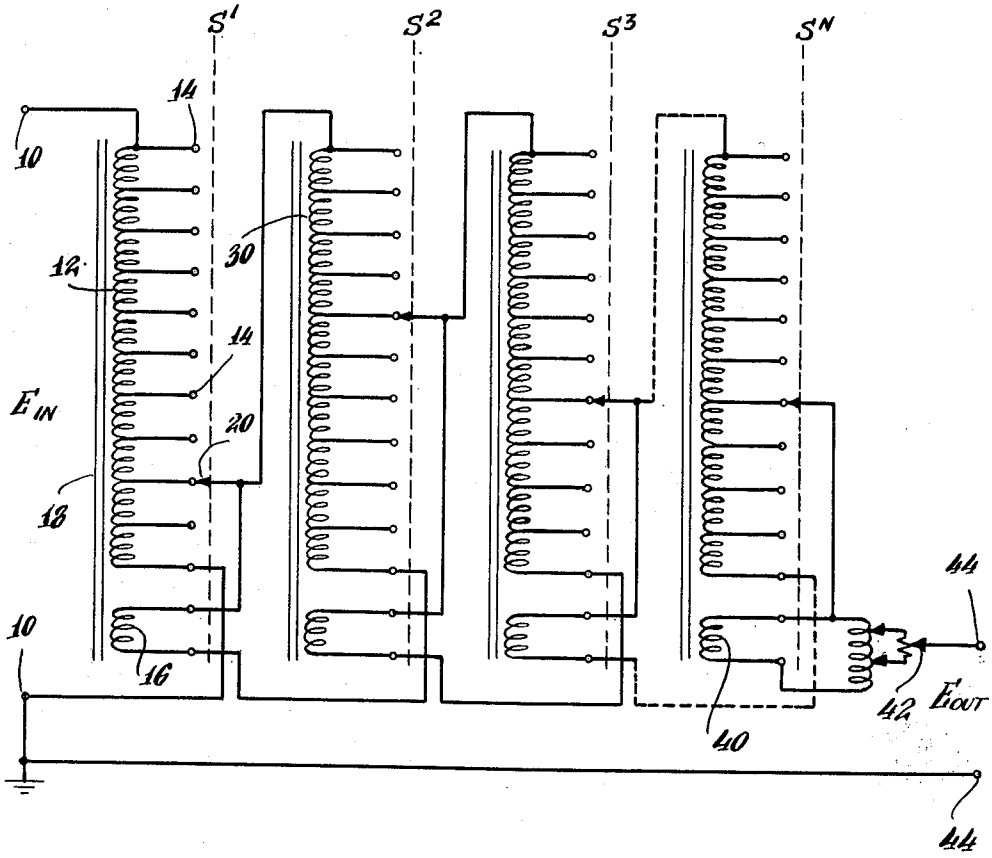
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PRECISION RATIO TRANSFORMER

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PRECISION RATIO TRANSFORMER

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This invention relates to precision transformers having adjustable ratios. More particularly, this invention relates to improved transformers for use in instrumentation or computer circuits where high accuracy is required.

Variable ratio transformers are well-known in the electrical art. However, in the majority of instances, the accuracy of the voltage ratio is not of great importance. This is true, for example, in nearly all power applications. However, in the past few years, with the increased importance of computers and similar devices, the precision of such transformers has become a matter of great importance. One application of such transformers is to supply a voltage output proportional to a given number. Such an output may be used, for example, in an analogue computer. Nearly all previous attempts to design suitable transformers for such purposes have been deficient in some respects. For example, in many of these transformers as the output voltage is varied, there is a disturbance of voltage ratio due to loading of successive stages. In other transformers it is often necessary to switch more than one tap at a time, thus introducing switching problems. In still others there is a variation in no-load input impedance with a change in output voltage ratio switch setting.

It is, therefore, a primary object of this invention to provide an improved variable ratio transformer.

Another object is to provide such a transformer which has high precision.

Another object is to provide such a transformer wherein the voltage ratio is undisturbed by loading effects.

Another object is to provide such a transformer wherein the output voltage may be varied by switching only one tap at a time.

Another object is to provide such a transformer which has a constant no-load input impedance regardless of setting.

The manner in which the above objects are achieved will be more apparent from the following description taken in conjunction with the single figure of the attached drawing which illustrates in schematic form a transformer constructed in accordance with this invention.

A transformer is provided which comprises a series of sets of windings. Each set includes a primary winding and a secondary winding which are magnetically flux-linked but electrically isolated from one another. Means are provided for applying an input voltage across the primary winding of a first set. A plurality of substantially equally spaced taps are provided along the primary winding of each set and a suitable pick-off is positionable along the taps of each primary winding. Each pick-off is electrically connected both to its associated secondary winding and to one end of the primary winding of the next set. The secondary winding is also electrically connected to the second end of the primary winding of the next set. Suitable output terminals are connected between one end of the primary winding of the first set and the secondary winding of the last set.

The figure illustrates a decade type transformer constructed in accordance with the invention. The term "decade" indicates that the transformer is constructed to operate in accordance with the numerical base **10**. It is to be understood however, that the transformer of this invention is not so limited but may be equally well adapted for use with any numerical base. Input terminals

10 are electrically connected to the ends of a primary winding **12**. Winding **12** is sub-divided by means of taps **14** into 10 portions having equal numbers of turns, thus constituting the first decade. A secondary winding **16** is mounted on the same core **18** and has a number of turns exactly equal to that existing between adjacent primary taps **14**. A suitable pick-off **20** is movable to any of taps **14** and is electrically connected to both secondary winding **16** and the primary winding **30** of the next decade. The other side of secondary **16** is also connected to primary **30** so that the voltage produced by the secondary becomes the input voltage to the primary winding of the second decade. This same circuitry is repeated through as many decades as required. The secondary winding **40** of the last decade may be tapped by any suitable means **42** such as, for example, the precision transducer illustrated in United States Patent 2,843,822 of L. B. Scott: The output terminals **44** are connected across this last transducer and one of the primary input terminals **10** of the first decade which serves as a reference terminal and may be grounded as shown.

With particular reference to the first decade, it will be noted that as pick-off **20** moves to any given tap on winding **12**, the associated portion of secondary winding **16** is caused to assume the voltage of the selected tap. As the output voltage of winding **16** is exactly equal to the voltage existing between any two taps **14**, such voltage is divided by means of the succeeding transformer primary **30**. As this procedure is continued for the required number of decades, it will be seen that an exceedingly accurate and precise voltage output may be obtained.

A number of other advantages of this invention will also be apparent. For example: (1) It will be noted that only one tap is changed at a time, thus adding greatly to the simplicity of the system. (2) As no direct connection is ever made across a primary winding, the voltage ratio in the connected tap is undisturbed by loading effects. Unlike conventional ratio transformers, all the current taken by each decade is supplied by the secondary winding of the preceding decade transformer. (3) The impedance appearing at the input to the transformer will be independent of the switch combination in effect. (4) Each of the secondary windings may be in either additive or substractive relationship with its primary winding. The polarity of the final secondary **40** will enable the output voltage to be greater than the maximum tap setting or less than the minimum.

In the drawing and foregoing description, each movable tap **20** is connected to the end of its associated secondary winding **16**. However, this is not a necessary requirement. Each of taps **20**, for example, could be connected to the mid-point, or any other portion, of winding **16**. Similarly, the succeeding primary winding need not be tapped from an end of the secondary. It is only necessary that each primary be energized solely from the preceding secondary.

It is to be understood that various other modifications may occur to those skilled in the art. The scope of the invention is not to be understood as limited by the scope of the illustrations and examples given but only as defined in the appended claims.

I claim:

1. A precision ratio transformer which comprises a series of sets of windings, each of said sets comprising a primary winding and a secondary winding, said primary and secondary windings of each set being magnetically flux-linked; means for applying an input voltage to the primary winding of a first set; a plurality of tap means spaced along the primary winding of each set; pickoff means selectively positionable along the tap means of each of said primary windings; first conductor means

electrically connecting each of said pickoff means with a first portion of its associated secondary winding and with a first portion of the primary winding of a next set along the series; second conductor means electrically connecting a second portion of said associated secondary winding with a second portion of the primary winding of said next set; and output means connected between the primary winding of said first set and the secondary winding of the last set.

2. The apparatus of claim 1 wherein the primary and secondary windings of each set are electrically isolated from one another.

3. The apparatus of claim 2 wherein the first and second portions of each primary winding comprise, respectively, the first and second ends of said winding.

4. The apparatus of claim 3 wherein the first and second portions of each secondary winding comprise, respectively, the first and second ends of said winding.

5. A precision ratio transformer which comprises a series of sets of windings, each of said sets comprising a primary winding and a secondary winding, said primary and secondary windings of each set being magnetically flux-linked but electrically isolated from one another; means for applying an input voltage across the primary winding of a first set; a plurality of tap means substantially equally spaced along the primary winding of each set; pickoff means selectively positionable along the tap means of each of said primary windings; first conductor means electrically connecting each of said pickoff means with a first end of its associated secondary winding and with a first end of the primary winding of a next set along the series; second conductor means electrically connecting the second end of said associated secondary winding with the second end of the primary winding of said next set; and output means connected between a first end of the primary winding of said first set, and the secondary winding of the last set.

6. The transformer of claim 5 wherein said primary windings have an equal number of taps.

7. The transformer of claim 6 wherein the voltages between adjacent taps of each primary are identical.

8. The transformer of claim 7 wherein the voltage induced across each secondary winding is equal to the voltage between adjacent taps of its associated primary winding.

9. The transformer of claim 8 wherein the output means includes output pickoff means operable to select any potential existing along the secondary winding of the last set.

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