

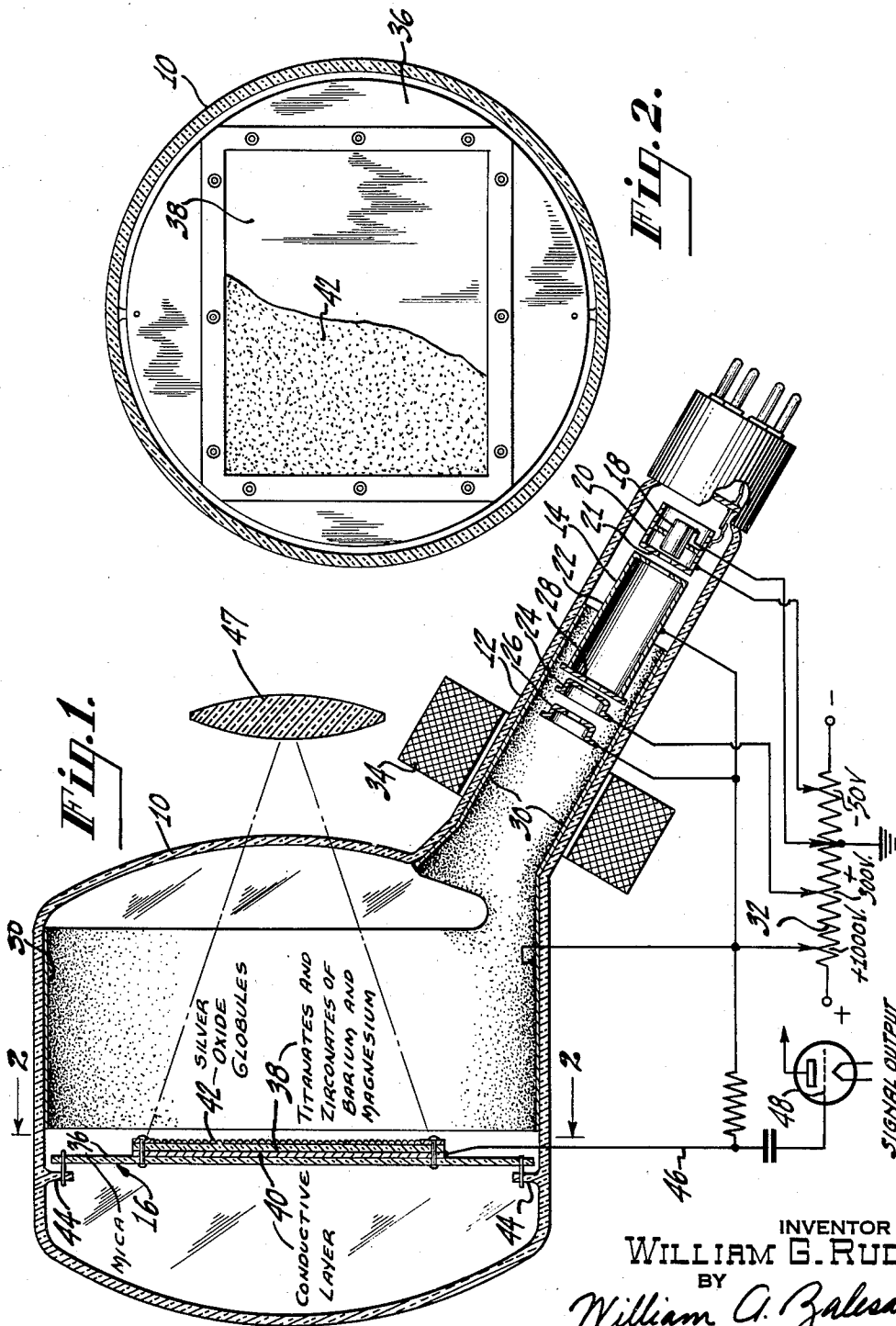
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CERAMIC MOSAIC FOR CAMERA PICK-UP TUBE

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CERAMIC MOSAIC FOR CAMERA PICK-UP TUBE

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This invention is directed to a cathode ray camera tube for television. More specifically, the invention is directed to a novel and improved target electrode for a television camera pickup tube of the iconoscope type.

The iconoscope type of television camera pickup tube is one in which an electron gun forms a high velocity electron beam, which is scanned over a photosensitized target electrode. A charge pattern is established on the photosensitized surface of the target electrode by the light variations of an optical image focused thereon. The electron beam, in scanning over the charge pattern established on the target electrode, sets up a series of signal pulses in a conductive signal electrode, capacitively coupled to the photosensitized surface of the target. This series of signal pulses constitutes the signal output of the tube. Such a camera tube is similar to that described in U. S. Patent 2,189,985 to W. H. Hickok. The target of such a tube has been made with a thin sheet of mica, upon one surface of which is formed a mosaic of photosensitized material. On the opposite surface of the mica sheet is applied a conductive coating of a suspension of carbon in a binder, or a commercial coating such as aquadag. The mica sheet used for the target electrode is one which is formed from a high-grade type of mica found principally in certain regions of Africa and India. This mica must conform to critical specifications in that it must not have any organic inclusions. It must have no gas bubbles between its surfaces. The mica sheet must have no irregularities such as waves in the mica formed in any way. To be used for a target, the mica sheet must be carefully split so that the surfaces of the sheet present no jumps in laminations. Lastly, such a mica sheet must be one which, when subjected to a baking temperature in the order of 900° C., will not blister. The presence of any of the above defects tend to produce spurious signals in the output signal of the tube. These critical requirements entail expensive and careful processing to obtain proper targets. Furthermore, under uncontrollable political conditions, the source of such mica is endangered and it becomes a critical material, so that its use for television pickup tubes is greatly limited.

It is therefore an object of my invention to provide an iconoscope target electrode of novel construction and improved design and formed of material which can be readily obtained but which nevertheless has all of the necessary characteristics for use in a target. It is a further object of my invention to provide a novel target electrode for an iconoscope pickup tube, which makes the use of mica unnecessary and which nevertheless provides a target having improved and desirable characteristics.

It is another object of my invention to provide an iconoscope type of pickup tube in which the formation of the target electrode is simplified by the elimination of the critical manufacturing steps and other objectionable features associated with targets using mica.

The invention specifically is directed to the use of a

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ceramic sheet composed for the most part of zirconium oxide and titanium oxide. The ceramic sheet is one which has a much greater dielectric constant than mica, so that it can be used with a greater thickness. Furthermore, by using a ceramic target sheet in an iconoscope I have produced an improved pickup tube, in particular, one which has a higher signal strength as well as other advantages not normally expected and not present when mica is used.

Fig. 1 discloses in section an iconoscope camera pickup tube in accordance with my invention.

Fig. 2 is a sectional view of the tube of Fig. 1 along line 2—2 of Fig. 1.

Fig. 1 discloses an iconoscope-type television pickup tube having an evacuated tubular envelope 10 with a neck portion 12 mounted at an angle to the axis of the tubular envelope portion. Mounted within the envelope neck portion 12 is an electron gun 14 for providing a beam of electrons which are accelerated and directed toward a target electrode 16. The target 16 is mounted transversely to the axis of the tubular neck portion 12, and substantially perpendicularly to the axis of the tubular envelope.

The electron gun is of a conventional type and consists of a cathode electrode 13 formed of a short tubular element closed at the end closest to target 16 by an end wall which, in turn, is coated in a well-known manner with a mixture of barium and strontium oxides to provide a source of electron emission. Enclosing and supporting the tubular cathode 13 is a coaxial tubular control grid electrode 20 closed by an apertured wall portion 21 at its end closest to target 16, and as shown in Fig. 1. Spaced along the axis of the tubular envelope portion 12 from control grid electrode 21 is a first tubular accelerating electrode 22 and a second and third accelerating electrodes 24 and 26 respectively. The first accelerating electrode 22 is closed at its end facing the target electrode 16 by a metal wall portion or disc 28 having a centrally-disposed aperture therethrough. Accelerating electrodes 24 and 26 are in the form of shallow thimbles or recessed discs or plates, each having a centrally-disposed aperture coaxial with the apertures in the electrode wall portions 28 and 21 respectively.

A conductive film 30 formed of any appropriate material, such as metal or a suspension of carbon particles in a binder, is coated on the inner surface of the envelope neck portion 12 from a point surrounding the end of the gun structure 14 into the tubular envelope portion to a point adjacent the target electrode 16 as is shown in Fig. 1. The coating 30 is connected conductively to accelerating electrodes 26 and 22.

The several electrodes of the electron gun 14 are connected to several points, respectively, of a voltage divider 32 to establish operating potentials on the electrodes. The potential values indicated in Fig. 1 are those used under one set of operating conditions. These values are not limiting, but are indicative of those which have been used successfully in a tube of the type described.

Electron emission from the coated surface of cathode 13 is formed into an electron beam, as is well-known, and is accelerated and directed through the several apertures of the gun electrodes. The beam passes along the axis of the tubular envelope portion 12 and is focused by gun 14 to a small spot on the target electrode 16. The electron beam is scanned over the surface of target 16 by magnetic fields in any conventional manner, as for example, by fields established between two pairs of coils mounted about the tube neck 12 in a yoke structure 34. The coils of each pair of scanning coils are connected in series to sources of saw-tooth currents to provide line and frame

scanning, respectively, of the electron beam over the surface of target 16.

As shown in Fig. 1 and in greater detail in Fig. 2, the target electrode consists of essentially a supporting plate 36 formed of some insulating material such as mica. Riveted to the support plate 36 is a target assembly including an insulating ceramic sheet 38. On the surface of the insulating sheet 38, adjacent to the support plate 36 is formed a conductive film or coating 40. The film may be of any appropriate material such as metal or a colloidal suspension of carbon or graphite particles in a binder, such as aquadag.

On the opposite face of the insulating sheet 38, there is formed a photosensitive mosaic 42 which consists essentially of small islands or insulated particles of photosensitized silver oxide. The mosaic 42 may be formed in the manner described in U. S. Patent to Essig, No. 2,065,570, granted December 29, 1936. The mosaic is however, normally formed by dusting on the target sheet 38 a coating of silver oxide which is then fired in a furnace to a temperature of between 850° and 900° C. to reduce the silver oxide to silver, or more likely to a silver-silver oxide eutectic. Although silver metal melts at 960° C., the eutectic formed at the firing temperature of around 900° tends to coalesce or to form into small globules, which become insulated by the surface of sheet 38 from each other.

After riveting the target assembly to the support plate 36, the whole target 16 is mounted within the envelope 10 by fastening support plate 36 to glass studs 44 sealed to the envelope wall. Target 16 is mounted perpendicularly to the axis of the tubular envelope 10 and transversely to the path of the electron beam along the axis of envelope neck portion 12.

After the target assembly is mounted into the tubular envelope 10 and the tube evacuated and processed in the normal manner, the silver-silver oxide mosaic 42 is further oxidized and then sensitized by evaporating within the tube envelope cesium metal which condenses on the mosaic surface of the target. If an excess of cesium condenses on target 16 when light is directed on the mosaic, there is no photoelectric response. Accordingly, the target 16 is heated to slowly drive off the excess cesium metal to a point where the mosaic particles are again insulated from each other and yet there is sufficient cesium left on the target surface to provide satisfactory photosensitivity.

The operation of the tube shown in Fig. 1 is briefly that in which the electron beam of gun 14 will strike the target 16 with an energy of substantially 1000 volts. This initiates from the target surface a secondary electron emission which drives the target surface under the beam positively to a potential of about three volts higher than the potential of the collector electrode 30. At this potential the secondary electrons leaving the target surface will pass partially to the collector electrode 30 and partially will be re-distributed to other portions of the target driven positively by the beam. The re-distribution electrons tend to drive these other portions of the target down to a potential of substantially 1½ volts minus with respect to collector potential 30.

An optical image is focused upon the mosaic surface 42 of the target electrode 16 by any appropriate lens system indicated at 47. The sensitized mosaic 42 will emit electrons photoelectrically from each portion of the target surface and in proportion to the amount of light striking that part. In this manner, there is established on target 16 a distribution of charges or a charge pattern corresponding to the optical image or light distribution focused upon the sensitized target surface.

The photoelectrons emitted from the mosaic 42 tend to raise the potential of the illuminated portions of the target to a point somewhere between the minus 1½ volts and plus 3 volts positive with respect to collector potential. As the electron beam is again scanned over the

target surface, each portion of the target area struck by the electron beam is instantaneously brought to the 3 volts positive with respect to collector potential and from a potential which varies according to the amount of light falling upon that target portion. The instantaneous driving of each target portion positively by the beam, produces a current pulse in the signal plate 40, which is capacitively coupled to the mosaic surface of the target. The pulse is proportional to the amount that each area of the target is raised by the electron beam. The beam then in scanning the charge pattern of the target surface sets up a succession of current pulses which in turn provide corresponding voltage charges in the circuit 46 of the back plate 40, which is coupled to the control grid 43 of the amplifier tube circuit. In this manner, there is produced an output signal of the tube.

The insulating sheet 38 of target 16 may be of the high-grade form of mica described above. However, I have found that a thin ceramic wafer formed principally of titanium oxide and zirconium oxide, when used in a target as a material for insulating sheet 38, results in an improved target having many advantages.

Such a ceramic sheet may be formed by mixing the constituents of the ceramic in an organic binder or water suspension to provide a rather thick viscous material which is flowed out onto an endless belt and passes under a knife blade to scrape off the excess material and to provide a consistent thickness of the material. The belt passes through an oven which bakes out the binder material, leaving the ceramic in a somewhat plastic state. The ceramic is then removed and placed on refractory setters, which are merely flat supports of aluminum oxide or aluminum silicate or other heat-resistant material, which are used to carry the plastic sheets into a furnace where they are fired at around 2500° F. This temperature is controlled very carefully and the firing causes the ceramic to fuse into a hard brittle sheet. Firing is very important. Clean oxidizing flames are absolutely essential as well as cleanliness in other kiln operations.

The composition of the ceramic used may include from 40% to 80% by weight of titanium dioxide, from 20% to 60% by weight of zirconium oxide and small percentages of magnesium and barium titanates and zirconates. The mica target sheet used in iconoscope tubes, of the type described, normally have a thickness of between 1 to 2 mils, and a dielectric constant of about 5.5. These parameters provide the requisite capacity between the signal plate 40 and the mosaic 42 of the target for the electron beam of gun 14 of around 0.2 microampere to discharge each elemental area on each scan of the beam across the target. The dielectric constant of the ceramic target sheet described above can be varied by controlling the amount of titanium oxide and zirconium oxide as well as the amounts of magnesium and barium used. Ceramic sheets have been made having dielectric constants respectively of 28, 38, 45 and 85. The dielectric constants of these sheets are roughly proportional to the amount of titanium oxide used. However, as the percentage of titanium oxide increases in the ceramic, the target sheet becomes more brittle and will not stand the heat shock occurring during the formation of the silver-silver oxide eutectic on its surface at around 900° C. It has been found that a satisfactory target sheet, however, is that having a dielectric constant of around 28. Accordingly, since the ceramic target sheet has roughly 5 to 6 times the dielectric constant of the mica, the ceramic need not be limited to the 1 to 2 mils thickness required for the mica. Thus, a ceramic target sheet is used having a thickness of between 10 to 12 mils and is sufficiently rugged for handling and tube processing. This, then provides substantially the same capacity between the signal plate 40 and the mosaic surface 42 of the target; as in targets using 1-2 mil thick mica.

It has been indicated above, that the ceramic used for the target surface is principally a composition of titanates

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and zirconates of barium and magnesium, and that the composition can be varied over wide ranges to provide any desirable dielectric value. It is also possible to use other well-known ceramic compositions having substantially the same characteristics and which can be formed into hard flat sheets which are required for the target structure. However, it is necessary that the ceramic sheets be free from any foreign particles, such as dirt or particles introduced from the setters used in the manufacturing process. It has been found that extraneous materials which become deposited on the ceramic sheet in its plastic state and which also become fused into the ceramic by the firing process introduce spurious signal voltages in the televised picture. Furthermore, it is necessary that the surfaces of the ceramic be entirely uniform and at all points equidistant, so as to provide a constant capacity coupling between the signal plate and the mosaic of the target. That is, indentations in the surfaces of the ceramic sheet, such as scrapes or unevenness produced for example, by the knife blade in the manufacturing process, all tend to show up in the televised picture as spurious signals.

I have found that the use of a ceramic target sheet of the type described above has provided a consistently higher signal strength than that provided in tubes using the mica target sheet. It is not clear just what is the reason for the better signal with the ceramic target, but it may be due to the greater absorption of the cesium material on the surface of the ceramic. It is possible that the ceramic material provides a minutely roughened or porous structure which absorbs a greater amount of cesium than is possible on the corresponding mica surface. This increased cesium absorption appears to increase the photosensitivity of the target and provide a higher signal strength. The use of the ceramic target has provided an increased signal strength in the order of 10%-15% that produced by the mica target.

Another advantage of the ceramic target is that the ceramic sheets are rigid and flat and when mounted upon the target support 36 maintain their rigidity so that there is not introduced any distortion of the mosaic target surface from its normal plane. This then eliminates any possible picture distortion effect which is often introduced into a mica target by the fact that a mica mosaic surface can become warped and nonplanar.

A further advantage of the use of the ceramic target is that the signal plate 40 has a much greater adherence to the ceramic than to the mica surface. Normally, the conductive layer 40 is one formed from a colloidal suspension of carbon or graphite particles in a binder. Such a coating on the ceramic surface 38 has been found to adhere to a very great degree and can not be removed by careless handling of the target. However, such a coating on a mica surface as has been utilized in conventional targets, however, is vulnerable to scratches and is easily removed. Removing of any portion of the signal

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plate will produce white spots in the televised picture.

While certain specific embodiments have been illustrated and described, it will be understood that various changes and modifications may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. An electron discharge device comprising an electron gun structure for providing an electron beam along a path, a target electrode spaced from said gun and mounted transversely to said beam path, said target electrode comprising a ceramic sheet, a photosensitized mosaic film on the surface of said ceramic sheet facing said electron gun, and a conductive film on the opposite surface of said ceramic sheet, said ceramic sheet comprising a mixture of metal titanates and zirconates in amounts to provide a dielectric constant of substantially 28, said ceramic sheet comprising a material including from 40% to 80% by weight of titanium oxide.

2. An electron discharge device comprising an electron gun structure for providing an electron beam along a path, a target electrode spaced from said gun and mounted transversely to said beam path, said target electrode comprising a ceramic sheet, a photosensitized mosaic film on the surface of said ceramic sheet facing said electron gun, and a conductive graphite film on the opposite surface of said ceramic sheet, said ceramic sheet comprising a material including from 40% to 80% by weight of titanium oxide.

3. An electron discharge device comprising an electron gun structure for providing an electron beam along a path, a target electrode spaced from said gun and mounted transversely to said beam path, said target electrode comprising a ceramic sheet, a photosensitized mosaic film on the surface of said ceramic sheet facing said electron gun, and a conductive graphite film on the opposite surface of said ceramic sheet, said ceramic sheet comprising a material including from 40% to 80% by weight of titanium oxide and the remainder including one or more of the oxides of zirconium, magnesium and barium.

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