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AUTOMATIC POWER OUTPUT LIMITING CONTROL SYSTEM FOR AUDIOMETERS

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Fig. 1

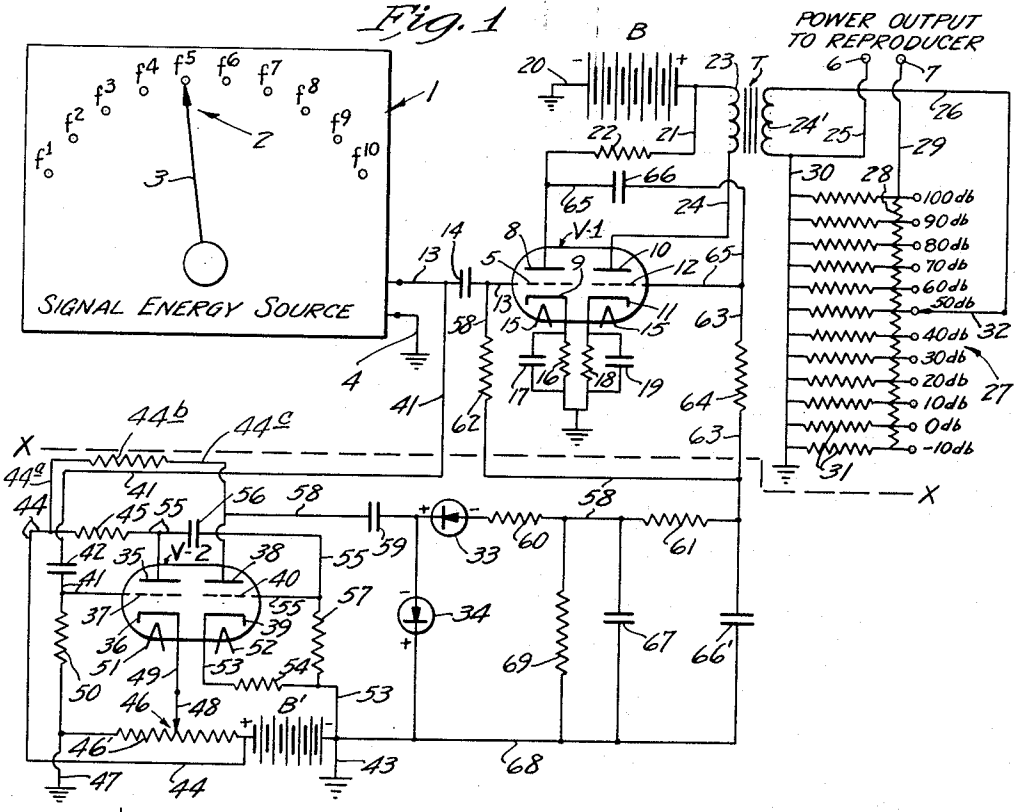
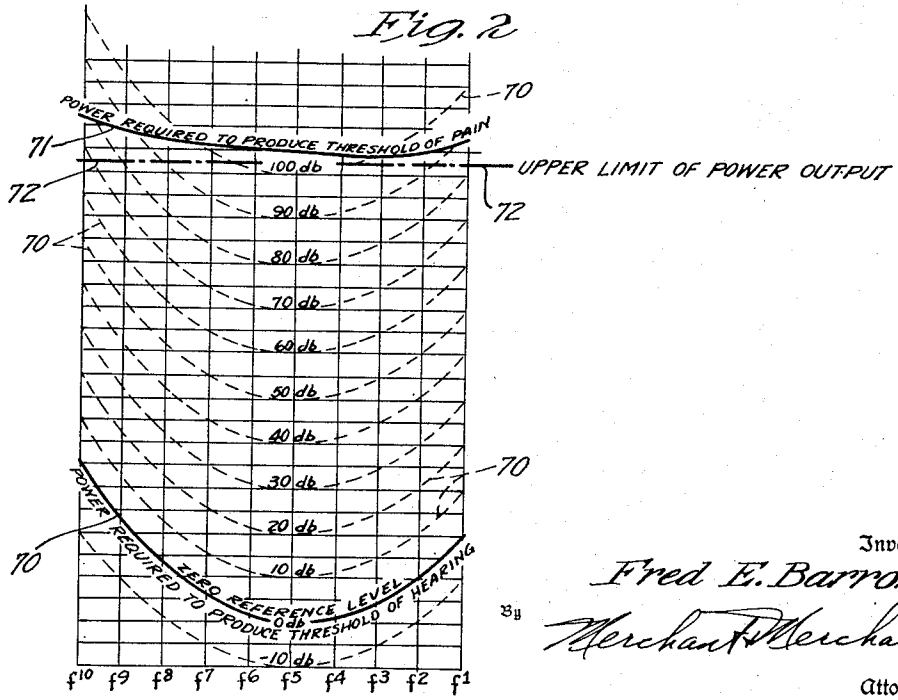


Fig. 2



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AUTOMATIC POWER OUTPUT LIMITING CONTROL SYSTEM FOR AUDIOMETERS

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1

This invention relates to improvements in audiometers and more particularly to automatic power output limiting control systems for audiometers. For the purpose hereof it should be understood that "audiometers" are devices, instruments, apparatus or systems used in conjunction with suitable audio frequency reproducers, of the air conduction type or the bone conduction type, to test the hearing characteristics of the human ear; audiometers of the present day being of the variable frequency, variable power output type. The instant invention does, in fact, pertain particularly to this type or kind of audiometer. Such audiometers comprise a manually variable source of signal energy, a signal energy amplifier located intermediate the signal generator and the electrical power output of the audiometer, and a manually-operative power output controller, usually in the nature of a manually variable output attenuator, also intermediate the signal energy source and the electrical output of the audiometer.

Generally speaking, the characteristic power output curve of such audiometers is adjusted to approximate that required to produce threshold hearing, for a normal human ear, at all test frequencies within the test frequency range of the audiometer, at a single setting of the manually operative power output control. Since the sensitivity of the human ear is different at different frequencies, it will be obvious that the characteristic power output curve of the audiometer must be relatively high at frequencies whereat the sensitivity of the normal human ear is relatively low and must be relatively low at frequencies whereat the sensitivity to the human ear is relatively high. Furthermore, since the sensitivity of the normal human ear and the sensitivity of the usual reproducer usually both fall off rather sharply near the high and low limits of the test frequency range of the audiometer, it will be apparent that the characteristic electrical power output curve of the audiometer must, in order to compensate for these factors, essentially rise rapidly adjacent the high and low limits of the test frequency range.

In the art of audiometry, it is desirable, insofar as possible, to test the hearing characteristics of the human ear for each test frequency at different power output values from threshold of hearing power output value to a maximum value close to but somewhat below threshold of pain value, and it is, in fact, this very desire which has created a serious problem in the art and to the solving of which the instant invention is directed. This problem is that of automatically

2

limiting the power output of the audiometer at all test frequencies to a maximum value close to but nevertheless below threshold of pain value, in order to save the human subject of the test from discomfort and to prevent damage to the human ear or test reproducer. This problem arises from the fact that, whereas much greater output power is required at some test frequencies, such as those adjacent the high and low frequency ends of the test frequency range, than at other frequencies, such as those in the intermediate portion of the test frequency range, to produce threshold hearing, the power required to produce threshold pain is nearly uniform throughout the entire test frequency range. Hence, it will be clear that, in an audiometer having a characteristic power output curve approximating that required to produce threshold hearing at all test frequencies and which is, therefore, much higher at some test frequency points than at others, the output power will essentially rise above threshold of pain value at some test frequencies when the output power is adjusted to a level or value below threshold of pain value for other test frequencies, unless some means be provided to attenuate or eliminate the signal energy of the output whenever the signal energy at the source rises above a selected maximum value close to but safely below that which would produce threshold of pain power at the output.

An object of the instant invention is, therefore, to provide an improved automatic power output limiting control system or means for variable frequency, variable power output audiometers of the class described, which will automaticaly prevent the output power of the audiometer from rising above a predetermined maximum value close to but below threshold of pain value at all frequencies throughout the test frequency range.

Another important object of the invention is the provision of an improved output power control system or means for accomplishing, in addition to the last above stated objective, a complete cut-off or eradication of signal energy at the audiometer output, responsive to any and all increases in signal power at the signal source above a predetermined maximum value closely approaching but nevertheless below a value capable of producing threshold of pain power at the audiometer output.

The above and other important objectives and advantages of the invention will be made apparent or further elaborated on in the accompanying specification, claims and appended drawings.

In the accompanying drawings, like characters indicate like parts throughout the several views.

Referring to the drawings:

Fig. 1 is a view, partly in box diagram and partly in schematic electric wiring diagram, of an audiometer incorporating a preferred embodiment of my invention; and

Fig. 2 is a graph illustrating certain characteristics of the audiometer diagrammatically illustrated in Fig. 1.

Referring now to Fig. 1, those parts of the audiometer which may be considered as conventional are located above horizontal broken line XX, whereas those parts or elements peculiar to my improved power output limiting control system are located below said broken line XX. The audiometer or audimeter system shown above line XX in Fig. 1, comprises a suitable variable frequency source of signal energy 1 provided with a suitable calibrated frequency selector comprising a frequency selector switch 2. The frequency selector switch 2, as shown, comprises a frequency selecting switch arm 3, which cooperates selectively with a circumferentially-spaced series of fixed contacts, identified by *f*–1 through *f*–10, respectively, and each representing a different test frequency within the test frequency range of the audiometer. While the variable frequency source of signal energy 1 may be of various types capable of providing suitable signal energy at the various desired test frequencies, this signal energy source 1 will most usually be of the conventional type employing a tunable signal electronic oscillator tube as a signal generator.

As shown in the diagram, one of the output terminals of the variable frequency source 1 is connected to ground by a lead 4 and the other thereof is connected to the control grid 5 of a suitable signal energy amplifier V1 interposed between the signal source 1 and the electrical output terminals 6 and 7 of the audiometer, and which latter may be connected to a suitable reproducer, not shown, but which may be of the air conduction type or of the bone conduction type. The amplifier V1, as shown, is of the two-stage variety involving first and second electronic amplifier sections of which the input section comprises a plate element 8, a cathode element 9, and the said control grid element 5, and of which the output section comprises a plate element 10, a cathode element 11, and a control grid element 12. The input and output sections of the amplifier V1 may be contained within the same or different envelopes or tubes, but, as illustrated, these are contained within a common envelope and comprise sections of a conventional twin triode vacuum tube. As shown, the previously described connection from the other of the output terminals of the signal energy source 1 to control grid 5 is through a lead 13 having interposed therein a suitable coupling condenser 14. The cathode heaters for the input and output sections of amplifier V1 are indicated by 15 and these may be assumed to be energized from a suitable source, not shown. The cathodes 9 and 11 of the amplifier V1 are connected to ground, the first through a grid biasing resistor 16 and a by-pass condenser 17 and the latter through a grid biasing resistor 18 and by-pass condenser 19. The plate circuit for the input section of V1 comprises a suitable source of high voltage D. C., such as a battery B, having its negative side connected to ground at 20 and its positive side connected to plate 8 through a lead 21 having interposed therein a load-resistor 22, said plate 8, cathode 9 and ground through biasing resistor 16. The high voltage plate circuit for the output section of amplifier V1 comprises the said high voltage D. C. supply source B, the primary winding 23 of a power output transformer T, a lead 24 to plate 10, cathode 11, grid bias resistor 18 and ground connection back to the negative side of the source B. One side of the secondary winding 24' of output transformer T is connected directly to the power output terminal 6 by a lead 25 and the other side of said secondary winding 24' is connected to the power output terminal 7 by a lead 26 and a power output controller in the nature of a calibrated variable attenuator, indicated as an entirety by 27. The amplified signal voltage present in the plate circuit of the input section of V1 is impressed upon the control grid 12 of the output section of V1 by a lead 65 and coupling condenser 66. Hence, the amplified signal voltage in the plate circuit of the input section of V1 is reflected in the plate circuit of the output section of V1.

The calibrated variable attenuator illustrated comprises a tapped series resistor 28 having its upper end connected to output terminal 7 by a lead 29, a lead 30 from lead 25 to ground, and a plurality of shunt resistors 31, of different values and each connected to ground lead 30 at one end and to a different calibration point or tap point on the series resistor 28, and a power output selector switch comprising a manually movable switch arm 32 and cooperating selectably engageable contacts, indicated respectively by —10, 0, and 10 through 100 by steps of 10, each connected to a different said tap point on the series resistor 28. The switch contact reference numerals given indicate different selectable output power values at the electrical output terminals 6 and 7 in terms of sound pressure energy in desibels (db) with respect to the zero reference point or level, which in audiometry is threshold of bearing value or level available at the reproducer. Hence, the 0 switch contact represents threshold of bearing output power level, —10 contact indicates an output power level 10 db below threshold hearing power output level, and the switch contact reference characters 10, 20, etc., up to 100 each indicate different degrees of power output in decibels above threshold of hearing level.

As shown, the automatic power output control system, shown largely below the broken line XX of Fig. 1, comprises a 2-stage electronic signal amplifier V2 in the nature of a twin triode amplifier tube, a rectifier 33, and a rectifier 34. The input section of this twin triode amplifier V2 comprises a plate element 35, a cathode element 36 and a control grid element 37, and the output section of this twin triode amplifier comprises a plate element 38, a cathode element 39 and a control grid element 40. The output signal energy of the source 1 is impressed upon the control grid 37 of the input section of the control system amplifier V2 by electrical connections comprising a lead 41 having interposed therein a coupling condenser 42 and connecting to the lead 13 at a point ahead of the coupling condenser 14. The plate circuit for the input section of V2 comprises a suitable source of high voltage D. C. such as a battery B1, a ground connection 43 from the negative side of battery B1, a lead 44 from the positive side of battery B1 to plate 35 and having interposed therein a resistor 45, plate 35, cathode 36 and a variable grid bias resistance in the na-

ture of a potentiometer 46 comprising a resistor 46' and slide arm. One end of the potentiometer resistance element 46' is connected to the positive side of battery B1 and the other end thereof is connected to ground at 47. The sliding arm of the potentiometer 46 is indicated by 48 and is connected to the cathode 36 through lead 49. The control grid 37 is connected to ground through a resistor 50. For the purpose hereof, the input section of amplifier V2 is biased to cut off, by adjustment of the variable bias potentiometer 46, for all applied signal voltages up to a predetermined value close to but below the value or level which will produce threshold of pain power at the outlet. The cathode heaters 51 and 52 of the input and output sections respectively of V2 may be assumed to be energized from a suitable source of energy, not shown. The cathode 39 of V2 is connected to the negative side of battery or source B1 and ground through a lead 53 and biasing resistor 54. The control grid 40 of the output section of V2 is connected to the plate 35 of the input section thereof by a lead 55 having interposed therein a coupling condenser 56, so that the amplified signal voltage of the plate circuit of the input section of V1 is impressed upon the output section grid 40 and will be reflected in the plate circuit of the output section. The control grid 40 is also connected to ground through part of lead 55, a resistor 57 and part of lead 53 and ground lead 43. The plate circuit for the output section of V2 comprises the D. C. source B1, lead 44, a lead 44*a*, a load resistor 44*b*, a lead 44*c*, and part of lead 58.

The plate 38 of the output section of V2 is connected to the signal energy source 1 and to control grid 5 of amplifier V1 through a plate lead 58 having interposed therein a condenser 59, the rectifier 33, filter resistor 60 and 61 and a grid bias resistor 62, lead 13 and its interposed coupling condenser 14. Similarly, the plate 38 of the output section of V2 is connected to the control grid 12 of the output section of V1 through part of lead 58, the condenser 59, the rectifier 33, filter resistors 60 and 61, a lead 63 having interposed therein a grid bias resistor 64 and part of lead 65. It will be noted that the negative side of rectifier 33 faces the control grids 5 and 12 of V1 and that the positive side of rectifier 33 faces the plate 38 of V2. Preferably, and as shown, filter condensers 66' and 67 are connected between opposite ends of resistor 61 and ground lead 68 and another filter resistor 69 is connected to a point intermediate filter resistor 60 and 61 to ground lead 68. Also, in the preferred arrangement illustrated, the rectifier 34 has its negative side connected to a point in lead 58 intermediate condenser 59 and rectifier 33 and has its positive side connected to ground lead 68, to provide a full-wave rectification, voltage doubling circuit.

Operation

In graph Fig. 2, the vertical lines *f*–1 through *f*–10 inclusive, respectively, each indicates a different test frequency available by adjustment of the audiometer frequency selector switch 2 to a correspondingly identified position. Referring further to Fig. 2, the characteristic power output curve of the audiometer is indicated by 70. By full lines on Fig. 2, the characteristic power output curve is shown positioned at zero reference level (0 db), where the output power closely approximates that required to produce threshold hearing at all test frequencies and, which, is obtained by engagement of the switch arm 32 of power output selector switch 27 with contact 0 db. By dotted lines in Fig. 2, the characteristic power output curve 70 is shown positioned at one power output level below threshold of hearing value and at several power output levels above threshold of hearing value, each achieved by engagement of switch arm 32 of selector switch 27 with a correspondingly marked contact of the calibrated power output attenuator 27. Referring still further to Fig. 2, the threshold of pain power output curve is indicated by 71 and it is important to note that this curve is relatively very flat as compared to the threshold of hearing curve 70, and is therefore much closer to zero reference level (0 db) at test frequencies near the high and low limits of the test frequency range than at certain test frequencies near the intermediate portion of the test frequency range. In audiometry, it is desirable to conduct hearing, for all test frequencies, at various power levels above zero reference level (0 db) to a maximum power output level close to but nevertheless safely below threshold of pain power output level represented by curve 71. By comparing the upper dotted line positions of curve 70 with curve 71, it will be immediately apparent that the output power cannot be equally increased above zero reference level (0 db) for all test frequencies without producing threshold pain power at some of the frequencies adjacent the upper and lower limits of the test frequency range. Hence, it is desirable to automatically limit the output power of the audiometer to a maximum level or value relatively close to but nevertheless safely below threshold of pain output power value represented by curve 71. Such a maximum upper limit of power output is indicated by broken line 72 in Fig. 2 and, for the purpose hereof, it may be assumed that my improved power output limiting system definitely limits the power output of the audiometer, for all test frequencies, to values indicated by line 72.

As previously indicated, the input section of control system amplifier V2 is biased to cut off, by adjustment of the arm 48 of potentiometer 46, for all applied signal voltages up to a maximum predetermined value required to produce output power up to the maximum limit represented by broken line 72 of Fig. 2. Hence, it will be seen that the control system hereof is normally inoperative, and will remain inoperative so long as the signal energy of the source 1, impressed on the control grid 37 through leads 13 and 41, does not exceed a value which will produce output power exceeding the upper limit represented by broken line 72 of Fig. 2. However, when the signal energy of the source 1 rises to a value which results in output power of a maximum equal to or approximating that represented by broken line 72 of Fig. 2, the bias voltage on the input section of amplifier V2 will be exceeded and the excess voltage will be amplified in the plate circuit of the input section of amplifier V2 and will be impressed upon the control grid 40 of the output section of amplifier V2 through lead 55 and coupling condenser 56. The amplified signal voltage of the input section of V2 will, therefore, be reflected in and further amplified in the plate circuit of the output section of the amplifier V2; this amplified signal voltage being then rectified by the rectifiers 33 and 34 and cooperating circuit components and applied to control grids 5 and 12 of audiometer amplifier V1 through leads 58, 63 and resistors 62 and 64, as an amplification-re-

ducing negative D. C. grid bias potential. This negative D. C. grid bias potential thus applied to grids 5 and 12 of audiometer amplifier V1 positively prevents any further material increase in output power above the predetermined maximum output power value established by line 72, and which is below threshold of pain power value at all test frequencies. Preferably, however, the amplification factor of the control system will be sufficiently high to bias the audiometer amplifier V1 to cut off responsive to only a very slight increase in signal energy above that required to bring the output power up to the upper limit established by broken line 72 of Fig. 2, so that the output power of the audiometer will not only be reduced or leveled off responsive to increases in signal energy above the maximum value indicated by broken line 72 of Fig. 2, but below threshold of pain power values, but will actually be eliminated entirely when the signal voltage rises above such a predetermined maximum value. This last-mentioned feature is of great importance in that it eliminates the possibility of conducting tests at some test frequencies at power output values below those indicated on the calibrated scale of the power output controller or attenuator 27 of Fig. 1.

My invention has been thoroughly tested and found to be entirely adequate for the accomplishment of the objectives set forth; and, while I have shown a preferred embodiment of my invention, it will be understood that the same is capable of modification without departure from the spirit and scope of the invention as defined in the claims.

I claim:

1. In a variable frequency, variable power output audiometer having a signal energy amplifier located intermediate its signal source and the audiometer output and which includes an electronic signal energy amplifier having plate and cathode and control grid elements, the latter of which is connected to the signal energy source, of a normally inoperative automatic output power control system for the audiometer positively limiting the output thereof to a maximum value close to but below threshold of pain value at all test frequencies, said automatic output power control system comprising electronic signal energy amplifier means having plate and cathode and control grid elements and having its control grid connected to the signal energy source at a point ahead of the control grid of the first-said amplifier, means biasing the control system signal energy amplifier means to cut off for all applied control grid signal voltages below a predetermined maximum value close to but below that which would be required to produce threshold of pain power at the audiometer output, a plate circuit for the control system amplifier means, and a control circuit operatively associated with the plate circuit of the control system signal energy amplifier means, said control circuit comprising a rectifier having a D. C. connection to an element of the audiometer signal energy amplifier other than the plate thereof and to which that amplifier is responsive to D. C. control potential of the polarity thus applied to reduce its amplification factor, the control system being rendered operative only when the signal voltage impressed upon the control grid of its amplifier overcomes the biasing means, the control system amplifying the applied signal voltage to such an extent that the audiometer signal energy amplifier will be abruptly biased to cut off responsive to applied signal voltage of value greater than is required to overcome the biasing means of the control system amplifier but of less value than is required to produce threshold pain power at the audiometer output.

2. The combination with a variable frequency, variable power output audiometer system comprising a variable frequency source of signal energy, and a signal energy amplifier intermediate the said source and the electrical power output of the audiometer and having plate and cathode and control grid elements, and means coupling the control grid of said audiometer amplifier to the signal energy source; of an automatic power output control system for said audiometer comprising first and second electronic amplifiers each having plate and cathode and control grid elements, means coupling the control grid of the first control system amplifier to the signal energy source independently of the audiometer system amplifier, means biasing the first control system amplifier to cut off for all applied signal voltages below a predetermined maximum value close to but below the value required to produce threshold of pain power at the audiometer output, a plate circuit for the first control system amplifier, means for impressing amplified signal voltage of the plate circuit of the first control system amplifier on the control grid of the second control system amplifier, a rectifier having its negative side connected to the control grid of the audiometer system amplifier and its positive side connected to the plate of the second control system amplifier, the amplification factor of the control system being such that the audiometer system signal amplifier will be abruptly biased to cut off responsive to applied signal voltage at the control grid of the control system amplifier of value greater than is required to overcome the biasing means of the control system amplifier but of less value than is required to produce threshold pain power at the audiometer output.

3. The combination with a variable frequency, variable power output audiometer system comprising a variable frequency source of signal energy, and a signal energy amplifier intermediate the said source and the electrical power output of the audiometer and having plate and cathode and grid elements, and means coupling the control grid of said audiometer amplifier to the signal energy source; of an automatic power output control system for said audiometer comprising first and second electronic amplifiers each having plate and cathode and control grid elements, means coupling the control grid of the first control system amplifier to the signal energy source independently of the audiometer system amplifier, means biasing the first control system amplifier to cut off for all applied signal voltages below a predetermined maximum value close to but below the value required to produce threshold of pain power at the audiometer output, a plate circuit for the first control system amplifier, means for impressing amplified signal voltage of the plate circuit of the first control system amplifier on the control grid of the second control system amplifier, a rectifier having its negative side connected to the control grid of the audiometer system amplifier and its positive side connected to the plate of the second control system amplifier through the medium of a coupling condenser, and a second rectifier having its negative side connected to the positive side of the first rectifier independently of said condenser and its positive side connected to the cathode of the second con-

trol system amplifier, the amplification factor of the control system amplifier being such that the audiometer signal energy amplifier will be abruptly biased to cut off responsive to applied signal voltage at the control grid of the control system amplifier of value greater than is required to overcome the biasing means of the control system amplifier but of less value than is required to produce threshold pain power at the audiometer output.

4. The combination with an audiometer comprising a variable frequency source of signal energy the characteristic power output curve of which approximates that required to produce threshold hearing at a plurality of test frequencies and is higher and more closely approaches threshold of pain value at some test frequencies than at other test frequencies, said audiometer comprising a manually operative power output controller intermediate the signal source and the power output of the audiometer and responsive to which the output power may be varied upwardly from threshold of hearing level for all test frequencies to a level whereat the output power is close to but below threshold of pain value at some test frequencies and would be above threshold of pain value at other test frequencies if the power output was allowed to rise proportionately for all test frequencies, and a signal energy amplifier also located intermediate the signal source and the audiometer output and which includes an electronic signal energy amplifier having plate and cathode and control grid elements, the said control grid element being connected to the output of the signal energy source, of a normally inoperative automatic output power control system for said audiometer positively limiting the output power of the audiometer to a maximum value close to but below the threshold of pain value at all test frequencies irrespective of the setting of the manually operative variable output power controller, said automatic output power control system comprising electronic signal amplifier means having plate and cathode and control grid elements and having its control grid connected to the signal energy source at a point ahead of the control grid of the audiometer amplifier, means biasing the control system signal energy amplifier means to cut off for all applied control grid signal voltages below a predetermined maximum value close to but below that which would be required to produce threshold of pain power at the audiometer output, a plate circuit for the control system amplifier means, and a control circuit operatively associated with the said plate circuit of the control system amplifier means, said control circuit comprising a rectifier and a D. C. connection to an element of the audiometer signal energy amplifier other than the plate thereof and to which that amplifier is responsive to D. C. control potential of the polarity thus applied to reduce its amplification factor, the control system amplifying the applied signal voltage to such an extent that the audiometer signal energy amplifier will be abruptly biased to cut off responsive to applied voltage of value greater than is required to overcome the biasing means of the control system amplifier but of less value than is required to produce threshold pain power at the audiometer output.

5. In a variable frequency, variable power output audiometer the characteristic power output curve of which approximates that required to produce threshold hearing and hence is higher and more closely approaches threshold of pain value at some test frequencies than at other test frequencies, said audiometer having a manually variable power output controller responsive to which the power output may be varied upwardly from threshold of hearing level for all test frequencies to a level whereat the output power is close to but below the threshold of pain level at some test frequencies and would be above the threshold of pain level at other test frequencies if the output power was allowed to rise proportionately for all test frequencies, a signal energy amplifier also located intermediate the signal source and the audiometer output and which includes an electronic signal energy amplifier having plate and cathode and control grid elements, and means impressing the output signal energy of the source on the control grid of said amplifier, a normally inoperative automatic output power control system for said audiometer positively limiting the output power of the audiometer to a maximum value close to but below the threshold of pain value at all test frequencies irrespective of the setting of the manually operative variable output power controller, said automatic output power control system comprising electronic signal amplifier means having plate and cathode and control grid elements, means impressing the output signal energy of the signal source on the control grid of the control system amplifier, means applying a positive grid biasing potential to the cathode of the control system amplifier of such value as is required to bias said amplifier to cut off at a control grid applied signal voltages up to a predetermined maximum value close to but below that required to produce threshold of pain power at the output of the audiometer, a high voltage plate circuit for the control system amplifier, a control circuit operatively associated with said plate circuit, said control circuit comprising a rectifier providing a source of D. C. control potential, means connecting the negative side of the rectifier to the control grid of the audiometer amplifier and the positive side of the rectifier to the plate of the control system amplifier, the control system amplifying the applied signal voltage to such an extent that the audiometer signal energy amplifier will be abruptly biased to cut off responsive to applied signal voltage of value greater than is required to overcome the biasing means of the control system amplifier but of less value than is required to produce threshold pain power at the audiometer output.

6. The combination with an audiometer comprising a variable frequency source of signal energy the characteristic power output curve of which approximates that required to produce threshold hearing at a plurality of test frequencies and is higher and more closely approaches threshold of pain value at some test frequencies than at other test frequencies, said audiometer comprising a manually operative power output controller intermediate the signal source and the power output of the audiometer and responsive to which the output power may be varied upwardly from threshold of hearing level for all test frequencies to a level whereat the output power is close to but below threshold of pain value at some test frequencies and would be above threshold of pain value at other test frequencies if the power output was allowed to rise proportionately for all test frequencies, and a signal energy amplifier also located intermediate the signal source and the audiometer output and which includes an electronic signal energy amplifier having plate and cathode and control grid

elements, the said control grid element being connected to the output of the signal energy source, of a normally inoperative automatic output power control system for the audiometer positively limiting the output power of the audiometer to a maximum value close to but below threshold of pain value at all test frequencies irrespective of the setting of the manually operative output controller, said automatic power control system comprising electronic signal amplifier means having plate and cathode and control grid elements and having its control grid connected to the signal energy source at a point ahead of the control grid of the audiometer amplifier, means applying a biasing potential to an element of the control system amplifier other than the plate thereof of sufficient value and proper polarity to bias the said amplifier to cut off at all applied control grid signal voltages below a predetermined maximum value close to but below that which would be required to produce threshold of pain power at the audiometer output, a plate circuit for the control system amplifier means, and a control circuit operatively associated with the said plate circuit

of the control system amplifier means, said control circuit comprising a rectifier and an electrical connection from the D. C. side of the rectifier to the control grid of the audiometer amplifier, the control system amplifying the applied signal voltage to such an extent that the audiometer signal energy amplifier will be abruptly biased to cut off responsive to applied signal voltage of value greater than is required to overcome the biasing means of the control system amplifier but of less value than is required to produce threshold pain power at the audiometer output.

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