

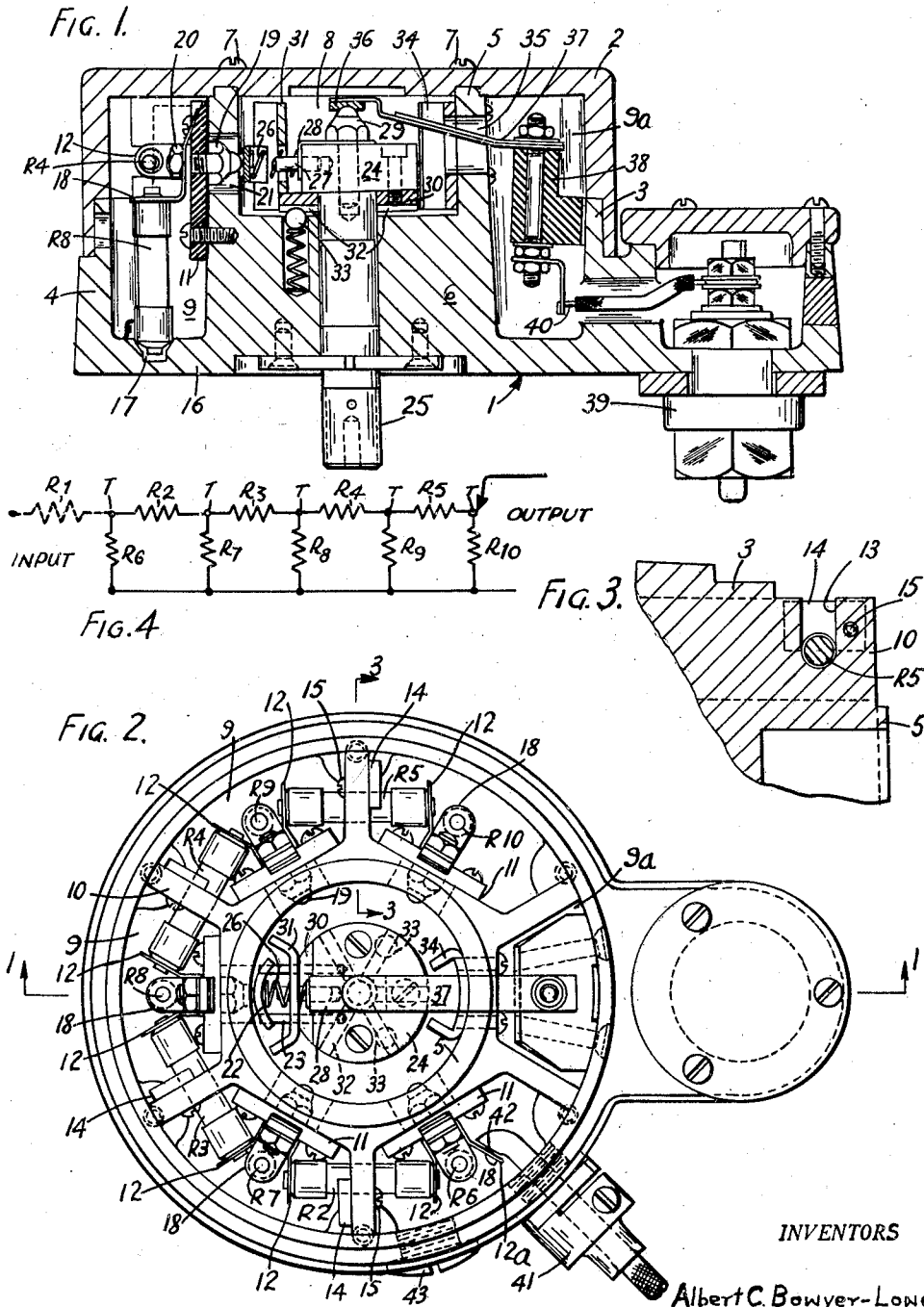
Jan. 3, 1950

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2,493,653

ELECTRIC ATTENUATOR

Filed Dec. 10, 1945



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UNITED STATES PATENT OFFICE

2,493,653

ELECTRIC ATTENUATOR

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Application December 10, 1945, Serial No. 634,002
In Great Britain October 10, 1944

14 Claims. (Cl. 178-44)

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This invention relates to attenuators as used in telecommunication engineering for introducing a variable loss into a circuit without altering the other characteristics of the circuit. Attenuators normally consist of a number of resistances connected in a manner to provide an attenuating network suitable for the purpose required. For use on high frequencies, a network is commonly employed which comprises a plurality of similar sections connected in series, each section being composed of a series resistance and a shunt resistance connected in L-type formation. With such an arrangement each section reduces the power or voltage presented to fit from the preceding section, and by provision of a suitable switching or tapping-off device in conjunction with the sections an attenuator can be constructed to provide, by operation of the switching or tapping device, a plurality of stages of attenuation progressively increasing insteps. Such an attenuator is commonly called a "step attenuator," and it is to this kind of attenuator that the present invention more particularly relates.

An object of the present invention is to provide an improved construction of a step attenuator, designed to reduce, as far as possible, stray or distributed capacity between the resistances, and between the resistances and the usual earthed metal case of the device, and stray coupling between the input and output of the attenuator.

In a step attenuator according to the invention, screens connected to the metal case of the device so as to be earthed therewith are provided in the case to partition it into compartments, the series resistances being arranged to pass through the screening partitions respectively, so that the ends of each series resistance are disposed in adjacent compartments at opposite sides of the intervening partitioning screen, and the shunt resistances being arranged within said compartments respectively. With this arrangement, the ends of each series resistance are screened from each other, and the junction points of the series and shunt resistances of each section with the series resistance of the next section of the attenuator are disposed in separate compartments shielded by the partitioning screens.

In executing the described arrangement, it is most convenient to mount the resistances in the case of the device so that the series resistances are substantially perpendicular to the shunt resistances, the latter being arranged substantially upright in the compartments and parallel to the screening partitions, and the series resistances

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arranged substantially horizontally and passing through the screens as described.

The series resistances are preferably supported by their ends in clips which are mounted in the compartments and are insulated from, and spaced as far as possible from, adjacent earthed metal parts of the case and screening partitions. The shunt resistances are preferably each supported at one end by a clip which is electrically connected, preferably by direct mechanical mounting, with the clip or clips provided in the same compartment for the series resistances, the other end of each shunt resistance being directly supported by the case of the device so as thereby to be electrically connected thereto without interposed connecting wires or the like.

The case of the device is provided with screened input and output sockets which are disposed so that the conductors from them which are connected to the resistance network are disposed in separate compartments formed by the screening partitions, so that the input and output leads are effectively screened from each other.

The clips forming the junction points above-mentioned are connected to suitable contact studs or the like arranged to lie in the path of a movable pick-up contact which is adapted to move over the studs and is connected to an output lead for tapping off stages of attenuation in steps as desired. Suitable locating means, such as spring-loaded detents or balls, may be provided to ensure proper registration of the pick-up contact with the adjacent contact stud in each position of adjustment of the pick-up contact. The pick-up contact is preferably furnished with a screen which moves with the contact and screens it from all other contact studs or the like than the one which for the time being the pick-up contact is engaging.

In the preferred construction, which provides a compact device, the resistances are disposed in a circular arrangement in the case which is provided with radial screening partitions, the contact studs or the like facing radially inwards in a circular array, and the pick-up contact is mounted to rotate within the circular array of contact studs or the like for selectively engaging them.

A preferred embodiment of the invention will now be described with reference to the accompanying drawings, in which

Fig. 1 is a cross-section of the device taken along the line I—I of Fig. 2.

Fig. 2 is a plan of the device with the cover removed,

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Fig. 3 is a fragmentary sectional view of a detail, taken on line 3—3 of Fig. 2, and

Fig. 4 is a diagram of the attenuator network.

It will be convenient to refer first to Fig. 4 which shows an attenuator network comprising five similar sections connected in series and composed respectively of series and shunt resistances R_1 and R_6 , R_2 and R_7 , R_3 and R_8 , R_4 and R_9 , R_5 and R_{10} . The points T indicate the junction points previously mentioned and by arranging a pick-up contact P to travel along the points T, various stages of attenuation may be made available. For reasons unconnected with the present invention, the first series resistance R_1 of the network is provided in apparatus extraneous to the device presently to be described, and to indicate this the resistance R_1 is shown in broken lines. Fig. 4 also depicts in developed form the arrangement of the resistances (R_1 omitted) as employed in the device of Figs. 1 to 3 now to be described.

The device illustrated has a metal case comprising a base casting 1 and a main cover 2 the rim of which fits over a spigot 3 formed on the outer wall 4 of the base 1 and the top of which locates on the rim 5 of a recessed central boss 6 which upstands from the base 1 above the outer wall 4, the cover 2 being secured to the rim 5 by screws 7. The cover 2 thus closes the recess in the boss 6 to form a chamber 8 which is totally enclosed by metal. The cover 2 also forms with the base 1 an annular space surrounding the boss 6, which is totally enclosed by metal.

The annular space surrounding the boss 6 is partitioned into compartments 9 by radial webs 10 which extend between the boss 6 and the outer wall 4 and are formed integrally with the base 1. The partitions 10 are of such height as to meet the top of the cover 2, and so completely separate the compartments 9 from one another. For an attenuator having five network sections as shown in Fig. 4, six partitions 10 forming six compartments are provided. In five of the compartments 9 there are fixed to the boss 6 insulating blocks 11 which carry metal clips 12 supporting by their ends the cartridge-type series resistances R_2 , R_3 , R_4 and R_5 which are mounted horizontally in the case and pass through four of the partitions 10 respectively, so that the ends of each resistance are in separate compartments at opposite sides of a partition 10, as shown more clearly in Fig. 2. For easily mounting the series resistances in this manner, the four partitions 10 concerned have their portions above the outer wall 4 provided with horizontal slots 13 (Fig. 3) on a level with the clips 12, so that the resistances can readily be slid sideways into the slots 13 and brought into engagement with their supporting clips 12. In order to complete the screening partitions, the slots 13 are afterwards closed by metal closing plates 14 (Figs. 2 and 3) which cover the open part of the slots 13 and are secured to the partitions 10 by means of screws 15. As seen in Fig. 3, the blind ends of the slots 13 and the adjacent portions of the plates 14 are shaped to fit fairly closely around but not touching the resistances.

The cartridge-type shunt resistances R_6 , R_7 , R_8 , R_9 and R_{10} are mounted upright in separate compartments 9 with their lower ends supported directly on the bottom 16 of the base 1 by being located in suitable recesses 17 in the bottom 16, the upper ends of these resistances being mounted in metal clips 18 mounted on the insulating blocks 11.

The clips 12 and 18 in each compartment 9 are secured to their insulating block 11 so as to be

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electrically connected together, by means of a common contact stud 19 passing through the block and clips and fitted with a lock nut 20, the head of the contact stud 19 protruding into the chamber 8 through a hole 21 in the annular wall of the chamber 8. The hole 21 is made large enough for adequate insulation spacing of the stud 19 from the surrounding metal of the boss 6. In this way, a circular array of contact studs 19, providing the junction points T of Fig. 4, protrude into the chamber 8 for selective engagement by a rotary pick-up contact 22 provided in that chamber.

The rotary contact 22, in the form of an arcuate brush, is slidably mounted for parallel movement on a pair of parallel pins 23 fixed in an insulating enlargement or head 24 on the end of an insulating spindle 25 which passes axially through the boss 6 and projects from the bottom 16 of the base 1 for attachment of a control knob or the like of its projecting end. The contact 22 is loaded by a spring 26 guided by a pin 27 fixed in the head 25, so that the contact is urged outwards towards the annular wall of the chamber 8. The spring 26 is secured at one end, as by soldering, to the brush contact 22 and is conductively connected, for instance soldered, at its other end to a metal strip 28 fastened under a contact stud 29 screwed into the head 24, so that the contact 22 is electrically connected to the stud 29.

Fixed to the underside of the insulating head 24 is a metal disc 30 which carries a metal shield 31 upstanding around the contact 22 as shown, so as to screen the contact 22 from all the contact studs 19 other than the one which the contact 22 is for the time being engaging. The underside of the disc 30 has V-grooves 32 or the like formed therein, and the boss 6 is bored to receive spring-loaded balls 33 which press against the underside of the disc 30 and are adapted to locate in the grooves 32 in the positions of engagement of the contact studs 19 by the contact 22, in order to ensure proper indexing of the contact 22 to its adjusted positions. The screen 31 is electrically connected to the case of the device, and thereby earthed, through the disc 30 and the balls 33. A suitable stop 34 is fixed to the annular wall of the chamber 8 to mark the end rotary positions of the contact 22, the stop 34 being engaged by the screen 31.

It will be recalled that the resistances of the device occupy only five of the six compartments 9. The stop 34 is mounted opposite the sixth compartment 9a over a hole 35 in the annular wall of the chamber 8 opposite that compartment. Electrical connection to the rotary contact 22 is made by a contact 36 which rides on the stud 29 and is carried by a spring blade 37 which passes with clearance through the stop 34 and hole 35 and is mounted on an insulating block 38 which is fixed in the compartment 9a to the spigot 3 of the base 1. Adjacent the compartment 9a, the base 1 is extended to form a fitting for the output socket 39 of the device, the blade 37 being connected by a conductor 40 to one output lead, the other output lead being connected to the socket 39 and thus to the base 1. The output socket and leads are thereby effectively screened from the other parts of the device.

The input socket 41 is screwed into the outer wall 4 of the base 1 of the device adjacent the compartment 9 in which the first shunt resistance R_6 is situated. One input lead is connected to the socket 41 and thus to the base 1. The other input lead 42 is connected electrically to the first

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junction point T of the network, namely, the junction between the resistances R_6 and R_2 , the connection conveniently being made to a free clip 12a in the aforesaid compartment housing the resistance R_6 . As shown in Fig. 2, two alternative positions are provided for the input socket, the unused inlet being closed by a suitable plug 43. The input leads are thus effectively screened from the output.

In the operation of the device, the pick-up contact 22 while being moved from one contact stud 19 to another is short-circuited to the case by its spring 26 causing the contact 22 to engage the annular wall of the chamber 8. The purpose of this arrangement is to obtain silent adjustment of the attenuator, to eliminate noise that would otherwise be produced during adjustment in other apparatus to which the attenuator may be connected.

By the improved screening obtained with the device described, an advantage results in that owing to the greatly reduced capacitance, much less input power is required at high frequencies as compared with known constructions of step attenuators, and the accuracy of calibration of the device holds good over a wide range of frequencies, up to frequencies of the order of 100 megacycles, thus making the device especially valuable for obtaining accurately known extremely small output powers or voltages as are used for the purpose of measuring the sensitivity of radio receivers and for other purposes in high frequency laboratories, and in the commercial manufacture of radio equipment.

We claim:

1. An electric attenuator comprising a metallic case having internal metallic partitions forming a series of adjoining compartments within said case, a resistance network housed within said case comprising a plurality of network sections connected in series, each section comprising a series resistor and a shunt resistor, the shunt resistors of said network being disposed within said compartments respectively, said partitions having apertures therein respectively, the series resistors of said network extending through said apertures respectively in insulated relation to said partitions so that the ends of each series resistor are disposed in adjacent compartments at the opposite sides of the intervening partition between such compartments, whereby the ends of each series resistor are screened from each other and the junction points of the series and shunt resistors of each network section with the series resistor of the next section of the network are disposed in separate compartments shielded by said partitions, and a switch mounted in said case for selecting sections of said network to furnish a range of selectable stages of attenuation.

2. An electric attenuator as defined in claim 1, and comprising support means in said compartments for supporting the series and shunt resistors of said network substantially perpendicularly to each other.

3. An electric attenuator comprising a metallic case having internal metallic partitions forming a series of adjoining compartments within said case, a resistance network housed within said case comprising a plurality of network sections connected in series, each section comprising a series resistor and a shunt resistor, the shunt resistors of said network being disposed within said compartments respectively, said partitions having apertures therein respectively, the series resistors

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of said network extending through said apertures respectively in insulated relation to said partitions so that the ends of each series resistor are disposed in adjacent compartments at opposite sides of the intervening partition between such compartments, clip means mounted within said compartments in insulated and spaced relation to the walls thereof and supporting said resistors by their ends, whereby the ends of each series resistor are screened from each other and the junction points of the series and shunt resistors of each network section with the series resistor of the next section of the network are disposed in separate compartments shielded by said partitions, and a switch mounted in said case for selecting sections of said network to furnish a range of selectable stages of attenuation.

4. An electric attenuator comprising a metallic case having internal metallic partitions forming a series of adjoining compartments within said case, a network of cartridge resistors housed within said case comprising a plurality of network sections connected in series, each section comprising a series resistor and a shunt resistor, the shunt resistors of said network being disposed within said compartments respectively, said partitions having apertures therein respectively, the series resistors of said network extending through said apertures respectively in insulated relation to said partitions so that the ends of each series resistor are disposed in adjacent compartments at the opposite sides of the intervening partition between such compartments, means in each compartment supporting the shunt resistor therein at one end in direct electrical connection with said case, support means mounted in each compartment in insulated and spaced relation to the metallic walls thereof and including a conducting clip supporting the other end of the shunt resistor in the compartment and a conducting clip supporting the end of each series resistor extending into the compartment, a plurality of contact studs respectively conductively connected to said clips in each compartment and protruding through a wall of the compartment in insulated relation thereto, and a movable selector contact mounted in said case for selectively engaging said studs.

5. An electric attenuator comprising a metallic case containing a circular array of adjoining compartments separated by radial partitions, a plurality of contact studs associated with individual compartments and mounted in insulated relation thereto to project radially inwards therefrom towards the centre of said array, a rotary selector contact insulated from said case centrally mounted within said array for selectively engaging said studs, a plurality of clip assemblies mounted in individual compartments in conductive connection with the respective studs associated with said compartments and insulated from said case, a plurality of cartridge resistors individually in said compartments supported at one end by said clip assembly and at the other end in direct electrical connection with said case, said partitions having apertures therein and a plurality of cartridge resistors extending individually through said apertures between adjacent compartments and each supported at its ends by the respective clip assemblies in such adjacent compartments, all said resistors together constituting a network of series resistors constituted by said resistors extending between adjacent compartments and shunt resistors constituted by said resistors mounted within the individual compartments.

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6. An electric attenuator as defined in claim 5, and further comprising a metallic shield extending about said contact and mounted to move therewith.

7. An electric attenuator as defined in claim 5, wherein said selector contact is adapted to be short-circuited to said case when not engaging one of said studs.

8. An electric attenuator as defined in claim 5, and further comprising a screened input socket and a screened output socket mounted on said case in locations such that input and output conductors passing through said sockets respectively enter different compartments within said case whereby to shield the input and output conductors of the attenuator from each other.

9. An electric attenuator of the class described comprising a metallic case having a base and upstanding concentric annular outer and inner walls forming a chamber within said inner wall and an annular space between said inner and outer walls, and having metallic walls extending radially between said inner and outer walls to partition said annular space into a series of adjoining compartments screened from one another, a plurality of clip assemblies in individual compartments and mounted on said inner wall and insulated therefrom, each clip assembly including a contact stud and said inner wall having apertures therein through which said contact studs respectively protrude into said chamber in insulated relation to said inner wall, a plurality of cartridge resistors disposed upright within individual compartments and each supported at its lower end by said base so as to be in direct electrical connection therewith and each supported at its upper end by said clip assembly in the compartment, said radial partition walls each having an aperture therein, a plurality of cartridge resistors disposed horizontally in the individual apertures in said radial walls so as to each extend into adjacent compartments and each being supported at its ends by the respective clip assemblies in such adjacent compartments, whereby to form a resistance network comprising a plurality of network sections connected in series, each section comprising a series resistance constituted by said horizontal resistor and shunt resistance constituted by said upright resistor in a compartment, the ends of each series resistor being screened from each other by the intervening partition wall and the junction points of the series and shunt resistors of each section of the network with the series resistor of the next section of the network being disposed in separate compartments, and a rotary selector contact assembly axially mounted within said chamber in insulated relation to said case for selectively engaging said contact studs protruding into said chamber, means axially extending from said case for rotating said selector contact assembly, and conductor means insulated from said case and leading from said selector contact assembly to the exterior of said case without entering any compartment containing resistors.

10. An electric attenuator as defined in claim 9, wherein said rotary contact assembly includes a contact mounted for radial movement and spring means urging said contact radially outwards so as to engage with said inner wall and

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be thereby short-circuited to said case when not engaging one of said contact studs.

11. An electric attenuator as defined in claim 9, wherein said rotary contact assembly includes a contact for selectively engaging said studs and a metallic screen extending about said contact and rotatable therewith to shield said contact from all other of said contact studs than the one which said contact selectively engages.

12. An electric attenuator as defined in claim 9, wherein said rotary contact assembly includes a contact mounted for radial movement and spring means urging said contact radially outwards so as to engage with said inner wall and thereby be short-circuited to said case when not engaging one of said contact studs, and a metallic shield rotatable with said contact and extending thereabout to shield said contact from all other of said contact studs than the one which said contact selectively engages.

13. An electric attenuator as defined in claim 9, wherein said annular space includes a compartment free from resistors, and wherein the attenuator further comprises an output socket housing mounted on said base beyond said outer wall and adjacent said compartment, said outer wall having an aperture therein affording communicating between said housing and said compartment, and an insulating mount fixed within said compartment and supporting a conductor extending through an aperture in said inner wall to make electrical connection with said rotary contact assembly, the supported end of said conductor within said compartment being electrically connected with a lead extending through said aperture in said outer wall into said socket housing.

14. An electric attenuator as defined in claim 9, wherein said annular space includes a compartment free from resistors, and wherein the attenuator further comprises an output socket housing mounted on said base beyond said outer wall and adjacent said compartment, said outer wall having an aperture therein affording communicating between said housing and said compartment, and an insulating mount fixed within said compartment and supporting a conductor extending through an aperture in said inner wall to make electrical connection with said rotary contact assembly, the supported end of said conductor within said compartment being electrically connected with a lead extending through said aperture in said outer wall into said socket housing, said outer wall having an aperture therein opposite the compartment housing the first resistor of the network for attachment of an input socket thereto.

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