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MEANS FOR METERING HIGH-FREQUENCY CURRENT

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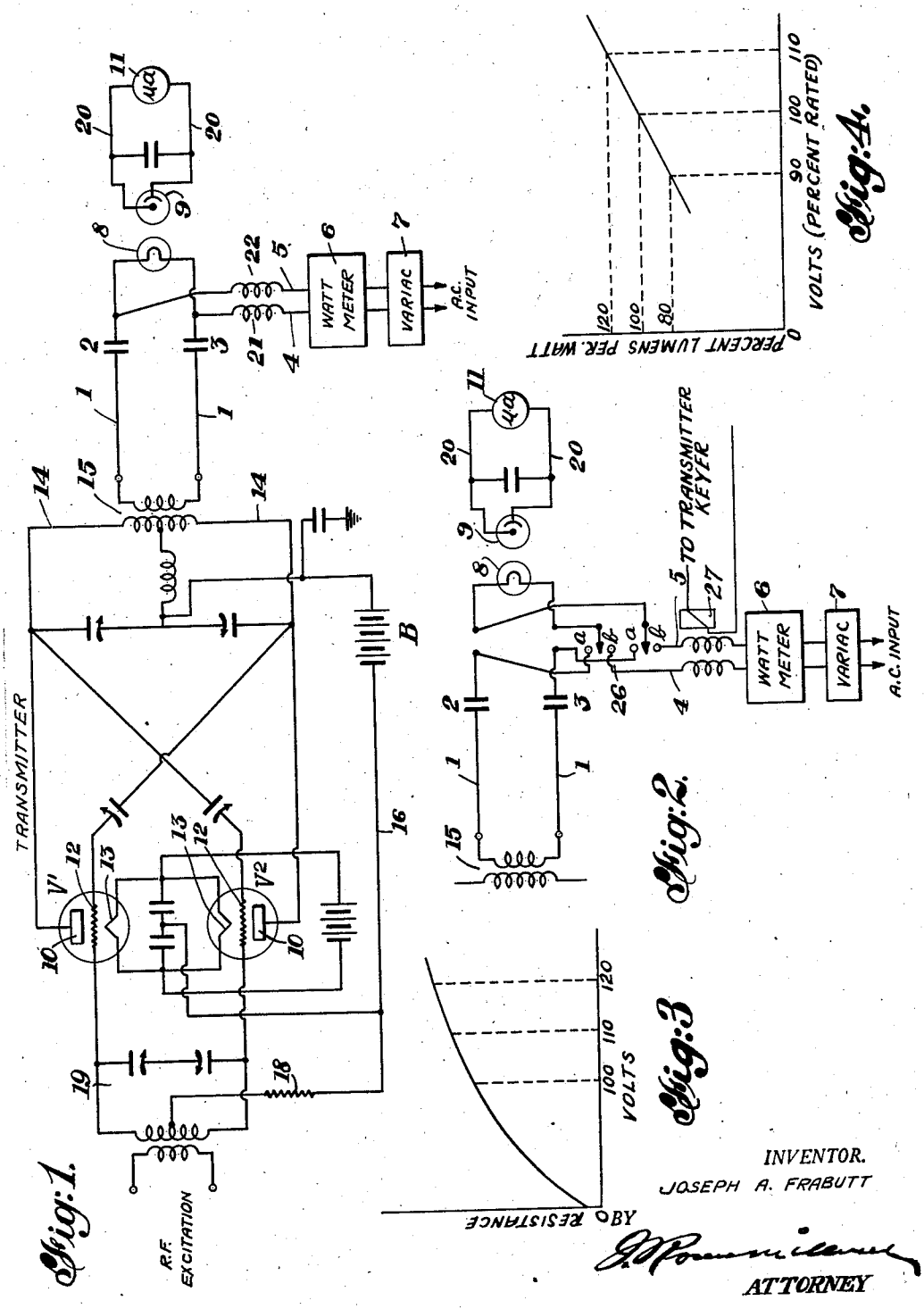


Fig. 1.

Fig. 2.

Fig. 3

Fig. 4.

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MEANS FOR METERING HIGH-FREQUENCY CURRENT

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6 Claims. (Cl. 171—95)

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This invention relates to an improved method of metering high frequency current. It includes a simplified electro-responsive means therefor adapted for the metering of high frequency current consumption with a materially greater degree of accuracy than has been heretofore attained.

A method as heretofore proposed for the metering of high frequency current supply employs a lamp energized by the H. F. current in conjunction with a photo-electric cell and circuit to micro-ammeter wherein the incandescent lighting of the lamp in response to the current magnitude determines the reading of the ammeter. This method, however, has been found to have an objectionable variable factor incident to the changing resistance value of the lamp filament responsive to the heat condition thereof. This factor is of considerable importance particularly in ultra-high frequency ranges because of impedance relations between the source, the lamp filament and the coupling line therebetween, for the filament being the load resistance terminating the line is too variable if worked over its full range of temperature and resistance to permit adjustment and maintenance of proper power transmission from the source to the load.

In accordance with the present improvements a higher degree of accuracy in the metering of the high frequency current output is obtained by the energizing of the lamp from the H. F. source or transmitter and likewise from a supplemental low frequency source of constant value, the function of which is to maintain the lamp filament in a constantly heated condition so as to operate in a limited heating range to have substantially uniform resistance values or a substantially flat resistance curve, i.e. showing the resistance substantially independent of the temperature.

A preferred embodiment of the improved circuit arrangement for the high frequency current metering or calibration by the improved method, with associated metering and protective or auxiliary devices employed is shown in the drawing herewith.

Fig. 1 shows the final stage of a radio transmitter connected to use the metering method according to this invention; and

Fig. 2 shows a modified metering circuit used in case it is necessary to key the transmitter or any source of radio frequency supply connected to be metered.

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Figures 3 and 4 show graphs of certain characteristics of a lamp filament.

In Figure 1 I have shown a complete system illustrating the improvement of my invention. In this system at the left there is shown a source of high frequency currents, a portion of a radio transmitter and in particular the high power amplifier which is of the push-pull type and comprises two electron tubes V1 and V2. These tubes have the usual anodes 10, grids 12 and filaments or cathodes 13. The tubes are supplied by the usual anode battery connected in the neutral line. In the input circuit, there is a resonant circuit 19 and in the output circuit the transformer 15 whose primary leads are connected to the respective anodes over lines 14. For the purposes of my invention this source of high frequency current could be replaced by any other equivalent source.

In accordance with this invention an incandescent lamp 8 is connected to the secondary of the transformer 15 by line 1—1 and in optical relation with this lamp there is a photo-electric cell 9 whose circuit is connected by lines 20—20 to a micro-ammeter 11. Across this connection is a by-pass condenser. In the arrangement thus far described the high frequency output current of the transmitter will by heating of the lamp filament and excitation of the photo-electric cell show an indication on the micro-ammeter of the current flow responsive to the light intensity from the lamp filament. This indication however is varied not only proportionately to the variation of current magnitude but likewise with relation to the changing resistance value of the lamp filament, the latter having non-uniform rate of change at lower temperature as related to the rate of change in a lower temperature range. The effect of this condition is to make it difficult to determine the H. F. output with the desired high degree of accuracy.

As a feature of the present invention special provision is made to maintain the lamp filament heated within a high temperature range during operation, thus to confine its action within a range of temperature wherein the temperature coefficient of resistance curve is substantially level and the resistance change is substantially proportionate to change of current flow, i. e. independent of temperature changes. This is effected by the employment of circuit connections for lamp excitation from an external low frequency source and which is further accompanied by the inclusion in the external cir-

cuit of a watt meter for indication of its power which can be used comparatively to calibrate the lamp load so that the micro-ammeter reading will vary over a suitably narrow range.

As shown the external current source is fed to the lamp by leads 4—5 from a low frequency A. C. source, through the variac, or adjustable voltage transformer 7 and through a suitable watt meter 6. In series with the leads between the watt meter and the high frequency leads there are provided the high frequency choke coils 21—22 protectively to prevent the high frequency current feeding back into the low frequency lines. Similarly, series capacitors 2—3 are included in the H. F. leads 1—1 to prevent feed back of the low frequency current into the H. F. transmitter.

As is well known an incandescent lamp filament such as that made from tungsten has a positive temperature coefficient of resistance so that in a temperature range as used for lighting its resistance is high. In the design of such lamps they are given a rated voltage and in operation the voltage is somewhat critical. In Figure 3 there is shown a graph which will serve to illustrate in a typical way the resistance-voltage characteristic of a tungsten filament in the vicinity of the operating voltage range, say of a lamp whose voltage has a 110 rating. As indicated, the characteristic has become flatter and straighter than in the lower heat and voltage ranges, that is the characteristic at this range approaches linearity and the rate of change of resistance is lower. In Figure 4 a similar graph illustrates the characteristic between lumens per watt and the voltage herein. The figures for vertical coordinates indicate in some cases valuations of greater range of lumens relatively to the voltage changes. This relation is of advantage in producing correspondingly greater spread in the effects on the ammeter. It will thus be seen from the characteristic of such lamps that it is possible to confine the power measurements over a relatively narrow operating range where the change in values is nevertheless of substantial scope and still the resistance change is relatively small. My invention is so arranged so as to take advantage of these relations.

In the operation of the described metering circuit arrangement:

The variac may be used to adjust the potential of the external low frequency or complemental current supply so that the lamp will be constantly lighted by energizing from either or both of the current supply sources dependent on the high frequency transmitter output; and

The low frequency feed to the lamp shall occur only under conditions of deficiency of the high frequency input and it shall be sufficient for the determined or required heating of the lamp filament to make up the deficiency. Accordingly, as the low frequency input is indicated by the watt-meter 6 and the total current supply is indicated by the calibrated micro-ammeter 11, computation by deduction of the watt-meter reading from the micro-ammeter reading will indicate the high frequency output at any given time. It is of course understood that in making such computation the microammeter under an assumed voltage level could be calibrated to read in watts. From the foregoing it is obvious that in one mode of operation of my device a low frequency A. C. source serves to keep the lamp filament heated to the proper range of temperature as well as resistance and that under an

estimated high frequency power output and after its simulation by the low A. C. power adjustment, proper line impedance adjustments between high frequency source and lamp filament can be made suitable for that resistance range.

In Fig. 2 there is shown a modified arrangement which is used when it is necessary to key the transmitter. The arrangement corresponds generally to the first described arrangement but includes a relay switch 26 the coil 27 of which is energized by a keyer (not shown) in the transmitter circuit for opening the complemental or external feed circuit to the lamp load in response to the keying operation to avoid a chirping signal resulting from variation of the lamp load.

In position *a* the lamp is energized by the transmitter. In position *b* the lamp is energized by the external A. C. source.

What is claimed is:

1. In a high frequency energy metering system, a high frequency transmitter, a metering circircuit in series with the transmitter output, a filament lamp energized by the metering circuit, a photo-electric cell energized by the light from the lamp, a micro-ammeter connected in circuit relation to the photo-electric cell, an external current source connected to feed a complemental current to the metering circuit to bring the heating of the lamp filament to within a predetermined temperature range, a metering device connected to meter the complemental current supply and filtering means to prevent high frequency from entering said metering device.

2. In a high frequency energy metering system, a high frequency transmitter, a metering circuit in series with the transmitter output, a filament lamp in series with the metering circuit, a photo-electric cell energized by the light of the lamp, a micro-ammeter connected in circuit with the photo-electric cell, an external low frequency current source connected to feed a complemental current supply to the metering circuit to bring the heating of the lamp filament to within a predetermined temperature range, the connections from said external source including a voltage control transformer, a watt meter and high frequency filtering means interposed between the metering circuit and the watt meter, and low frequency filtering means interposed between the metering circuit and the transmitter.

3. In a high frequency energy metering system, a high frequency transmitter, a metering circuit in series with the transmitter output, a filament lamp in series with the metering circuit, a photo-electric cell energized by the light of the lamp, a micro-ammeter connected in circuit with the photo-electric cell, an external low frequency current source connected to feed a complemental current supply to the metering circuit to bring the heating of the lamp filament to within a temperature range in which the resistance of the filament is approximately independent of the temperature, the connections from said external source including a voltage control transformer, a watt meter and high frequency choke coils interposed between the metering circuit and the watt meter, and condensers interposed between the metering circuit and the transmitter.

4. A system for metering electric energy from a high frequency source comprising a predominantly resistive load for transforming electric energy into radiant energy, means for impressing said high frequency energy upon said load, means for impressing electric energy from a conven-

tional power source upon said load, means for metering said energy from said conventional power source, means for metering the total radiant energy emitted by said load and means for adjusting one of the levels of electric energy to bring the radiant energy emitted by said load within a predetermined calibrated range whereby the amount of high frequency energy may be readily computed.

5. A system for metering the electric energy from a high frequency source comprising an incandescent lamp, means for impressing said high frequency energy upon said lamp, means for impressing electric energy from a conventional power source upon said lamp, means for metering said second-named electric energy, means for metering the light emitted from said lamp and means for adjusting one of the levels of energy to bring the light emitted by said lamp within a predetermined calibrated range.

6. A system for metering electric energy from a high frequency source which comprises an incandescent lamp having a metallic filament,

means for impressing electric energy from a conventional power source upon said lamp, means for superimposing high frequency energy upon said lamp, means for metering the electric energy from said conventional source, means for metering the light energy emitted by said lamp, and means for adjusting the amount of energy from said conventional source to bring the light emitted by said lamp within a predetermined calibrated range.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,240,955	Mittelmann	May 6, 1941
1,901,741	Fetsch, Jr.	Mar. 14, 1933
1,590,420	Chubb	June 29, 1926
2,081,839	Rankin	May 25, 1937