Nov. 10, 1942. K. SCHLESINGER 2,301,820

MODULATION OF PHOTO-CURRENT AMPLIFIERS

Filed July 8, 1938

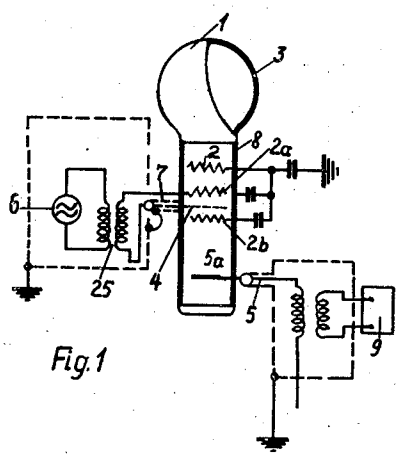


Fig. 1

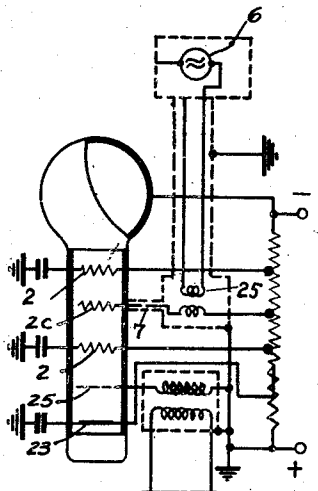


Fig. 2

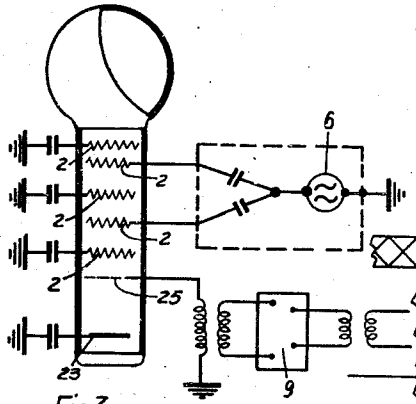


Fig. 3

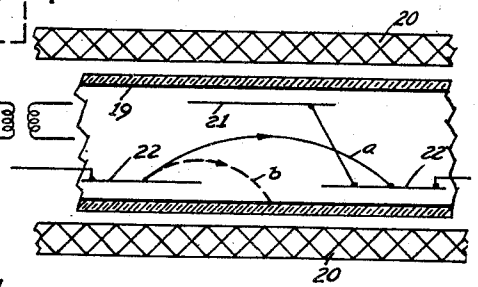


Fig. 4

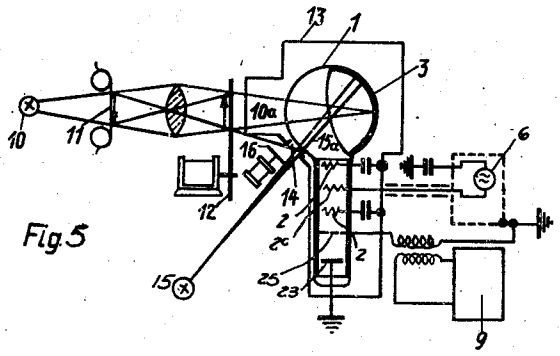


Fig. 5

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MODULATION OF PHOTO-CURRENT AMPLIFIERS

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2 Claims. (Cl. 178—7.2)

The present invention relates to television transmitting arrangements and more particularly to such arrangements, wherein a photo-electric cell combined with an electron current multiplier is used for generating and amplifying the picture signals.

In arrangements of this type it is desirable for numerous reasons to modulate a high-frequency carrier wave by the signal currents derived from the photo-sensitive cathode. This principle results automatically in a conjoint amplification of the D. C. component, is devoid of interfering slow building-up transients, is very insensitive to microphonic noises, mains hum and other external interferences. The carrier frequency principle is particularly suitable for transmission of the signals on line-channels.

In known arrangements of the above mentioned type serious difficulties are caused by the problem of modulating the carrier frequency in accordance with the varying potentials supplied by the photo-cell or the multiplier, the primary current of which represents the signals to be modulated upon the carrier wave and still contains the D. C. component.

Care must be taken that the carrier frequency is brought completely to zero when a black image point is to be transmitted. Usually this is accomplished by special bridge-connections, i. e. by compensating methods. In the case of multiple grid tubes a complete control is not readily obtained, so long as the tubes act as class A amplifiers, as there always flows a feed current which would result in a strong signal.

It is one object of the present invention to provide in an arrangement for television transmitting purposes in combination an electron multiplier comprising a photosensitive cathode, a plurality of impact anodes adapted to emit secondary electrons and a collecting anode, and means for varying the current to be picked-up by the collecting anode in accordance with a carrier frequency to be modulated.

It is another object of the present invention to provide in an arrangement for television transmitting purposes, in addition to the just mentioned means, additional means for causing said current to have an extreme value during the synchronizing signals.

The invention will be better understood, and further features of the invention will be seen from the following more detailed description and the accompanying drawings, of which in a purely diagrammatic fashion and by way of example,

Fig. 1 shows an embodiment of the invention comprising a photo-electric cell combined with an electron current multiplying system, a control grid within the multiplier, means for generating a carrier frequency and means for varying the potential of the control electrode in rhythm with the carrier frequency.

Fig. 2 shows another embodiment of the invention comprising a photo-cell similar to that shown in Fig. 1 and means for varying the potential of one of the impact anodes of the multiplier in rhythm with the carrier frequency,

Fig. 3 shows a further embodiment of the invention comprising a photo-cell similar to that shown in Fig. 2 and means for varying the potential of a plurality of impact anodes in rhythm with the carrier frequency,

Fig. 4 represents a cross-sectional view through a tube and illustrates a modification of the modulating system; and,

Fig. 5 shows a still further embodiment of the invention similar to that of Figs. 1 and 3 wherein means are provided for influencing the output current of the multiplier by the synchronizing impulses.

Referring first to Fig. 1, the multiplier 1 is of the type wherein a plurality of net-shaped electrodes 2 activated for secondary electron emission are used as impact anodes. The photo-cathode 3 of the multiplier receives the light proceeding from the scanning device. A control grid 4 is arranged between two impact anodes and influenced by carrier frequency potentials from the generator 6. The control grid 4 is so well screened from the output circuit 5 by means of special screens provided inside and outside of the tube that between the control grid and the impact anode situated next to the same, a carrier frequency potential can be applied in direct fashion without this potential being capacitively transmitted directly to the output 5. The introduction of the carrier frequency potential can take place, for example, by an inductive coupling 25, the carrier frequency generator 6 being disposed, for example, at a remote place. Preferably, however, the generator and, in any case, the lead, are furnished with a separately earthed screening means 7. The control grid 4 itself is already screened from the output 5 by using activated nets as impact anodes, the grid being situated in the space between two capacitatively earthed nets. Beyond this a spreading of the grid control field from the control space into adjacent zones is avoided by a common or subdivided metal sleeve 8. Only for the sake of simplicity, those of the impact anodes 2 which are

mounted adjacent to the control grid 4, are designated by special reference numerals 2a and 2b.

A direct modulation of the carrier frequency amplifier 9 by the alternating grid potential having been avoided by the above described methods or other methods known in the high-frequency art, the operation of the arrangement is as follows: Electronic currents of different strength reach the impact anode 2a in proportion to the exposure of the photo-cell 3 upon the scanning operation. So long as the comparatively large surface grid 4, which is situated in front of this anode and is inactive in itself, is biassed sufficiently negatively in relation to the impact anode 2a the suctional field, which normally conveys the electrons to the next impact anode 2b, is missing. If on the other hand the control grid 4 has the same potential or even a positive potential in relation to 2a, the electrons are able to pass to the next impact anode 2b, are additionally multiplied, and finally reach the collector. The electronic current reaching the latter will accordingly in the first place always be proportional to the light exposure and secondly it will have the value "0" if the light exposure ceases, and also the excitation of the carrier frequency amplifier will be at zero if no light falls on the photo-cathode. In this way the desired carrier frequency wave form of the television transmission is produced in simple fashion without bridge connections or compensation.

Various modifications of this method are possible. Thus, for example, in place of one single controlled discharge path 2a, 2b there can also be employed a plurality of series-connected discharge paths operated in phase with one another, whereby the full-range control to zero can be additionally improved. Further, the method can also be employed in the case of magnetic multipliers, there simply being connected in front of an amplifying surface a control grid, which is connected to carrier frequency potentials in relation to the surface.

Within certain limits, the location of the controlling means within the multiplier can be selected as desired. It is, however, not desirable to include the control space in the first stages of the multiplier, as small electronic rays which still manage to pass through the blocking field are so amplified by the adjoining part of the multiplier that they are able to interfere with the black and thus produce a considerable background noise. It is also not desirable to perform the modulation in the final stage preceding the collector, as the screening of the oscillatory grid is more and more difficult. A spreading of electrons also cannot be so very easily avoided in the case of comparatively high intensity of current. It is accordingly advisable to perform the control approximately at the centre of the cascade.

Further, in place of a special control grid, one of the impact anodes itself can be furnished with alternating potentials as compared with the preceding anode. Generally speaking, this method will require higher controlling potentials. An arrangement of this kind is illustrated by Fig. 2. In this embodiment of the invention, no special inactivated control grid is provided. One of the impact anodes themselves (anode 2c in Fig. 2) is supplied with varying potentials by means of the carrier frequency generator 6. Of course, it is possible to impress varying potentials to more than one of the impact anodes.

Fig. 2 shows a particular collecting system which is preferably used in net multipliers. The unactivated collecting anode 25 is of grid like structure and is mounted between the last of the net shaped impact anodes 2 and a solid further impact anode 23 which, for example, consists of a metal plate activated for secondary emission.

In place of the inductive coupling it is also possible to use another form of coupling in the case of control both by means of grids as well as impact anodes, for example the simultaneous capacitative connection in parallel of a plurality of impact anodes with the interposition of an impact anode earthed by way of a condenser between each two of the parallel impact anodes connected with the same high-frequency generator, as shown in Fig. 3. The number of impact anodes earthed with respect to alternating current is preferably as large as possible in all cases.

Further, there can also be performed a deflection control, this being possible in both types of multipliers employing electromagnetic or electrostatic fields for guiding the electrons, and it can be realized both by electrostatic as well as by electromagnetic deflection.

Fig. 4 illustrates a known form of a multiplier in which the electronic current is guided along curved paths *a* from one plate shaped impact anode 22 to another by means of an additional electrode 21 and a magnet coil 20 disposed about the multiplier system. In an arrangement of this kind it is possible, for example, so to control the current in this coil according to a carrier frequency that the electronic current passes from one impact anode to the next only in a certain phase of the high-frequency oscillation, and in the remaining phases moves past the next impact anode following a curved path somewhat as indicated by *b*.

There can also be provided a special control coil, not shown in the drawing, the axis of which, for example, forms a right angle with that of the coil 20, and which deflects the electronic current laterally out of the plane in which it normally passes from impact anode to impact anode.

The known undesirable, increasing dispersion of the electronic current can be prevented according to the invention by a sleeve electrode 19 surrounding the entire multiplier electrode system. This electrode, in the case of the deflection control described in the above can be employed at the same time as intercepting electrode for the electrons passing by the impact anodes.

A particular embodiment of arrangements according to the invention takes shape in connection with television transmitters if at the same time there is considered the transmission of synchronisation signals. According to a method which has been adapted in Germany and in England, the so-called "positive transmission system," it is required, for example, that the carrier wave should be modulated to zero only for the synchronisation signals, whilst in the case of black in the image it should assume a prescribed partial value of the maximum, for example 20%. With an arrangement according to the invention a complicated diaphragm of this kind can also be produced in a simple manner. For this purpose, for example, it is merely necessary by means of a second light source to allow a constant light to fall on the photocathode. In Fig. 5, for example, an arrangement of this kind is illustrated diagrammatically. The modulation of the carrier wave by the photo-currents takes place in a manner described in connection with Figs. 1 to 4 and preferably according to the arrangements shown in Fig. 2. The light source 10 lights the

object to be transmitted which, for example, is a film 11. The image of the film is reproduced on the Nipkow disc 12 and the modulated light beam 10a impinges on the photocathode 3. In this arrangement the multiplier is situated in a light-proof casing or housing 13. Through a special and separate opening in the casing as indicated at 14 a second beam of light 15a from the second lamp 15 of constant intensity falls on the photocell. In this manner it is accomplished that even when the scanning light 10a has disappeared in the case of black in the image there is still a residual illumination of the cathode 3 by the auxiliary light 15. This residual illumination corresponds to a residual current, which continues even during the black in the image and only disappears when the second light source 15 is also disconnected. This disconnection can take place, for example, in optical fashion by means of a slotted disc 16, which rotates in front of the opening 14. It can, however, also take place electrically by supplying to a special impact anode biases from a synchronisation impulse generator, these biases ceasing when a synchronisation signal is to be transmitted. There can also be employed the same impact anode 2c which, as shown, is already connected with the carrier frequency generator, if the same is so biassed that in the case of ceasing excitation the cell current to this impact anode is blocked. For this purpose the impact anode is strongly biassed negatively, and during the transmission of the synchronisation signals the carrier frequency generator 6 is blocked. All of these methods are known to those skilled in the high-frequency art. Further, it is readily possible to set forth reversals of these arrangements for cases in which synchronisation signals are to have an overwhelming amplitude and the image is transmitted as a negative (American method of transmission). In the American transmission method in particular, in which the synchronisation signals are transmitted with full transmission current intensity, care will require to be taken that the auxiliary light 15 is more powerful than the strongest main light 10, and also only lights up during the synchronisation periods. This is capable of being accomplished by exchanging the requisite spokes of the siren 16 for openings when employing a constant light source, or also by using a glow lamp as light source 15 and by means of numerous other known, electrically controllable light sources (Braun tubes, Kerr cells and the like).

I claim:

1. In a television transmitter system, an electron multiplying tube comprising a photosensitive cathode and an output electrode, a plurality of mesh-like impact anodes adapted to release secondary electrons when struck by impinging primary electrons supported in substantially parallel relationship and substantially perpendicular to the tube axis, said impact anodes being located intermediate the cathode and the output electrode, a mesh-like modulating electrode positioned within the tube and located intermediate the impact anodes, means to generate a carrier frequency, a scanning means, means to illuminate the photosensitive cathode of the multiplier by the scanning means with progressively changing light intensities measuring the intensity of the image points of a subject as analyzed by a scanning operation so that the electrons released from the photosensitive cathode are proportional to the image intensities, means for applying operating voltages to the impact anodes and the other output electrode so that electrons released by said light from said photosensitive cathode are caused to move toward the output electrode and to release secondary electrodes upon each impact on the impact anodes, and means to supply the generated carrier frequencies to the modulating electrode to vary thereby the amplitude of the electron current in the tube in the region between the impact anodes, and an output circuit connnected to the output electrode.

2. In a television transmitting system, an electron multiplying tube comprising a photosensitive cathode and an output electrode, a plurality of mesh-like impact anodes supported in substantially parallel relationship and substantially perpendicular to the tube axis and adapted to release secondary electrons when struck by impinging primary electrons, said impact anodes being located intermediate the cathode and the output electrode, a mesh-like modulating electrode positioned within the tube and located intermediate the impact anodes, means to generate a carrier frequency, means to project light on the photosensitive cathode of the multiplier so that photoelectrons will be released from the photosensitive cathode proportional to the intensity of the light projected thereon, means for applying operating voltages to the impact anodes and the output electrode so that the photoelectrons released from said photosensitive cathode are caused to move toward the output electrode and to release secondary electrons upon impact with the impact anodes, and means to supply the generated carrier frequency to the modulating electrode to thereby vary the amplitude of the electron current in the tube in the region between the impact anodes and an output circuit connected to the output electrode.

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