

Oct. 1, 1963

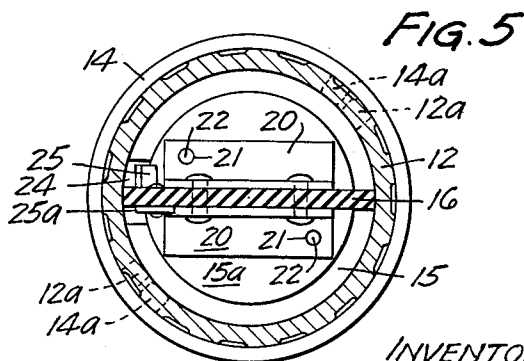
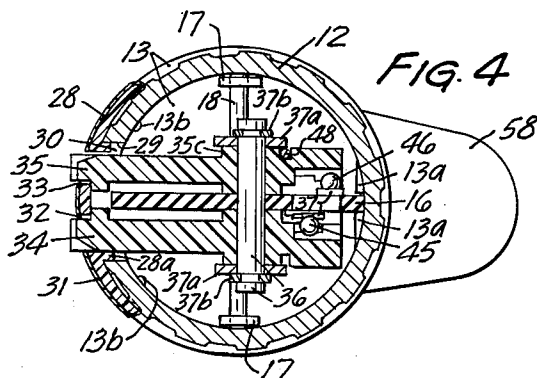
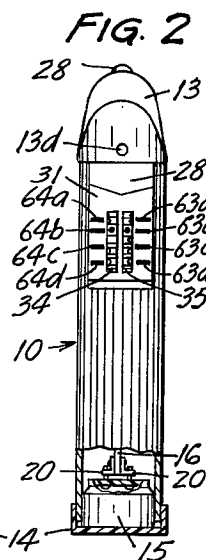
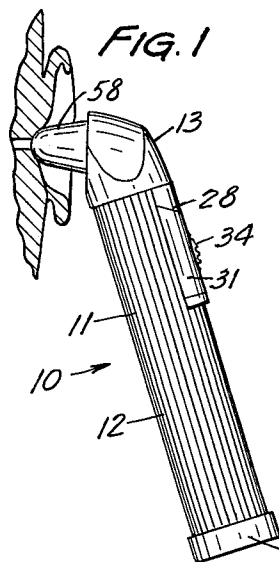
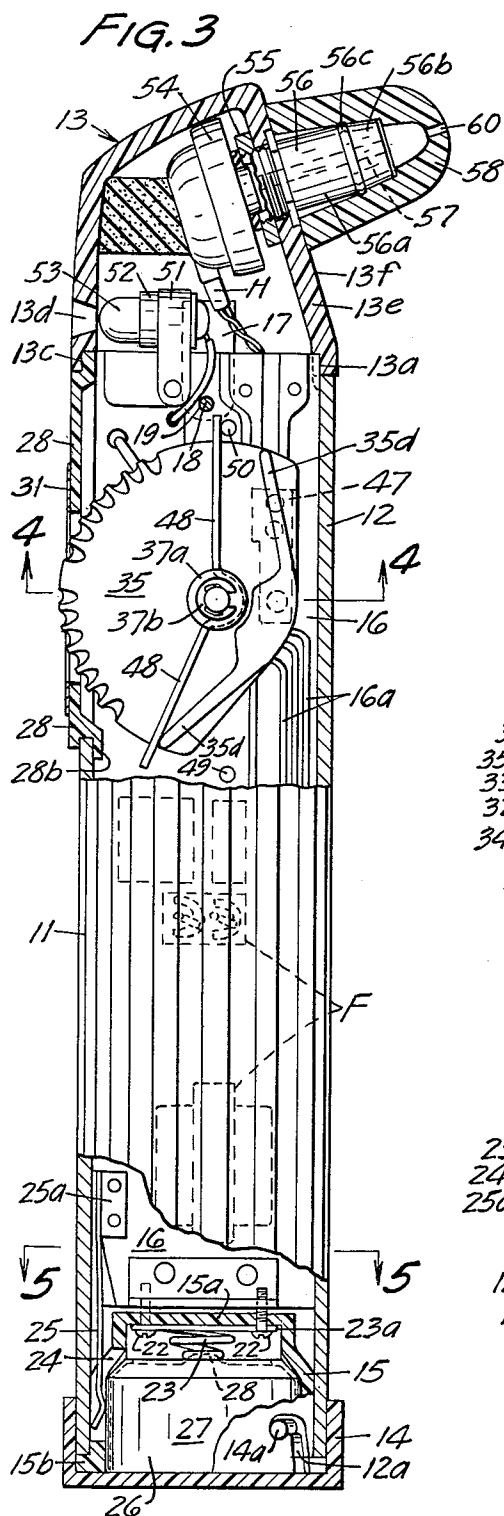
C. D. MULLIN ETAL

3,105,876

HEARING CHECKING DEVICE

Filed May 9, 1960

2 Sheets-Sheet 1



INVENTORS
 CLAYTON D. MULLIN
 JOHN F. ROSE
 BY *George F. Williamson*
H. Dale Palmatier
 ATTORNEYS

C. D. MULLIN ETAL
HEARING CHECKING DEVICE

2 Sheets-Sheet 2

FIG. 8

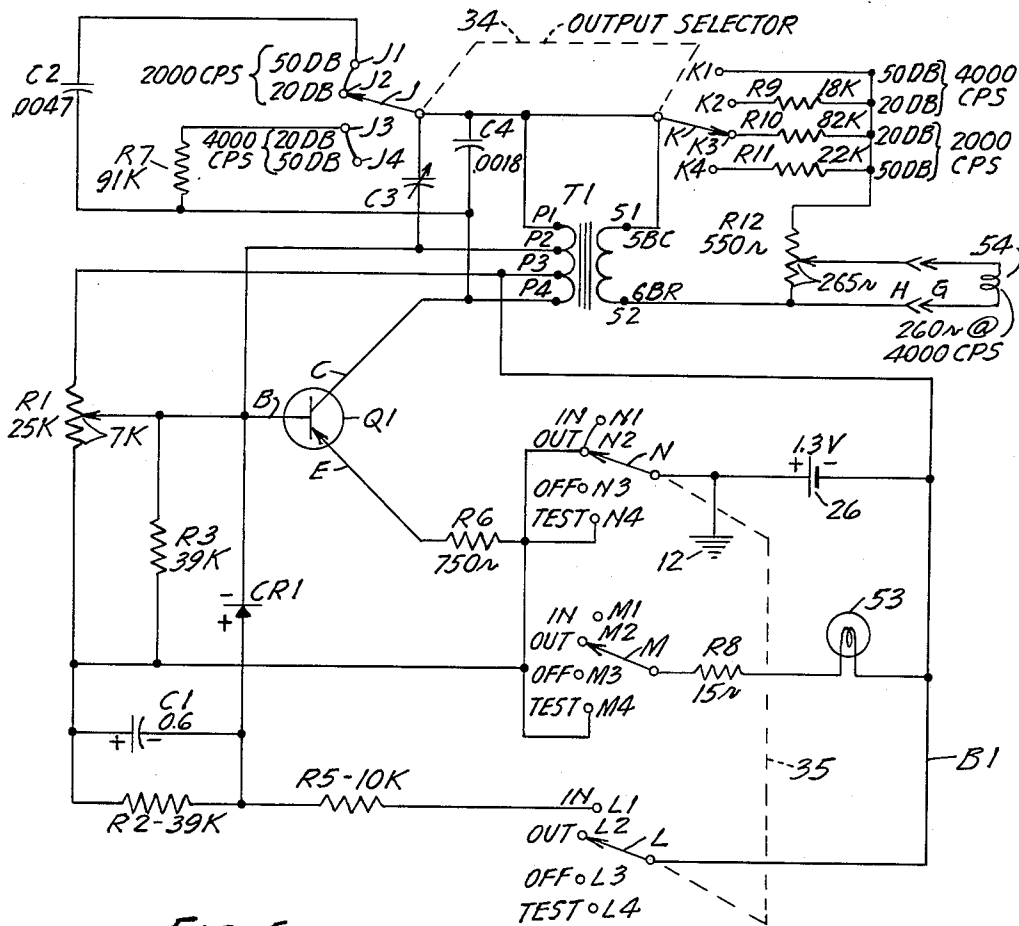


FIG. 6

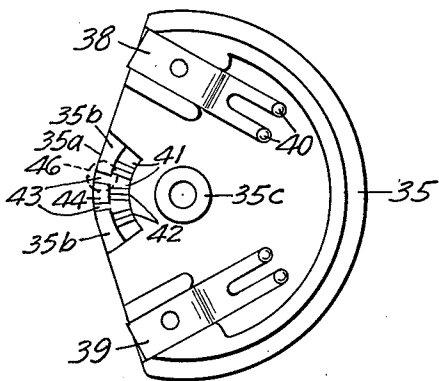
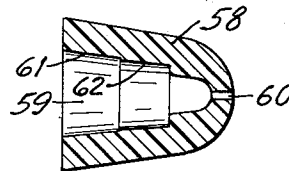


FIG. 7



INVENTORS
CLAYTON D. MULLIN
JOHN F. ROSE
BY *George F. Williamson*
H. Dale Palmater
ATTORNEYS

1

2

3,105,876

HEARING CHECKING DEVICE

Clayton D. Mullin, St. Paul, and John F. Rose, Minneapolis, Minn., assignors to Maico Electronics, Inc., Minneapolis, Minn., a corporation of Minnesota
Filed May 9, 1960, Ser. No. 27,652
5 Claims. (Cl. 179-1)

This invention relates to apparatus for checking the hearing capabilities of a person.

There are many instances in which it is desirable to make a rapid, but accurate, check of the hearing capabilities of a large number of persons in such a manner as to determine if any individuals have pronounced deficiencies in this regard. For instance, it is frequently desirable to make a determination of the hearing capabilities of all the students in a school.

Various types of audiometers have been known in the past, but many of such audiometers are rather difficult to operate and they are usually prescribed for use under closely controlled sound condition, and require that the complicated apparatus be a fixed or permanent installation.

With these considerations in mind, it is to the elimination and improvement of these disadvantages in the prior art to which the present invention is directed, along with the inclusion therein of other novel and desirable features.

An object of our invention is to provide a new and improved device of simple and inexpensive construction and operation for determining hearing capabilities of a person.

Another object of our invention is to provide novel apparatus for readily and easily checking the hearing capabilities of a person at a plurality of frequency and intensity levels.

Still another object of our invention is to provide a new and novel hearing check device which is completely embodied in a single unit which may be held in a person's hand and easily carried from place-to-place to facilitate checking of the hearing capabilities of a large number of persons at a location where such persons congregate or are likely to be found, such as in schools and the like.

A further object of our invention is to provide an improved apparatus for quickly checking the hearing capabilities of a number of persons in rapid succession while still maintaining high standards of sterilization and allowing the apparatus to be adapted for use with ears of various sizes of various persons.

These and other objects and advantages of our invention will more fully appear from the following description made in connection with the accompanying drawings wherein like reference characters refer to the same parts throughout the several views and in which:

FIG. 1 is a side elevation view of the invention and showing a fragmentary sectional view of a human ear, the hearing capabilities of which are being checked;

FIG. 2 is a rear elevation view of the device which is shown partly in section for clarity of detail.

FIG. 3 is an enlarged side elevation view of the device which is shown partly in section for clarity of detail.

FIG. 4 is a section view taken at 4-4 in FIG. 3, and in this view certain elements in the background have been removed for clarity;

FIG. 5 is a section view taken at 5-5 in FIG. 3;

FIG. 6 is a detail elevation view showing the inner side of one of the switching controls;

FIG. 7 is a detail section view of the ear tip detached from the device; and

FIG. 8 is a schematic circuit diagram of the hearing checker.

The hearing checker is indicated in general by numeral 10 and includes a housing 11 which encloses the self-contained circuitry and mechanism to be hereinafter described. Housing 11 includes a tubular and generally cylindrical body or casing 12 which is similar in size and shape to that of a conventional two-cell flash light, so as to be well adapted to be held and carried in a person's hand, a head 13, a removable cap 14 and a battery well 15.

The tubular casing 12 encloses a printed circuit board 16 which extends throughout the length of the casing and is oriented generally on a diameter of the casing 12. The printed circuit board comprises a portion of the framework of the device 10 for holding the various portions of the housing 11 in assembly.

Head 13, which is formed of rigid material and may be of a moulded plastic construction, is provided with a pair of embedded and fixedly placed depending apertured ears 17 extending into the upper end of the tubular casing 12 and normally carrying, in the apertures thereof, a spring pin 18 which extends across a diameter of the casing 12 and extends through an aperture 19 in the upper portion of the printed circuit board 16 for releasably holding the head 13 and circuit board in assembly. It should be noted that the pin 19 is readily extractable from the aperture 18 and from the apertured ears 17, and is normally maintained in the apertured ears by the casing 12.

The lower end of the printed circuit board 16 has a pair of small angle brackets 20 affixed on opposite sides thereof as by rivets, and the outwardly extending flange portions of the angle brackets 20 are provided with threaded apertures 21 into which are threaded screws 22 extending through the bottom 15a of the battery well 15 and which also extend through bights 23a at the ends of coil spring 23 for securing the battery well 15 and printed circuit board 16 in assembly with the casing 12 and head 13. It will be noted that the battery well 15 has an out-turned substantially annular flange 15b which bears against the bottom edge of the casing 12 so that as the screws 22 are tightened, the battery well and head effectively clamp against opposite ends of the casing 12. The battery well 15 has a slotted aperture 24 in one side thereof through which a spring contact 25 extends for engagement with the sidewall 26 of the battery 27. The other battery contact, or tip end 28 bears against the spring contact 23. The spring contact 25 is formed integrally of a bracket portion 25a which is anchored to the printed circuit board 16 as by rivets.

The cap 14 is provided with a pair of inwardly extending lugs 14a which are normally carried in the inner ends of the bayonet slots 12a in the end of the casing 12. The flange 15b of the battery well 15 is suitably notched to permit movement of the lugs 14a into and out of the slots 12a to permit removing of the cap 14.

The upper end of the circuit board 16 extends slightly into the head 13 and is maintained in predetermined orientation by spaced lugs 13a which extend slightly into the upper end of casing 12 to maintain head 13 and casing 12 in alignment. Additional lugs 13b on the head 13 also extend slightly into the casing 12 for alignment purposes.

The casing 12 and head 13 are maintained in predetermined annular orientation and are prevented from rotating with respect to each other by means of the switch cover assembly 28 which is constructed of rigid moulded material and is provided with in-turned flanges 28a which bear against the edges 29 of an elongate and broad slot 30 in the casing 12. The slot 30 opens through the upper end of the casing 12 and receives the switch cover assembly 28 throughout its length. The switch cover assembly has a lower end lip 28b which lies beneath and abuts against the casing 12 at the lower end of slot 30. The in-turned flanges 28a project upwardly into a recessed portion 13c

of the head 13 and prevent rotation of the head 13 with respect to the casing 12.

The switch cover assembly 28 is provided with a thin sheet covering 31 which carries legends to be hereinafter more fully explained. The switch cover assembly is provided with slots 32 and 33 through which extend peripheral portions of generally circular and rotatable switch control elements 34 and 35 respectively.

The circuit board 16 has a post 36 extending there-through and affixed thereto and rotatably mounting the switch control elements 34 and 35 respectively on opposite sides of board 16. The rotatable switch control elements 34 and 35 are secured on the post 36 by means of washers and retaining rings 37a and 37b respectively. In FIG. 6 is shown the inner surface switch control element 35, and an understanding of one is sufficient for an understanding of both in view of the similar construction. The element 35 carries a pair of contact elements 38 and 39, each of which has a pair of contacts 40 to effect bridging across a pair of conductive strips similar to those indicated at 16a on the printed circuit board so as to effect a switching function to be hereinafter more fully described in connection with the circuit diagram in FIG. 8. Each of the switch control elements is provided with a plurality of recesses 41 and has detents 42 between the recesses and on the inner face thereof at a position inwardly from the edge 35a. Each of the elements 35 is also provided with recesses 43 and detent 44 next adjacent the edge 35a. Said recesses and detents cooperate with balls 45 and 46 which are mounted at opposite sides of the printed circuit board adjacent the control elements 34 and 35 and which are cradled in apertures in leaf spring 47 so as to urge the balls into the recesses and thereby maintain the control elements at predetermined positions unless manually shifted. The ball 46 cooperates with recesses 43 and detent 44 of element 35 to normally hold the control element 35 in either one of two positions, but it being understood that the control element 35 may be rotated so that the ball 46 engages the surface portion 35b and thereby permits the control element to be swung to any of four positions. The ball 45 is located to cooperate with recesses and detents 41 and 42 which are arcuately spaced such as to hold control element 34 in any one of four positions.

The rotary control element 35 is further provided with a spring 48 mounted on the arcuate hub 35c beneath washer 37a. The opposite ends of spring 48 are engageable with outwardly protruding flange portions 35d and with rigid posts 49 and 50 affixed to the printed circuit board. While the spring engages one of the posts, such as 50, the other end of the spring engages the corresponding flange 35d, and when the rotatable control element 35 is rotated so that ball 46 moves up on surface portion 35b, the spring 48 is flexed and will return the control element 35 to a position wherein the ball 46 may set in recess 43 when released.

A bracket 51 mounts a light socket 52 which carries a test light 53. The light is disposed adjacent an aperture 13d in the head 13 so as to be visible from the exterior.

The receiver or speaker 54 is secured in the head 13 by means of a fitting 55 and at the inner side of the front wall 13e of the head which has a flat outer surface 13f. An ear tip-mounting post 56 having a central passage or aperture 57 extending longitudinally there-through is integrally mounted with the head 13 and is thereby affixed to the head. The passage or aperture 57 is disposed directly in front of the receiver 54 so as to transmit sound outwardly there-through. It will be noted that the mounting post 56 has a substantially cylindrical portion 56a adjacent the flat surface 13f and has an outwardly convergently tapering outer end portion 56b and an annular rib or bead 56c between the cylindrical and tapering surface portions.

The ear tip 58 is removably secured on the post 56 so as to be adapted to be readily and easily changed so

that tip 58 may be sterilized and so that the size of the tip may be changed to be adapted to ears of various sizes. The tip 58 is constructed of a resiliently flexible moulded material so as to be slightly deformable to positively grip the post 56 when applied in the fashion shown in FIG. 3. The tip 58 has a post-receiving interior chamber portion 59 and an aperture 60 through the outer end thereof. The chamber 59 is defined by an inwardly convergent tapering conical surface 61 which extends inwardly a distance slightly less than the distance between rib 56c and surface 13f and the surface of chamber 59, at a position inwardly of surface 61, as at 62, is substantially cylindrically formed. It should be pointed out that when the tip 58 is to be removed from the post 56, the tip need merely be tipped to an oblique angle with respect to post 56 whereupon the tip 58 will pop off the post, yet when the tip is applied as in FIG. 3, it grips the post and is securely held in position.

As will become apparent hereinafter in connection with the circuit diagram, the several positions of the rotatable control elements perform the following functions. When the round dot on the control element 35 is adjacent mark 63a the unit is entirely off and the circuit is open from the battery; when adjacent the mark 63b, the test light 53 is operated, whereupon the operator of the unit will know that the battery has or has not sufficient power to operate the sound producing circuit in a manner to produce the desired sound intensity level; at position 63c the sound producing circuit is in operation except that the signals are not being transmitted to the receiver; and at position 63d sound-producing signals are produced and transmitted to the receiver whereupon the sound is produced. It should be pointed out that when the dot of element 35 is disposed at either of positions 63b or 63d, the control element 35, when released, will be returned by spring 48 to the next adjacent position.

When the control element 34 is oriented so that the round dot on the edge thereof is disposed adjacent the mark 64a, the circuit is adjusted to produce sound at the receiver with a pitch of 4000 cycles per second and an intensity level of 50 decibels; and when the dot is moved to mark 64b the circuit is adjusted to produce sound of 4000 cycles and 20 db; when the dot is positioned adjacent mark 64c sound is produced at 2000 cycles at 20 db and when the dot is adjacent mark 64d sound is produced at 2000 cycles and 50 db.

It will be understood that the printed circuit board 16 carries a number of circuit elements, some of which are shown in dotted line in FIG. 3 and indicated in general by the letter F.

With respect to the circuit shown in FIG. 8, the several positions of control element 34 will be clear. Schematically, the circuit of control switch 35 is represented as several banks of stationary contacts N1-N4, M1-M4 and L1-L4, and each of these banks has a corresponding multi-position rotatable wiper contact N, M and L respectively. The several positions of the control element 35 reading from bottom to top in each of the banks, are "test," meaning battery testing; "off" meaning circuit off and disconnected from battery; "out" meaning circuit prepared for operation, but sound not being produced; and "in," sound being produced and directed in a person's ear.

The circuit includes a transistor Q1, the base electrode B which is connected in series through a rectifier CR1 and a resistor R5, stationary "in" contact L1 and movable contact L to the negative side of battery 26. The base electrode B is also connected to the movable center tap of potentiometer R1, the upper end of which is connected to an intermediate primary winding tap T3 of transformer T1, the lower end of potentiometer R1 being connected to a resistor R3 which provides a shunt between the center tap of R1 and the lower end thereof. The lower end of potentiometer R1 is connected through a series resistor R2 to the connection between diodes

5

CR1 and resistor R1. Condenser C1 is connected in shunt with resistor R2. The lower end of potentiometer R1 is also connected directly to "test" contact M4 and to "in" contact N1, "out" contact N2 and "test" contact N4. Said last mentioned contacts are also connected with one end of resistor R6, the other end of which is connected with the emitter electrode E of transistor Q1.

The remaining contacts, comprising "off" contact N4; "in" contact M1; "out" contact M2; "off" contact M3; "out" contact L2; "off" contact L3 and "test" contact L4 are all open. The wiper contact L of switch 35 is connected directly to a bus B1 which is directly connected to the intermediate tap P3 of the primary winding in transformer T1. Movable contact M is connected to bus B1 through series resistor R8 and bulb 53. Movable contact N is grounded to the case 12 and is connected to the positive side of battery 26, the negative side of which is connected to the bus B1.

The collector electrode C is connected directly to the end P4 of the primary winding of transformer T1.

The base electrode B is also directly connected to the intermediate primary winding tap P2 of transformer T1.

The control switch 34 has, schematically, two banks of stationary contacts J1-J4 and K1-K4, and corresponding wiper contacts J and K.

The wiper contact J is connected directly to the end P1 of the primary winding in transformer T1, and is also connected through a condenser C4 to the collector electrode C of the transistor Q1, and is also connected through a trimmer condenser (170 mmfd.-780 mmfd.) to the base electrode B of the transistor, and is also directly connected to the wiper contact K and to one end S1 of the transformer secondary winding. The contacts J1 and J2 (2000 cycles) are connected with each other and are connected through a condenser C2 to the collector electrode C of the transistor. The contacts J3 and J4 are connected with each other and are connected through a resistor R7 to the collector electrode C of the transistor.

The coil of receiver 54 is connected at its opposite ends through plug G and jack H to the bottom end and to the movable center tap, respectively, of potentiometer R12. The lower end of potentiometer R12 is also connected to the lower end 52 of the transformer secondary winding. The upper end of potentiometer R12 is connected through resistor R11 to contact K4, is connected through resistor R10 to contact K3, is connected through resistor R9 to contact K2 and is directly connected to contact K1.

It should be noted in the drawings that typical values of the circuit components are shown and with the circuit constructed accordingly satisfactory operation is obtained.

In the test position of control switch 35, the light 53 is connected to the battery and if lighting is visible to the operator through the aperture 13d, the operator may conclude that the battery is satisfactory for use. If no light is visible the battery 26 is exhausted and should be replaced. Likewise the battery should be replaced if a dull red glow appears momentarily and then disappears.

When the control switch 35 is moved to the tone "out" position, the instrument is operating, although sound is not produced at the receiver. The sound may be made audible by moving the control switch 35 to the "in" position, whereupon the tone is audible at a frequency and intensity level in accordance with the adjustment of control switch 34. Ordinarily the switch 34 will be adjusted to the proper position so as to predetermine the tone pitch and the intensity level, prior to the manipulation of control switch 35 to make the sound audible. It will be seen that by adjusting control switch 34, the sound produced will have a frequency of 2000 or 4000 c.p.s. at either of the intensity levels of 20 db or 50 db.

The ear tip 58 should be replaced and cleaned before testing each subject or person. An ear tip of suitable size should be applied so as to produce when inserted into

6

the ear canal, an acoustic seal. Of course care must be taken to prevent the aperture 60 in the ear tip from being covered or obstructed by the fleshy areas in the ear.

It should be noted that the battery 26 may be readily and easily replaced by merely removing the cap 14.

It should further be noted that ready and easy access can be had to all of the components in the housing 11 to facilitate maintenance and service if needed. By merely removing the screws 22, the battery well 15 will slip out the bottom end of the casing 12 and the head 13 along with the printed circuit board and switch cover assembly 28 will slip off the top end of the casing, whereupon the switch cover assembly 28 is merely lifted off and the pin 19 is removed to disassemble the printed circuit board 16 from the head 13. When the jack H carried on its card is removed from the plugs on the receiver 54, the head and circuit board are entirely disassembled.

It will, of course, be understood that various changes may be made in the form, detail, arrangement and proportion of the parts without departing from the scope of my invention which consists of the matter described herein and set forth in the appended claims.

What is claimed is:

1. Apparatus for determining hearing capability of a person, comprising an elongate housing adapted to be carried in a person's hand, an ear tip having a dome-shaped front end to be inserted slightly into and sealed against the periphery of the ear canal, an ear tip mounting secured to the housing, the tip and mounting respectively having interfitting portions defining a releasable snap coupling holding the tip in stationary relation with respect to the housing, one of said interfitting portions being of resiliently deformable material for releasably gripping the other interfitting portion, the interfitting portion of the tip being integrally formed with the tip and substantially smoothly contoured to permit ready and easy cleaning and sterilizing thereof, the mounting and tip having sound-transmitting openings therethrough, sound-producing means in the housing and transmitting the same through said openings and including a manually operable control regulating production of sound.

2. Apparatus for determining hearing capability of a person, comprising an elongate housing adapted to be carried in a person's hand, an ear tip shaped to be inserted into the ear canal and being constructed of substantially rigid but resiliently deformable material, said housing having a tip-mounting portion including a rigid mounting post projecting outwardly from the housing and having an annular rib thereon spaced from the housing, said tip having a post-receiving opening and a smoothly contoured rib-gripping portion with an internal diameter slightly smaller than the diameter of the rib whereby to detachably secure the tip on the post, the tip and tip-mounting portion having sound-transmitting openings therethrough, and sound-producing means in the housing transmitting sound through said openings and including a manually operable control regulating production of sound.

3. Apparatus for determining hearing capability of a person, comprising an elongate housing having a head end portion with a generally flat exterior surface on one side thereof, a mounting post on the housing and projecting outwardly from said surface, said post having an annular rib thereon spaced from said surface by a first distance, an integral, one-piece ear tip shaped to be inserted into the ear canal and said ear tip having an inner end and a substantially closed outer end, said tip having a post-receiving opening therein and extending through said inner end, said inner end of the tip abutting against said exterior surface of the housing and the wall of the opening tapering convergently from said inner end to a diameter slightly less than the diameter of the rib at a distance from said inner end slightly less than said first distance whereby the tip is stable on the post and removable therefrom for ready replacement and sterilization, the post and tip having sound transmitting openings there-

through, sound producing means in the housing and directing the sound through said openings and including a manually operable control for regulating production of sound.

4. Apparatus for determining hearing capability of a person, comprising an elongate housing adapted to be carried in a person's hand, the housing having a slot at one side thereof and extending longitudinally thereof, an ear tip secured in stationary relation to one end portion of the housing and shaped to be inserted into the ear canal, the housing and tip having sound-transmitting openings therethrough, sound producing means in the housing and including a battery-powered audiofrequency signal generating circuit means including a battery, said circuit means also including manually operable control means for regulating the production of sound, said control means including a rotary control disc oriented longitudinally of the housing and having an arcuate thumb-engaging surface projecting through the slot in the housing to be operated by a fore-and-aft rolling action of a person's thumb, frame means in the housing rotatably mounting the rotary element, and cooperating switching contact means on the frame means and on the rotary element and connected with the circuit means for regulating the production of sound, whereby to prevent a person whose hearing is being checked from detecting, apart from the sound being produced, the nature of the regulation of the sound.

5. A self-contained audible sound-producing apparatus, comprising a tubular, open-ended casing having a slot in one side thereof, an elongate, rigid printed circuit board having circuit means thereon for producing an audio-frequency signal and having a rotatable control mounted thereon for movement to a number of positions for stopping and starting the signal, said circuit board being

disposed in said casing and oriented substantially on a diameter thereof with a peripheral portion of said control protruding outwardly through the slot in the casing, a receiver housing on one end of the casing, an insulating battery well in the other end of the casing having a battery therein, said housing having an ear insert tip mounted in stationary relation thereon with a sound-transmitting opening and said housing also having a receiver connected to said circuit means and directing down through the opening in the ear tip, a movable cover secured over the battery well, a pair of apertured ears on the receiver housing and projecting into the casing on opposite sides of the circuit board, a mounting pin extending through the apertures of said ears and through an aperture in the board, conductive means securing said well to the corresponding end of the circuit board whereby to clamp the receiver housing and battery well against opposite ends of the casing and in rigid relation with the circuit board, a spring contact anchored by said conductive securing means in the well and engaging the tip end of the battery, a second contact anchored on the circuit board and projecting into the battery well and engaging the battery shell, said conductive means and said second contact being connected with the circuit means for supplying power thereto from the battery.

References Cited in the file of this patent

UNITED STATES PATENTS

2,487,038	Baum	Nov. 8, 1949
2,508,918	Hinos	May 23, 1950
2,573,438	Hathaway et al.	Oct. 30, 1951
2,924,705	Jones	Feb. 9, 1960
3,037,082	Tegner et al.	May 29, 1962