

May 15, 1928.

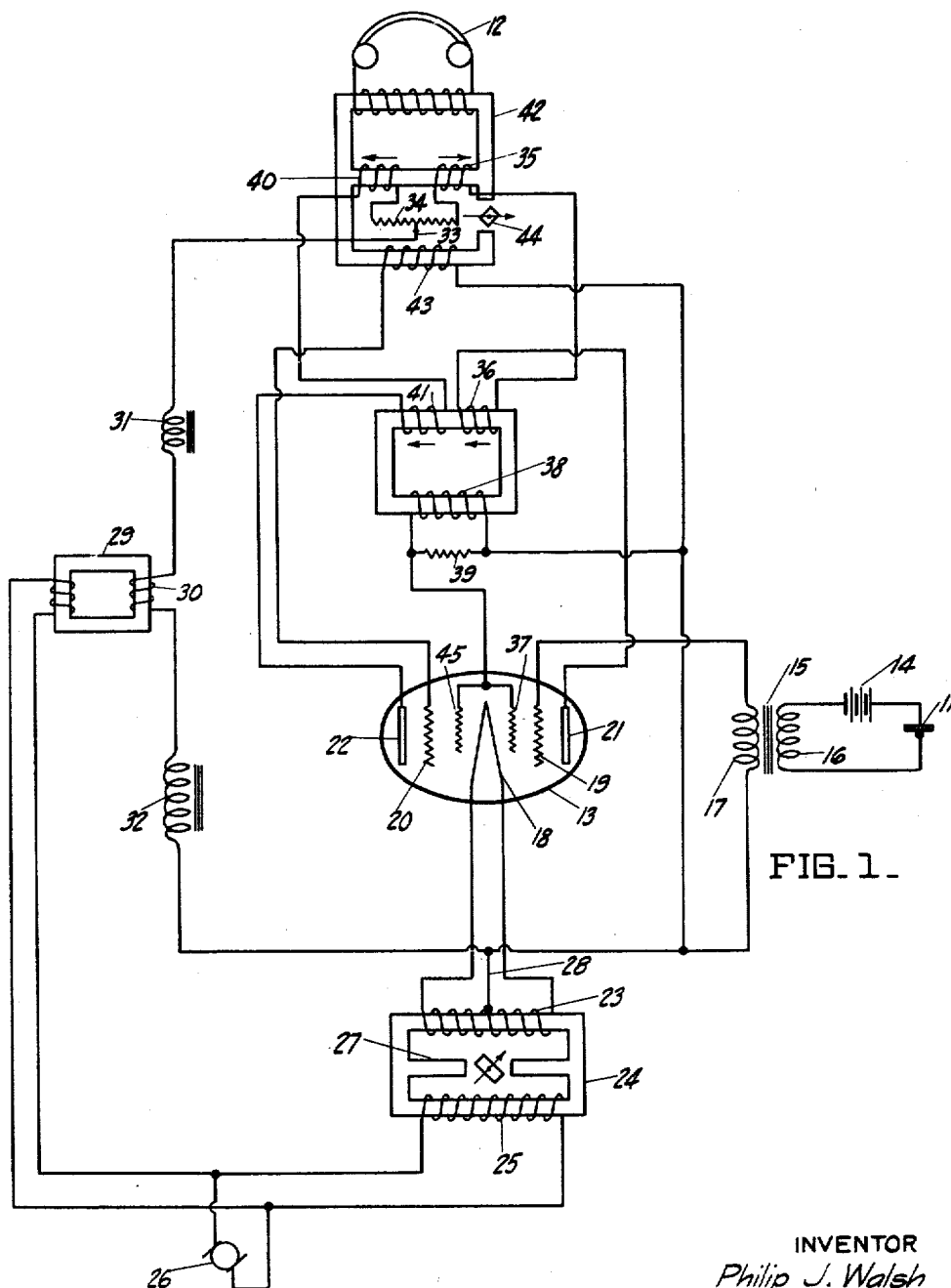
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P. J. WALSH

PULSATION COMPENSATOR

Filed Feb. 23, 1926

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

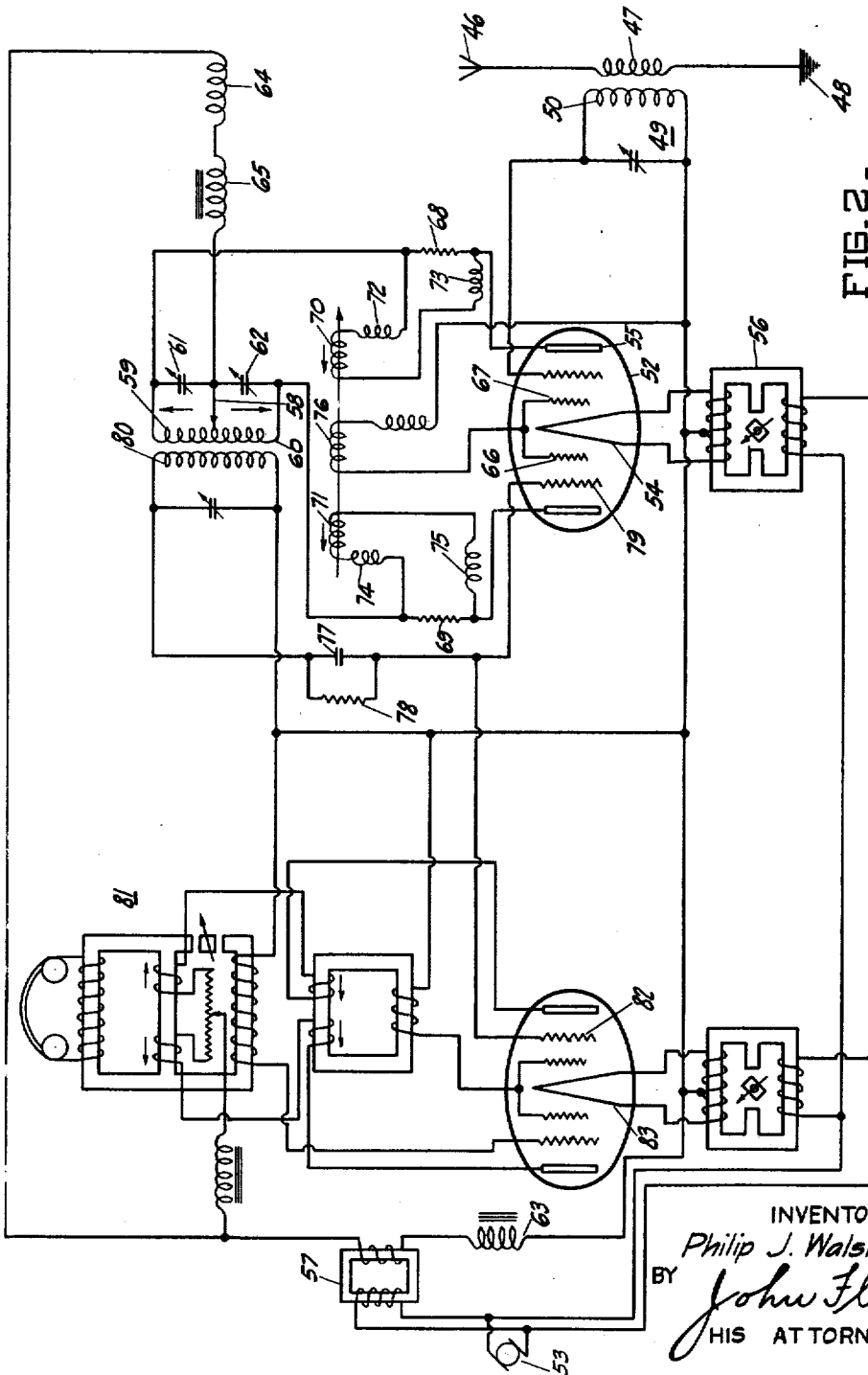


FIG. 2 -

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PULSATION COMPENSATOR.

Application filed February 23, 1926. Serial No. 89,975.

This invention relates to a scheme in which electronic emission devices, such as audions, are utilized. Such devices find their greatest commercial application in the field of radio, since a large majority of receiving sets now use one or more such tubes as amplifiers and as detectors.

It is common, in such devices, to use batteries as the source of electrical energy for heating the filament (which is the electron emitting element) as well as for impressing a positive potential on the plate where the electrons are received. It is well-known that the electron flow from the filament to the plate, forming the "space current" can be varied to a large extent by varying the potential of a point between these two electrodes; and this is accomplished by the aid of a control electrode, usually in the form of a grid spaced close to the filament. It is due to this feature that the amplifying effect is secured.

It has been proposed to utilize commercial sources of electrical energy, such as direct or alternating current generators for the filament and plate voltage; but in such cases, it is evident that the pulsations due to commutator ripple, or to the variations of the alternating current, are reflected in the system so as to cause an annoying hum in the output of the system. This effect is noticed loudly in either radio frequency systems or in audio frequency systems. Due to it, the application of commercial power, or forms other than of batteries, has been very limited indeed.

I am aware that there are various forms of converters now on the market, intended to overcome this disadvantage; but I believe they either operate imperfectly, or else they are complex and therefore expensive. It is accordingly one of the objects of my invention to make it possible to compensate for the hum or pulsations in a system of this character, in a novel and inexpensive manner.

It is another object of my invention to provide a system in which the effect of the current pulsations is compensated in the tube itself, as by the aid of additional electrodes.

My invention possesses many other advantages, and has other objects which may be made more easily apparent from a consid-

eration of several embodiments of my invention. For this purpose I have shown a few forms in the drawings accompanying and forming part of the present specification. I shall now proceed to describe these forms in detail which illustrate the general principles of my invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of my invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a schematic wiring diagram of an audio frequency system of signaling utilizing my invention; and

Fig. 2 is a wiring diagram of a modified form, involving the use of radio frequency as well as audio frequency.

In Fig. 1 there is illustrated a telephone system using a transmitter 11, for affecting a telephone receiver 12, at the top of the figure. A thermionic device 13 is used in a manner to be hereinafter described, to amplify the impulses generated by the transmitter 11 in a circuit including the transmitter and a source 14 of steady direct current potential. As the transmitter 11 is operated, these impulses in its local circuit are generated in a well-known manner; and in order to transmit these impulses to the amplifying devices, a transformer 15 is utilized, having its primary coil 16 in closed circuit with transmitter 11, and its secondary coil 17 connected to the input terminals of the thermionic device 13.

This device in the present instance is shown as of the double type; that is, while it has but a single heated filament 18, yet it has a pair of control grids 19 and 20, one on each side of the filament, and controlling respectively the flow of electrons to the plates 21 and 22. Of course there could be substituted for this double device, a pair of devices, and such substitution is obvious. The filament 18 is fed from the secondary coil 23 of a transformer 24, the primary 25 of which is connected to a conventional type of alternator 26. This alternator can deliver current of about 500 or 1000 cycles, although lower frequencies could be utilized. In order to regulate the effective current applied to the filament, the transformer 24 has a shunt path 27 of adjustable magnetic reluctance for the flux set up by the primary 25, whereby

an adjusted amount of this flux is permitted to thread the coil 23.

The secondary coil 17, which receives the impulses to be amplified, has one of its terminals connected to the filament, by way of a centre connection 28 on coil 23, and has its other terminal connected to the control electrode 19. In this way the impedance of the electron path between filament 18 and plate 21 is controlled in accordance with the received impulses.

The potential for plate 21 is also derived from alternator 26, and through a transformer 29. The secondary coil 30 of this transformer has a pair of heavy choke coils 31 and 32 connected with it in series. Since the space current between plate 21 and filament 18 can flow only in one direction, it is seen that only half-cycles of current are permitted to pass through coils 31 and 32; and since these coils are of high inductance, these half-cycles are more or less merged together to form a pulsatory direct current.

In the present instance the complete circuit for the space current can be thus traced: from plate 21, filament 18, coil 23, connection 28, coils 32, 30, and 31, a tap 33 on a resistance 34, the right hand portion of this resistance, coil 35, coil 36, back to plate 21. The purpose of coils 35 and 36 will be hereinafter explained.

For the present, let us confine our attention to the effect of the pulsations due to the use of the alternator 26. In the first place, due to it supplying the filament current, the filament temperature is caused to vary, with attendant variations in space current impedance. When the temperature increases, the impedance decreases, unless compensated for; and vice versa. To secure this compensation, an auxiliary control electrode or grid 37 is placed between the filament 18 and plate 21, which is caused to increase the impedance of the tube space when the filament current increases, and vice versa. The manner in which this is accomplished will now be described.

Coil 36 is inductively coupled with a coil 38, shown as bridged by a high resistance 39. When the filament temperature increases, causing a momentarily increased flow in the output circuit traced, an E. M. F. is of course induced in coil 38. This E. M. F. can be applied in such manner between grid 37 and filament 18, that the grid is given a negative charge, thereby increasing the impedance of the space between filament 18 and plate 21, and restoring the space current flow to normal. For effecting this result, the coil 38 is connected as shown between grid 37 and filament 18. Upon a decrease of filament temperature, the reverse process is accomplished, and grid 37 is charged positive, decreasing the space current impedance. It is also evident that

fluctuations in the space current flow due to the use of coil 30 as the source of plate potential can be similarly compensated for.

Up to now, our discussion has been confined to a condition where no impulses are being received in coil 17. With no further provisions, it is evident that fluctuations in the space current caused by these signal impulses would also be wiped out by the compensating effect of grid 37; and thus it is necessary to provide an arrangement whereby the system discriminates against such signals so as to permit them to persist, and to affect the phones 12.

It is for this purpose that the additional elements are added. The space current flow from filament 18 to plate 22 is likewise furnished by the same source 26, in parallel with the other space current. The circuit can be traced as follows: from plate 22, filament 18, coil 23, connection 28, coils 32, 30, and 31, tap 33, left hand portion of resistance 34, coil 40, coil 41, back to plate 22. The coils 40 and 35 are opposed; and are coupled on a common core 42. The tap 33 is provided so as to balance these two coils exactly when no signals are received. Resistance 34 can be of the order of one or two hundred ohms. Furthermore, due to chokes 31 and 32, the supply of current from coil 30 is a pulsatory direct current, the effective value of which is substantially constant; so that when signals are transmitted and the space current from filament 18 to plate 21 is varied, thus causing a corresponding variation in current in coil 35, then the effective current flowing in coil 40 is oppositely varied, for their effective sum must be a constant, although momentarily there are fluctuations.

It thus comes about that the coils 35 and 40 are unbalanced when signals are received, and cause the generation of a substantial E. M. F. in coil 43, placed on the same core 42 as coils 35 and 40. The degree to which coil 43 is affected is controlled by the aid of a rotatable armature 44 placed in a gap in core 42 whereby the reluctance of that part of the core coupling the coil 43 to the other two, can be varied. The coil 43 is used to accentuate the unbalance by affecting the impedance of the path between filament 18 and plate 22. This is done by connecting one terminal thereof to filament 18, and the other to the control grid 20. The phone 12 is inductively coupled to coils 35 and 40 so as to be operated in accordance with this unbalance. Further description of the operation of this part of the invention is considered unnecessary, for it is described and claimed in my Patent No. 1,594,582, issued August 3, 1926, and entitled "Amplifier system."

The compensation for the unavoidable pulsations is effected, in a manner now to be

described, by coupling coils 41 and 36 in such manner that they are cumulative. Coil 38 furthermore affects second auxiliary grid 45 interposed between filament 18 and plate 22.

Now let us again assume that no impulses are being transmitted by coil 17 to the system. Pulsations due to variations in E. M. F. in coil 30, cause equal variations in the effective value of the two space currents; therefore coils 35 and 40 are maintained in balance, although not exactly neutralized at each instant. Nevertheless, the currents through coils 41 and 36, which are cumulatively wound, are varied, which in turn affect coil 38 and thereby grids 37 and 45 to return the space current flow to normal. Variations in filament temperature similarly cause no unbalance between coils 35 and 40, but they do vary the current flow through coils 36 and 41, and consequently affect coil 38 and grids 37 and 45. Of course coil 38 must be properly connected in order to secure proper compensation instead of an increased variation from normal of the space currents.

Now let us assume that coil 17 passes impulses to the system. Due to coils 41 and 36, these impulses have no effect upon grids 37 and 45, as can readily be demonstrated. For each increase in current flow in coil 36 (which is the equivalent of an increase in space current between filament 18 and plate 21), there must be a corresponding and equal decrease in current in coil 41 (which is the equivalent of a decrease in space current between filament 18 and plate 22), due to the constant nature of the effective current fed from coil 30. Accordingly the sum of the magnetic effects of coils 36 and 41 due to signaling impulses, is always constant; and it is only the undesired pulsations which cause this sum to vary. Therefore grids 37 and 45 have their potentials varied only when the filament heat varies, or when the current in coil 30 varies.

It is found that with the aid of my invention, substantially no pulsations are heard in phones 12 due to the use of a pulsatory current in the system. The cancellation or compensation of the pulsations is accomplished even though the system operates to affect the space currents respectively between filament 18 and plate 21, and between filament 18 and plate 22, in opposite direction; for when these space currents are unequal, due to a signaling impulse, the same potential on grids 37 and 45 cause unequal changes in the impedances in the space current path, and compensates for the unequal changes caused in these paths by the filament and plate ripple.

The compensating actions set forth have been somewhat generalized; as a matter of fact, they take place immediately upon in-

ipient parasitic fluctuations, so as to check them at the start. The phase relations by proper connection could readily be shown to be such as to affect this result. The ultimate function of the system is a periodic variation in the potential of grids 37 and 45, in step with the incipient fluctuations, and of the same frequency as the source of supply 26.

In Fig. 2, I show substantially the same scheme applied to a radio frequency receiving and amplifying system. An absorbing circuit is shown, consisting of elevated conductors 46, loading coil 47, and a ground connection 48. A tunable circuit 49 is inductively coupled with the coil 47, as by the aid of the inductance coil 50 forming part of the circuit, the other part being a variable condenser 51.

The signaling impulses received affect a thermionic device 52 in a manner entirely similar to that described in connection with device 13 of Fig. 1. A source 53 of alternating current supplies the filament 54 with current as well as potential to the plate 55. A transformer 56, similar to transformer 24 of Fig. 1, is used to transmit the energy to the filament; and a transformer 57, similar to transformer 29 of Fig. 1, is used to transmit plate current to the device 52. The plate current as before, divides at tap 58 between a pair of opposed coils 59 and 60. These coils are the equivalent of coils 35 and 40 in Fig. 1, except that, dealing with radio frequencies, they are air cored, and may be tuned by variable condensers 61 and 62. Chokes 63, 64, and 65 serve effectively to subdue violent pulsations, while grids 66 and 67 serve as before to compensate for the pulsations that persist due to the alternations of source 53.

Coils 59 and 60 are included respectively in the two plate circuits as before; they include however, resistors 68 and 69 which are bridged by the air cored coils 70 and 71. These coils are cumulatively associated, and are the equivalents of coils 36 and 41 of Fig. 1. To prevent parasitic capacitative effects, radio frequency chokes 72, 73, 74 and 75 are included in the circuits of coils 70 and 71. Coil 76 is inductively associated with coils 70 and 71, and affects the grids 66 and 67 in the same way as coil 38 affects grids 37 and 45 in Fig. 1. The operation of the system so far as compensation is concerned is obviously similar to that of Fig. 1.

Instead of affecting a phone such as 12 of Fig. 1, however, in the present system a detector effect is secured by including a grid condenser 77 and a high resistance leak 78 across it, in the circuit of grid 79, which is the equivalent of grid 20 in Fig. 1. By the aid of this arrangement, only rectified half-waves of the carrier frequency cur-

rent are allowed to flow in the circuit external to coil 80, which is the equivalent of coil 43 in Fig. 1.

These detected waves can be passed to an audio frequency amplifier system 81 entirely similar to the system illustrated in Fig. 1, and therefore requiring no detailed description. It is sufficient merely to state that the grid 82, corresponding to grid 19 of Fig. 1, is connected to grid 79; and that the other input electrode (filament 83) is connected to filament 54. It is thus seen that the grid 79 and filament 54 replace the two terminals of coil 17 in Fig. 1.

I claim:

1. In combination, an electronic emission device having an electron emitting electrode, and a plate electrode, means for imposing a potential upon the plate electrode that is positive with respect to the electron emitting electrode, said means having a variable potential, means operating in response to the size and direction of the current variations due to variations in said potential to affect the space between the electron emitting electrode and the plate in such a sense as to tend to maintain the space current constant in spite of said variations, and means cooperating with said affecting means for allowing impedance variations in the path to vary the current in said path.

2. In combination, an electronic emission device having an electron emitting electrode, and a plate electrode, a circuit connecting said electrodes, said circuit including a source of variable potential for impressing a potential upon the plate electrode that is positive with respect to the electron emitting electrode, means affecting the impedance of this circuit in response to each variation of current due to variations in said potential, in such a sense as to tend to maintain the space current constant in spite of the fluctuations, other means causing additional variation in impedance in the space between the electrodes, and means cooperating with said affecting means and operating in response to such variations in impedance for allowing the impedance variations to affect the current flow in said circuit.

3. In combination, an electronic emission device having an electron emitting electrode and a plate electrode, a circuit connecting said electrodes, said circuit including a source of potential for impressing a positive potential on the plate with respect to the electron emitting electrode, another circuit paralleling said electrode connecting circuit, means for varying the impedance of the path between the two electrodes, and means associated with both of said circuits for additionally varying said impedance but active only when there are current fluctuations in the same direction in both circuits.

4. In combination, an electronic emission device having an electron emitting electrode and a plate electrode, a circuit connecting said electrodes, said circuit including a source of potential for impressing a positive potential on the plate with respect to the electron emitting electrode, another circuit connected in parallel with said electrodes and supplied by said source, means for oppositely varying the impedances of the paths in the two circuits, and means responsive only to like fluctuations in both paths for additionally varying said impedances.

5. In combination, a thermionic device having a filament adapted to be heated for causing it to emit electrons, and a plate electrode, a circuit connecting said electrodes, a source of fluctuating potential connected to the filament for heating it, means operating in response to the size and direction of the variations in current due to variations in said potential to affect the space between the filament and plate, in such a sense as to tend to maintain the space current constant in spite of said variations, and means cooperating with said affecting means for allowing impedance variations in the path to vary the current in said path.

6. In combination, a thermionic device having a filament adapted to be heated for causing it to emit electrons, and a plate electrode, a circuit connecting said electrode, a source of fluctuating potential connected to the filament for heating it, means affecting the impedance of this circuit in response to each variation of current due to variations in said potential, in such a sense as to tend to maintain the space current constant in spite of the fluctuations, other means causing additional variation in impedance in the space between the electrodes, and means cooperating with said affecting means and operating in response to such variations in impedance for allowing the impedance variations to affect the current flow in said circuit.

7. In combination, an electron emission device having an electron emitting electrode, a plate electrode, a circuit connecting the plate electrode and the electron emitting electrode, including a source of potential, another circuit paralleling said plate and electron emitting electrode and supplied from said source, means whereby signaling impulses impressed upon the input side of the device causes opposite variations in the impedance of the two circuits, and means whereby pulsations originating in the combination but from causes other than said impulses are minimized, comprising a pair of cumulatively wound coils, one in each of said two circuits, and controlling means operating in accordance with the changes in the combined effect of said coils.

8. In combination, a pair of circuits, each

including a space current path formed between a source of electrons and a plate electrode, said plate and source of electrons forming a part of the circuit, a common
 5 source for said circuits, means whereby the impedances of the space current paths can be oppositely varied, and means whereby undesired pulsations originating in the combination are minimized, comprising a pair of
 10 cumulatively wound coils, one in each circuit, and means responsive to the changes

in the combined effect of said coils for varying the impedance of said space current paths.

9. The combination as set forth in claim 15 8, in which the impedance varying means are control electrodes interposed in the space currents.

In testimony whereof I have hereunto set my hand.

PHILIP JOHN WALSH.

DISCLAIMER

1,669,958.—*Philip John Walsh*, San Francisco, Calif. PULSATION COMPENSATOR.
 Patent dated May 15, 1928. Disclaimer filed February 29, 1932, by the patentee.

Therefore, as regards claim 1, hereby disclaims from the scope of this claim, any interpretation of the word "path" in line 15 and also in line 16 of that claim, other than that it refers to a path including the electron emitting electrode and the plate electrode; further, your petitioner disclaims from the scope of claim 1, any combination of elements in which the element:—"means operating in response to the size and direction of the current variations due to variations in said potential to affect the space between the electron emitting electrode and the plate in such a sense as to tend to maintain the space current constant in spite of said variations" comprises a circuit operating merely by frequency discrimination to obtain electrical effects corresponding to the current variations referred to in this element.

As regards claim 2, your petitioner hereby disclaims from the scope thereof, any combination of elements in which the element:—"means affecting the impedance of this circuit in response to each variation of current due to variations in said potential, in such a sense as to tend to maintain the space current constant in spite of the fluctuations" comprises a circuit operating merely by frequency discrimination to obtain electrical effects corresponding to the variations of current referred to in this element.

As regards claim 5, your petitioner hereby disclaims from the scope thereof any interpretation of the word "path" in line 14 and also in line 15 of this claim, other than that it refers to a path including the electron emitting electrode and the plate electrode; further, your petitioner disclaims from the scope of claim 5, any interpretation of the words "variations in current" in line 8 of this claim, other than variations in the space current referred to in line 11 of this claim.

As regards claim 6, your petitioner hereby disclaims from the scope thereof, any interpretation of the element "a circuit connecting said electrode" other than a circuit connecting the filament and the plate electrode; further, your petitioner disclaims from the scope of claim 6, any interpretation of the words "variation in current" in line 8 of this claim, other than variations in the space current referred to in line 10 of this claim.

[*Official Gazette March 22, 1932.*]

including a space current path formed between a source of electrons and a plate electrode, said plate and source of electrons forming a part of the circuit, a common
 5 source for said circuits, means whereby the impedances of the space current paths can be oppositely varied, and means whereby undesired pulsations originating in the combination are minimized, comprising a pair of
 10 cumulatively wound coils, one in each circuit, and means responsive to the changes

in the combined effect of said coils for varying the impedance of said space current paths.

9. The combination as set forth in claim 15 8, in which the impedance varying means are control electrodes interposed in the space currents.

In testimony whereof I have hereunto set my hand.

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As regards claim 2, your petitioner hereby disclaims from the scope thereof, any combination of elements in which the element:—"means affecting the impedance of this circuit in response to each variation of current due to variations in said potential, in such a sense as to tend to maintain the space current constant in spite of the fluctuations" comprises a circuit operating merely by frequency discrimination to obtain electrical effects corresponding to the variations of current referred to in this element.

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As regards claim 6, your petitioner hereby disclaims from the scope thereof, any interpretation of the element "a circuit connecting said electrode" other than a circuit connecting the filament and the plate electrode; further, your petitioner disclaims from the scope of claim 6, any interpretation of the words "variation in current" in line 8 of this claim, other than variations in the space current referred to in line 10 of this claim.

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