April 28, 1936. E. WALDSCHMIDT 2,039,134

PHOTOTUBE

Filed Dec. 6, 1932 2 Sheets-Sheet 1

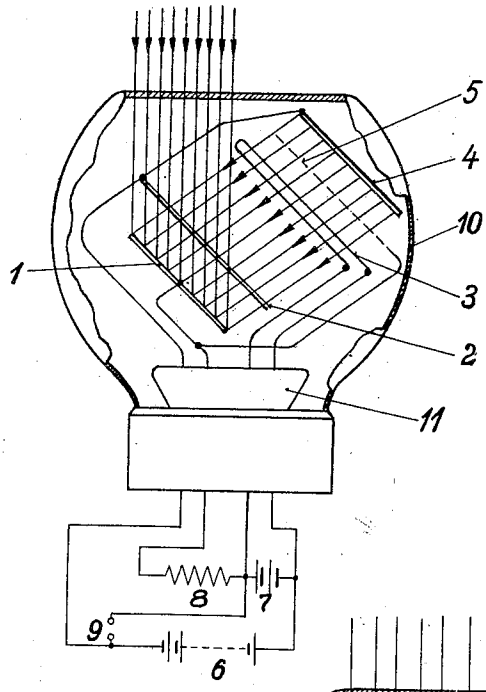


FIG. 1

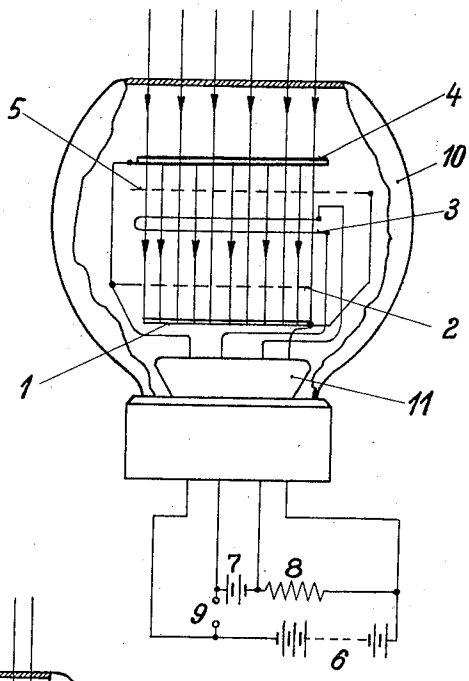


FIG. 2

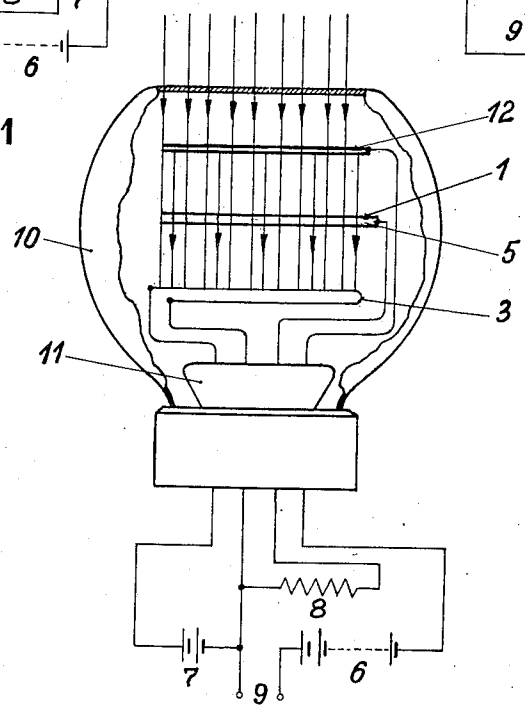


FIG. 3

Inventor:

Ernst Waldschmidt

April 28, 1936. E. WALDSCHMIDT 2,039,134

PHOTOTUBE

Filed Dec. 6, 1932 2 Sheets-Sheet 2

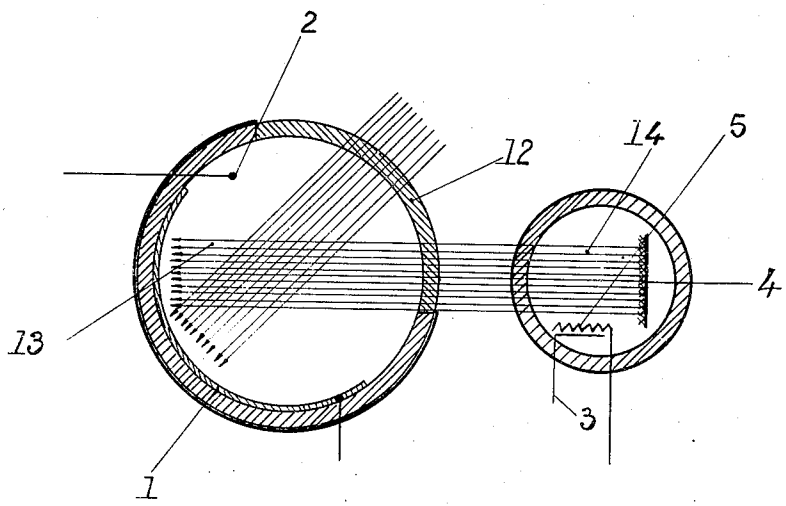


Fig 4

Inventor:

Ernst Waldschmidt

Patented Apr. 28, 1936

2,039,134

UNITED STATES PATENT OFFICE

2,039,134

PHOTOTUBE

Ernst Waldschmidt, Berlin, Germany

Application December 6, 1932, Serial No. 645,941
In Germany December 7, 1931

6 Claims. (Cl. 250—27.5)

The phototubes heretofore known supply relatively weak currents, so that from a practical standpoint the same can be employed only in conjunction with amplifying arrangements. High frequencies, such as required, for example, for television purposes, are, however, extremely difficult to amplify without distortion, owing to the relatively high self-capacity of the photo-tube.

The object of the invention is an arrangement with photo-tubes with electro-optical amplification, which enables the distortions occasioned by the use of ordinary amplifying arrangements substantially to be avoided.

The photo-tube according to the invention is based on the following principle:

The photo-current generated in the known manner by the light radiation is employed in the first place for controlling, for instance, a three-electrode system. The anode of this system is coated with fluorescent or phosphorescent substances, which are caused to light by the electrons transmitted, dependent on the number thereof. In this connection the corresponding strength of light is directly proportional of the number of electrons which are transmitted per unit of time. The luminous rays thus created re-act on the photo-electric coating, and produce a correspondingly amplified photo-current, which in turn results in an increased passage of current in the three-electrode system (amplifier system). The operation of the photo-tube according to my invention accordingly might be referred to as a photo-electric back-coupling. In the anode circuit of the amplifier valve there is connected in the manner known any desired consuming apparatus or an additional amplifying arrangement. Naturally, if desired, there may also be connected between the photo-tube and the tube containing the luminous coating causing the back-coupling an additional correspondingly equipped and dimensioned amplifying arrangement. In this case there is obtained by the amplified photo-current a considerably increased luminous radiation, and accordingly a more powerful back-coupling. The arrangement last referred to may be employed with particular advantage in the case of systems operating with low frequency.

The invention is illustrated in the accompanying drawings, in which Fig. 1 shows an embodiment of the photo-tube according to the invention, whereat the exciting light strikes against the photo-cathode 1 without touching the anode 4 of the amplifying system.

Fig. 2 shows a further embodiment of the photo-tube wherein the exciting light passes through the perforated anode of the amplifying system.

In Fig. 3 an arrangement is shown, wherein the photo-anode and the anode of the amplifying system are combined and form one common anode through which the exciting light is passing.

Fig. 4 shows an arrangement wherein the photo-system and the amplifier system are arranged in two separate and spatially suitably co-ordinated valves.

Fig. 1 shows particularly an electrode arrangement mounted in a glass vessel 10 on a press 11, in which the exciting light strikes against the photo-cathode 1. The photo-current thus produced acts on the grid 5, which is directly connected to the photo-cathode 1, and accordingly controls the amplifying system 3 and 5, 4. By reason of the electron current passing between 3 and 4 there is produced at the anode 4 which is coated with a luminous material a luminous radiation, which corresponds with the particular strength of current and acts on the photo-cathode 1, and accordingly creates a photo-electric back-coupling. 2 is the photo-anode, which is directly connected with the anode 4. In the outer circuit the anode battery 6 and the heating battery 7 are provided. The grid 5 is connected to the cathode 3 across a leak resistance 8. 9 are the output terminals of the amplified photo-current.

In Fig. 2 the exciting light passes through the anode 4, which is perforated in screen-like fashion, on to the photo-cathode 1. The anode 4 carries on its inner side the luminous coating, which is caused to light by the passage of the electrons and creates the back-coupling radiation, which strikes against the photo-cathode 1. 2 is the photo-anode.

In the arrangement illustrated in Fig. 3 the photo-electric coating 1 is provided on the grid 5 itself. In this arrangement the light also passes through the openings in the screen-like anode 12, which is coated with a luminous substance on the inner side. The photo-anode and the amplifying system anode are combined in this arrangement to form one anode.

Naturally, innumerable other possibilities of connection and forms of embodiment are conceivable. Thus, for example, it is possible to provide the photo-electric system and the amplifier system creating the luminous radiation in the same vacuum, or in two separate and spacially suitable co-ordinated valves.

An arrangement of this kind is shown in Fig. 4. In this figure 13 is the container housing the photo-electric system and 14 the envelope con-

taining the amplifier system. The window is indicated by 12. The other parts are designed by the same numerals as the corresponding parts in the foregoing figures.

In the first case it is desirable to employ high-vacuum photo-tubes. In the second case it is also possible to use photo-tubes filled with rare gas at the usual pressure. In arrangements such as described in conjunction with Figs. 2 and 3 it is desirable to employ perforated plates, the perforation area of which is equal to the surface coated with the luminous substance. In certain cases, however, it may prove to be desirable to increase the luminous area up to 8/10 or 9/10 of the complete area. At the same time it is also advisable to make the distance of the luminous anode from the photo-cathode as small as possible. The luminous substances employed, generally speaking, will be only those substances which possess the shortest possible after-lighting period. Accordingly, for the purpose of the invention, it is considered desirable to employ the chemically purest substances. The photo-cathode should be screened off against the light of the hot cathode. Failing this the photo-effect resulting from this luminosity requires to be compensated by a suitably selected grid bias.

I claim:

1. A photo-electric tube comprising an envelope including a window and housing a photo-electric cathode and an anode therefor, said cathode being mounted to receive light through said window, an amplifier comprising a thermionic cathode, a grid and an anode, said amplifier anode mounted parallel to and opposite said photo-electric cathode and having its surface facing said photo-electric cathode coated with a luminescent material, means connecting said grid with said photo-electric cathode, means connecting said anodes with each other and terminals to connect said electrodes with a suitable circuit.

2. A photo-electric tube comprising an envelope including a window and housing a photo-electric cathode and an anode therefor, said window mounted laterally with respect to said cathode, said cathode being mounted to receive light through said window, an amplifier comprising a thermionic cathode, a grid and an anode, said amplifier anode mounted parallel to and opposite said photo-electric cathode and having its surface facing said photo-electric cathode coated with a luminescent material, means connecting said grid with said photo-electric cathode, means connecting said anodes with each other and terminals to connect said electrodes with a suitable circuit.

3. A photo-electric tube comprising an envelope including a window and housing a photo-electric cathode and an anode therefor, said cathode being mounted to receive light through said window, an amplifier comprising a thermionic cathode, a grid and a perforated anode, said amplifier anode mounted parallel to and opposite said photo-electric cathode between said cathode and said window and having its surface facing said photo-electric cathode coated with a luminescent material, means connecting said grid with said photo-electric cathode, means connecting said anodes with each other and terminals to connect said electrodes with a suitable circuit.

4. A photo-electric tube comprising an envelope including a window and housing a photo-electric cathode and an anode therefor, said cathode being mounted to receive light through said window, an amplifier comprising a thermionic cathode, a grid and a perforated anode, said amplifier anode mounted parallel to and opposite said photo-electric cathode between said cathode and said window and having its surface facing said photo-electric cathode coated with a luminescent material, said photo anode and said anode of the amplifier being combined to form one structural unit, means connecting said grid with said photo-electric cathode, means connecting said anodes with each other and terminals to connect said electrodes with a suitable circuit.

5. A photo-electric tube comprising an envelope including a window and housing a photo-electric cathode and an anode therefor, said cathode being mounted to receive light through said window, an amplifier comprising a thermionic cathode, a grid and a perforated anode, said amplifier anode mounted parallel to and opposite said photo-electric cathode between said cathode and said window and having its surface facing said photo-electric cathode coated with a luminescent material, said photo cathode and said amplifier grid on the one hand and said photo anode and said amplifier anode on the other hand being combined to form structural units, means connecting said grid with said photo-electric cathode, means connecting said anodes with each other and terminals to connect said electrodes with a suitable circuit.

6. A photo-electric tube comprising an envelope including a window and housing a photo-electric cathode and an anode therefor, said cathode being mounted to receive light through said window and an amplifier comprising a thermionic cathode, a grid and an anode having its surface coated with a luminescent material, said coated surface of said anode facing said photo-electric cathode, means connecting said grid with said photo-electric cathode, means connecting said anodes with each other, and terminals to connect said electrodes with a suitable circuit.

ERNST WALDSCHMIDT.