TK-45 3-Vidicon Color Camera

The RCA TK-45 Vidicon Color Camera is a compact and economical color camera chain employing the new Type 7038 Vidicon pickup tube.

The TK-45 is used primarily in hospital rooms to produce live color pictures of surgery for medical instruction, although it is useful in any application where adequate light can be made available. A light level of approximatetly 2500 foot-candles is required by the Vidicon color chain to produce high quality pictures. Possible industrial applications of the Vidicon color camera include observation of combustion efficiency in jet exhausts, open hearths and blast furnaces.

The Type 7038 Vidicon pickup tube has no side tip seal-off. This design feature permits use of smaller deflection components for the tube, and a significant overall reduction in camera size. Provision for remote control of the camera lens turret and optical focus mechanisms facilitates use of the camera in hazardous areas or in locations where it is impractical to have an operator. The camera can be mounted, without the viewfinder, at its top when suspended for hospital surgical applications as shown in Fig. 13, or it can be attached to a cradle head for standard pedestal mounting as can be seen in Fig. 14.

FIG. 15. TK-45 color camera suspended overhead and focused on the operating field by a special mirror.

Vidicon Color Camera Chain

Component units of the complete camera chain are shown in block diagram form in Fig. 16. The processing amplifiers, colorplexer, aperture compensator, automatic carrier balance, master monitor and power supplies are identical to those previously described for the image orthicon camera chain. The camera auxiliary, camera control, utility amplifier and shading amplifier are customarily mounted at the operating position in a console desk section adjacent to the master monitor; although provisions can be made for rack-mounting, if desired.

The processing amplifier inserts pedestal, adds gamma correction, generates shading signals, provides monitor and CRO switching, and delivers the correct video level to the colorplexer. The colorplexer, which is also described in another section, performs the necessary matrixing and modulation to provide a standard color signal. A modulation type shading generator is used, the gain of which varies in proportion to the shading waveform supplied by the processing amplifier. The utility amplifier is necessary in the chain to effectively cancel the vidicon dark current and provide more system gain. Gain of the amplifier is adjusted remotely by a set of push-buttons at the control position. The camera auxiliary unit provides regulated focus and alignment current for the camera subchassis.

As an accurate means for measuring vidicon signal current, a calibration pulse equal in amplitude to the recommended peak beam current of the vidicon, is injected into the preamplifier input by depressing a button at the camera operating position. This also provides an indication of the gain of the system. In addition to supplying a video signal to the control position, a second output is provided to a monitor amplifier in the camera. This amplifier with its associated circuitry provides the necessary mixing of signals and feeds them to the viewfinder for registration purposes. An external monitor also can be fed from this circuitry during the initial setup of the equipment. This is advantageous in installations where no viewfinder is used, and the equipment cannot be located near the operating position. The camera will operate properly with cable runs up to 500 feet.

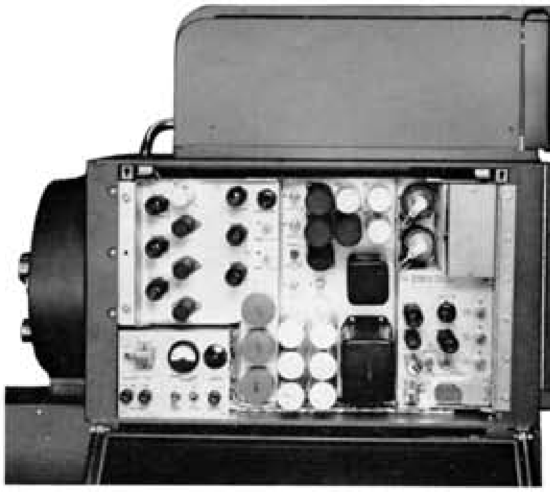


FIG. 17. Left side view of camera with hinged door lowered to show deflection chassis and associated components.

Camera

The TK-45 Camera contains the three vidicon pickup tubes with associated deflection and high voltage circuitry, a four-position lens turret, relay optical system and three video preamplifiers.

The deflection circuits are contained on recessed type chassis mounted vertically on the left side of the camera, as shown in Fig. 17. The three preamplifiers are mounted

FIG. 16. Functional block diagram of vidicon color camera chain.

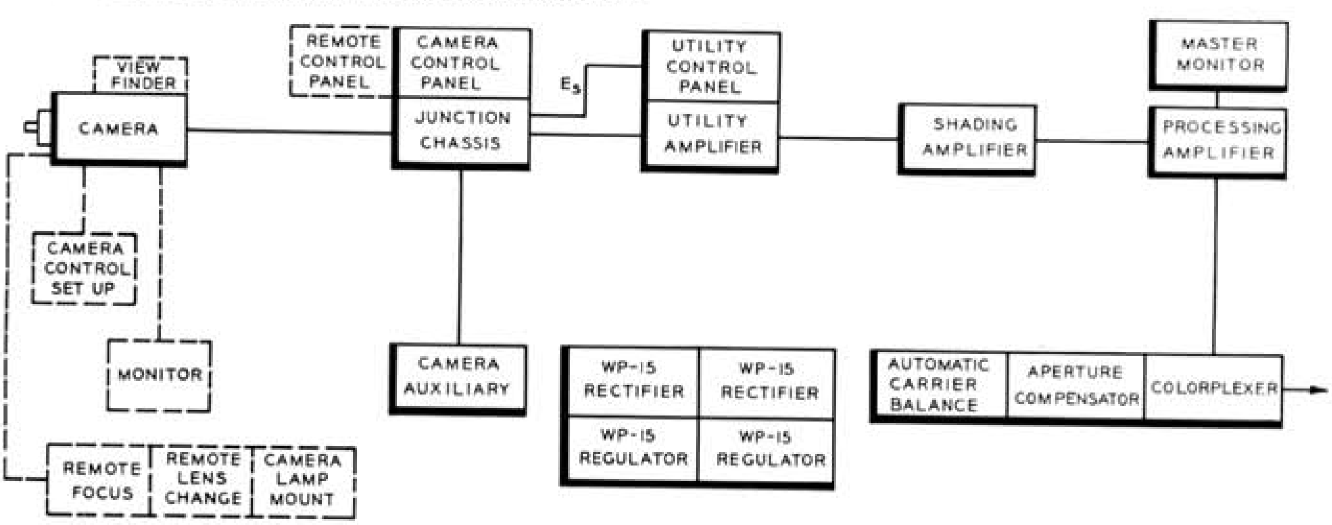


FIG. 18. Pedestal-mounted TK-45 vidicon color camera, shown equipped with remote-control lens change unit.

on the right side, as shown in Fig. 19. The preamplifiers are shock mounted to minimize microphonics, and hinged to provide withdrawal for ease of servicing. Each employs a low-noise cascode input stage to provide the best possible signal-to-noise ratio.

The camera control contains circuitry to operate the camera remotely. A feature of this unit is a plug-in control panel which can be taken physically to the camera for setup purposes and then returned to its normal operating position at the control desk.

Components of the relay optical system are arranged as shown in Fig. 20. The optical image formed in the field lens by the objective lens in use, is separated into red, green and blue components by the dichroics, shaped by trimming filters, and transferred to the photocathodes of the vidicons by the three relay lenses. The system features a dichroic film cemented between glass prisms. Use of these prisms simplifies cleaning, and eliminates inherent secondary reflection encountered when using dichroic-coated glass plates. As another point of interest, the front-surface mirrors previously used in the light path are included as part of the prism. Advantage is taken of the fact that almost total reflection takes place from a glass-to-air surface, set at 45 degrees to a light ray. No coating is used.

Since the vidicon has no seal-off tip on its side, the tube can be inserted in the yoke assembly from the rear. This has the advantage of keeping all mechanical adjustments associated with the vidicon faceplate securely locked in position. Complete support of the lens turret is provided by the front bearing to minimize bending and binding of the turret shaft. Ball bushings for longitudinal travel, and ball bearings for rotation, are used to reduce static friction of the system to a negligible amount under conditions of remote drive.

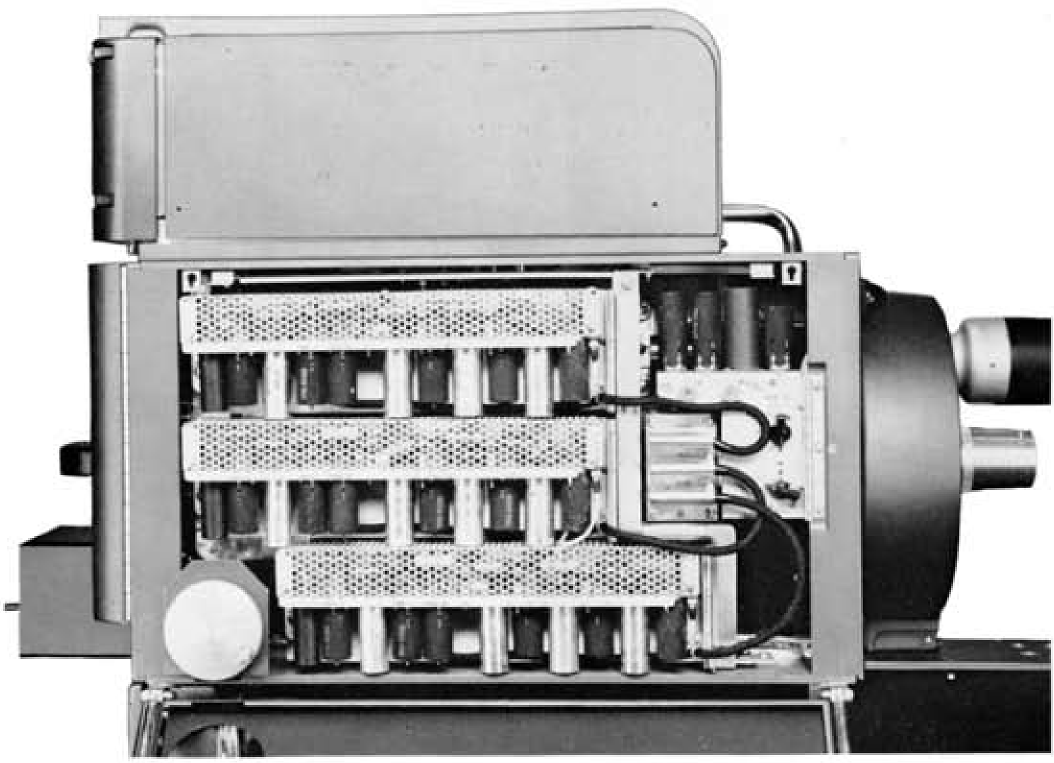
Remote Operation

When using the equipment in hazardous areas or in places where it is impractical to have a cameraman, provision has been made for controlling the turret rotation and the optical focus from a remote position.

A special control panel is located at the operating position for controlling the turret rotation, focus, and the pan and tilt of the mirror associated with the medical mounts.

The unit for remote lens change mounts under the front portion of the camera and is coupled by a toothed belt to the turret shaft. A geneva movement is utilized in this unit to minimize stresses in the lens mount where long focal lengths are required. The time between lens positions is two seconds. Lens selection is accomplished by pushing one of four pushbuttons located on the remote control panel. Local control is provided on the unit to simplify preliminary adjustment of the camera.

FIG. 19. Right side view of camera with door lowered to show hinged video preamplifier chassis.



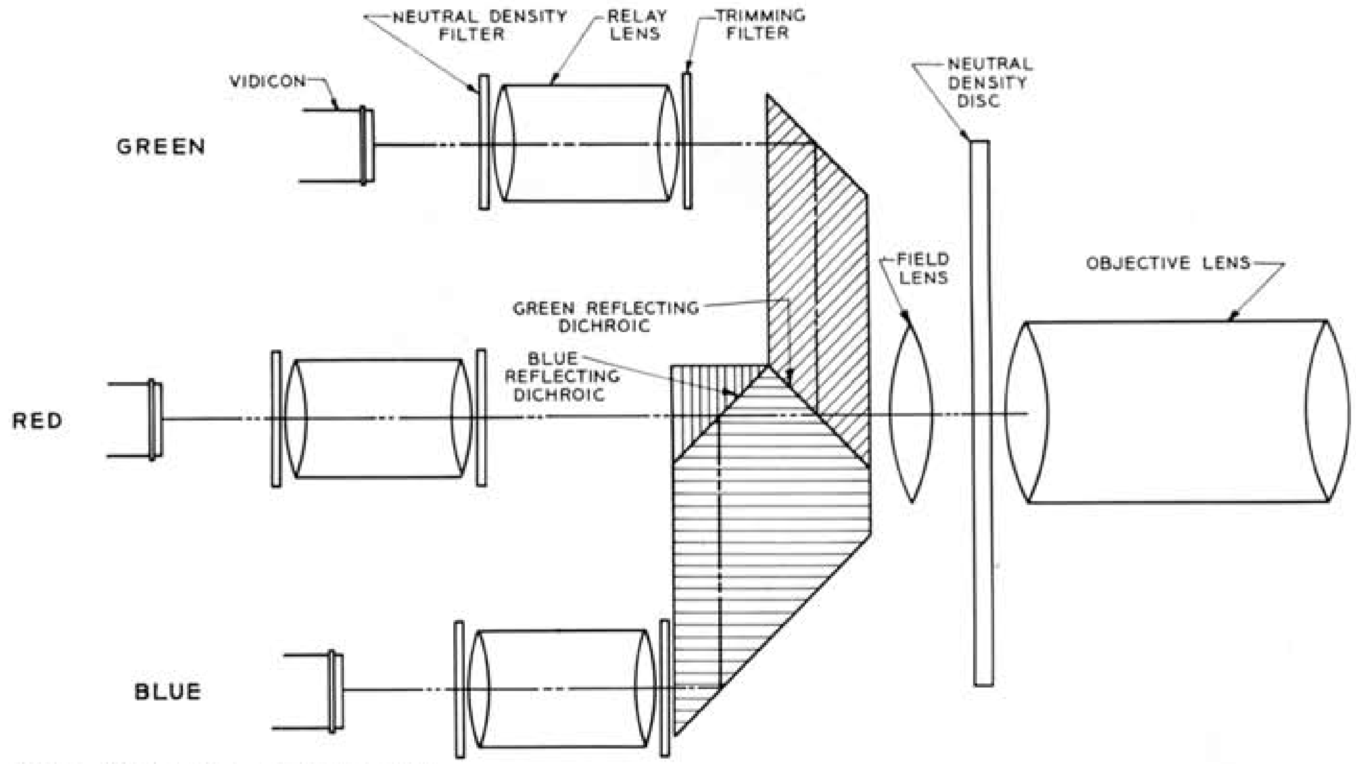
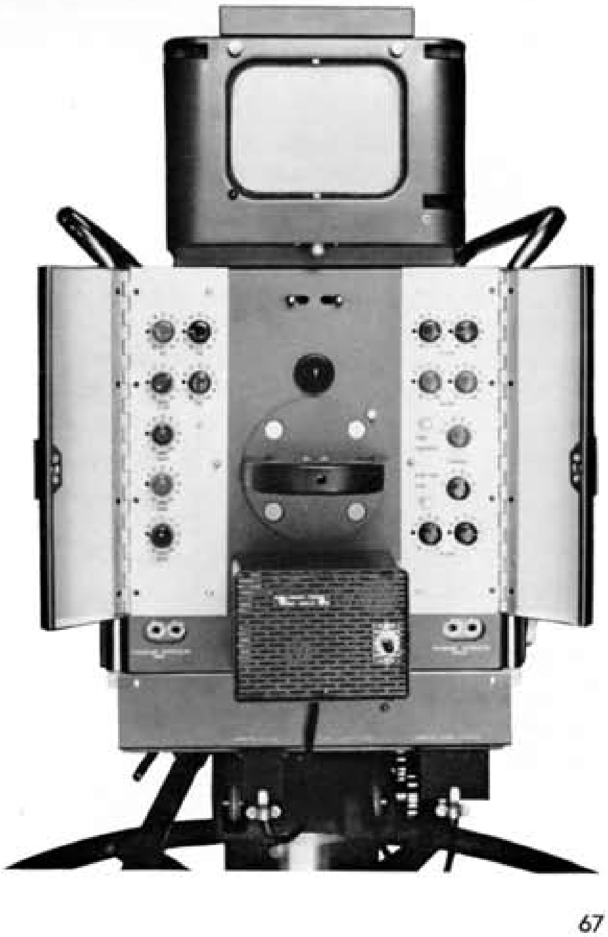


FIG. 20. Diagram of camera optical system.

FIG. 21. Rear view of camera showing vidicon controls, lens turret handle (center), and remote-control focus unit.



The remote focus unit is attached to the rear of the camera. This unit provides a full two and one-half inches of travel in ten seconds. Focusing is accomplished by operating a lever key located on the remote control panel. Local control is provided on the unit to simplify preliminary adjustment of the camera.

Surgical Installation

For surgical operating room applications a system of crosstracks is mounted to the ceiling. Suspended at opposite ends of a common boom are a camera and a lamp. A coaxial system of camera and operating lamp optical axes was chosen since with this method the camera automatically follows the positioning of the lamp with no mechanical interference problems. Best illumination is along the axis of a surgical lamp, which makes coaxial viewing with the camera ideal, especially where relatively small and deep operations are concerned. A mirror is suspended at a nominal angle of forty-five degrees over the center of the lamp through which a hole is provided so that the camera can view the operation. The lamp may be moved from its normal vertical position forty-five degrees in any direction except away from the camera where it is restricted to thirty degrees. The mirror assembly is coupled to the lamp in a manner that keeps the camera optical axis on the lamp optical axis for any position of the lamp. Remote control of pan and tilt of the mirror assembly is provided to allow the camera to explore within the illuminated area of the lamp.

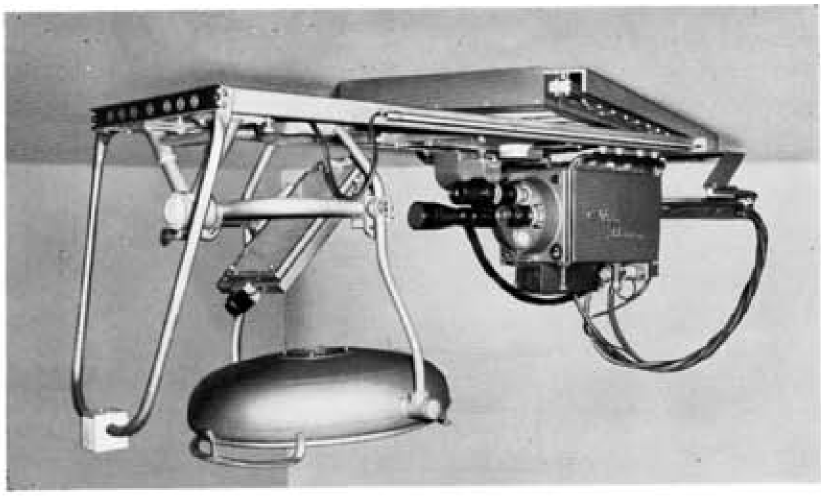


FIG. 22. Typical TK-45 camera overhead mounting for surgical use employs a system of cross-tracks with camera, lamp and mirror suspended.

Normally the camera is in front of the operating surgeon with the lamp positioned in such a manner as to supply light over his shoulder. This arrangement gives the camera the same field of view as the surgeon. Since the orientation of this field is very important to those who are viewing the picture, deflection reversal switches are provided on the camera so that during preliminary setup the desired orientation may be obtained. The camera lamp system can travel in both horizontal directions on the overhead tracks and can swivel a full 360°. The ceiling fixture for mounting the camera in an operating room is shown in Figure 22.

To obtain the small fields of view involved in the surgical application of this camera, lenses of considerable focal length must be used at relatively short throw distances. Since the light transmission capability of lenses used at low magnification is reduced, it is necessary to have more than the 1500 foot-candles of incident light to obtain the minimum light requirement on the vidicon photosurface. The need for extra illumination is aggravated by the difficulty of illuminating deep cavities. The approximate fields of view provided by the standard complement of lenses are:

Lens	*Field of View (inches)*
18 inch	2.9 x 3.8
13 inch	5.5 x 7.4
8½ inch	9.6 x 12.8

Vidicon Sensitivity

When low light levels are encountered, the sensitivity of the vidicon may be increased by raising the voltage across the photosurface which increases the lag or the apparent smearing of moving objects. Lag is probably most easily understood as the inability of the scanning beam to remove all of the energy stored in the photosurface on the first scan. Some energy remains to be removed on later scans after the subject has moved. The result is smearing of moving objects.

The surgical use of the camera is an example of an application where lag is not a serious problem since the scene being televised contains subject material which has relatively slow movement. Added sensitivity of the system may be gained by increasing the video gain of the system until the limit of the system sensitivity is determined by the resultant signal-to-noise ratio.

Another factor to be considered when raising the signal electrode voltage to increase the sensitivity is dark current. This is a current which flows through the photosurface of the vidicon in the absence of light and varies as a power function of the voltage impressed across the photosurface. In the film application of the vidicon where sufficient light is available and the signal electrode voltage is low, the dark current is a negligible portion of the signal. In the live pick-up application, the dark current can become an appreciable portion of the required video signal. Since this dark current exhibits itself as a false pedestal (black level shift) which is not normally the same in all three channels, a means for injecting an equal and opposite polarity signal is provided for cancellation.

Compensation for the variations in scene illumination or highlight reflectance is accomplished by the adjustment of a neutral variable density disk in the common light path. This method of keeping the video output signal of the camera chain at a constant level is preferred over other methods of adjusting the system gain electrically. The above method allows the setup of all electrical controls to the optimum point and effectively provides a method of varying scene illumination. Being in the common light path, there are no tracking problems. This disk is remotely controlled from the camera operating position.

FIG. 23. The three-vidicon color camera used in conjunction with optical microscope for group demonstrations.

Color TV Microscopy

Color television has extended the usefulness of the ordinary optical mircoscope by permitting group observation of enlarged images in color. When the microscope is used in conjunction with the 3-vidicon color camera, images can be transmitted electrically to one or more viewing rooms and displayed on monitors, or projected onto a large screen for group observation. Thus, many observers can see simultaneously, in color and in the same enlarged detail, exactly what the microscopist sees using the microscope. The basic principles of color television microscopy are shown in the diagram of Fig. 24.

A television microscope assembly developed for use in color TV microscopy is illustrated in Fig. 23. A lathe-type bed, similar to that used as a machine tool, is mounted on the surface of a special microscope bench. On the bed are mounted keyed plates adapted to fit the bases of several standard types of microscopes used for ordinary microscopy, for dark field microscopy and for phase contrast work. Illuminators of several types are similarly aligned optically using the keyed base on the lathe bed. The television camera is suspended so as to insure alignment with the optical system of the microscope. The camera views essentially the same field as that displayed on the eyepiece of the microscope. The whole of this assembly is mounted on heavy-duty, rubber tired casters which allow it to be somewhat portable.

In order to ensure high quality, stable operation, provision has been made for the unit to be supported on retractable steel feet once it has been placed in a required area of operation. Thus, the television microscopy function can be quickly established in any one of several locations.

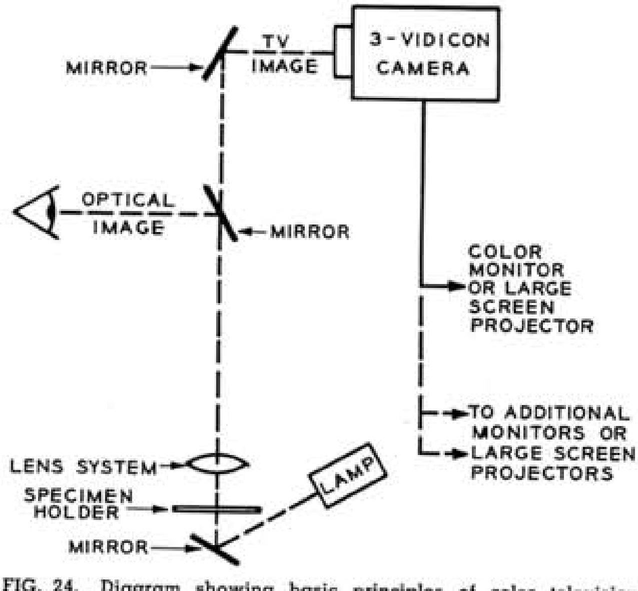


FIG. 24. Diagram showing basic principles of color television microscopy.