switch means may provide for selection of continuous periodic pulsing or demand pulsing in response to the actual heart functioning. Further, the normal amplitude and rate adjustment are provided.

The placement unit 3 further includes an oscilloscopic display portion 6 having three distinct display portions or traces 7, 8 and 9 which are adapted to individually display information from corresponding inputs. The display portion 7 is connected, as hereinafter described, to the releasable connector means 5. The display portion 8 is connected to external electrodes 10 which are applied to the patient's body to establish an electrocardiogram in the normal manner. A patient ground electrode 11 is also provided. In addition, the third display portion 9 is connected to a set of auxiliary input leads 12 for insertion of an auxiliary significant detection physiological input, for example, establishing a trace in accordance with the blood pressure by connection of a blood pressure transducer or the like to establish a corresponding trace. The signals, as previously noted, are simultaneously displayed one above the other and permit the surgeon performing the electrode placement to simultaneously view the internal electrocardiogram derived from the electrode 1, the external electrocardiogram derived from the external electrodes and the physiological information derived from the auxiliary input. Each display portion 7 - 9 is provided with suitable controls to allow accurate vertical positioning of the traces and adjustment of the relative amplitudes of several signals, in accordance with known electronic design.

In the illustrated embodiment of the invention, the electrode placement unit further includes a selection switch means which is connected to the connector means 5. The illustrated selection switch means includes a pair of push buttons 13 and 14. The one button 13 establishes a display position in which electrode 1 is connected to the display portion 7. The second push button 14 of the switch means interconnects the electrode 1 to the pacing unit 2 to provide for the desired periodic pulsing of the heart. During the automatic pacing, the surgeon can visually detect the heart action via the external electrodes related electrocardiogram pres-

ented on display portion 8. The simultaneous trace presentation of the various information is a great advantage to the surgeon in insertion to a proper placement and subsequently in determining whether or not proper placement in fact has been made.

The pacing unit 2 is further especially constructed for novel cooperative functioning with the placement apparatus, and a preferred construction is shown in FIG. 2. The unit 2 includes a pulse source 15 which may be any suitable means such as that presently widely employed in a Pacemaker pulse generator. In accordance with the present invention, the connection component of connector 5 includes an automatic switching means for selective interconnection of the pulse source 15 to the electrode 1 and to display portion 7. The connector 5 is particularly a two-part unit providing a releasable electrical interconnection, with a socket or receptacle 16 formed as a part of pulsing unit 2. The receptacle 16 is adapted to receive an electrical jack 17 formed as a part of the placement unit 3.

The illustrated receptacle 16 is a spring loaded switch unit having a first spring contact 18 which is connected to one side of the electrode 1 via an electrode lead 19. The spring contact 18 is biased to normally engage a fixed contact 20 as shown in FIG. 2. The fixed contact 20 is connected via a lead 21 to one side of the pulse source 15. Thus, the normally closed contacts 18 and 20 define a switch connecting the one side of the electrode to the pulse source 15. The opposite side of the electrode 1 is connected to a common electrode lead 22 directly to the opposite side of the pulse source 15 and thus in the normal disengaged switched position of FIG. 2, the pulse source 15 is connected directly to the electrode 1 and will provide desired pulsing thereto.

The switch means further includes a second spring contact 23 connected to the lead 21 and thus to the switched side of the pulse source 15. In the separated position of FIG. 2, the spring contact 23 is not otherwise connected in the circuit of the unit 2 but provides an external contact means for selective connection to the placement unit 3, as hereinafter described. The switching unit similarly includes a third contact 24 shown as a ring-like contact connected to the common electrode lead 22.

The spring contacts 18 and 23 and the ring contact 24 are mounted within a suitable insulating housing portion 25 which is recessed to accept the connector jack 17. The recess is generally a cylindrical recess with the contacts 18, 23 and 24 axially spaced within the recess. In particular, the spring contacts 18 and 23 are leaf-spring members having their outer ends bent and biased inwardly into the recess opening of the housing 25. The ring contact 24 is mounted adjacent the entrance of the housing and is generally a U-shaped spring contact which also projects slightly inwardly into the recess.

The jack 17 includes a contact shaft which enters the recess and forces the spring-like contacts 18, 23 and 24 outwardly to establish a firm electrical and physical interengagement between the respective contacts and the aligned portion of the contact shaft.

The contact shaft is secured to a suitable insulating housing or support 26 within the placement unit 3 such that when the pacing unit 3 is introduced into the recess 4 the contact shaft moves inwardly into sliding engagement with the respective contacts 18, 23 and 24. The shaft is formed with three distinct contact portions

including a first contact 27 on the outermost end of the shaft. A second intermediate contact 28 is spaced from the first contact 27 by a suitable insulator 29. The contacts 27 and 28 are generally spaced in accordance with the axially spacing of the terminal ends of the lead-spring contacts 18 and 23. In the assembled relation therefor the spring contacts engage the first and second contacts 27 and 28 of the shaft and thereby provide for electrical circuit interconnection. A third contact 30 is separated from the intermediate contact 28 by a suitable insulator 31. The contact 30 is aligned with the ring contact 24 in the assembled relation of the pacing unit 2 and the placement unit 3. The interconnection of the contact shaft with the contacts results in the outward movement of the spring contacts 18 and 23. The outward movement of the spring contact 18 opens the switch to the pulse source 15 and thereby removes the pulsing means connection to the electrode 1. The pulse source 15 is now connected into the circuit through the second spring contact 23 and the intermediate shaft contact 28.

The electrode 1 is now connected into the circuit through the connection to the spring contact 18 and the shaft contact 27 and through the common ring contact 24 and the third contact 30 of the shaft, as follows.

Referring particularly to FIG. 3, the placement unit 3 is diagrammatically illustrated including a first electrode signal display preamplifier 32 connected through a three-channel multiplexer 33 to the display portions 7 - 9 to establish the trace in portion 7. A preamplifier 34 has its input connected to the external trace electrodes 10 and a similar auxiliary preamplifier 35 connected to leads 12 is connected as a third input to the multiplexer 33 to provide drive signals to the corresponding portions of the oscilloscope display 7 - 9.

The selection switch means 13 - 14 is connected to the contact member 17 and connects the electrode 1 to the preamplifier 32, or to the pulse source 15. The illustrated selection switch means is a single pole, double throw unit having a common pivoted pole 36 connected to the end contact 27 of the contact shaft. The pole 36 is selectively and oppositely movable by the buttons 13 and 14 between engagement with a pacing contact 37 and a display contact 38. Contact 37 is connected directly to the intermediate contact 28 of the contact jack. Contact 38 is connected as an input to the preamplifier 32. The opposite sides of the preamplifier 32 is connected directly to the third contact 30 of the jack.

In the assembled relationship shown in FIG. 1 and FIG. 3, the pulse source 15 is disconnected from the electrode 1 at the contact 20 and is interconnected into the circuit through the external connection of contact springs 18 and 23 to the interrelated contacts of the placement contact member 17.

With the selection switch means in the display position, the electrode leads 19 and 22 are connected directly as the input to the related preamplifier 32, as follows. Lead 19 is connected to the spring contact 18 and via the shaft contact 27 to the common pole 36 of the selection switch means. The pole 36 is connected via the display contact 38, in the assumed position, to the one side of the preamplifier 32. The opposite side of the preamplifier 32 is connected via the third contact 30 of the jack, the ring contact 24 and the lead 22 to the opposite side of the electrode. Thus, in this position the signal output of the electrode 1 is displayed on the

oscilloscope and particularly in portion 7 to provide an indication of the position of the electrode tip within the heart.

In the alternate position of the selection switch means and particularly in the pacing position, the electrode leads 19 and 22 are reinterconnected to the pulse source 15.

The Pacemaker lead 21 is connected to the actuated spring contact 23 and thus to the intermediate contact 28 of the jack. The pacing contact 37 of the selection switch means which is now engaged by the common pole 36 is connected to contact 28. The common pole 36 is also connected to the contact 27, now engaged by the spring contact 18 to complete a connection of the power source lead 21 to the electrode lead 18. The opposite side of the electrode 1 is connected via the lead 22 directly to the opposite side of the pulse source 15. Thus, in this position the electrode lead 19 is disconnected from the preamplifier 32 and connected to the pulse source 15 to provide for automatic pulsing of the electrode 1 and the corresponding signaling of the heart.

To insert the electrode 1 into the patient, the special pacing unit 2 is assembled with the placement unit 3. The external electrodes 10 are properly attached to the patient's body along with the common ground electrode 11 connected to the patient's leg. The pressure transducer or other auxiliary means is interconnected to amplifier 35 as the third input. The electrode 1 is then introduced into the patient's vein with the selection switch means 13 - 14 in the display position. During the electrode placement, the surgeon simultaneously views the external electrocardiogram trace on portion 8, the internal electrocardiogram trace on the portion 7 as well as the auxiliary physiological information presented on the portion 9. When the trace portion 7 indicates that proper placement has been achieved, the selection switch means 13 - 14 is actuated to the pacing position and the results are observed. If a proper capture has been achieved, the heart action will be readily apparent by a review of the external electrocardiogram trace on display portion 8. If proper capture had not been obtained, the external electrocardiogram immediately reflects such information to the surgeon. To relocate the electrode, the surgeon merely returns the switch means 13 back to the display mode and again observes the internal trace directly without the necessity of making any other changes in the circuit or apparatus.

Once stable pacing has been established, the pacing unit 2 is disconnected from the pacing unit 3. The contact 18 of the first contact member 16 is released to connect lead 19 to the pulse source 15 via contacts 18 - 20 and lead 21. There is no interruption of the pacing and no new connection need be made to the patient to maintain the already desired established pacing. The patient is then in condition for removal back to his room or has been provided with the necessary pacing assembly without the necessity of any transport to or from his bed.

After removal of the pacing unit, the pacing unit can be attached to the patient's arm or the like to maintain the desired pacing. If, subsequently, a small permanent Pacemaker is to be implanted within the patient's body the inserted electrode can be connected to the permanent Pacemaker. Alternatively, emergency insertion of a temporary pacing means unit may be made in accor-

dance with the teaching of the present invention. Subsequently, the temporarily inserted electrode can be employed to maintain proper pulsing of the heart while a permanent electrode is inserted into the heart and connected to a permanent Pacemaker, after which the temporary electrode is removed. Thus the various modifications to the present invention can be made if desirable for any reason. The present or illustrated embodiment of the invention, however, provides a relatively inexpensive construction employing a common selection means for any one of a number of different pacing units for providing maximum convenience to the surgeon which is, of course, of very great practical significance in view of the delicate nature of the implanting operation under the most favorable circumstances.

Although described in the above preferred construction, various modifications can be made within the scope of the present invention. Although the detection switch means is shown as a part of the electrode placement unit, the pacing unit can be provided with the desired switching means with the interconnecting contacts providing for the selective intercircuit connection. The pacing unit will not be of the variety which will be directly implanted into the body as a permanent Pacemaker and consequently the minaturization and the like is not as important. The switching means is, however, preferably placed on the placement unit to minimize the expense and the like. Further, if desired, the switching means may be eliminated and the insertion and removal of the pacing unit employed as the switching unit for selectively establishing the automatic pacing and the interconnection of the electrode unit to the placement unit. This, of course, would require the removal and insertion of the pacing unit if it is desired to check the capture and thus does not provide as convenient a method as the relatively inexpensive concept of providing the separate selection switch means.

The present invention thus provides a very convenient and reliable instrumentation which permits convenient emergency implanting as well as an improved implanting under surgical room conditions without the necessity for fluoroscopic viewing.

The illustrated embodiment employs a pulse source unit especially constructed to fit within a recess in the placement apparatus. Various pulse sources are presently manufactured and cannot be used as such. As a practical solution, the placement apparatus may be constructed without a special Pacemaker plug in the recess and provided with an adapter means to accommodate the various available pulse sources. The adapter means would be connected to the output of the Pacemaker and have means connected to the placement apparatus and to the electrodes. The adapter would further have the necessary internal switching to produce the previously described function and operation. Further, the outer end assembly of the adapter could be a two-piece unit which, when separated, provides the automatic connection of the electrodes to the pulse source. Alternatively the outer end of the assembly could be a single unit which was separated from the pulse source and electrodes and the electrodes then connected directly to the output of the pulse source.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims, particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

I claim:

1. An electrode placement apparatus for intracardial placement of an electrode, comprising
 - a multiple part circuit connection means including a first circuit connector means and a second circuit connector means releasably connected to the first connector means,
 - a pacing means having a pulsing means and an electrode connection circuit connected to said first connector means,
 - an electrode placement means having electrode signal input means for display of the output of the electrode connection circuit means, said placement means including said second connector means, and
 - selection switch means connected to said connection means to selectively connect said electrode connection circuit to the electrode signal input means and to the pulsing means.
2. The electrode placement apparatus of claim 1, wherein
 - said electrode placement means includes external electrode signal means and display means for the output of the external electrodes.
3. The electrode placement apparatus of claim 1, wherein
 - said first connector means includes a first contact member attached to the pacing means and said second connector means includes a second complementing member attached to the electrode placement means,
 - said first contact member having electrode contact means connected to the electrode connection means and pulse contact means connected to said pulse means,
 - said second contact member having display contact means for connection to the display means and second pulse contact means connected to the first pulse contact means of the first contact member,
 - automatic switch means being connected to said first contact member and responsive to release of said connector means to connect the electrode connection circuit means to the pulsing means and responsive to interengagement of said connector means to operatively disconnect the electrode connection circuit means from the pulse means and operatively connect the electrode connection circuit means to said connector means, and
 - said selection switch means being connected to said second contact member for selectively operatively connecting the electrode input means to the display means and to the pacing means for selectively pacing the heart and for display of the heart action as appears at the electrode connection means.
4. The electrode placement apparatus of claim 3, wherein
 - said electrode placement means includes a first display means connected to said display contact means for visual display of traces corresponding to the signal on the electrode and a second display means, and
 - external electrode means connected to said second display means to establish an external electrocardiogram.
5. The electrode placement apparatus of claim 3, wherein
 - said first contact member includes a socket having said electrode contact means projecting into said

- socket and said pulse contact means is longitudinally spaced from the electrode contact means and projects into said socket, said contact means being spring loaded,
- said second contact member being a shaft and said second pulse contact means axially spaced in accordance with the contact means of the first contact member.
6. The electrode placement apparatus of claim 3, wherein
 - said automatic switch means includes a leaf spring integrally connected to said first contact member and biased to a first position to connect the electrode connection circuit means to the pulsing means upon release of said connector means and moved to a second position by the interengagement of said connector means to open the electrode connection circuit means from the pulse means and connect the electrode connection circuit means to said connector means, and
 - said selection switch means connected to said second contact member for selectively operatively connecting the electrode input means to the display means and to the pulsing means for selectively pacing the heart and for display of the heart action as appears at the electrode connection means.
7. An electrode placement apparatus for the intracardial placement of an electrode, comprising
 - a heart pacing means for generating heart stimulating pulse signals,
 - electrode means for insertion into a heart,
 - a display means adapted to respond to signals generated by the heart in said electrode means, and
 - a connection means connected to said pacing means and said display means and including a first switch means to selectively connect said electrode means to said pacing means and to said display means, and a second switch means to automatically connect said pacing means to said electrode means in response to separation of the pacing means from the display means.
8. The electrode placement apparatus of claim 7 wherein
 - said display means including a plurality of aligned display viewing members each having a separate input means,
 - a first of said input means being connected to said first switch means,
 - a set of external heart beat sensing electrode means connected to a second of said input means, and
 - an auxiliary input means connected to a third of said input means.
9. An electrode placement unit for intracardial placement of an electrode by releasable connection to a pacing means having a pulsing means and an electrode connection circuit means connected to a first connector means of a multiple part circuit connection means, comprising
 - a second circuit connector means of a said multiple part circuit connection means and releasably connected to a complementing second connector means,
 - a display means having an electrode signal input means for display of the output of the electrode connection circuit means, said placement means including said second connector means, and

13

selection switch means connected to said second connector means and to said signal input means to selectively connect said electrode connection circuit means to the electrode signal input means and to the pulsing means.

10. The electrode placement unit of claim 9, having external electrode signal means and related display means for the output of the external electrodes.

11. The electrode placement unit of claim 9, wherein said selection switch means includes a pair of pushbutton inputs,

one pushbutton input establishing the connection to the pulsing means and the second pushbutton input establishing the connection to the display means.

12. The electrode placement unit of claim 9, having said display means including a plurality of aligned display viewing portions each having a separate input means,

a first of said input means being connected to said selection switch means,

a set of external heartbeat sensing electrode means connected to a second of said input means, and an auxiliary input means connected to a third of said input means.

13. A pacing unit for selectively connecting an electrode for pulsing a heart and for establishing a signal in accordance with the function of the heart for operating an electrode placement unit having a signal display means connected to a first connector means of a multiple part circuit connection means, comprising

a pulsing means,

an electrode connection circuit means,

a second connector means of the circuit connection means releasably engageable with said first connector means and connected to said pulsing means and said connection circuit means,

14

automatic switch means responsive to release of said first and second connector means to connect the electrode connection circuit means to the pulsing means and responsive to interengagement of said connector means to operatively disconnect the electrode connection circuit means from the pulsing means and operatively connect the electrode connection circuit means to said first connector means for selective connection to the display means and to the pulsing means.

14. The pacing unit of claim 13, wherein said automatic switch means includes contacts connected to and forming a part of said second connector means.

15. The pacing unit of claim 13, wherein said automatic switch means includes a lead spring defining a first contact member of the second connector means and biased to a first position engaging a fixed contact member to connect the electrode connection circuit means to the pulsing means upon release of said connector means and moved to a second position by the interengagement of said connector means to open the electrode connection circuit means from the pulsing means and connect the electrode connection circuit means to said first connection means, and

said second connector means having a third contact member connected to the fixed contact member for selectively operatively connecting the electrode input means through said first connector means to the display means and to the pulsing means for selectively pacing the heart and for display of the heart action as appears at the electrode connection means.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,768,487 Dated October 30, 1973

Inventor(s) FREDERICK A. ROSE

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column	4,	Line	28,	after "noted" cancel "of" and insert --- if ---;
Column	4,	Line	66,	after "complementing" cancel "connecting" and insert --- connector ---;
Column	6,	Line	64,	after "for" cancel "th" and insert --- the ---;
Column	8,	Line	5,	at the end of the line, cancel "lead-" and insert --- leaf- ---
Column	8,	Line	47,	after "opposite" cancel "sides" and insert --- side ---;
Column	9,	Line	63,	at the end of the line cancel "permanet" and insert --- permanent ---;
Column	10,	Line	25,	after "the" cancel "minaturization" and insert --- miniaturization ---;

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Inventor(s) FREDERICK A. ROSE Page 2

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 12, line 43, after "7" cancel "f" and insert
Claim 8 --- a comma (,) ---;

Column 12, line 60, before "said" cancel "a"
Claim 9

Column 14, line 16, before "spring" cancel "lead"
and insert ---leaf---.

Signed and sealed this 23rd day of July 1974.

(SEAL)
Attest:

McCOY M. GIBSON, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents