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THERMOELECTRIC COOLING OF VIDICONS

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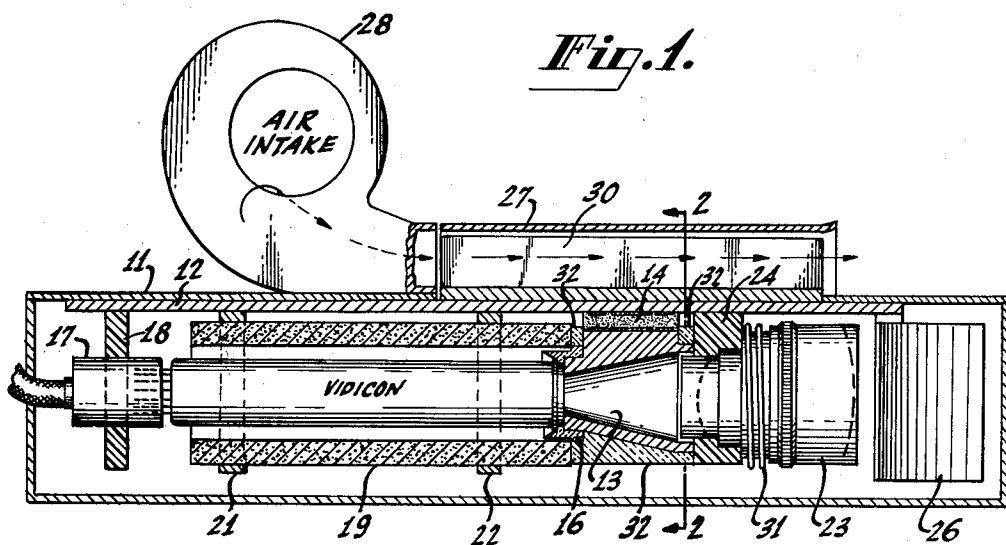


Fig. 1.

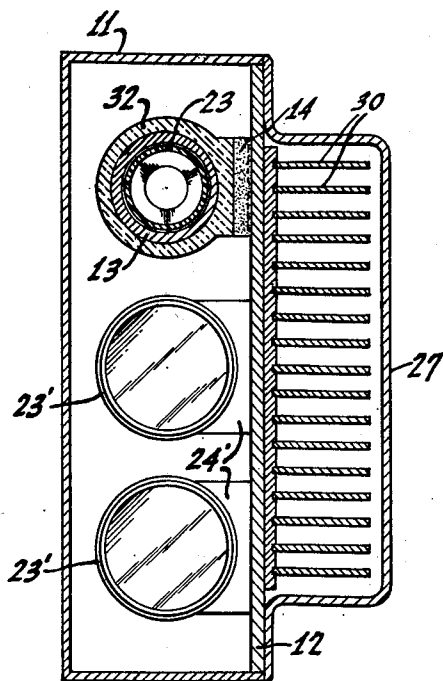


Fig. 2.

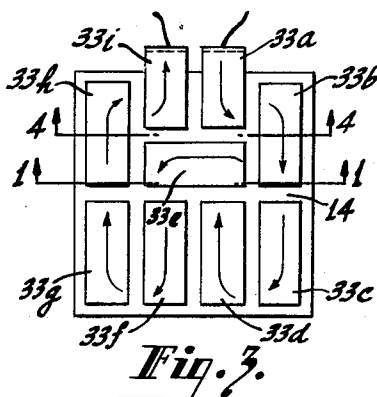


Fig. 3.

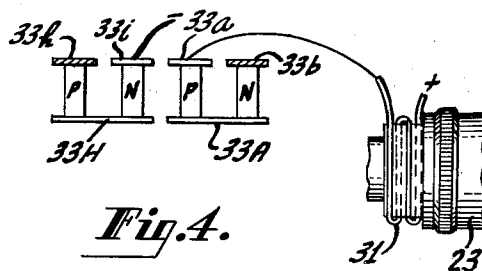


Fig. 4.

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THERMOELECTRIC COOLING OF VIDICONS
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The invention relates to improved television cameras that include a picture pickup tube of the type having a photoconductive target or screen, a vidicon being an example of a tube of this type. The invention relates particularly to thermoelectric cooling of pickup tubes of this type and to means for preventing the cooling current from skewing or otherwise adversely affecting the transmitted picture.

The invention will be described, by way of example, as it may be applied to the television color camera described in application S.N. 119,871, filed June 27, 1961, in the name of A. V. Bedford and entitled Color Television Camera System. This television camera comprises three color pickup tubes of the vidicon tube and one high resolution pickup tube such as an image orthicon which functions as a luminance pickup tube. It is desirable to cool the vidicon target both to improve the vidicon sensitivity and to prevent wide variations in the temperature of the vidicon target. The latter is of interest because the vidicon dark current increases with an increase in target temperature.

In practicing the present invention the cooling is done by use of a thermoelectric cooling unit, and the axial component of the magnetic field produced by the cooling unit current is balanced out by providing a bucking or cancelling axial field. Much of the magnetic field produced by the flow of current through the cooling unit is transverse to the longitudinal axis of the vidicon and can be prevented from reaching the vidicon by means of shielding. It is found, however, that there is a magnetic field component that is coaxial with the vidicon which is of sufficient strength to affect the vidicon deflection and skew the transmitted picture unless it is prevented from reaching the vidicon.

The invention will be described in detail with reference to the accompanying drawing, in which:

FIGURE 1 is a plan view, partly in section, illustrating one embodiment of the invention,

FIGURE 2 is a view in cross section taken on the line 2—2 of FIGURE 1,

FIGURE 3 is a plan view of a thermoelectric cooling unit that is included in the apparatus of FIGURE 1, and

FIGURE 4 is view in cross section taken on the line 4—4 of FIGURE 3, together with a showing of a field balancing coil and circuit connections as employed in the apparatus of FIGURE 1.

In the several figures similar parts are indicated by like reference characters.

Referring to FIGS. 1 and 2, the three vidicons of the color camera are supported in a comparatively deep rectangular box 11 that is of mu metal for shielding purposes. Only one vidicon with its cooling means, axial field cancellation means, and optical system is shown, the other two vidicons being positioned beneath the one shown in FIG. 1 and being cooled and protected from magnetic fields in the same way. The following description applies to all three vidicons.

A metal plate 12 is attached to the side of the box 11. The base plate serves to support the various elements, and also serves as a heat sink.

The face plate end of the vidicon is supported in firm abutting relation to a block of copper 13 which is cooled by a thermoelectric cooling unit 14. Thus the face plate and the photoconductive target located close thereto are

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cooled. The cooling unit 14 is in close contact with the base plate 12. The copper block 13 may be supported from the base plate 12 with the cooling unit 14 clamped between the block 13 and the base plate 12. The cross section view of the cooling unit 14 in FIG. 1 is taken on the line 1—1 of FIG. 4.

In order to hold the face plate end of the vidicon in position, a ring-like member 16 of nylon is supported on the small end of the copper block 13. A portion of member 16 extending beyond the block 13 is shaped to receive the end of the vidicon in a snug fit thereby supporting the end of the vidicon. The other end of the vidicon is supported by a tube socket 17 which in turn is supported by an insulating support 18 secured to the base plate 12.

The vidicon is surrounded by a cylindrical shield 19 of ferrite. This shield is supported by metal supports 21 and 22 which are secured to the base plate 12.

A camera lens 23 is positioned in front of the vidicon for imaging the scene to be transmitted on the vidicon target. The lens is supported by an insulating support 24 which is secured to the base plate 12. The camera lenses for the other two vidicons are indicated at 23' in FIG. 2. The supports for these lenses are indicated at 24'.

The mirror 26 for reflecting one of the primary colors of the scene to the camera lens is supported by the base plate 12, and is adjusted to be at an angle of 45 degrees to the vertical.

A heat exchanger 27 containing cooling fins 30 is secured in close contact with the base plate 12 to remove heat from the hot side of the cooling unit 14. A blower 28 forces air through the heat exchanger.

The heavy flow of direct current through cooling unit 14 produces a magnetic field that should not reach the vidicon. The component of this field transverse to the longitudinal axis of the vidicon does not disturb the vidicon because it is shielded by the ferrite shield 19. The axial component of this field cannot be prevented from reaching the vidicon by the use of shielding, however, since there must be a clear optical path for the scene to be imaged on the orthicon target. The problem is solved by providing a balancing field that bucks out the axial field. This balancing field is provided, in the specific example illustrated, by a balancing coil 31 comprising two turns of wire, that are connected in series with the cooling unit so that the cooling current flows through the coil. The balancing coil 31 is of sufficient diameter and is so positioned that it does not interfere with the optical path of the scene being televised. In the example illustrated, the two turns are wound around the lens mounting structure. They are wound in the direction to provide a magnetic field that opposes the undesired axial magnetic field of the cooling unit.

The cooling unit and cancellation of its axial field will be discussed further, but at this point attention is directed to the optics chamber located between the camera lens and the vidicon. It will be noted that it is conical in shape, being formed by a conical opening in the copper cooling block 13. The chamber is both light proof and dust proof, this being insured by the use of suitable thermal insulation 32 such as urethane which seals the joints.

Refer now to the thermoelectric cooling unit shown in plan view in FIG. 3 and in section in FIG. 4, the section being taken on the line 4—4 of FIG. 3 looking in the direction of the arrows. In the sectional view of FIG. 4 the foamed-in-place insulation of the cooling unit is omitted for the purpose of showing the structure. The cooling unit illustrated is of a well known type comprising P type and N type materials (FIG. 4) which are connected in series relation by means of copper plates 33a, 33b, etc. on the hot side of the unit and by means of copper plates 33A, etc. on the cold side of the unit. Only the first cop-

per plate 33A and the last copper plate 33H on the cold side are shown.

In the example illustrated, the cooling current, about 20 amperes in this example, flows from plate 33a, down a P type element to plate 33A through plate 33A and up an N type element to plate 33b, through plate 33b and down a P type element to plate 33B (not shown), etc., until the final copper plate 33i is reached. The direction of the current flow will be understood from the foregoing description and from an inspection of FIG. 3 where the arrows on the copper plates indicate the direction of current flow. One result of this current flow is the production of a magnetic field having a component that is coaxial with the vidicon as previously stated. The coil 31 for bucking out this axial field is shown in FIG. 4 connected in series with the cooling unit. If the cooling current is increased either manually or automatically (as by means of a thermostatic control), this causes the field bucking current flowing through coil 31 to be increased by the same amount. Thus, there results a stronger bucking field which balances out the increased axial field component due to the increased cooling current.

What is claimed is:

1. A picture pickup tube of the type having a photoconductive target close to the end or face plate of the tube; means for cooling said target, said means comprising a metal cooling block in contact with said face plate, said cooling block having an opening therethrough which is coaxial with said tube for providing an optical path through which an image may be formed on said target, a thermoelectric cooling unit in contact with said cooling block; a magnetic field balancing coil positioned opposite the face plate of said tube and positioned coaxially with said tube, and means connecting said coil and said cooling unit in series, said coil being wound in the direction to provide a field that opposes the axial component of the magnetic field caused by the current flow through the cooling unit, said coil also having a number of turns such that its field balances out said axial component.

2. A picture pickup tube of the type having a photoconductive target close to the end or face plate of the tube; means for cooling said target, said means comprising a metal cooling block in contact with said face plate, said cooling block having an opening therethrough which is coaxial with said tube for providing an optical path through which an image may be formed on said target, a thermoelectric cooling unit in contact with said cooling block; a magnetic field balancing coil positioned opposite the face plate of said tube and positioned coaxially with said tube, means connecting said coil and said cooling unit in series whereby the cooling current flows through both said coil and said cooling unit, said coil being wound in the direction to provide a field that opposes the axial component of the magnetic field caused by the current flow through the cooling unit, said coil also having a number of turns such that its field balances out said axial component, and electromagnetic shielding means surrounding said tube for shielding it from the transverse component of said magnetic field.

3. In combination, a vidicon having a face plate at one end and a photoconductive target close to said face plate, a cooling block of good thermal conductivity positioned with one end in contact with said face plate, said cooling block having an opening therethrough that is coaxial with said vidicon for providing an unobstructed optical path, a camera lens positioned at the other end of said cooling block with the optical axis of the lens coaxial with the vidicon, a thermoelectric cooling unit positioned against said cooling block for cooling it when cooling current flows through said cooling unit, said cooling current producing an undesired axial magnetic field component, and means for producing a balancing magnetic field to balance out said axial component.

4. In combination, a vidicon having a face plate at one end and a photoconductive target close to said face plate, a cooling block of good thermal conductivity positioned with one end in contact with said face plate, said cooling block having an opening therethrough that is coaxial with said vidicon for providing an unobstructed optical path, a camera lens which has the lens elements in a lens mounting structure that is positioned at the other end of said cooling block with the optical axis of the lens coaxial with the vidicon, a thermoelectric cooling unit positioned against said cooling block for cooling it when cooling current flows through said cooling unit, said cooling current producing an undesired axial magnetic field component, and means for producing a balancing magnetic field to balance out said axial component, said last means comprising a coil wound around the lens mounting structure.

5. In combination, a vidicon having a face plate at one end and a photoconductive target close to said face plate, a cooling block of good thermal conductivity positioned with one end in contact with said face plate, said cooling block having an opening therethrough that is coaxial with said vidicon for providing an unobstructed optical path, a camera lens which has the lens elements in a lens mounting structure that is positioned at the other end of said cooling block with the optical axis of the lens coaxial with the vidicon, a thermoelectric cooling unit positioned against said cooling block for cooling it when cooling current flows through said cooling unit, said cooling current producing an undesired axial magnetic field component, and means for producing a balancing magnetic field to balance out said axial component, said last means comprising a coil wound around the lens mounting structure and connected in series with said cooling unit.

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