PATENT SPECIFICATION

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708,175

Date of filing Complete Specification: Sept. 20, 1951.

Application Date: Sept. 21, 1950. *No. 23217/50.*

Complete Specification Published: April 28, 1954.

Index at acceptance:—**Class 106(4)**, I1(A: M), I6.

COMPLETE SPECIFICATION

Improvements in and relating to Indicating Scales

We, THE BRITISH BROADCASTING CORPORATION, a British Body Corporate, of Broadcasting House, London, W.1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to indicating devices of the type comprising a single calibrated scale and a fiducial index which are relatively movable in dependence upon movement of an element, an indication of the position of the element being obtainable by visual observation of the relative positions of the fiducial index and a single set of markings on the scale, or by observation of the relative positions of one of these parts (index or markings) or its optical image, and an optical image of the other.

In this specification and in the claims references to the index and markings are intended to include optical images of the index and markings respectively wherever the context admits.

It is common to all forms of indicating device of the type set forth that the scale markings suffer from errors introduced either during calibration, or subsequently. These may be due to wear and tear of associated mechanism or to long period drifts in the characteristics of the associated apparatus of which the said element forms part.

The object of this invention is to provide means by which there can be corrected a further type of error which may occur in certain specialised apparatus where the calibrated indicating device has associated with it a "range-changing" device, for example where such apparatus is an R/C (resistance-capacity) oscillator having a single indicating scale marked to read from say 20 to 200 c/s, but provided with a range switch which raises the frequency by a factor of 10 or 100 at will. In apparatus of this kind there will usually be basic errors of calibration of the scale when the range switch is set to one only of its several positions, e.g. "X 1," or "X 10," or "X 100," and the present invention is not concerned with the correction of such errors. But when the frequency range is changed the desired factors of 1, 10, or 100 will never be exactly achieved, there being in general a substantially constant percentage error associated with each of these ranges. This is the further type of error above referred to.

According to the present invention in an indicating device of the type specified associated with range-changing means, there are provided means operating automatically in accordance with operation of the range-changing means to move the index relatively to the scale, independently of any movement of the said element, into positions appropriate for each range.

This invention also includes a modification of the invention as set forth in which, instead of a single movable index, there are provided a support carrying a plurality of index markings and means for moving the support automatically in accordance with operation of the range-changing means to bring into operation the appropriate one of said index markings for each of said ranges.

The invention will be described by way of example with reference to the somewhat diagrammatic drawings accompanying the provisional specification, in which:—

Figs. 1, 2 and 3 are views in front elevation of parts of certain embodiments of the invention,

Figs. 4 and 5 are views in front elevation of arrangements to which the present invention can be applied, and

Fig. 6 is a view in side elevation of the embodiment of Fig. 5.

Referring to Fig. 1, it will be assumed by way of example that an R/C oscillator is provided with a circular, disc-shaped dial or scale 4 on which the basic calibration of 20—200 c/s is marked by scale markings such as shown at 5. The scale is read against a fiducial index such as 3a. There will be assumed to be three frequency ranges controlled by a " range-switch " (not shown) marked " X 1," " X 10," and " X 100." It is known practice to design such oscillators so that the calibration scale follows a logarithmic law of frequency against angular position of the calibration mark. This has the merit that, should the nominally fixed resistance or capacitance components of the frequency-controlling network vary with age, or from one sample to another, the resulting frequency error which is constant in percentage at all parts of the scale can be corrected by the rotation of the dial relative to its mounting shaft. If the instrument had but one range (say X 1), this range could be made exactly correct by such means. But in a 3-range instrument the other two ranges may still be in error after the first range has been corrected.

According to the invention, as applied to the correction of the frequency errors of the other ranges, means may be provided to move the fiducial index automatically relative to the scale when the range switch is operated into one of a plurality of suitable, predetermined, fixed positions.

In the simple and cheap form of the invention shown in Fig. 1, the movement of the fiducial index is provided for by using a transparent plate mounted on the shaft 2 of the range-change switch. The plate 1 bears the fiducial marks 3a, 3b, 3c, and is located between the user's eye and the calibrated dial 4. Reference numbers may be placed against the marks 3a etc. to indicate the positions of the frequency-range switch to which they apply.

The advantages of this construction are that it is cheap and, furthermore, that the marking of the lines 3a etc. can be effected rapidly and simply at a final stage in the manufacture of the oscillator.

For example, the " X 10 " range may first be checked with line 3b used as a reference, this line having been previously engraved on the plate 1. Any frequency error is corrected in the known manner, by rotating the log-like scale 4 relative to the shaft on which it is mounted. The " X 1 " range is then switched into use to bring the mark 3a over the scale. This mark is, at this stage, only a pencilled line; its position will be altered if the frequency scale is in error. Similarly, the " X 100 " range is associated with the mark 3c.

Parallax between the marks 3 and the scale 5 during this process of calibration is avoided by using powerful local illumination to throw up from the inner face of the plate 1, which is close to the scale 4, the reflected image of the pencil mark 3 which has been marked on the outer surface of 1. When the pencil line and its image are aligned with the appropriate mark 5 on the scale 4, the pencil line is known to be correctly placed. Finally, after these pencil markings have been checked, the plate 1 is removed from its shaft 2 and, by a similar optical technique the final calibration lines are marked on the inner face of the plate 1 corresponding to the pencil markings 3a and 3c.

An alternative construction is shown in Fig. 2. Here, instead of three fiducial marks there is provided one movable mark 6, carried on an arm 7 pivoted at 8 and having its position determined by projections or cams 9a, 9b and 9c on the shaft 9 of the range switch which engage with the remote end of 7. These projections may as shown be in the form of three adjustable screws which as the range switch is moved cause the index 6 to move relative to the scale 4 by the amount required to correct for the frequency error.

In yet another form of the invention shown in Fig. 3 which is a modification of that in Fig. 2, the arm 7 carries a lens 11 through which the scale marks 5 are viewed. When the arm 7 is moved, the image of the scale marks moves relative to the fixed fiducial index 12, which is secured to the oscillator housing at 10. The index 12 may be a blade set on edge in order to avoid parallax.

It should be observed that in this construction, as in those previously described, it is unnecessary for the axis of the pivot 8 or the arm 7 to be coincident with the axis of rotation of the scale 4, and it is therefore possible to arrange for a relatively coarse adjustment at 9 in Fig. 2 to correspond to a relatively small movement of the index 6 or 12.

The lens 11 may be cylindrical with its geometrical axis parallel to the index 12, if the movements it makes are small, but if the errors to be corrected are large and the lens makes large movements, it should be spherical, otherwise the scale marks as viewed through the lens 11 will not exactly align with the blade 12.

In describing the arrangements of

Figs. 4 to 6 which do not embody the present invention, but to which the present invention can be applied as will be described later, it will be assumed, as is commonly true, that the angular motion of the shaft carrying the scale 4 is related to the oscillator frequency by a mathematical function which is free from erratic deviations from a smooth curve. It will also be assumed that the markings 5 on the scale 4 follow in a general way the same law and are also free from erratic departures from a "smooth" function. In such a piece of apparatus the errors of calibration found on final test will show no sudden changes as the frequency is varied, though there may be a smooth change from positive through zero to negative values and so on. One arrangement for correcting such errors is shown in Fig. 4.

For simplicity it may be assumed that the instrument with which the scale 4 is associated has but one frequency range. The index 3 is carried on a lever 15 pivoted at 16 and carrying a roller 17 pressed by suitable means (not shown) into engagement with a profiled surface 14 carried on the scale 4 or caused by suitable linking mechanism to move in a predetermined fixed relation with it. The profiled surface 14 may take the form, for instance, of a steel ribbon set on edge, arranged out of sight behind the scale 4 or on a shaft coupled to the scale. The profile of the ribbon may be modified in known manner by screws or other means, so that the index 3 is caused to move in correspondence with this profile. The shape of the profile is adjusted at suitable points around the scale to correct for the calibration errors of the instrument.

The lever 15 may be caused to move in a predetermined and adjustable manner in many other ways. In Figs. 5 and 6 a simple construction is illustrated which is economical in design. Behind the scale 4 and on the same shaft 13 is mounted a plate 23 pierced with a number of tapped holes to take adjusting screws 19. A thin flexible plate 18 has cut in it a number of tongues, one to each screw and these tongues are distorted by the pressure of the screws. Engaging with the tongues is a relatively large diameter roller 20 carried on an arm 21 which is pivoted at 22, and carries a lens 11, where a fixed index (not shown) is used, or, if preferred, the index. By suitable adjustment of the screws 19 the scale calibration errors can be eliminated by causing the movement of the arm 21 to cancel the error.

Provision, according to the present invention, for correcting the error associated with range-changing may be made in the arrangement of Fig. 4 or Figs. 5 and 6 by arranging that the pivot 16 of Fig. 4 or 22 of Figs. 5 and 6 is caused to move by a predetermined fixed amount when the range-switch is moved to a new position.

It will be appreciated that the calibration errors of the dial itself arise from a set of circumstances which are distinct from those associated with the change of range. The dial errors are in fact associated with specific parts of the scale 5, and in general are largely independent of the frequency range. The one profile ribbon 14 or deformed plate 18 will therefore serve for all frequency ranges, the constant percentage frequency error of the latter being taken care of by the shift of the pivot axis 22 or 16.

To clarify the description, the application of this invention to the correction of the errors of indication in an R/C oscillator has been described, but it will be appreciated that the mechanisms described are of wide application. The scale here assumed to be directly viewed, might be replaced by an optically projected image of a scale; the fiducial index, assumed here to be the "fixed" member, may be carried on the moving element; the scale, here assumed to be of disc shape, may be on a cylindrical surface; the relative movement between scale and index may be rectilinear, the scale being a straight one; or again, the fiducial index may be in the form of an optically projected image, any desired movements of the said index being made by the use of movable mirrors, prisms or lenses inserted in the path of a light beam.

What we claim is:—

1. An indicating device of the type specified associated with range-changing means and comprising means operating automatically in accordance with operation of the range-changing means to move the index relatively to the scale, independently of any movement of the said element, into positions appropriate for each range.

2. A modification of the indicating device according to claim 1, wherein, instead of a single movable index, there are provided a support carrying a plurality of index markings and means for moving the support automatically in accordance with operation of the range-changing means to bring into operation the appropriate one of said index markings for each of said ranges.

3. An indicating device according to claim 1, wherein the said automatically-operating means serve to move a lens relatively to the scale and index in such

a manner as to produce an apparent relative movement between the scale and index.

4. An indicating device according to claim 1 or 3, wherein the said automatically-operating means are adjustable.

5. An indicating device according to claim 1, substantially as described with reference to Fig. 2, Fig. 3, Fig. 4 or Figs. 5 and 6.

6. An indicating device according to claim 2, substantially as described with reference to Fig. 1.

Dated this 20th day of September, 1951.
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London, E.C.4.

PROVISIONAL SPECIFICATION

Improvements in and relating to Indicating Scales

We, THE BRITISH BROADCASTING CORPORATION, a British Body Corporate, of Broadcasting House, London, W.1, do hereby declare this invention to be described in the following statement:—

This invention relates to indicating devices of the type comprising a calibrated scale and a fiducial index which are relatively movable in dependence upon movement of an element, an indication of the position of the element being obtainable by visual observation of the relative positions of the fiducial index and markings on the scale, or by observation of the relative positions of one of these parts (index or markings) or its optical image, and an optical image of the other.

It is common to all forms of indicating device of the type set forth that the scale markings suffer from errors introduced either during calibration, or subsequently. These may be due to wear and tear of associated mechanism or to long period drifts in the characteristics of the associated apparatus of which the said element forms part.

It is one of the objects of this invention to provide means capable of correcting such errors.

The further object of this invention is to provide means by which there can be corrected a further type of error which may occur in certain specialised apparatus where the calibrated indicating device has associated with it a "range-changing" device for example an R/C (resistance-capacity) oscillator having an indicating scale marked to read from say 20 to 200 c/s, but provided with a range switch which raises the frequency by a factor of 10 or 100 at will. In apparatus of this kind there will usually be basic errors of calibration of the scale which it is the first-mentioned object of the invention to remove when the range switch is set to one only of its several positions, e.g. "X 1," or "X 10," or "X 100." But when the frequency range is changed the desired factors of 1, 10, or 100 will never be exactly achieved, there being in general a substantially constant percentage error associated with each of these ranges. This is the further type of error above referred to.

According to the present invention in an indicating device of the type specified there are provided means permitting additional relative movement between the index and scale markings, such additional movement being either such that there is provided a small plurality of fixed predetermined relative positions of the index and scale markings for any position of said element or such that the extent of the additional movement is varied automatically in accordance with the position of said element.

The invention will be described by way of example with reference to the accompanying, somewhat diagrammatic drawings in which:—

Figs. 1, 2, 3, 4 and 5 are views in front elevation of parts of certain embodiments of the invention and

Fig. 6 is a view in side elevation of the embodiment of Fig. 5.

Referring to Fig. 1, it will be assumed by way of example that an R/C oscillator is provided with a circular, disc-shaped dial or scale 4 on which the basic calibration of 20—200 c/s is marked by scale markings such as shown at 5. The scale is read against a fiducial index such as 3a. There will be assumed to be three frequency ranges controlled by a "range-switch" (not shown) marked "X 1," "X 10," and "X 100." It is known practice to design such oscillators so that the calibration scale follows a logarithmic law of frequency against angular position of the calibration mark. This has the merit that, should the nominally fixed resistance or capacitance components of the frequency-controlling network vary with age, or from one sample to another, the resulting frequency error which is constant in percentage at all parts of the

scale can be corrected by the rotation of the dial relative to its mounting shaft. If the instrument had but one range (say X 1), this range could be made exactly correct by such means. But in a 3-range instrument the other two ranges may still be in error after the first range has been corrected.

According to the invention, as applied to the correction of the frequency errors of the other ranges, means may be provided to move the fiducial index relative to the scale when the range switch is operated into one of a plurality of suitable, predetermined, fixed positions.

In a very simple form of the invention suitable for three ranges, the movement of the fiducial mark is made as a separate non-automatic adjustment following the movement of the range switch, the fiducial mark being capable of being set in any one of three predetermined, fixed positions, for example by the use of a " click " mechanism. In this form the invention can be applied as a modification to existing R/C oscillators.

In the simple and cheap form of the invention shown in Fig. 1, the movement of the fiducial index is provided for by using a transparent plate 1 pivoted on the oscillator housing at 2 and arranged to engage with a click-mechanism which determines three angular positions of the plate 1. The plate 1 bears the fiducial marks 3a, 3b, 3c, and is located between the user's eye and the calibrated dial 4. Reference numbers may be placed against the marks 3a etc. to indicate the positions of the frequency-range switch to which they apply, and the plate 1 is pre-set by the user to bring the correct fiducial mark into use when the frequency-range is changed.

The advantages of this construction are that it is cheap and can be applied to existing oscillators and, furthermore, that the marking of the lines 3a etc. can be effected rapidly and simply at a final stage in the manufacture of the oscillator.

For example, the " X10 " range may first be checked with line 3b used as a reference, this line having been previously engraved on the plate 1. Any frequency error is corrected in the known manner, by rotating the log-like scale 4 relative to the shaft on which it is mounted. The " X 1 " range is then switched into use and the plate 1 rotated to bring the mark 3a over the scale. This mark is, at this stage, only a pencilled line; its position will be altered if the frequency scale is in error. Similarly, the " X 100 " range is associated with the mark 3c.

Parallax between the marks 3 and the scale 5 during this process of calibration is avoided by using powerful local illumination to throw up from the inner face of the plate 1, which is close to the scale 4, the reflected image of the pencil mark 3 which has been marked on the outer surface of 1. When the pencil line and its image are aligned with the appropriate mark 5 on the scale 4, the pencil line is known to be correctly placed. Finally, after these pencil markings have been checked, the plate 1 is removed from its bearing 2 and, by a similar optical technique the final calibration lines are marked on the inner face of the plate 1 corresponding to the pencil markings 3a and 3c.

A refinement of this construction is to mount the plate 1 directly on the shaft of the range-change switch, thus making the adjustment automatic.

An alternative construction is shown in Fig. 2. Here, instead of three fiducial marks there is provided one movable mark 6, carried on an arm 7 pivoted at 8 and having its position determined by projections or cams 9a, 9b and 9c on the shaft 9 of the range switch which engage with the remote end of 7. These projections may as shown be in the form of three adjustable screws which as the range switch is moved cause the index 6 to move relative to the scale 4 by the amount required to correct for the frequency error.

In yet another form of the invention shown in Fig. 3 which is a modification of that in Fig. 2, the arm 7 carries a lens 11 through which the scale marks 5 are viewed. When the arm 7 is moved, the image of the scale marks moves relative to the fixed fiducial index 12, which is secured to the oscillator housing at 10. The index 12 may be a blade set on edge in order to avoid parallax.

It should be observed that in this construction, as in those previously described, it is unnecessary for the axis of the pivot 8 of the arm 7 to be coincident with the axis of rotation of the scale 4, and it is therefore possible to arrange for a relatively coarse adjustment at 9 in Fig. 2 to correspond to a relatively small movement of the index 6 or 12.

The lens 11 may be cylindrical with its geometrical axis parallel to the index 12, if the movements it makes are small, but if the errors to be corrected are large and the lens makes large movements, it should be spherical, otherwise the scale marks as viewed through the lens 11 will not exactly align with the blade 12.

Mechanisms such as those of Figs. 2 and 3 may be adapted to the correction of

a different form of error. It will be assumed, as is commonly true, that the angular motion of the shaft carrying the scale 4 is related to the oscillator frequency by a mathematical function which is free from erratic deviations from a smooth curve. It will also be assumed that the markings 5 on the scale 4 follow in a general way the same law and are also free from erratic departures from a " smooth " function. In such a piece of apparatus the errors of calibration found on final test will show no sudden changes as the frequency is varied, though there may be a smooth change from positive through zero to negative values and so on. One arrangement for correcting such errors is shown in Fig. 4.

For simplicity it may be assumed that the instrument with which the scale 4 is associated has but one frequency range. The index 3 is carried on a lever 15 pivoted at 16 and carrying a roller 17 pressed by suitable means (not shown) into engagement with a profiled surface 14 carried on the scale 4 or caused by suitable linking mechanism to move in predetermined fixed relation with it. The profiled surface 14 may take the form, for instance, of a steel ribbon set on edge, arranged out of sight behind the scale 4 or on a shaft coupled to the scale. The profile of the ribbon may be modified in known manner by screws or other means, so that the index 3 is caused to move in correspondence with this profile. The shape of the profile is adjusted at suitable points around the scale to correct for the calibration errors of the instrument.

The lever 15 may be caused to move in a predetermined and adjustable manner in many other ways. In Figs. 5 and 6 a simple construction is illustrated which is economical in design. Behind the scale 4 and on the same shaft 13 is mounted a plate 23 pierced with a number of tapped holes to take adjusting screws 19. A thin flexible plate 18 has cut in it a number of tongues, one to each screw and these tongues are distorted by the pressure of the screws. Engaging with the tongues is a relatively large diameter roller 20 carried on an arm 21 which is pivoted at 22, and carries a lens 11 or, if preferred the index. By suitable adjustment of the screws 19 the scale calibration errors can be eliminated by causing the movement of the arm 21 to cancel the error.

Provision for correcting the error associated with range-changing may be made in the arrangement of Fig. 4 or Figs. 5 and 6 by arranging that the pivot 16 of Fig. 4 or 22 of Figs. 5 and 6 is caused to move by a predetermined fixed amount when the range-switch is moved to a new position.

It will be appreciated that the calibration errors of the dial itself arise from a set of circumstances which are distinct from those associated with the change of range. The dial errors are in fact associated with specific parts of the scale 5, and in general are largely independent of the frequency range. The one profile ribbon 14 or deformed plate 18 will therefore serve for all frequency ranges, the constant percentage error of the latter being taken care of by the shift of the pivot axis 22 or 16.

To clarify the description, the application of this invention to the correction of the errors of indication in an R/C oscillator has been described, but it will be appreciated that the mechanisms described are of wide application. The scale here assumed to be directly viewed, might be replaced by an optically projected image of a scale; the fiducial index, assumed here to be the " fixed " member, may be carried on the moving element; the scale, here assumed to be of disc shape, may be on a cylindrical surface; the relative movement between scale and index may be rectilinear, the scale being a straight one; or again, the fiducial index may be in the form of an optically projected image, any desired movements of the said index being made by the use of movable mirrors, prisms or lenses inserted in the path of a light beam.

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London, E.C.4.

Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press.—1954.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

708,175 PROVISIONAL SPECIFICATION

1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

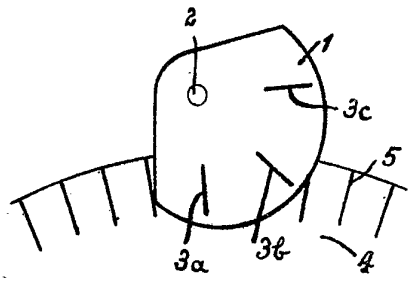

Fig. 1.

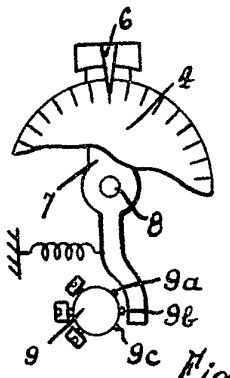

Fig. 2.

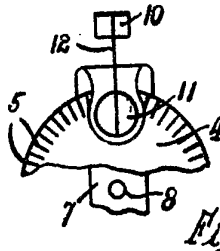

Fig. 3.

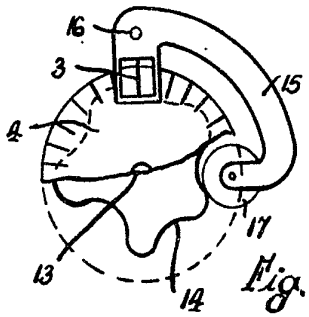

Fig. 4.

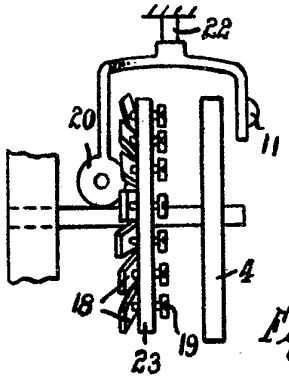

Fig. 6.

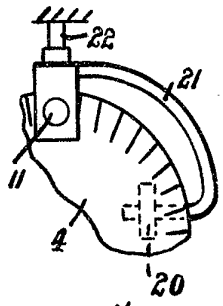

Fig. 5.