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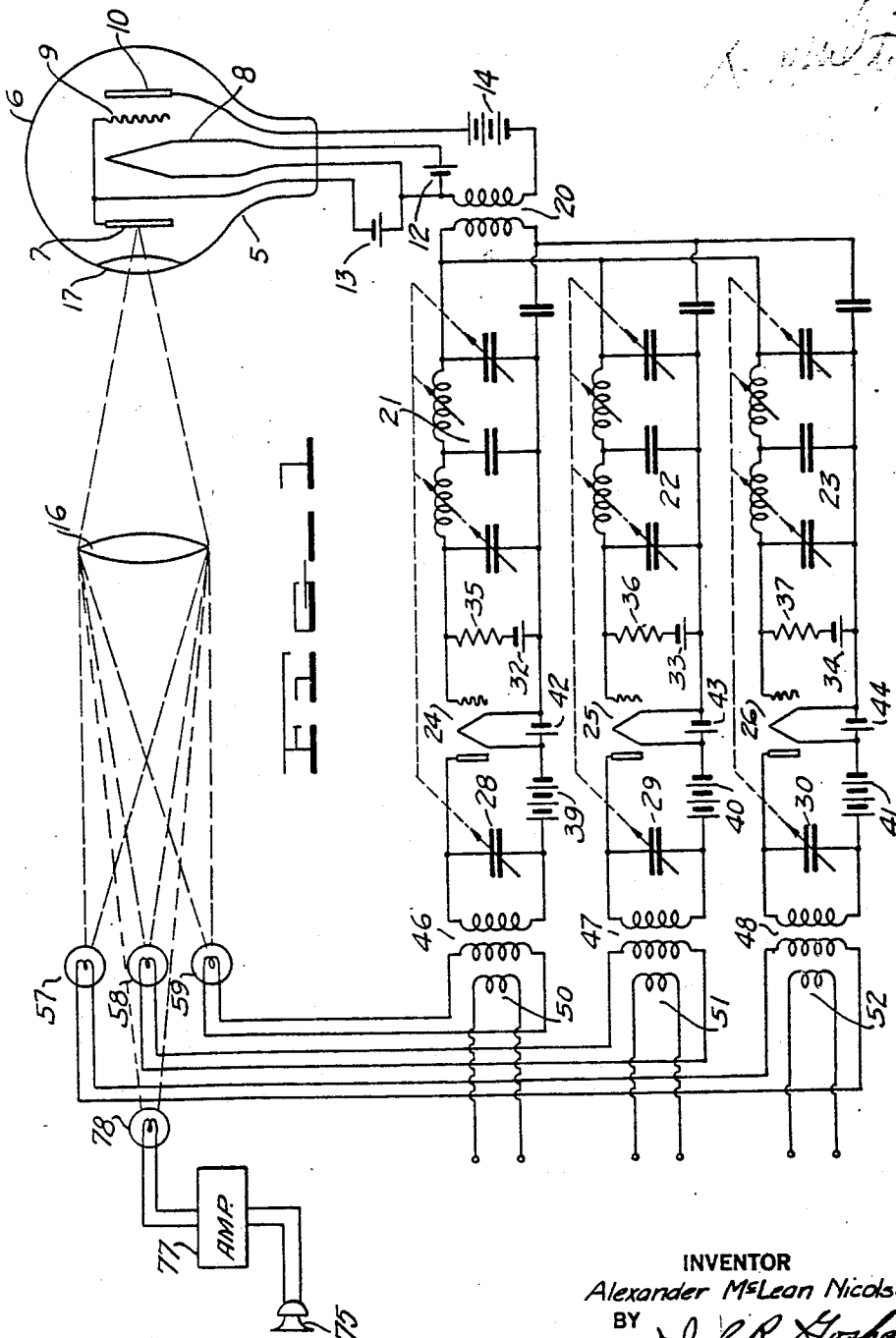
A. McL. NICOLSON

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PHOTO OSCILLATOR MODULATOR SYSTEM

Filed Oct. 17, 1930

2 Sheets-Sheet 1



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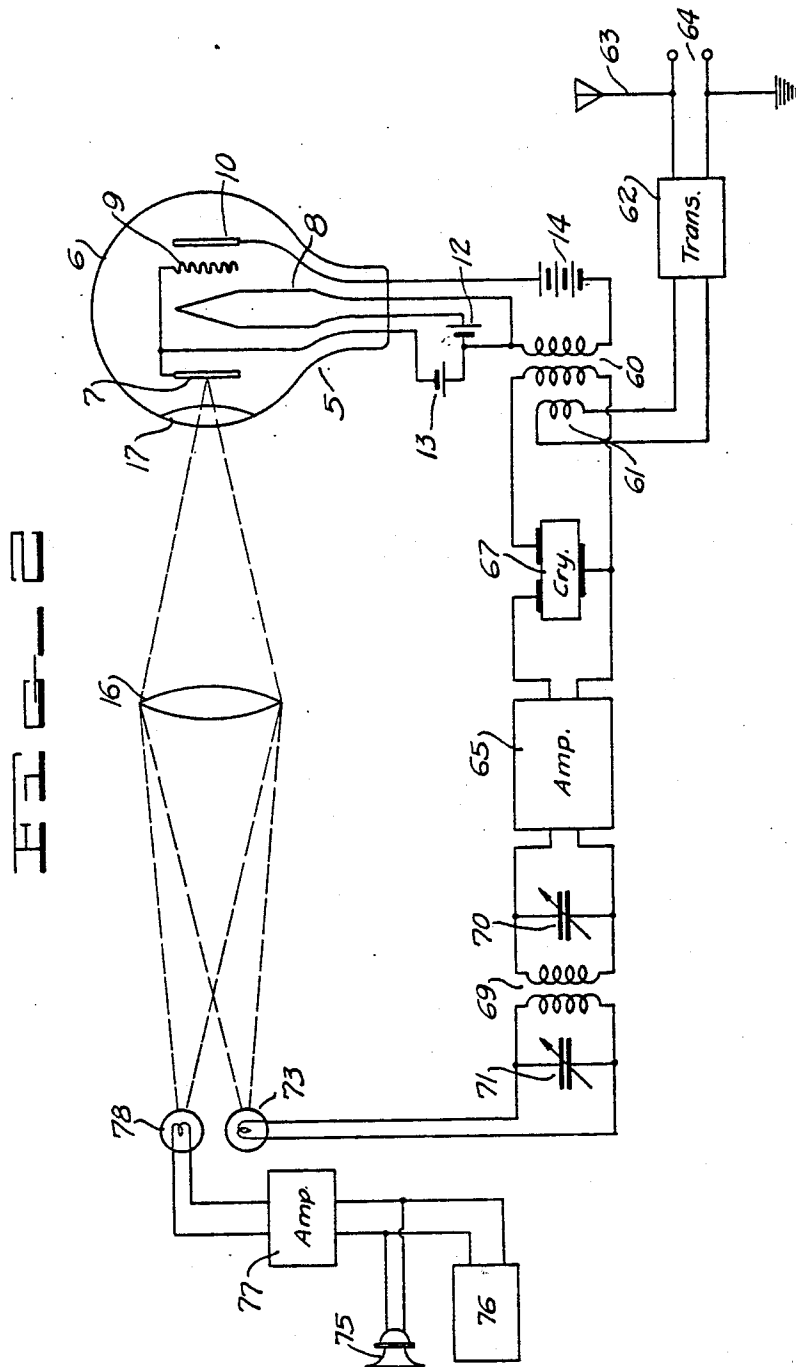
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PHOTO-OSCILLATOR-MODULATOR SYSTEM

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9 Claims. (Cl. 179—171)

This invention relates to the generation of electrical oscillations, and particularly to the generation of electrical oscillations and their modulation by signal variations.

5 An object of this invention is to generate electrical oscillations utilizing a photosensitive medium and light path.

Another object of the invention is to generate electrical oscillations, a portion of the circuit
10 being a light path which serves as a modulating medium.

A further object of the invention is to generate electrical oscillations by utilizing a wave retardation circuit in the electrical portion of a photo-
15 electric circuit.

It is well known in the art how to generate electrical oscillations by means of a triode vacuum tube, in which system the output of the tube is connected to the input to feed back a certain proportion of the output energy to regenerate and
20 sustain the oscillations. It is also well known how electrical vibrations may be created by mechanical generating apparatus such as mechanical vibrators and the like.

25 In the present invention, however, the action of a varying light beam in accordance with the oscillations to be generated, are directed on a photoelectric cell device. After amplification within the device or with external amplifiers, the varying light beam is again created from energy released by the light variations. Within the electrical portion of the circuit is a wave retardation or delay circuit which slows up the transmission
30 therethrough of the wave in accordance with its constants and depending upon the frequency desired to be generated. This delay circuit is adjustable, permitting different frequencies to be obtained. A particular feature of this invention is the use of a compound photoelectric cell amplifier as a unitary structure within a single
40 evacuated envelope. This device has a light sensitive cathode directly connected to the control electrode of the vacuum tube, while the filament thereof serves as the anode of the photocell combination. With this arrangement, therefore, a considerable amount of output potential may be obtained without the use of an external
45 amplifier. Furthermore, with the present oscillating system, a plurality of various oscillations may be generated, employing the same light path and photoelectric cell system to provide a compound generator.

50 The oscillator-modulator system disclosed below is the above mentioned photo-electrical
55 oscillator circuit which is modulated by varying

the light path, in accordance with the signal variations. That is, an auxiliary source of light is provided which varies in accordance with the signals to be transmitted along the light channel provided for the carrier frequencies.

The invention will be more fully understood from the following description taken in conjunction with the accompanying drawings, in which:

Figure 1 is a schematic circuit of a compound oscillating system; and,

Fig. 2 is a schematic circuit of an oscillator-modulator system with its associate transmission apparatus.

Referring specifically to Fig. 1, a photocell-amplifier 5 is shown contained within an evacuated
15 envelope 6, the elements of which are a light sensitive cathode 7, a thermionic filament 8, a thermionic control element 9, and a thermionic anode 10. The cathode 7 is photo-active only anteriorly, and is large enough to obscure variations of thermionic light and heat waves. The anode 10 may also enclose the other elements of the device 5 with an opening to permit light
20 reaching the cathode 7. The filament 8 is energized from a source of potential 12, while the potential supply 13 is used for the cathode 7. The plate of the amplifier 5 is energized from a source of potential 14. A light ray may be focussed by a lens 16 on the light active cathode 7 through a window 17 of the envelope 6.

30 The output of the photocell-amplifier 5 is transmitted through an output transformer 20 into delay circuits 21, 22 and 23, after which it is amplified in vacuum tube amplifiers 24, 25 and 26, respectively. These amplifiers are of the type well known in the art with tuned plate circuits having variable capacities as shown at
35 28, 29 and 30, respectively. The delay circuits 21, 22 and 23 are also variable, and are mechanically associated with the tuneable elements 28, 29 and 30, so that when an amplifier is adjusted for a particular frequency output desired, the delay circuit is adjusted accordingly, in order to create the proper oscillating period within the particular circuit. Of course, these elements
45 may be tuned separately, although unicontrol is preferable. The amplifiers are biased with the sources of potential 32, 33 and 34 obtained through a series of resistance elements 35, 36 and 37. The anodes are energized from potential sources 39, 40 and 41, while the filaments are energized from sources 42, 43 and 44.

50 The outputs of the three amplifiers are transmitted through output transformers 46, 47 and 48, these transformers having third windings 50, 55

51 and 52, from which current may be obtained to supply modulator systems, transmitters or the like. The other secondary windings of the output transformers are connected to light sources in the form of lamps 57, 58 and 59, which may be neon or incandescent. The light rays from these sources are focussed through the lens 16 on the photosensitive element 7 in the envelope 6. Each circuit of the above described system operates independently of one another; the various amplifiers being tuned to the particular frequency desired from any particular circuit. The delay circuits further serve as filters for obtaining the desired frequency, since the operation of the oscillator is dependent upon the delay obtained between the creation of the light impulse and the result thereof returning to the light source. Of course, either circuit may be operated singly or any two may be operated together, according to the frequencies desired. Any one of sources 57, 58 and 59 may be modulated by another light source 78 focussed on the cell 5. The light source 78 receives its energy from a signal source 75 of any well known type after amplification in an amplifier 77. The modulated currents may be transmitted through transmitters 46, 47 or 48.

In Fig. 2 a modulator-oscillator system is shown wherein the device 5 of Fig. 1 is employed with the same focussing lens 16 and potential supply sources 12, 13 and 14. In this particular system a three winding output transformer 60 is used, wherein a third winding 61 is connected with a transmitting system 62 for space transmission over an antenna 63 or wire transmission over conductors 64. In the present system one of the amplifiers of Fig. 1 is shown in the block 65, while the delay circuit is shown in the form of a piezoelectric crystal 67, which may have a fixed value of delay, depending upon the frequency of oscillations desired. The output of the amplifier is transmitted through an output transformer 69, the circuits of which may be tuned by variable capacity elements 70 and 71. A light source 73 produces the light waves for impression upon the photosensitive element 7.

This system, so far as the generation of oscillations is concerned, operates in identically the same manner as the system of Fig. 1, that is, a variation in light rays from the source 73 impinging on the element 7 creates a proportional difference in potential between control grid 9 and filament 8, which being delayed through the element 67 is amplified and impressed on the light 73 at a certain definite instant later to create the second impulse, which is propagated around the circuit in the manner stated. The present system, however, has this generating frequency varied or modulated by signals initiating from different sources such as the microphone 75 or television apparatus 76. After amplification by the amplifier 77, the signaling variations are impressed upon the modulating light source 78 which is focussed upon the light sensitive element 7 of the device 5. With the impression of the second oscillations in the form of light variations upon the sensitive element 7, together with the generated light variation from the source 73, differential voltages are produced in the device 5, which may be impressed upon the transmitter 62 for broadcasting or direct transmission.

Particular advantages of the above oscillator-modulator are that modulation occurs without distortion, inasmuch as there is no flux density

curve to be considered in the light system, or any limitations on the amplitude thereof except for the constants of the electrical circuit which may be increased in size as desired. Furthermore, the compound oscillating system, such as shown in Fig. 1, may be employed, and all generated frequencies modulated within the same system from various sources in accordance with the method and manner disclosed in Fig. 2. It is obvious that a minimum of apparatus is required for 100% modulation of a considerable number of signals on different carrier frequencies.

Although the invention has been described in two of its preferred embodiments, it is to be understood that there are many other systems which may involve the principles of this invention, and which are contemplated to be within the scope of the appended claims.

What is claimed is:

1. In an electrical oscillating system, a photocell device, a plurality of light sources for actuating said cell, and respective electrical circuits connecting said photocell and said light sources, said electrical circuits having therein current delay devices of different values for energizing said light sources definite time intervals after the actuation of said photocell in accordance with the frequency of the currents impressed thereon, to generate a plurality of alternating currents of different frequencies.

2. In an electrical oscillating system, a light sensitive device, a plurality of sources of light for actuating said device, respective electrical amplifiers for actuating said light sources, said amplifiers being actuated in turn by said photocell and selective delay circuits for coupling said amplifiers to said light sensitive device, said amplifiers energizing said light sources definite time intervals after actuation of said device in accordance with frequencies impressed thereon.

3. In an electrical oscillating system, a plurality of light sources, electrical circuits for energizing said light sources, respective means within said electrical circuits for energizing each of said light sources at a different period, a light sensitive device actuated by all of said light sources, and means for impressing the electrical variations generated by said device on said electrical circuits, said variations being impressed upon said light sources at time intervals thereafter determined by the frequencies of said vibrations.

4. In an oscillator-modulator device, a plurality of light sources, a light sensitive device actuated by said light sources, a circuit interconnecting one of said light sources and said device for energizing said one light source, means in said circuit for delaying the transmission therethrough of said energizing currents, a definite time interval after the actuation of said device, to produce a continuous oscillating current, and signalling means for energizing said second light source at a different frequency from said oscillating current.

5. In an oscillating system, a light sensitive device, a plurality of light sources, means connecting the output circuit of said device and said sources and cooperating therewith for producing oscillating currents having different frequencies, said means including means for segregating said different frequencies generated and delaying each of said frequencies for different time intervals during transmission between said device and said light sources, and respective amplifying systems for energizing said light sources individually.

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6. In an electrical transmission circuit, a photo-
electric cell, electrical amplifying circuits for
amplifying currents generated in said cell in
accordance with the frequencies thereof, means
5 for producing a plurality of light rays with the
outputs of said amplifiers, said light rays being
focused upon an element of said photoelectric
cell, means for varying the intensity of one of said
light rays with signals to be transmitted, means
10 located in said amplifier circuits for delaying the
transmission of the output currents of said cell to
said light producing means definite time intervals
in accordance with the frequencies of the current
impressed thereon, and means coupled to the out-
15 put circuit of said amplifiers for transmitting
modulated light signals to a receiving station.
7. In an electrical system for the production
of oscillations, means for producing a plurality
of light impulses, a corresponding plurality of
20 vacuum tube amplifier circuits, energy for said
light impulses being derived from said vacuum
tube amplifier circuits, current delay circuits in
said amplifier circuits for shifting the phase of
the currents through said amplifier circuits in
25 accordance with the frequencies of the currents
impressed thereon, a light sensitive device actu-

ated by said light impulses, said device amplify-
ing the generated currents within said cell, and
means for impressing the output of said cell upon
said phase shifting circuits.

8. The method of producing electrical varia- 5
tions in current and voltage with a light-to-cur-
rent translator and a current-to-light translator,
comprising actuating each of said translators with
the output of the other of said translators and
variably dephasing the output of said light-to- 10
current translator before it actuates said current-
to-light translator thereby changing the time of
actuation of said translators and varying the
frequency of the current produced.

9. The method of producing a plurality of elec- 15
trical variations in current and voltage with a
light-to-current translator and a plurality of
current-to-light translators, comprising actu-
ating each of said current-to-light translators with
the output of said light-to-current translator and 20
actuating said light-to-current translator with
the outputs of said plurality of current-to-light
translators and varying the periods said cur-
rent-to-light translators are actuated after actu-
ation of said light-to-current translator. 25

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