

Nov. 11, 1941.

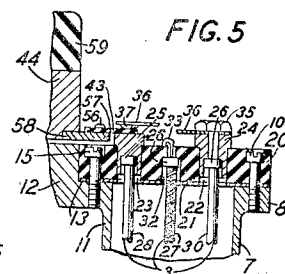
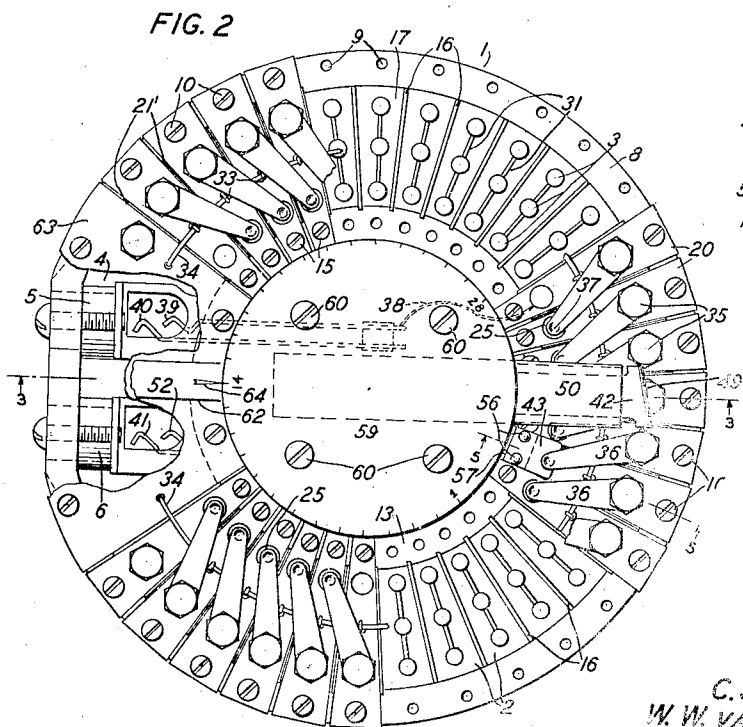
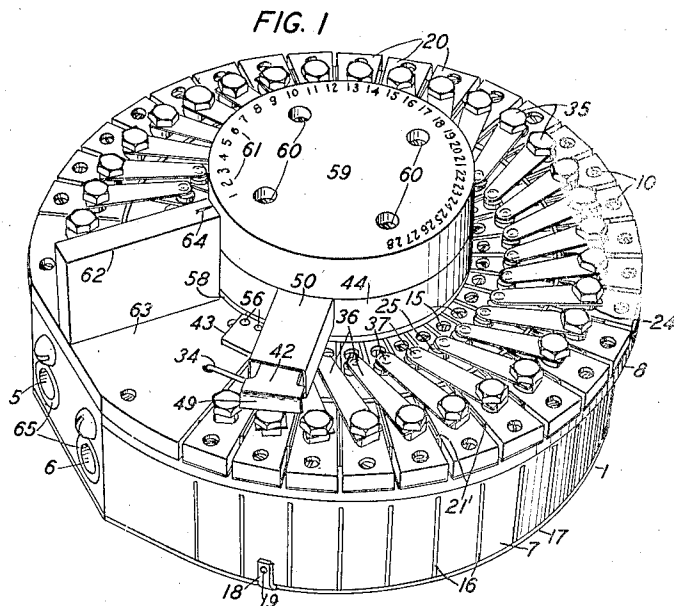
C. J. CHRISTENSEN ET AL

2,261,961

ATTENUATOR DEVICE

Filed Oct. 10, 1940

2 Sheets-Sheet 1



INVENTORS
C. J. CHRISTENSEN
W. W. VAN ROOSBROECK
BY
J. Mac Donald
ATTORNEY

Nov. 11, 1941.

C. J. CHRISTENSEN ET AL

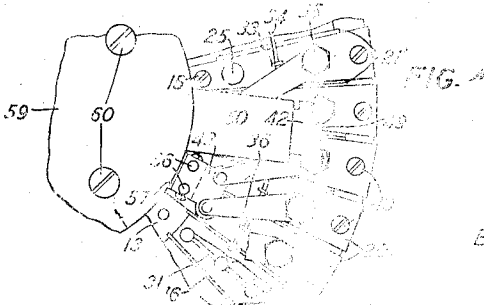
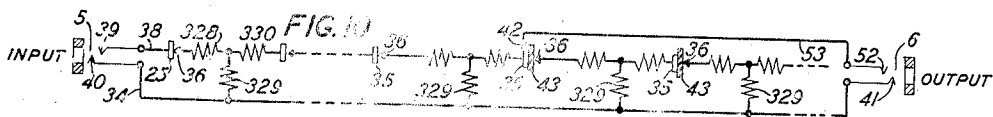
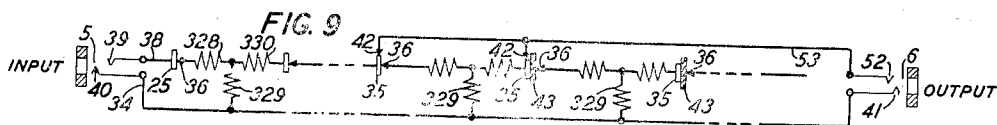
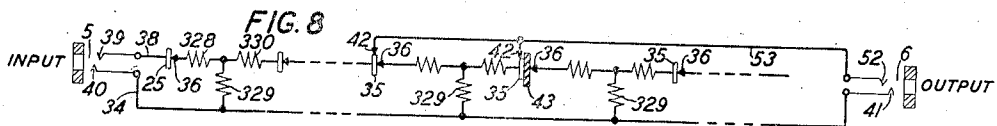
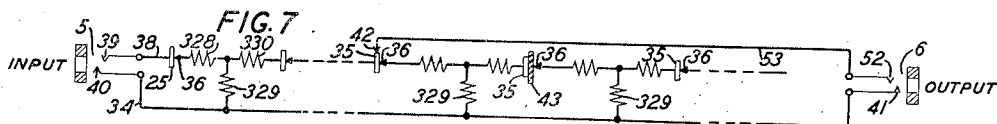
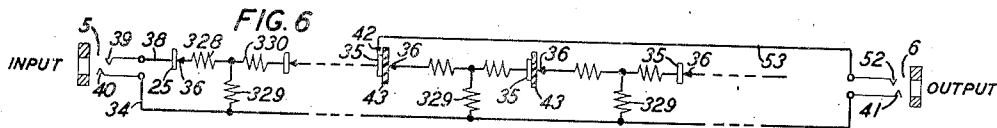
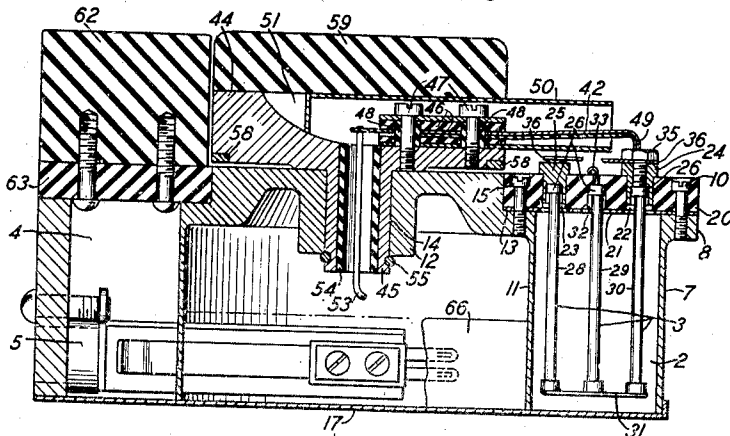
2,261,961

ATTENUATOR DEVICE

Filed Oct. 10, 1940

2 Sheets-Sheet 2

FIG. 3



INVENTORS
C. J. CHRISTENSEN
W. W. VAN ROOSBROECK
BY
J. Mac Donald
ATTORNEY

UNITED STATES PATENT OFFICE

2,261,961

ATTENUATOR DEVICE

Carl J. Christensen, Flushing and Willy W. van
Roosbroeck, New York, N. Y., assignors to Bell
Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

Application October 10, 1940, Serial No. 360,572

6 Claims. (Cl. 178—44)

This invention relates to a variable electrical attenuator device, and more particularly to an attenuator device comprising a plurality of electrical attenuator pads and means for selectively switching the pads in and out of an electrical system.

The object of the invention is to provide a variable attenuator device suitable for use in an electrical system in which a wide range of attenuation change is required and in which the changes made must be of a precise and dependable character.

A feature of the invention resides in the structure and arrangement of movable selective members.

Another feature resides in spring contacts associated with the attenuator pads and providing for selective connection of the pads.

Another feature resides in the arrangement of electrical elements forming the pads.

Another feature resides in electrical shielding means provided in the device.

Another feature resides in the structure of a casing providing the electrical shielding.

In the drawings:

Fig. 1 is a top view in perspective of the variable attenuator device;

Fig. 2 is a top view of the device with certain parts broken away or removed to show inner portions of the device;

Fig. 3 is a side view of the device, partly in section, taken on the line 3—3 in Fig. 2;

Fig. 4 is a fragmentary portion of Fig. 2 but with the movable selective member in a different position;

Fig. 5 is a side view, in section, of a fragmentary portion of the device taken on the line 5—5 in Fig. 2; and

Figs. 6, 7, 8, 9 and 10 are schematic circuit diagrams of the arrangement of elements in the device of this invention and show a number of steps in the operation of the device.

This attenuator device has been found to be particularly useful in connection with audiometers but obviously may be used in connection with other electrical apparatus.

The device comprises, as shown in Figs. 1, 2 and 3, a casing 1 having therein a plurality of compartments 2, adapted to house a plurality of electrical resistance elements 3. A relatively large compartment 4 is also provided in the casing to house a pair of telephone jacks 5 and 6. The casing 1 comprises an outer ring-shaped metal member 7 having a peripheral top flange 8 which is drilled and tapped at suitably spaced

points 9 to receive screws 10. An inverted cup-shaped metal member 11 of much smaller diameter than the member 7 is nested within the member 7 so that the members 7 and 11 form respectively outer and inner walls of the compartments provided in the casing. The upper end of the member 11 is reduced in diameter to provide an annular ledge 13 and has a downwardly directed boss 12 which is centrally apertured at 14 to receive a rotatable switch member of the device. Tapped holes are provided at suitably spaced points in the ledge 13 to receive screws 15. The members 7 and 11 are concentrically arranged and are held in spaced relation by means of metal wall members 16 which extend radially outward of the member 11 and into engagement with the member 7. The members 7 and 11 may be metal casings saw-slotted at suitably spaced points to receive ends of the wall members 16 and the wall members 16 may be solder-connected to or otherwise securely attached to the members 7 and 11. A circular metal plate 17 is provided as a back plate for the casing, the plate 17 having apertured tab portions 18 secured by means of screws 19 to the member 7. The upper end of each compartment 2 is closed by means of a segmental block 20 of insulating material and an underlying metal strip 21, the strip 21 being apertured to accommodate but not make a contact with the resistance elements 3 and being also apertured to accommodate the screws 10 and 15. Upwardly extending side flanges 21' are provided on the metal strip 21 to extend upwardly about side portions of the blocks 20. The blocks 20 are apertured and counterbored to accommodate the upper portions of the screws 10 and 15 and are also provided with spaced apertures 22 and 23 in which are suitably mounted the respective metal studs 24 and 25. The lower end of each stud 24 and 25 is recessed to frictionally hold an upper end of one of the resistance elements 3, which end may be metal coated or have a metal cap 26 applied thereto.

The resistance elements 3 may be of any form or construction found suitable for use in the attenuator device but are herein shown as resistance rod elements equipped with metal end caps 26. Each element may comprise, for instance, a rod of insulating material coated on the outside with a carbonaceous material and have a metal cap 26 force-fitted or otherwise applied to each end of the rod and in electrical contact with the carbonaceous material. In some instances we have used a carbon coated rod with the carbon

coating arranged in a helical path as shown at 27 in Fig. 5.

Three concentric rows 28, 29 and 30 of resistance elements 3 of predetermined resistance values are provided in the attenuator, the resistance elements being divided into groups of three and each group occupying a separate compartment 2. The lower ends of the resistance elements in each compartment 2 are electrically connected by means of a conducting strap 31, as shown in Fig. 3. The resistance elements in the inner row 28 have their upper ends force-fitted into the studs 25 and are thus suspended within the compartments 2. Upper ends of the resistance elements in the outer row 30 are force-fitted into the studs 24. The resistance elements in the central row 29 have their upper ends force-fitted into recessed apertures 32 provided in the blocks 20. A lead-out wire 33 is electrically connected to the upper end of each resistance in the row 29 and is electrically connected to a wire 34 which extends as shown in Figs. 1, 2 and 4 across the upper face of the blocks 20 of insulating material. The wire 34 serves as a strap connection for the upper ends of the resistance elements in the row 29.

Each stud 24 is internally threaded to receive a contact screw 35 which extends through an apertured leaf-spring contact 36 to support one end of the contact spring 36 on the upper end of the stud 24. The leaf-spring contact 36 extends diagonally across portions of two adjacent blocks 20 and into spring-pressed engagement with a stud 25 on a block 20 succeeding the one bearing the point of anchorage of the contact 36, and is embossed on its free end 37 to provide a rounded contact point for engagement with the stud 25. It will be seen that each compartment 2 contains three resistance elements 3 arranged in parallel spaced relation, that the resistance elements in each compartment are electrically connected at their lower ends, the central resistance elements throughout the attenuator are all electrically connected at their upper ends, and that a leaf-spring contact 36 extends from the stud 24 serving the outermost resistance element in each group to the stud 25 serving the innermost resistance element in the next succeeding group. The electrical connecting arrangements are such that T-type attenuator pads are in effect formed by the resistance elements in each compartment, the resistance elements in the rows 28 and 30 being in series connection and forming the top portion of the T pad, and the resistances in the row 29 forming the upright leg portion, as shown in Figs. 6, 7, 8, 9 and 10. In these figures the resistance elements 3 are identified by that number and the row in which the resistance element is located is indicated by the row number. For instance, 328 indicates resistance 3 in row 28. The resistances in rows 28 and 30 are connected in series through the leaf-spring contacts 36 and the studs 24 and 25 and the series line of resistances is electrically connected by means of a suitable conductor wire 33 to the tip contact 39 of a telephone jack 5 which serves as an input connection to the attenuator. The ring contact 40 of the jack 5 is electrically connected to one end of the conductor 34 which is in electrical connection with the lead-out wires 33 of the resistance elements in the row 29. The other end of the conductor 34 is electrically connected to the ring contact 41 of the telephone jack 6 which serves as an output connection of the attenuator.

As shown in Figs. 1, 2, 3 and 4, the attenuator is provided with a laminated metal wiper contact 42 and a contact separator 43 which is made of suitable sheet insulating material. The wiper contact 42 and the separator 43 are carried by a rotatable member 44 provided with a downwardly extending cylindrical tube portion 45 which is journaled in the boss portion 12 of the member 11. The wiper contact 42 is clamped at one end between aperture blocks 46—46 of insulating material supported on the member 44 by means of screws 47 which pass through insulating bushings 48. A downwardly turned wide free end portion 49 of the wiper contact 42 extends into frictional engagement with the contact screws 35. A tubular metal shield 50 is mounted in a suitable channel 51 in the member 44 and extends about the wiper contact 42 almost to the free end portion 49. The shield 50 is in contact with the member 44 and serves as an electrical shield for the wiper contact 42, the inner end portion of which is electrically connected to the tip contact 52 of the output jack 6 by means of a flexible conductor 53 which passes downwardly through an insulating sleeve 54 mounted in the bore of the tubular portion 45 of the member 44, on the lower end of which is a retaining ring 55.

The separator 43 is a rectangular piece of sheet insulating material extending outwardly of the member 44 into a position to pass between the free ends of the spring contacts 36 and studs 25, and is made of sufficiently stiff insulating material to separate the free end of the spring contacts 36 from the studs 25. The inner end of the separator 43 is mounted by means of screws or rivets 56 on a lug 57 extending outwardly from a metal ring 58 secured by suitable means to the member 44. The position of the separator 43 relative to the wiper contact 42 is such that when the wiper contact 42 is rotated in a clockwise direction to selectively engage the screws 35, the separator 43 will be between the free end of the spring contact 36 and its associated stud 25 immediately ahead of the contact screw 35 served by the wiper contact 42. It will be seen by looking at Fig. 4 that the free end 43 of the wiper contact 42 is broad enough to make contact with two adjacent screws 35 at the same time, and that the separator 43 is also broad enough to hold two of the spring contacts 36 separated from their associated studs 25. It will also be apparent that if the wiper contact 42 is centered on a screw 35, the separator 43 will be in a position to separate two of the spring contacts 36 from their associated studs 25, and that if it is rotated clockwise slightly beyond this position, so that the wiper contact 42 still makes contact with only one screw 35, it will separate only one. Further rotation of the wiper contact 42 brings it into contact with two adjacent screws 35, while still only one spring contact 36 is separated from its associated contact 25. Still further rotation results in the separation of the next succeeding spring contact 36 from its stud 25 in addition, while the wiper contact 42 still makes contact with two adjacent screws 35. Finally, the wiper arm 42 can be rotated to make central contact on the next succeeding screw 35. Gradual introduction or removal of the attenuator pads relative to an electrical system in which the attenuator is used is therefore possible. It will be recognized that this gradual introduction or removal is quite advantageous and desirable in systems employing audiometers since this switching arrangement will not introduce clicks or

other objectionable noises developed in the operation of conventional types of switches.

A manually operated knob 59 of insulating material is mounted by means of screws 60 on the member 44 to provide for rotation of the wiper contact 42 and the separator 43. The knob 59 is suitably inscribed with numbers or marks 61 to indicate the switch position attained. A block 62 is mounted on a cover plate 63 over the compartment 4 and bears a scratch mark 64 as a comparing mark for the numbers on the knob 59.

Each group of resistance devices as above mentioned forms a T type attenuator pad and each pad is housed in a separate metal compartment defined by portions of the members 7 and 11, two wall members 16, the plate 17, and a metal strip 21. Sleeve conductors 65 of the telephone jacks 5 and 6 are in electrical connection with the member 7 and may be suitably connected to ground to ground-connect the metal compartments 2 in which the attenuator pads are housed and also form a ground connection for the compartment 4 containing the telephone jacks 5 and 6. The shield 50 enclosing the greater portion of the wiper contact 42 is also electrically connected to ground through the rotatable member 44 which is in frictional contact with the member 11. The side flanges 21' of the metal strips 21 also help to carry off to ground any stray capacities developed in the relatively movable contact portions of the switch. An upright metal wall member 66 is provided on the inner surface of the back plate 17 to extend in the space between the telephone jacks 5 and 6. This provides an electrical shield plate between the two telephone jacks.

It will be seen that in the structure above described each T pad is enclosed within a metal compartment which serves as an electrical shield for the T pad, that the spaced fixed contacts comprising the studs 24 and 25 are electrically shielded by the flange portions 21' of the strips 21, the wiper contact 42 is electrically shielded by the shield 50, and that a shield plate 66 is provided between the telephone jacks. Since all of the shielding means provided in the structure are in electrical connection and may have a common ground connection, stray capacities developed in the structure may be led off to ground.

The attenuator may be operated to gradually switch in and out of an electrical system the attenuator pads and portions thereof. This will be seen by following the steps in its operation shown in Figs. 6, 7, 8, 9 and 10.

Fig. 6 shows the wiper contact 42 in central engagement with a contact screw 35 and the insulating separator 43 insulating the two next succeeding spring contacts 36 from the circuit. In this position the first T pad is in the circuit.

In Fig. 7 the insulating separator 43 has been moved so that it is only effective in the second of the two contacts 36 above mentioned in regard to Fig. 6. In this position the first T pad and a portion of the second T pad are in the circuit.

In Fig. 8 the wiper contact 42 and the separator 43 have been moved so that the separator 43 is still as effective as in Fig. 7 but the wiper contact 42 is on two adjacent contact screws 35. In this position the first T pad is in the circuit and the wiper contact is connected in parallel to the two ends of the next T pad.

In Fig. 9 the wiper contact 42 is still in parallel with the second T pad but the separator 43 is in

a position to insulate the two ends of the third T pad.

In Fig. 10 the wiper contact 42 and the insulating separator 43 have been moved so that the separator 43 is still holding ends of the third T pad out of the circuit but the parallel connection of the wiper contact 42 to the second T pad has been changed to a single connection at the right-hand end of the second T pad.

What is claimed is:

1. An electrical attenuator device comprising a casing, compartments formed in said casing, spaced fixed contacts supported on said casing, resistance elements supported by said contacts and suspended within said compartments, leaf spring contacts supported on certain of said fixed contacts and in spring pressed engagement with other of said fixed contacts, a movable wiper arm to selectively engage said fixed contacts and a movable separator of insulating material extending at an angle relative to said wiper arm and operating between said leaf spring contacts and the fixed contacts spring pressed engaged thereby to selectively separate said leaf spring contacts from said fixed contacts.

2. An electrical attenuator device comprising a casing, compartments formed in said casing, concentric rows of resistance elements supported in said casing and suspended within said compartments, the resistance elements suspended within each of said compartments being arranged and connected to cooperatively form an electrical attenuator pad, concentric rows of fixed contact studs supported on said casing and in electrical connection with said resistance elements, contact screws mounted on the outer row of said fixed contact studs, leaf spring contacts supported on the outer row of said fixed contact studs by means of said contact screws and extending into spring pressed contact with the inner row of said fixed contact studs, a movable wiper contact in selective engagement with said contact screws and a movable separator of insulating material carried along with said wiper contact and operating between said leaf spring contacts and the inner row of said fixed contact studs to selectively separate said leaf spring contacts from the inner row of said fixed contact studs.

3. An electrical attenuator device comprising a cup-like casing having concentrically arranged inner and outer wall members, partition wall members in said casing extending from the inner to the outer wall members thereof and dividing the casing into a series of compartments, the wall members defining said compartments being made of conducting material, blocks of insulating material supported on said casing and extending over upper ends of said compartments, flanged and apertured strips of conducting material directly underlying said blocks, an inner and an outer row of contact studs supported in spaced relation on said blocks, an inner and an outer row of resistance elements supported by said contact studs and suspended within said compartments, an intermediate row of resistance elements supported by said blocks and suspended within said compartments, a strap conductor in each compartment and connecting the lower ends of the resistance elements in that compartment, a conductor extending across said blocks and connected to the upper end of each resistance element in said intermediate row, leaf spring contacts supported on the outer row of said contact studs and extending diagonally across said blocks

and into spring pressed engagement with the inner row of said contact studs, contact means anchoring said leaf spring contacts to said outer row of contact studs, a movable wiper contact to selectively engage said contact means, said wiper contact being of sufficient width to simultaneously engage two of said contact means, a movable strip of insulating material extending at an angle relative to said wiper contact and operable to selectively separate said leaf spring contacts from said inner row of contact studs, said movable strip being wide enough to simultaneously engage two of said inner row of contact studs, and a sleeve of conducting material extending in spaced relation about said wiper contact and in electrical connection with said casing.

4. An electrical attenuator device comprising a plurality of resistance elements arranged in concentric rows and divided into groups containing a resistance element in each row, a casing divided into a series of compartments to provide a separate compartment for each of said groups, the walls of said casing being made of conducting material to provide an electrical shield for each group of resistance elements, concentric rows of fixed contacts insulatingly supported on said casing and in electrical connection with said resistance elements, leaf spring contacts secured to the outer row of said fixed contacts and extending into pressure engagement with the innermost row of said fixed contacts, a movable wiper contact to selectively engage the contacts in the outer row of said fixed contacts and a strip of insulating material carried in advance of said wiper contact and movable simultaneously therewith to selectively separate said leaf spring contacts from the inner row of said fixed contacts.

5. An electrical attenuator device comprising a casing divided into a series of compartments extending radially about a common center of the casing, a group of resistance elements suspended within each compartment and arranged to form a resistance pad, rows of spaced fixed contacts

insulatingly supported on said casing and electrically connected to said resistance elements to form terminals for ends of the resistance pads, leaf spring contacts, each of said leaf spring contacts being supported at one end on one of said fixed contacts and having a free end in spring pressed engagement with another of said fixed contacts and forming separable electrical connections from one pad to another, a wiper contact to selectively engage said fixed contacts and a movable strip of insulating material extending in an offset advanced position relative to said wiper contact and operating against said leaf spring contacts to selectively open circuit the normal electrical connection between one pad and another.

6. In an electrical attenuator device comprising resistance elements arranged and connected in groups to provide attenuator pads and relatively fixed and movable contact means to selectively switch in said pads, a casing, a pair of jacks supported in said casing electrical conducting means extending from said jacks to said pads, said casing comprising an outer and an inner wall member of conducting material, partition wall members of conducting material connected to and extending between said inner and outer wall members and dividing said casing into a series of compartments to individually house and electrically shield said pads, a plurality of blocks of insulating material arranged to form a front wall of said casing, means for supporting said blocks, flanged strips of conducting material underlying said blocks and in contact with said inner and outer wall members, a back plate of conducting material secured to said outer wall member and in engagement with said inner wall member and an upright wall member of conducting material secured to said back plate and extending upwardly within said casing between said jacks to form an electrical shield between said jacks.

CARL J. CHRISTENSEN,
WILLY W. VAN ROOSBROECK.