PATENT SPECIFICATION

637,487

Date of filing Complete Specification: Feb. 7, 1949.

Application Date: Jan. 6, 1948. No. 382/48.

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Index at acceptance:—Class 37, A9(a5: c1: c2).

PROVISIONAL SPECIFICATION

SPECIFICATION No. 637,487

By a direction given under Section 17(1) of the Patents Act 1949 this application proceeded in the name of The Minister of Supply, of Adelphi, Strand, London, W.C.2.

THE PATENT OFFICE,
14th June, 1950

DS 39272/1(14)/3404 160 6/50 R

...fluctuations about a mean or datum level. The invention is particularly but not exclusively concerned with arrangements for indicating, measuring, recording or utilising the mean level of a voltage at audio frequencies and may be used, for example, in the analysis of speech or other audio frequency signals.

For the purpose of illustration the invention will be described hereinafter as though it were concerned only with speech signals; it will be understood that the invention is not limited to such application but is intended to be applied to the measurement of any fluctuating voltage of analogous form.

In the analysis of speech signals, the difficulty arises that speech is intermittent, the pauses taken over a period representing a considerable proportion of the total time. If, therefore, an average figure is required for the voltage level of speech signals not only must the fluctuating signal voltage be integrated over a known time but also allowance must be made for the time taken up by pauses. If the speaker is required to eliminate these pauses for the purpose of a measurement the resulting speech is almost certain to be unnatural in some way. The difficulty could be overcome by providing an integrating circuit in which arrangements are made for the storage condenser or equivalent integrating device to be subject to a known leakage during periods of signal, the leakage path being removed at all times when the signal level voltage level falls below a given small value.

...applied, means in the bridge circuit adapted to change its impedance in accordance with changes in a voltage applied thereto and means for indicating, measuring, recording or utilising the state of balance or unbalance of the bridge, the balance of said bridge circuit being at a predetermined datum level of applied voltage, corresponding to a predetermined datum level of said fluctuating voltage, whereby fluctuations of the fluctuating voltage about its datum level will be evidenced as depatures of said bridge circuit from its state of balance.

If an A.C. signal is to be examined a rectifier is preferably included in the circuit supplying the bridge, and if desired a smoothing circuit having a suitable time constant may be included so as to produce a D.C. voltage representing the integration to be carried out. The bridge may then take the form of a simple D.C. bridge the four arms of which comprise three D.C. resistors and one dry-contact rectifier element. The dry-contact element is then chosen and the resistance arms are so arranged that, at the datum level of signal voltage the bridge is balanced. That is to say, at the voltage then existing across the dry-contact rectifier element, the resistance of the element will be such as to balance the bridge. Thus, three arms of the bridge may comprise three equal resistors and the dry-contact rectifier element is then chosen to have a resistance equal to that of each of the resistors when subjected to an applied volt-

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PROVISIONAL SPECIFICATION

Improvements in or relating to Electric Measuring Circuits

I, EDMUND RAMSAY WIGAN, a British Subject, of 35, Montague Road, Southbourne, Bournemouth, Hampshire, do hereby declare the nature of this invention to be as follows:—

The present invention relates to a circuit arrangement for use in the measurement or utilisation of voltages subject to fluctuation at low frequencies, to enable the level of such a voltage to be observed as fluctuations about a mean or datum level. The invention is particularly but not exclusively concerned with arrangements for indicating, measuring, recording or utilising the mean level of a voltage at audio frequencies and may be used, for example, in the analysis of speech or other audio frequency signals.

For the purpose of illustration the invention will be described hereinafter as though it were concerned only with speech signals; it will be understood that the invention is not limited to such application but is intended to be applied to the measurement of any fluctuating voltage of analogous form.

In the analysis of speech signals, the difficulty arises that speech is intermittent, the pauses taken over a period representing a considerable proportion of the total time. If, therefore, an average figure is required for the voltage level of speech signals not only must the fluctuating signal voltage be integrated over a known time but also allowance must be made for the time taken up by pauses. If the speaker is required to eliminate these pauses for the purpose of a measurement the resulting speech is almost certain to be unnatural in some way. The difficulty could be overcome by providing an integrating circuit in which arrangements are made for the storage condenser or equivalent integrating device to be subject to a known leakage during periods of signal, the leakage path being removed at all times when the signal level voltage level falls below a given small value. The integrated signal will then be maintained during any pause in the speech signal. Such an arrangement, however, would involve the use of amplifiers and relays which the present invention avoids.

According to this invention an arrangement is provided for indicating, measuring or recording the mean level of a fluctuating voltage comprising a bridge circuit to which the fluctuating voltage is applied, means in the bridge circuit adapted to change its impedance in accordance with changes in a voltage applied thereto and means for indicating, measuring, recording or utilising the state of balance or unbalance of the bridge, the balance of said bridge circuit being at a predetermined datum level of applied voltage, corresponding to a predetermined datum level of said fluctuating voltage, whereby fluctuations of the fluctuating voltage about its datum level will be evidenced as depatures of said bridge circuit from its state of balance.

If an A.C. signal is to be examined a rectifier is preferably included in the circuit supplying the bridge, and if desired a smoothing circuit having a suitable time constant may be included so as to produce a D.C. voltage representing the integration to be carried out. The bridge may then take the form of a simple D.C. bridge the four arms of which comprise three D.C. resistors and one dry-contact rectifier element. The dry-contact element is then chosen and the resistance arms are so arranged that, at the datum level of signal voltage the bridge is balanced. That is to say, at the voltage then existing across the dry-contact rectifier element, the resistance of the element will be such as to balance the bridge. Thus, three arms of the bridge may comprise three equal resistors and the dry-contact rectifier element is then chosen to have a resistance equal to that of each of the resistors when subjected to an applied volt-

age at one half the datum voltage level.

For example, the bridge may comprise a simple Wheatstone's bridge arrangement comprising three resistances of say 1000 ohms and a dry-contact metallic rectifier having a resistance of 1000 ohms at an applied voltage of 1 volt. The rectifier is connected in circuit so that its resistance decreases with increasing applied voltage. The fluctuating voltage the mean level of which is to be indicated, or a D.C. voltage derived therefrom, is then applied across the arm of the bridge containing any two of the resistances, and a galvanometer, preferably a centre-zero meter, is connected across the other two poles of the bridge. As the D.C. potential is raised from zero ,the galvanometer will show a steadily increasing deflection in one direction (say negative) but will eventually reach a maximum and ultimately return through zero when the input potential reaches 2 volts, that is to say when the voltage on the dry rectifier terminals reaches 1 volt, so that its resistance is 1000 ohms and the bridge is balanced. If the input is then further increased the meter will be deflected in a positive sense.

Assume now that the arrangement is to be used to indicate the mean levels of speech signals. The signals will be in the form of comparatively short bursts. Let us further assume that the average level of the signal voltage constituting each burst is 2 volts. During the continuance of such a signal the galvanometer will remain at rest at its zero reading but very slight fluctuations in the mean level of the bursts of signals will give rise to positive and negative fluctuations of the galvanometer needle about its zero reading. For signals near the datum level of 2 volts therefore, the needle of the galvanometer has only very small distances to move in order to register the average value of the signals. It will thus be seen that a small percentage fluctuation in the signal voltage may be made to cause a large deflection of the meter. This means that the galvanometer may be given a long time constant so that a true integration of the signals is obtained without correspondingly increasing the effective time constant governing the response of the instrument. This may be illustrated by the following example.

With an arrangement as above described, employing a signal datum level of 2 volts let us assume that a 10% increase in the signal voltage, that is from 2.0 to 2.2 volts causes the meter to move from the centre zero to a steady reading half way to the right end of the scale. If now the ballistic behaviour of the meter is such that 90% of this deflection is reached in 1 second, at the end of a burst of signal enduring for 1 second a meter reading of 2.18 volts will be reached. This reading represents a difference of only 1% between the meter indication and the true signal level of 2.2 volts. From these figures it will be seen that although the ballistic time constant of the meter is 1 second for 90% deflection it will, in the network described, behave as though the time constant were 1 second for 99% deflection.

This effective time constant can be reduced still further by using a more sensitive meter having the same ballistic constant of 1 second for 90% deflection. For example it may be arranged that 1% change from the datum level of 2 volts causes $\frac{1}{2}$ scale deflection of the meter. The effective time constant then obtained is such that 99.9% of the steady reading is obtained in 1 second. The application of this principle is limited, however, by the range of measurements required for the meter, since the more sensitive the meter the smaller the range of voltage levels it may be used to measure.

In practice, if the arrangement is to be used as a speech signal indicator, the meter may be calibrated to read directly in decibels above and below the reference level represented by the centre mark or zero, that is by the balance conditions of the bridge.

For satisfactory operation the time constant of the meter should be controlled by resistive shunts and the introduction of capacities in the bridge and meter circuit avoided as far as possible, otherwise the capacities in the circuit are charged in one sense during the initial stages of the integration when the meter deflection is negative and increasing negatively, and a finite time is taken in passing through these values and for this charge to be neutralised, the integration being correspondingly falsified. By avoiding the introduction of capacity the meter current is caused to pass through these negative deflection values very rapidly so that no material part of the integration is lost. Errors of measurement due to this cause are thereby avoided.

If the D.C. supply available for the bridge is small, the highest possible sensitivity is important. This is achieved by choosing voltages and a type of varistor (e.g. dry-contact rectifier) such that, at the working voltage, the varistor is working on the steepest part of its resistance/voltage curve.

Variations may be made in the design of the circuit to suit particular requirements. For example, as is known in some

" speech meters " the time constant of the meter may be arranged to be different for " outward " and " return " movements of the pointer. This may be done either by modification of the meter itself or by modification of the circuit.

If desired, a relay may be substituted for the centre zero meter in an arrangement as above described, the relay having a change-over contact whereby fluctuations of the fluctuating voltage above and below its datum level will correspond to operation of the relay to one side or the other. The relay may then be used for example, to control a motor adapted to operate upon the amplifier or other device giving rise to the fluctuating voltage, in one sense or the other so as to reduce the fluctuations, thus restoring and maintaining balance of the bridge. The movements of the attenuator, gain control or other device controlled by the motor may then be made visible or recorded. Since the relay is only required to execute minute displacements, the delay between the mean level fluctuations of the signal voltage and their corresponding connections by the controlling meter will be insignificant. Thus a constant level signal output can be maintained by such an arrangement and an accurate record maintained of the fluctuations in the input level of the signal.

Dated the 6th day of January, 1948.

H. W. GRACE,
Acting for Applicant.

COMPLETE SPECIFICATION

Improvements in or relating to Electric Measuring Circuits

I, EDMUND RAMSAY WIGAN, a British Subject, of 35, Montague Road, Southbourne, Bournemouth, Hampshire, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The present invention relates to a circuit arrangement for use in the measurement of voltages subject to fluctuation at low frequencies, to enable the level of such a voltage to be observed as fluctuations about a mean or datum level. The invention is particularly but not exclusively concerned with arrangements for indicating, measuring or recording the mean level of a voltage at audio frequencies and may be used, for example, in the analysis of speech or other audio frequency signals.

For the purpose of illustration the invention will be described hereinafter as though it were concerned only with speech signals; it will be understood that the invention is not limited to such application but is intended to be applied to the measurement of any fluctuating voltage of analogous form.

In the analysis of speech signals, the difficulty arises that speech is intermittent, the pauses taken over a period representing a considerable proportion of the total time. If, therefore, an average figure is required for the voltage level of speech signals not only must the fluctuating signal voltage be integrated over a known time but also allowance must be made for the time taken up by pauses. If the speaker is required to eliminate these pauses for the purpose of a measurement the resulting speech is almost certain to be unnatural in some way. The difficulty could be overcome by providing an integrating circuit in which arrangements are made for the storage condenser or equivalent integrating device to be subject to a known leakage during periods of signal, the leakage path being removed at all times when the signal level voltage level falls below a given small value. The integrated signal will then be maintained during any pause in the spech signal. Such an arrangement, however, would involve the use of amplifiers and relays which the present invention avoids.

According to this invention an arrangement is provided for indicating, measuring or recording the mean level of a fluctuating voltage comprising a bridge circuit to which the fluctuating voltage is applied and comprising in one arm a rectifier and means for indicating, measuring or recording the state of balance or unbalance of the bridge, the balance of said bridge circuit being at a predetermined datum level of said fluctuating voltage, whereby fluctuations of the fluctuating voltage about its datum level will be evidence as departures of said bridge circuit from its state of balance.

If an A.C. signal is to be examined a smoothing circuit having a suitable time constant may be included so as to produce a D.C. voltage representing the integration to be carried out. The bridge may then take the form of a simple D.C. bridge the four arms of which comprise three D.C. resistors and one dry-contact rectifier element. The dry-contact element is thus chosen and the resistance arms are so arranged that, at the datum level of

signal voltage the bridge is balanced. That is to say, at the voltage then existing across the dry-contact rectifier element, the resistance of the element will be such as to balance the bridge. Thus, three arms of the bridge may comprise three equal resistors and the dry-contact rectifier element is then chosen to have a resistance equal to that of each of the resistors when subjected to an applied voltage at one half the datum voltage level.

An example of the present invention is illustrated in the accompanying drawing which shows a simple Wheatstone's bridge arrangement comprising three resistances A, B, and C each of, say, 1000 ohms and a dry-contact metallic rectifier D having a resistance of 1000 ohms at an applied voltage of, say, 1 volt. The rectifier is connected in circuit so that its resistance decreases with increasing applied voltage. The fluctuating voltage the mean level of which is to be indicated, or preferably a D.C. voltage derived therefrom, is then applied to the bridge at the input terminals 1 and a galvanometer G, preferably a centre-zero meter, is connected to indicate the extent of unbalance on the bridge. As the input potential is raised from zero, the galvanometer G will show a steadily increasing deflection in one direction (say negative)) but will eventually reach a maximum and ultimately return through zero when the input potential reaches 2 volts, that is to say when the voltage on the dry rectifier D reaches 1 volt, so that its resistance is 1000 ohms and the bridge is balanced. If the input is then further increased the meter will be deflected in a positive sense.

Assume now that the arrangement is to be used to indicate the mean levels of speech signals. The signals will be in the form of comparatively short bursts. Let us further assume that the average level of the signal voltage constituting each burst is 2 volts. During the continuance of such a signal the galvanometer G will remain at rest at its zero reading but very slight fluctuations in the mean level of the bursts of signals will give rise to positive and negative fluctuations of the galvanometer needle about its zero reading. For signals near the datum level of 2 volts therefore, the needle of the galvanometer has only very small distances to move in order to register the average value of the signals. It will thus be seen that a small percentage fluctuation in the signal voltage may be made to cause a large deflection of the meter. This means that the galvanometer may be given a long time constant so that a true integration of the signals is obtained without correspondingly increasing the effective time constant governing the response of the instrument. This may be illustrated by the following example.

With an arrangement as above described, employing a signal datum level of 2 volts let us assume that a 10% increase in the signal voltage, that is from 2.0 to 2.2 volts causes the meter to move from the centre zero to a steady reading half way to the right end of the scale. If now the ballistic behaviour of the meter is such that 90% of this deflection is reached in 1 second, at the end of a burst of signal enduring for 1 second a meter reading of 2.18 volts will be reached. This reading represents a difference of only 1% between the meter indication and the true signal level of 2.2 volts. From these figures it will be seen that although the ballistic time constant of the meter is 1 second for 90% deflection it will, in the network described, behave as though the time constant were 1 second for 99% deflection.

This effective time constant can be reduced still further by using a more sensitive meter having the same ballistic constant of 1 second for 90% deflection. For example it may be arranged that 1% change from the datum level of 2 volts causes ½ scale deflection of the meter. The effective time constant then obtained in such that 99.9% of the steady reading is obtained in 1 second. The application of this principle is limited, however, by the range of measurements required for the meter, since the more sensitive the meter the smaller the range of voltage levels it may be used to measure.

In practice, if the arrangement is to be used as a speech signal indicator, the meter may be calibrated to read directly in decibels above and below the reference level represented by the centre mark or zero, that is by the balance conditions of the bridge.

For satisfactory operation the time constant of the meter should be controlled by resistive shunts and the introduction of capacities in the bridge and meter circuit avoided as far as possible, otherwise the capacities in the circuit are charged in one sense during the initial stages of the integration when the meter deflection is negative and increasing negatively, and a finite time is taken in passing through these values and for this charge to be neutralised, the integration being correspondingly falsified. By avoiding the introduction of capacity the meter current is caused to pass through these negative deflection values very rapidly so that no material part of the integration is lost. Errors of measurement due to this cause

are thereby avoided.

If the D.C. supply available for the bridge is small, the highest possible sensitivity is important. This is achieved by choosing voltages and a type of rectifier, such that, at the working voltage, the rectifier is working on the steepest part of its resistance/voltage curve.

Variations may be made in the design of the circuit to suit particular requirements. For example, as is known in some "speech meters" the time constant of the meter may be arranged to be different for "outward" and "return" movements of the pointer. This may be done either by modification of the meter itself or by modification of the cicuit.

If desired, a relay may be substituted for the centre zero meter in an arrangement as above described, the relay having a change-over contact whereby fluctuations of the fluctuating voltage above and below its datum level will correspond to operation of the relay to one side or the other. The relay may then be used for example, to control a motor adapted to operate upon the amplifier or other device giving rise to the fluctuating voltage, in one sense or the other so as to reduce the fluctuations, thus restoring and maintaining balance of the bridge. The movements of the attenuator, gain control or other device controlled by the motor may then be made visible or recorded. Since the relay is only required to execute minute displacements, the delay between the mean level fluctuations of the signal voltage and their corresponding connections by the controlling meter will be insignificant. Thus a constant level signal output can be maintained by such an arrangement and an accurate record maintained of the fluctuations in the input level of the signal.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A meter for indicating, measuring or recording the mean level of a fluctuating voltage comprising a bridge circuit to which the fluctuating voltage is applied and comprising in one arm a rectifier and means for indicating, measuring or recording the state of balance or unbalance of the bridge, the balance of said bridge circuit being at a predetermined datum level of applied voltage, corresponding to a predetermined datum level of said fluctuating voltage, whereby fluctuations of the fluctuating voltage about its datum level will be evidenced as departures of said bridge circuit from its state of balance.

2. A meter according to claim 1 and in which the said member adapted to change its impedance is a dry-contact rectifier.

3. A meter according to claim 1 or 2 and comprising means for rectifying the said fluctuating voltage before it is applied to the said bridge circuit.

4. A meter according to any of the preceding claims and comprising resistive shunts in parallel with said means for indicating, measuring or recording the state of balance or unbalance of the bridge.

5. An electric meter substantially as hereinbefore described.

6. An electric meter substantially as hereinbefore described with reference to the accompanying drawing.

Dated this 7th day of February, 1949.

H. W. GRACE,
Agent for the Applicant.

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