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IMAGE TRANSDUCERS

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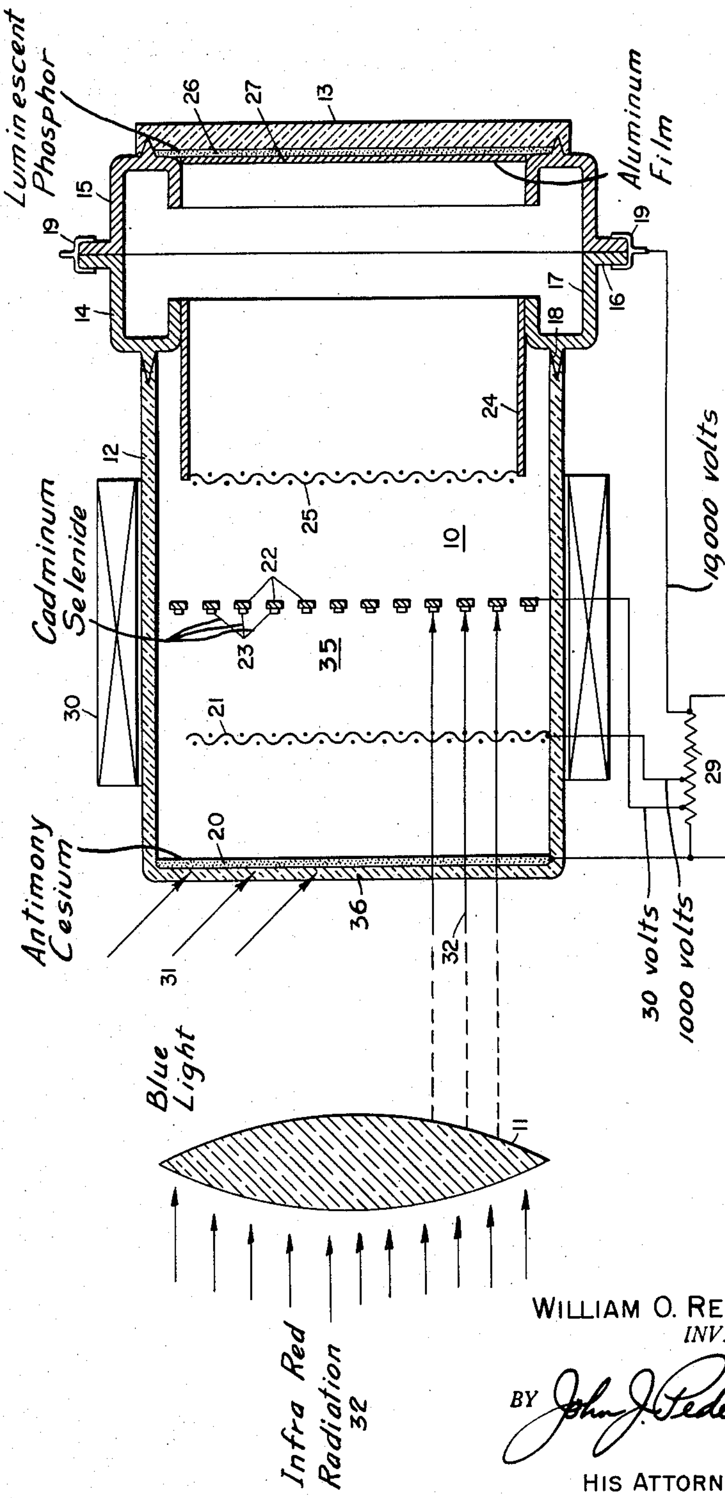

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2,903,596
IMAGE TRANSDUCERS

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1 Claim. (Cl. 250—213)

This invention relates to image transducers such as image converters and the like. Many devices known in the electrical and optical arts produce an output image which is a replica of an input image. For example, in pickup and storage tubes it is known to utilize a photosurface of restricted wavelength response to emit electrons only upon the incidence of energy of the proper wavelength. The electrons thus emitted may be directed by any known means to impinge upon a fluorescent screen having a different wavelength response characteristic, thereby illuminating the screen and producing an output image which is an exact replica of the input image but which is translated in frequency, as from the invisible to the visible spectrum. It is difficult to realize either high sensitivity or very high gain from such an elementary system, and various unsuccessful attempts have been made to increase the amplification. Moreover, it is difficult to improve the sensitivity of such a device because it depends in large measure upon the photocathode material used and the quantity of light energy which energizes the photosurface.

It is an object of this invention to produce both an accurate and a highly sensitive image transducer.

It is a further object of this invention to produce such a transducer which is responsive to two light sources, a first source which conditions the transducer for operation and a second source which activates the transducer to produce an output image.

It is a further object of this invention to produce a transducer which is sensitive to radiation in a wavelength region (i.e., the infra-red of wavelength longer than 1.2 microns) to which the presently known photoemissive surfaces, such as $SbCs_3$ or Ag—O—Cs, are not responsive.

In accordance with the invention, an image transducer includes a fluorescent screen and a photocathode, which is affixed to a surface substantially parallel to the fluorescent screen and is transparent to infra-red radiation, for emitting electrons in response to the incidence of visible light energy. A perforated target electrode comprising a conductive support element is disposed substantially parallel to and intermediate the fluorescent screen and the photocathode; the target electrode further comprises a layer of material facing the photocathode which has a characteristic impedance that is a function of the intensity of incident infra-red radiation. Interposed between the photocathode and the target electrode is means for accelerating the electrons to impinge on the target electrode at less than first cross-over velocity and produce thereon a charge sufficient to block the passage of electrons to the screen. Means are also included for projecting energy within the infra-red range through the photocathode onto the target electrode to vary the impedance of an image area of the target electrode as determined by such energy, and thus permit electrons to pass through the area to reproduce a corresponding image on the fluorescent screen.

The features of this inveniton which are believed to be novel are set forth with particularity in the appended claims. The invention itself, however, together with further objects and advantages thereof, may best be understood by reference to the following description taken in conjunction with the accompanying drawing, in which the single figure is a side view, partly in section and partly schematic, of a preferred embodiment of the invention.

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The drawing shows a cross-sectional view of an image transducer **10** which is disposed coaxially with an input lens system **11**, shown schematically as a convex lens. In the illustrated embodiment, transducer **10** comprises a cylindrical portion **12** and a translucent output window **13**; both pieces **12** and **13** may be constructed of glass. Two annular electrodes **14** and **15**, each of which is a mirror image of the other, are positioned between cylindrical portion **12** and output window **13**. Each electrode comprises a stem **17** having an outwardly directed flange **16** at one end and an internal base having a feathered sealing edge **18** at the other. Envelope section **12** and window **13** are sealed to projecting edges **18** of electrodes **14** and **15** respectively in any suitable manner as will be well understood in the art. A plurality of U-shaped conductive connectors **19**, or a single annular connector of U-shaped cross section, mechanically and electrically connect electrodes **14** and **15**.

A semi-transparent photocathode **20**, sensitive to blue light radiation, is formed on the interior of the input window **36** of transducer **10** opposite output window **13**. Photocathode **20** has an S–9 spectral response, 3100–6500 Angstroms (RMA standards) and may be formed, for example, by affixing a layer of antimony-cesium ($SbCs_3$) to the interior of transducer **10**. A first accelerating grid **21** is disposed in transducer **10** between photocathode **20** and output window **13**; grid **21** may be an ordinary mesh grid composed of a number of crossed cylindrical elements supported on their ends, such as is often used for accelerating an electron stream. In accordance with the invention, between grid **21** and output window **13** a perforated target electrode **35**, which may include a fine mesh grid **22**, is positioned; grid **22** has approximately 60% open area and from 500 to 700 holes per linear inch. The apertures of grid **21** are comparable in size to the apertures in fine mesh grid **22**. On the surface of mesh grid **22** facing accelerating grid **21**, a fine photosensitive film **23**, responsive to infra-red radiation, is deposited. Film **23** may be formed, for example, by affixing a layer of cadmium selenide or a thick layer of antimony trisulfide to grid **22**. Of course, suitable precautions must be taken when activating photocathode **20** to avoid caesium contamination or "poisoning" of infra-red sensitive film **23**; suitable techniques for accomplishing this are well known in the art.

A hollow cylindrical accelerating electrode **24** is positioned to be supported by and connected electrically with an inturned flange of electrode **14**. A second accelerating grid **25** is positioned to be supported by and in electrical contact with accelerating electrode **24**; grid **25** is placed at the end of electrode **24** opposite the portion contacting electrode **14**.

A fluorescent screen **26** is formed by depositing a suitable luminescent phosphor on the interior portion of output window **13**. An aluminum backing film **27** is affixed to fluorescent screen **26**; the compositions of, and techniques for depositing, fluorescent screen **26** and aluminum backing film **27** are well known and understood in the art. Aluminum film **27** is formed to contact a portion of electrode **15**.

A source of unidirectional operating potential **28**, which in this embodiment is a 10,000 volt direct current power source, is connected in parallel with a potentiometer **29**. Photocathode **20** is connected to the negative terminal, which is also the ground reference, of potentiometer **29.** Grid **21** is connected to a 1,000-volt tap on potentiometer **29,** and grid **22** is connected to a 30-volt tap. Electrodes **14** and **15,** and therefore grid **25** and aluminum film **27,** are connected to the 10,000 volt terminal of potentiometer **29.**

A solenoid-wound focusing coil **30** may be utilized in a known manner to provide a magnetic focusing field for the electron stream of transducer **10.** On the other hand, if the distances between the various electrodes of transducer **10** are short, no additional focusing means is required.

In operation, a source of blue light (not shown) is excited to produce energy represented schematically as flooding light rays **31,** which are incident on photocathode **20** as shown in the drawing. Photocathode **20** is constructed to emit electrons upon excitation by energy of a wavelength of the order of blue light. Upon energization of photocathode **20** by the flooding blue light, electrons leave photocathode **20** and are accelerated toward grid **21.** After passing through the plane of grid **21,** the electron stream is decelerated because grid **22** is at a much lower potential than is grid **21.** The decelerated electron stream approaches photosensitive film **23** at less than first cross-over velocity; i.e., a velocity such that upon impingement the number of secondary electrons emitted by photosensitive film **23** is less than the number of incident primary electrons. The incident electron stream charges photosensitive film **23** toward the potential of photocathode **20** and if the impedance of **23** is high enough for the electron current from **20** it may charge slightly below the potential of photocathode **20** by an amount determined by the initial velocity of emission of the photoelectrons and the difference between the contact potentials (or work functions) of film **23** and photocathode **20.** The electrons not required to maintain the charge on photosensitive film **23** are repelled toward grid **21.** Experimentation has shown that photosensitive film **23,** if placed within a few thousandths of an inch of photocathode **20,** will sufficiently accelerate the flooding electrons from photocathode **20** so that grid **21** is not required; however, such a construction introduces structural difficulties, while the particular embodiment illustrated has been found easy to construct and operate.

In accordance with the invention, imaging infra-red light rays **32** from an object exterior to lens system **11** pass through the lens system, through the glass input window **36** of transducer **10,** through photocathode **20** and grid **21,** and impinge on photosensitive film **23** to form a latent image corresponding to the pattern and intensity of the infra-red rays. The material of photosensitive film **23** is chosen to have a characteristic impedance which varies with the intensity of the incident radiation, within the infra-red range of wavelengths. As the incident radiation strikes film **23** and lowers its characteristic impedance, photosensitive film **23** becomes a better conductor and passes electrons from its surface toward the positive potential of grid **22** from whatever area imaging light rays **32** strike. Thus, these areas become more positive than cathode potential by an amount proportional to the intensity of the imaged light rays **32.** Electrons emitted from photocathode **20** will now pass grid **22** in those areas in the same proportions and be accelerated toward screen **26.**

While a particular embodiment of the invention has been shown and described, it is apparent that modifications and alterations may be made, and it is intended in the appended claim to cover all such modifications and alterations as may fall within the true spirit and scope of the invention.

I claim:

An image transducer comprising: a fluorescent screen; a photocathode, affixed to a surface substantially parallel to said fluorescent screen and transparent to infra-red radiation, for emitting electrons in response to the incidence of visible light energy; a perforated target electrode comprising a conductive support element disposed substantially parallel to and intermediate said fluorescent screen and said photocathode, and further comprising a layer of material facing said photocathode and having a characteristic impedance which is a function of the intensity of incident infra-red radiation; means interposed between said photocathode and said target electrode for accelerating said electrons to impinge on said target electrode at less than first cross-over velocity and produce thereon a charge sufficient to block passage of electrons to said screen; and means for projecting energy within the infra-red range through said photocathode onto said target electrode to vary the impedance of an image area thereof determined by said energy and permit electrons to pass through said area to reproduce a corresponding image on said fluorescent screen.

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