Aug. 26, 1958 D. R. DE TAR 2,849,691

WAVEMETER

Filed Nov. 3, 1954 2 Sheets-Sheet 1

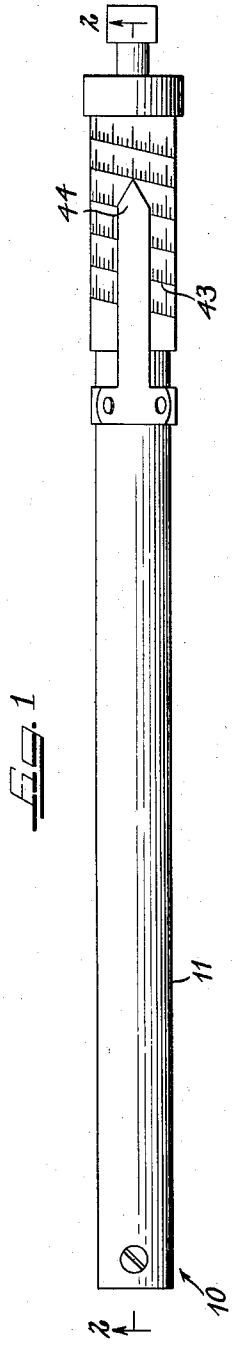


Fig. 1

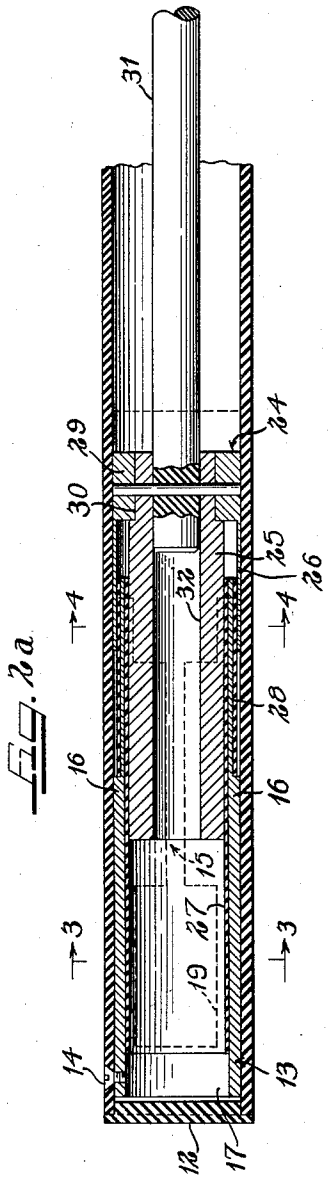


Fig. 2a

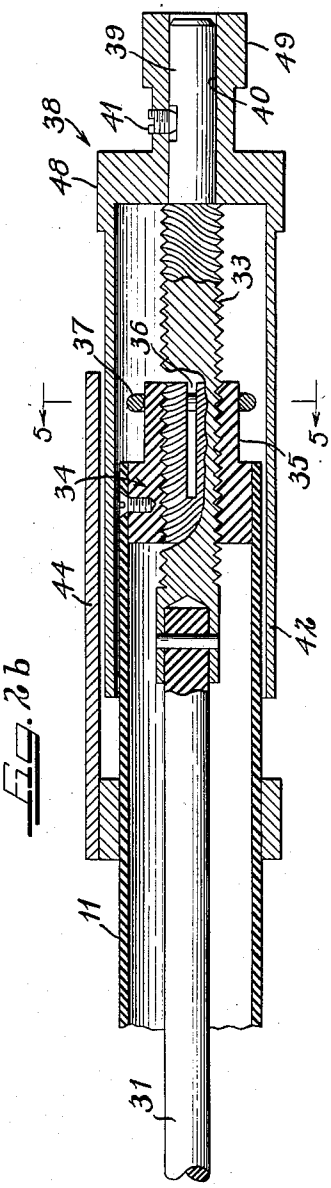


Fig. 2b

Inventor
DONALD R. DE TAR

Ooms, Mc Dougall, Williams & Hersh
Attys.

Aug. 26, 1958 D. R. DE TAR 2,849,691

WAVEMETER

Filed Nov. 3, 1954 2 Sheets-Sheet 2

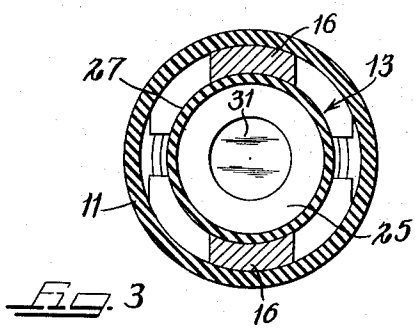


Fig. 3

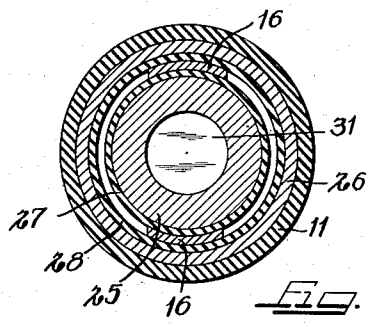


Fig. 4

Fig. 6

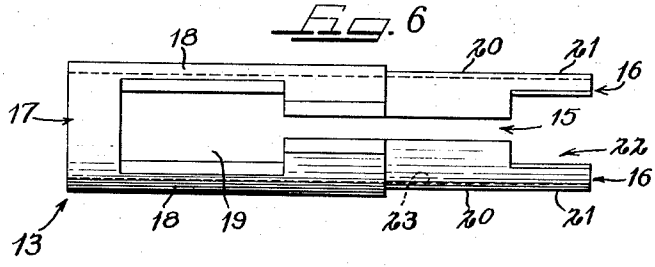


Fig. 7

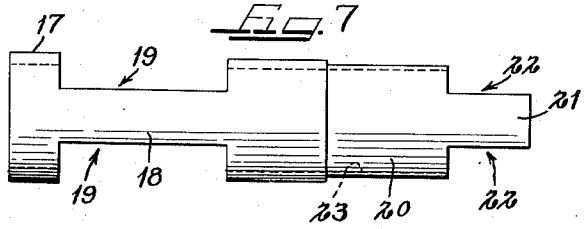
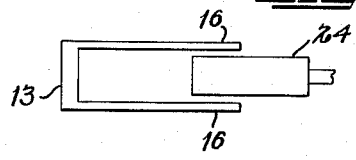


Fig. 8



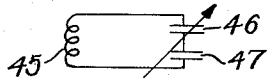


Fig. 9

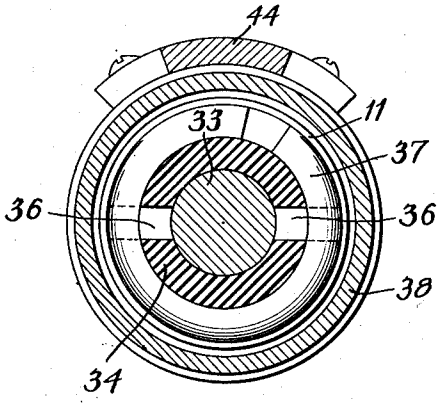


Fig. 5

Inventor
DONALD R. DE TAR

Ooms, McDougall, Williams & Hersh
Attys.

United States Patent Office 2,849,691
Patented Aug. 26, 1958

2,849,691

WAVEMETER

Donald R. De Tar, Stratford, Conn., assignor to Aladdin Industries, Incorporated, Nashville, Tenn., a corporation of Illinois

Application November 3, 1954, Serial No. 466,508

3 Claims. (Cl. 333—82)

One principal object of the invention is to provide an improved wavemeter or the like for use at ultrahigh frequencies, particularly in the ultrahigh frequency (U. H. F.) television band extending from 470 to 890 megacycles.

A further object of the invention is to provide an absorption type wavemeter which is inexpensive and small in size, yet is accurate and entirely reliable.

It is another object of the invention to provide an improved wavemeter which is simple and rugged in construction, easy to use and convenient to carry.

Further objects and advantages of the invention will appear from the following description, taken with the accompanying drawings, in which:

Figure 1 is an elevational view of an exemplary wavemeter constituting an illustrative embodiment of the invention;

Fig. 2*a* is a fragmentary double-size longitudinal sectional view taken generally along a line 2—2 in Fig. 1;

Fig. 2*b* is a continuation of Fig. 2*a* showing the opposite end of the wavemeter;

Figs. 3, 4, and 5 are cross-sectional views taken generally along lines 3—3, 4—4, and 5—5 in Figs. 2*a* and 2*b*;

Figs. 6 and 7 are plan and elevational views of an inductance element embodied in the wavemeter of Fig. 1;

Fig. 8 is a diagrammatic representation of the wavemeter; and

Fig. 9 is an approximate equivalent schematic diagram of the wavemeter.

Considered in greater detail, the drawings will be seen to illustrate an exemplary wavemeter **10** which in this instance comprises an elongated cylindrical tubular housing **11** made of a dielectric material. One end of the housing **11**, shown at the left in Figs. 1 and 2*a*, is closed by a dust cap **12**.

To provide an inductance loop, a conductive metallic sleeve **13** is mounted within the left hand end of the insulating housing **11** and in this instance is suitably secured to the housing **11** as by the illustrated screw **14**. In order that the sleeve may define an inductance loop, a pair of diametrically opposite longitudinal slots **15** are formed in the right hand end portion of the sleeve **13**. As shown to best advantage in Fig. 6, which is a view of the inductance element **13**, the slots **15** extend part way from the right hand end of the element **13** toward its left hand end. By virtue of the slots **15**, the sleeve **13** constitutes a generally U-shaped inductance loop having a pair of elongated arms **16** which are interconnected at their left hand ends by a ring-shaped portion **17** of the sleeve **13**. Adjacent the ring portion **17** the arms **16** have narrowed down portions **18** which are defined by cutouts **19** in the sleeve **13**. Adjacent the right hand end of the sleeve **13**, the arms **16** are provided with externally reduced portions **20** having terminal elements **21** which are reduced in width by cutouts **22**. Internally, the sleeve **13** is formed with a continuous cylindrical surface **23**.

In order to vary the capacitance between the arms **16** of the inductance loop defined by the sleeve **13**, the wavemeter **10** is provided in this instance with a capacitive tuning member, indicated generally by the character **24**. While the member **24** may assume various forms, it is illustrated as comprising inner and outer concentric cylindrical elements or sleeves **25** and **26** in capacitive relation to the arms **16** of the stationary sleeve **13**. In this instance, the arms **16** are telescopically disposed between the sleeves **25** and **26**. The sleeve **26** is adapted to be received over the externally reduced portions **20** of the arms **16**, while the inner sleeve **25** is adapted to be received within the internal cylindrical surface **23**. Thin walled insulating bushings **27** and **28** are interposed between the stationary sleeve **13** and the inner and outer capacitive tuning sleeves **25** and **26**. It will be seen that the inner tuning sleeve **25** is relatively long, while the outer sleeve **26** is relatively short. In the illustrated construction, the outer sleeve **26** is mounted on and conductively connected to the right hand end of the inner sleeve **25**. More specifically, the outer sleeve **26** is formed with an internally reduced or necked-down right hand portion **29** which is mounted on an externally reduced end portion **30** of the inner sleeve **25**. The connection between the sleeves **25** and **26** is primarily for mechanical rather than electrical reasons, and hence need not be conductive. Both sleeves **25** and **26** are at substantially the same electrical potential, amounting to the mean between the potentials of the arms or terminals **16** of the inductance element **13**. Accordingly, no substantial current flows between the sleeves **25** and **26**.

Provision is made for effecting relative longitudinal movement between the inductance element **13** and the capacitive tuning element **24**. In this way, the capacitance between the arms **16** may be varied so as to change the resonant frequency of the inductance loop defined by the element **13**. In this instance, the capacitive tuning element **24** is movable relative to the housing **11**, while the element **13** is stationary, but it will be understood that this arrangement might well be reversed. In the illustrated construction, the inner sleeve **25** of the capacitive tuning element **24** is connected to the left hand end of an insulating rod **31**, which is received within an axial bore **32** formed in the sleeve **25** and is pinned or otherwise suitably secured to the sleeves **25** and **26**. The rod **31** extends axially within the housing **11** toward its right hand end. In order to advance and retract the rod **31**, its right hand end is connected to a micrometer lead screw **33** which in this instance is provided with a quintuple left hand thread. The screw **33** is in threaded engagement with a nut **34** fixed in the right hand end of the housing **11**. To reduce friction and wear, the screw **33** is preferably made of metal, while the nut **34** is made of nylon or other similar plastic. For the purpose of preventing play or backlash between the screw **33** and the nut **34**, the latter is formed with an externally reduced or necked-down portion **35** which is longitudinally split by diametrically opposite slots **36**. A split circular wire spring or C-ring **37** is mounted on the outside of the reduced portion **45** to compress the split halves of the nut **34** into intimate engagement with the screw **33**.

To provide for manual adjustment of the wavemeter **10**, a generally cylindrical thimble-shaped dial or barrel **38** is mounted on the right hand end of the lead screw **33**. In the illustrated construction, the lead screw is formed with a reduced end portion **39** received within a bore **40** in the dial **38**. A setscrew **41** or some other fastening element is employed to secure the dial **38** to the lead screw **33**. The dial **38** is provided with a tubular left hand portion **42** which is telescopically received over the housing **11** and thus is effective to enclose the screw

33 and the nut 34. A suitable scale 43 may be applied to the outside of the dial 38. It will be understood that the scale 43 may be calibrated in terms of frequency or wave length. In this instance the scale 43 is helical in form. A pointer 44 is mounted on the housing 11 to cooperate with the indicia on the scale 43. Due to the helical lead of the scale 43, the pointer 44 remains opposite the scale as the dial is rotated to advance the screw 33.

In operation, the inductive element 13 of the wavemeter 10 is coupled to a resonant circuit or other element, the operating frequency of which is to be determined. This is done by holding the wavemeter 10 with its left hand end adjacent the coil or other inductive element of the resonant circuit. In this way, the slotted sleeve 13 is positioned in the magnetic field of the coil under test. The dial 38 is then adjusted until the wavemeter absorbs the maximum amount of energy from the circuit under test. The absorbtion of energy may be indicated in various ways, as will be understood by those skilled in the art. For example, if the device under test is an oscillator utilizing an electronic discharge device, the absorption of energy by the wavemeter may be manifested by the complete cessation of oscillations in the oscillator, or by a variation in the current to the grid or other electrode of the electron discharge device. In the typical oscillator, the grid current will drop when energy is absorbed from the oscillator by the wavemeter. It will be understood that the grid current may be measured by means of a suitable milliameter or the like. It will also be understood that rotation of the dial 38 advances the screw 33 through the split nut 34 and thereby moves the sleeves 25 and 26 in a longitudinal direction relative to the sleeve 13. Accordingly, the extent of telescopic engagement between the sleeve 13 and the sleeves 25 and 26 will be varied. The greater the extent of telescopic engagement, the greater will be the capacitance between the arms 16 of the inductance loop defined by the sleeve 13. It will be understood that the inductance provided by the slotted sleeve 13 is resonated by the capacitance between the arms 16. Accordingly, the resonant frequency of the wavemeter is varied by shifting the sleeves 25 and 26 longitudinally relative to the sleeve 13. The resonant frequency decreases progressively as the movable sleeves 25 and 26 are shifted into telescopic relation with the stationary sleeve 13. The tuning curve of the wavemeter is affected by the configuration of the sleeve 13 and the length of the sleeves 25 and 26. In the illustrated construction, the inner sleeve 25 is relatively long, with the result that it contributes capacitance between the arms 16 throughout the tuning range of the wavemeter. It will be understood that the capacitance afforded by the inner sleeve 25 increases progressively as the sleeve is moved into the slotted sleeve 13. The outer sleeve 26, being relatively short in this instance, comes into play primarily in the low frequency portion of the tuning range, as the sleeve 26 moves over the ends of the arms 16. The reduced width of the terminal portions 21 of the sleeve 13 affords a band-spreading effect, particularly at the high frequency end of the tuning range.

In Fig. 9 the inductance of the wavemeter, provided primarily by the slotted sleeve 13, is indicated by a lumped inductance coil 45, while the capacitances between the respective arms 16 and the capacitive tuning element 24 are represented by first and second variable capacitors 46 and 47 connected in series across the coil 45. This approximately equivalent schematic representation of the wavemeter illustrates the point that the capacitances between the arms 16 and the sleeves 25 and 26 are in series. Fig. 8 illustrates diagrammatically the capacitive relation between the capacitive tuning element 24 and the arms 16 of the U-shaped loop defined by the sleeve 13.

In view of the small size of the tuned circuit provided by the slotted sleeve 13 and the tuning sleeves 25 and 26, the wavemeter 10 may be employed effectively in cramped situations. Thus, the left hand or probe end of the wavemeter may be inserted into an extremely small opening and thus may be coupled closely to a coil or other tuned element which is relatively inaccessible. The tuned circuit of the wavemeter may be coupled to a circuit element of small size without being affected appreciably by electromagnetic fields or other adjacent elements. This is a matter of particular advantage in testing television tuners, in which the coils or other tuned elements are often small in size and closely spaced. Because of the length of the wavemeter, the left hand or probe end may be inserted into a deep opening to secure close coupling between a circuit under test and the tuned circuit of the wavemeter, while leaving the right hand or adjustment end of the wavemeter in a conveniently accessible position for easy operation. The wavemeter may be made any desired length simply by elongating the housing 11 and the insulating rod 31.

The helical form of the scale on the wavemeter dial provides great scale length in a small space. Since the pointer is stationary, while the scale is movable, the wavemeter may be read from a fixed angle. Accordingly, readings may be taken without moving the probe end of the wavemeter from the position of optimum coupling with the circuit under test.

By virtue of the stepped configuration of the slotted sleeve 13 and the difference in length of the inner and outer sleeves 25 and 26, the frequency scale or curve of the wavemeter may be made substantially linear. It will be recalled that the outer sleeve 26 is effective primarily at the low frequency end of the tuning range, while the reduced terminal ends 21 of the arm electrodes 16 provide band-spreading at the upper end of the tuning range. The capacitive relation between the movable sleeves 25 and 26 and the arms 16 eliminates any need for sliding contacts. Accordingly, the wavemeter is free from electrical noise.

The wavemeter may be coupled to a coil or other inductance element by positioning the sleeve 13 with the axis of the cutouts or windows 19 generally alined with the axis of the coil under test. In this way, the magnetic field from the coil will link the single turn loop provided by the sleeve 13. The wavemeter may be capacitively coupled to a circuit under test by placing one of the arm electrodes 16 adjacent a circuit element charged with a radio fraquency voltage.

Since the nut 34 preferably is made of an insulating material, there is no possibility that electrical noise will be introduced by sliding engagement between the nut and the screw 33. The spring loading of the split nut eliminates all backlash between the nut and the screw.

It will be observed that the dial or thimble 38 is provided with a large knob portion 48 for making a fine adjustment of the dial, together with a smaller, axially protruding knob 49 for spinning the dial when a more rapid adjustment is desired.

The wavemeter is small in size and light in weight and, accordingly, is easy to use and convenient to carry. Because of the simple, rugged construction of the wavemeter, there is little to get out of adjustment. Moreover, the wavemeter may be manufactured inexpensively.

Various modifications, alternative constructions and equivalents may be employed without departing from the true spirit and scope of the invention as exemplified in the foregoing description and defined in the following claims.

I claim:

1. An absorption type wavemeter, comprising an insulating elongated tubular generally cylindrical housing, an inductance element in the form of a conductive sleeve received within said housing adjacent one end thereof, said sleeve having a pair of diametrically opposite longitudinal slots formed therein and extending longitudinally

therealong part way from the end sleeve remote from said one end of said housing toward the end of said sleeve adjacent said one end of said housing, said slots defining a pair of opposed arm portions and an interconnecting ring portion extending between said arm portions at the end of said sleeve adjacent said one end of said housing, outer and inner movable tuning sleeves disposed in said housing, said arm portions of said first mentioned sleeve having reduced terminal elements telescopically received between said outer and inner sleeves, said ring portion being free of said tuning sleeves, an outer insulating bushing disposed between said outer sleeve and said reduced terminal elements, an inner insulating bushing disposed between said inner movable sleeve and said first mentioned sleeve, said outer and inner sleeves being conductively interconnected, and means for longitudinally moving said outer and inner sleeves to vary the extent to which said arm portions are received between said tuning sleeves and thereby vary the capacitances between said outer and inner sleeves and said arm portions, said means including an insulating rod connected to said movable sleeves and extending axially therefrom within said housing toward the end thereof opposite from said one end, a lead screw connected to the opposite end of said rod, a nut connected to said opposite end of said housing and in threaded engagement with said lead screw, a generally cylindrical dial telescoped over said opposite end of said housing and connected to said lead screw, said dial being manually rotatable to shift said movable sleeves, and a pointer element mounted on said housing and in indicating relation to said dial.

2. An absorption type wavemeter, comprising an insulating tubular housing, a U-shaped inductance element in the form of a conductive sleeve received within said housing adjacent one end thereof, said sleeve having a pair of diametrically opposite longitudinal slots formed in one end thereof and defining a pair of opposed arm portions on said sleeve and interconnected at one end by a bridge portion, interconnected outer and inner movable cylindrical tuning elements disposed in said housing, said arm portions being telescopically received between said outer and inner elements, said elements being free of said bridge portion, outer and inner insulating bushings disposed between said arm portions and said outer and inner elements, and means for longitudinally moving said outer and inner elements to vary the extent of telescoping between said cylindrical elements and said arm portions and thereby vary the capacitance between said arm portions, said means including a lead screw connected to said elements, a nut connected to said housing and in threaded engagement with said lead screw, a generally cylindrical dial telescoped over said housing and connected to said lead screw, said dial being manually rotatable to shift said movable elements, and a pointer element on said housing and in indicating relation to said dial.

3. An absorption type wavemeter, comprising an insulating elongated tubular generally cylindrical housing, an inductance element in the form of a conductive sleeve received within said housing adjacent one end thereof, said sleeve having a pair of diametrically opposite longitudinal slots formed therein and extending longitudinally therealong part way from the end of said sleeve remote from said one end of said housing toward the end of said sleeve adjacent said one end of said housing, said slots defining a pair of opposed arm portions on said sleeve and an interconnecting bridge portion extending between said arm portions, outer and inner movable tuning sleeves disposed in said housing, said arm portions being telescopically received between said outer and inner sleeves, said tuning sleeves being free of said bridge portion, an outer insulating bushing disposed between said outer sleeve and said arm portions, an inner insulating bushing disposed between said inner movable sleeve and said arm portions, and means for longitudinally moving said outer and inner sleeves to vary the capacitances between said outer and inner sleeves and said arm portions, said means including an insulating rod connected to said movable sleeves and extending axially therefrom within said housing toward the end thereof opposite from said one end, a lead screw connected to the opposite end of said rod, a nut connected to said opposite end of said housing and in threaded engagement with said lead screw, a generally cylindrical dial telescoped over said opposite end of said housing and connected to said lead screw, said dial being manually rotatable to shift said movable sleeves, and a pointer element mounted on said housing and in indicating relation to said dial.

References Cited in the file of this patent

UNITED STATES PATENTS

2,575,199	Stutt	Nov. 13, 1951
2,606,315	De Tar	Aug. 5, 1952
2,681,999	Boothby	June 22, 1954
2,710,379	Lubben et al.	June 7, 1955