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MEDICAL APPLICATIONS OF X-RAY TELEVISION

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SINCE the first medical application of the roentgen rays, continuous progress has been made both in the diagnostic and therapeutic domains in eliminating radiation hazards to which radiologists and operators of x-ray apparatus are exposed. Such fundamental means of protection as limiting the roentgen-ray beam by utilization of a multishutter and shielding the operator by walls of lead have proved of unquestionable value. The recent introduction of the image intensifier made possible remarkable further reduction in the exposure dose to the patient and the radiologist, and, at the same time, an improvement of detail perceptibility in fluoroscopy, but it still remained necessary for the radiologist to continue his studies in the fluoroscopic room, wearing a lead apron for protection. Why? The most important reason is that there has been no suitable optical device by which images on the photocathode screen of an image intensifier could be observed in another radiation-free room. In addition to this, it was rather difficult in practice to utilize the image intensifier alone in the fluoroscopic examination since its visual field was limited to a 5 inch circle. For this reason, an image intensifier and a routine fluoroscopic screen had to be used alternately or otherwise the image intensifier had to be moved in succession over several regions of the patient to perform a comprehensive examination. If a 9 or 11 inch image intensifier were utilized, the patient dose, as well as the scattered radiation dose to the radiologist during cineroentgenography or direct roentgenography on a tilting table, could likewise not be reduced substantially unless the television principle were applied. During the last few years, several reports concerning x-ray television have been published in Europe, the United States and Canada.[3–5] Since 1956, when the first attempt to utilize television in fluoroscopy was made by Nagaoka—one of the authors of the present paper—considerable research has also been carried out in Japan. In June, 1958, at the time that the construction plan of the Center for Adult Diseases—Osaka—was submitted, the authors projected the installation of an x-ray television system for practical use. Since August, 1959, when the closed circuit television for roentgen diagnosis in the Department of Radiology in the Center was installed, the basic and clinical examinations have been performed by this means. The purpose of the present paper is to report on the capability of the x-ray television unit, the first of its kind for practical use in Japan, and to discuss its possible applications.

EQUIPMENT AND METHOD

Description of the X-ray Television Device. As shown in Figures 1, 2 and 3, our x-ray television system consists of a high tension generator with a controller (maximum output: 50 ma. at 125 kv. or 500 ma. at 90 kv. for one second; and 3 ma. at 120 kv. for continuous use),* a Philips Symmetrix 90/90 tilting table with a rotating anode tube of 1×1 mm. focus, a Philips 5 inch image intensifier and a closed circuit television with a 14 inch and a 17 inch screen of the ordinary television picture tube for fluoroscopy and indirect roentgenography. In addition, a television camera and monitor for general viewing of a patient and a

* Manufactured by Shimazu Seisakusho Co., Ltd.

* The Department of Radiology, Center for Adult Diseases, Osaka—Seijinbyo Center (Director: Arao Imamura, M.D.).
† The Department of Electronics, Central Research Laboratories, Matsushita Electric Industrial Co., Ltd., Kadomacho, Osaka, Japan.

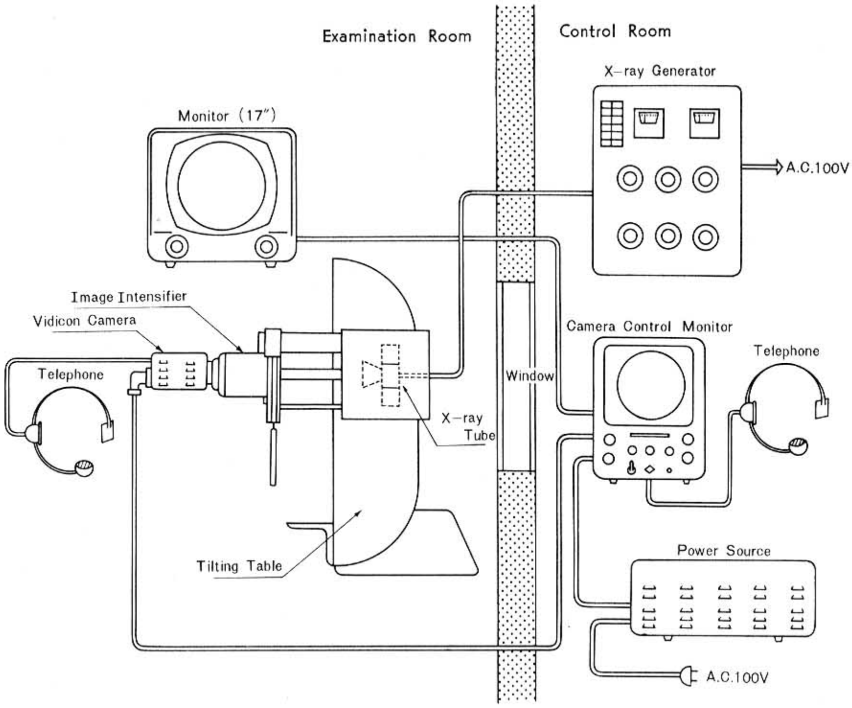

Fig. 1. General arrangement of the x-ray television equipment.

tilting table are provided.† Figures 3 and 4 show the television system in use.

Fluoroscopy. Radiologists can simultaneously view the fluoroscopic image through the television monitor screens, both in the control room (Fig. 3) and in the examination room (Fig. 4). Many physicians can take part in the fluoroscopic study with discussions by inter-telephones in brightly lit rooms.

Roentgenography. Two different methods of roentgenography are possible with the television system: direct roentgenography on the tilting table and indirect fluororoentgenography through the television monitor. In the latter, the roentgen images on the 14 inch monitor in the control room are photographed either on 35 mm. roll films or by using 16 mm. cinefilms.

Detail Perceptibility. Seven groups of copper wires of different diameters (0.23, 0.25, 0.33, 0.4, 0.5, 0.6 and 0.7 mm.) are provided as a test chart for the examination of detail perceptibility. Each group consists of wires of equal diameter arranged on an extremely thin plate of plexiglass with the distances between them being equal to their diameters.

† The television system equipment is manufactured by the Matsushita Electric Industrial Co., Ltd.

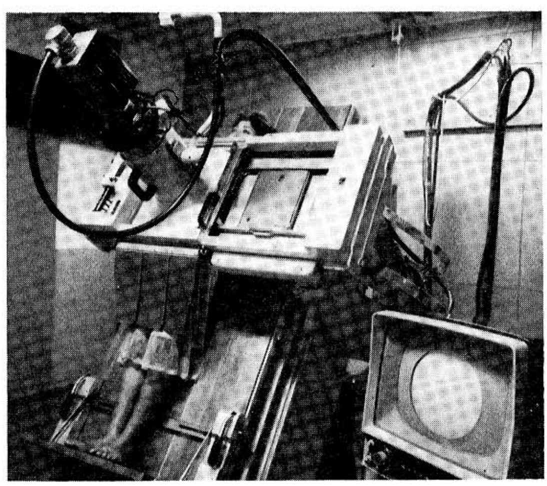

Fig. 2. Combination of Symmetrix 90/90 tilting table, 5 inch image intensifier and a closed circuit vidicon television camera with a 17 inch screen of an ordinary television picture tube for fluoroscopy.

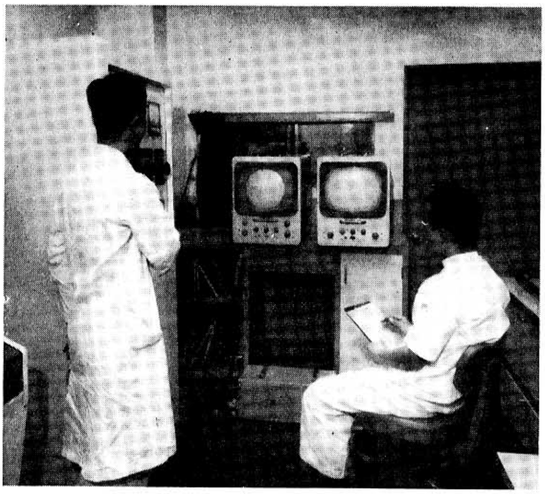

FIG. 3. The control room of the x-ray television system. There are two television monitors; the left one is for telefluoroscopy, teleroentgenography and telecineroentgenography and the right one for a general view of the examination room.

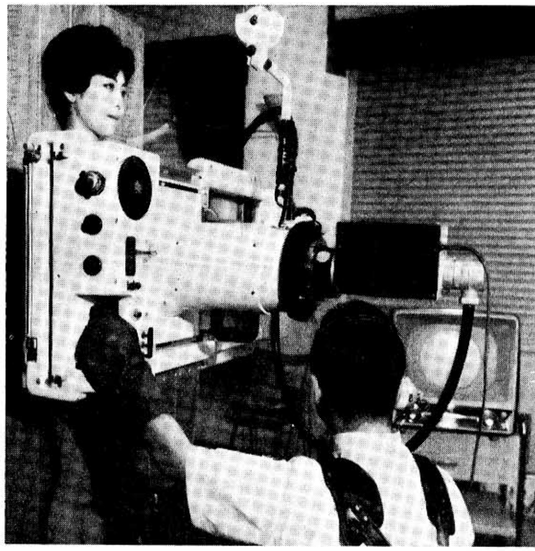

FIG. 4. The examination room of the x-ray television system.

Dose Meter. A Philips universal dose meter, type 37470, is employed. Ten plates of plexiglass, 30×30×1 cm. in size, and a plate of plexiglass, 30×30×5 cm. in size, are used as a phantom. These plexiglass plates can be added or reduced in number as the occasion demands.

Illumination Measurement on the Vidicon Faceplate. The direct measurement of illumination on the vidicon tube faceplate is difficult. Therefore, the luminous flux density at a fixed distance from the observation screen of an image intensifier is first measured by the use of a conventional illumination photometer. Secondly, by reproducing the same condition on an optical test bench, the illumination on the vidicon faceplate can be indirectly measured by the substitution method.

EXPERIMENTS AND RESULTS

TEST OF DETAIL PERCEPTIBILITY

A measurement of the detail perceptibility was performed using the copper wires with the smallest diameter of a group in which each of the wires was separately distinguished (Fig. 5, *A* and *B*). The detail perceptibility was evaluated with respect to: (1) fluoroscopy with the x-ray television monitor; (2) fluoroscopy with the image intensifier; and (3) fluoroscopy with the conventional fluorescent screen (Lerey-West "Sirius" HS screen).

The experimental data are shown in Figure 6; the distance of the focus to the photocathode screen of the image intensifier or of the focus to the conventional fluorescent screen was a constant 91 cm. The test chart was placed at a point 9 cm. from the photocathode screen of the image intensifier in the direction of the roentgen-ray tube when no phantom was used. With the phantom, the distance between the surface of the phantom facing the roentgen-ray tube and the focus of the roentgen-ray tube was always 58 cm. In the latter case, the detail perceptibility was evaluated by changing the depth of the test chart in a phantom 15 cm. thick; no detectable effect on the detail perceptibility was observed. Figure 6 shows that the detail perceptibility of the image intensifier is best, the x-ray television is slightly inferior to the former, and the conventional fluorescent screen is the poorest. As regards the detail perceptibility of the x-ray television system, one must take into consideration the fact that there is a significant difference due to the inclination of

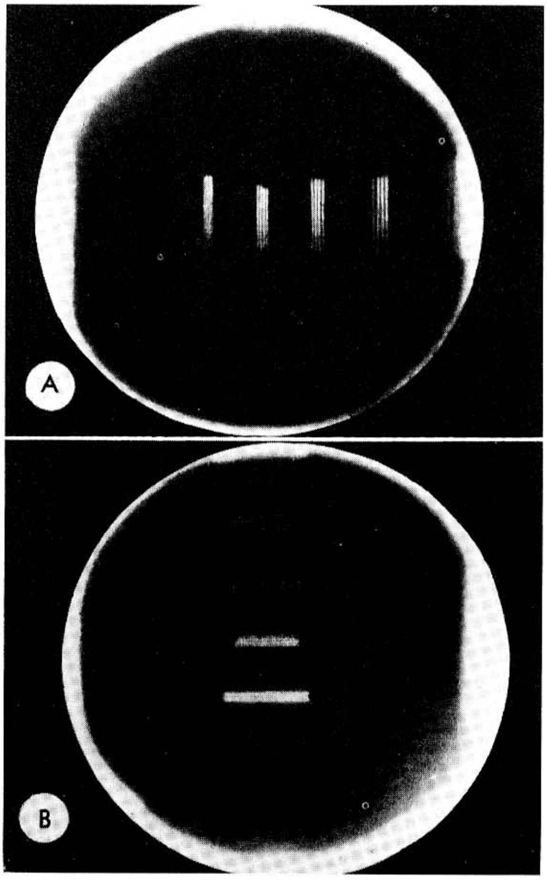

Fig. 5. Copper wires for the test of detail perceptibility. (*A*) The wires at right angles to the scanning lines of the television monitor are 0.4, 0.5, 0.6 and 0.7 mm. in diameter, left to right. (*B*) The wires parallel to the scanning lines are 0.7, 0.6, 0.5 and 0.4 mm. in diameter, top to bottom.

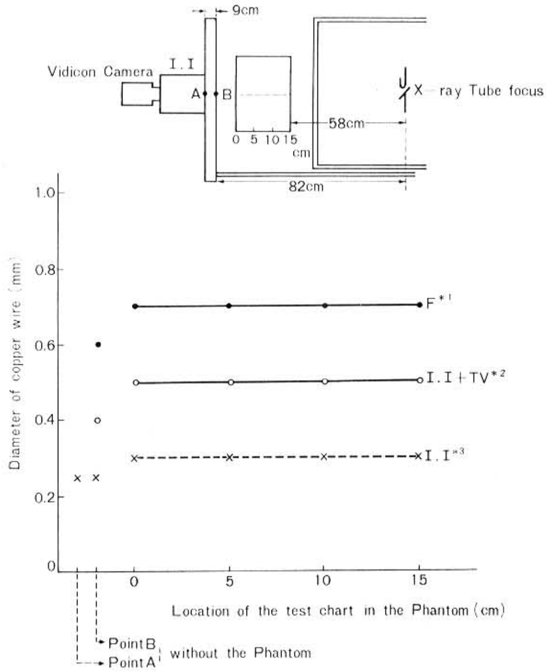

Fig. 6. Comparison of detail perceptibility of the fluoroscopic images by means of the conventional fluorescent screen, a combination of image intensifier and television, and image intensifier only.

Range of the diameters of the copper wires utilized for the test chart, 0.23–1.0 mm.; range of kilovoltage, 60–90 kv. peak; range of current, 2–3 ma.; focus size of the roentgen-ray tube, 1.0×1.0 mm.; grid ratio, 60–65/inch-24/cm.

*1 Conventional fluorescent screen.

*2 Combination of image intensifier and television.

*3 Image intensifier.

the copper wires of the test chart toward the scanning lines on the television monitor. When the wires are parallel with the scanning lines, the detail perceptibility is inferior by 0.1 mm. in diameter as compared to the case when the wires are vertical to the scanning lines (Table I and Fig. 5, *A* and *B*).

DOSIMETRY

The incident dose upon the object (*e.g.*, patient or phantom), the dose passing through the object and the scattered dose received during an examination were measured. The measurements were carried out by using the following factors: a 5 inch square roentgen-ray beam on the fluorescent screen, several kv. steps in the range from 60 to 120 kv., and currents of 2 and 3 ma.

Measurements of the Dose in the Plexiglass Phantom. The values of the incident dose upon a plexiglass phantom 15 cm. thick and the dose passing through it are given in Table II. That a relationship between the ratio of the exit dose to the entrance dose and the change of kilovoltage exists is evident (Fig. 7). Whether the x-ray television, the image intensifier or the conventional fluorescent screen is used, we can estimate roughly the patient dose received during fluoroscopy from this table. It was found that clear visualization of the pulmo-

TABLE I

COMPARISON OF JANKER'S AND THE PRESENT AUTHORS' DATA AS TO DETAIL PERCEPTIBILITY OF X-RAY TELEVISION SYSTEMS

Authors	Thickness of Phantoms (cm.)	Distance between the Test Chart and the Fluorescent Screen (cm.)	Minimum Diameter of Metal Wires That Are Distinguishable from Each Other (mm.)			
			F*	I. I.*	F+TV†	I. I.+TV*
Janker	0	0	0.4	0.3	0.8	0.6
Matsuda, Nagaoka, Takai, and Ninomiya	0	9	0.6	0.25	—	0.4 (0.5‡)
Janker	8		0.8	0.35	0.8–1.0	0.6
Matsuda, Nagaoka, Takai, and Ninomiya	15	9–24	0.7	0.33	—	0.5 (0.6‡)

* See Figure 6. F= conventional fluorescent screen; I.I.= image intensifier; TV= television.
† Combination of conventional fluorescent screen and television.
‡ Values in parentheses represent the detail perceptibility when the wires are parallel with the scanning lines of the television monitor.

nary field or the digestive tract with x-ray television was best accomplished by employing a current of 2–3 ma., and 70–75 kv. for the lungs (posteroanterior view), 75–80 kv. for the esophagus (oblique view), and 80–100 kv. for the intra-abdominal organs such as the stomach, the duodenum, the small and large intestines and the gallbladder. When the chest or the abdomen of a patient was thicker than usual, increase in the voltage did not show any appreciable improvement in detail perceptibility on the television monitor. From these clinical experiences and the experimental data, it seems to us that the necessary and satisfactory values in the ratio of the exit dose to the entrance dose are as follows: 0.7–1.0 per cent for fluoroscopy of the chest and 1.0–2.0 per cent for the abdominal organs (Table II and Fig. 7).

Measurement of the Patient Dose. We chose patients at random and measured the distribution of the dose in television fluoroscopy of the chest and abdomen with 2 ma., in relation to the thickness of the patient's

TABLE II

VALUES OF THE INCIDENT DOSE UPON A PLEXIGLASS PHANTOM 15 CM. THICK AND THE DOSE PASSING THROUGH THE PHANTOM USING A CURRENT OF 3 MA. THE ROENTGEN-RAY BEAM ON THE FLUORESCENT SCREEN WAS 5 INCHES SQUARE

kv.	Entrance Dose (r/min.)	Exit Dose (mr/min.)	Exit Dose / Entrance Dose (per cent)
60	1.57	14	0.82
70	2.36	28	1.10
80	3.15	48	1.52
90	3.88	75	1.93
100	4.66	100	2.14
110	5.32	125	2.34
120	5.50	148	2.69

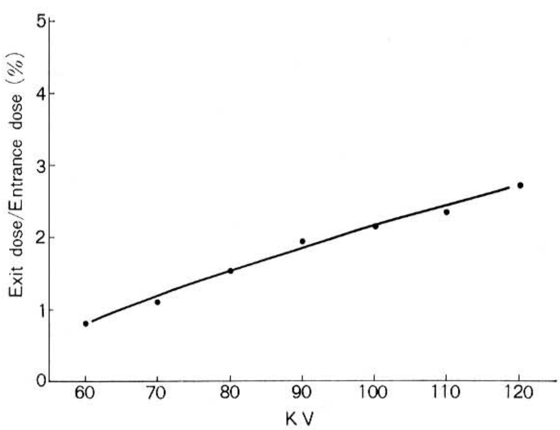

FIG. 7. Relationship between the ratio of the exit dose to the entrance dose and the change of kilovoltage using a current of 3 ma.

body (Fig. 8). The mean values were 2.0 ±0.3 r/min. for the chest and 3.4 ±0.7 r/min. for the abdomen. As may be seen from Figure 8, the thickness of the chest has no appreciable effect on the patient dose in fluoroscopsy of the lungs using television, although the dose increases gradually with the thickness of the abdomen in television fluoroscopy of the alimentary tract.

Measurement of the Scattered Ray Dose. The scattered ray dose of television fluoroscopy was measured perpendicular to the roentgen-ray beam at a point 100 cm. from the center of the phantom (Fig. 9), using 3 ma. and a 5 inch square roentgen-ray beam at the fluorescent screen. The amount of scattered radiation increases with increasing kilovoltage and the rate of increase is nearly linear up to 110 kv. As shown in Figure 9, at a distance of 100 cm. from the center of the patient, perpendicular to the direction of the roentgen-ray beam, the scattered dose will be approximately 0.15–0.2 mr/min. for examination of the chest, and 0.2–0.4 mr/min. for examination of the abdomen.

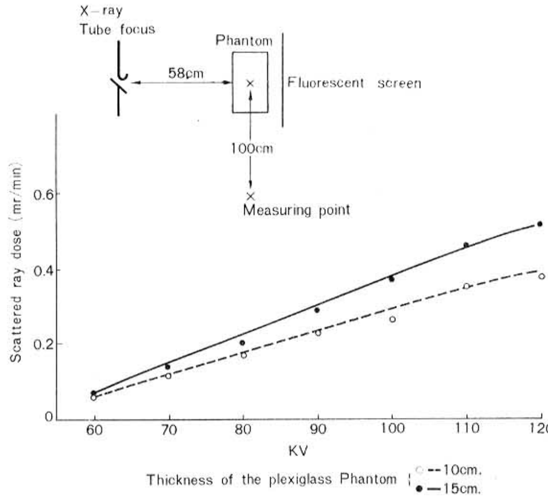

FIG. 9. Change of the scattered ray dose with change in kilovoltage using 3 ma. and a 5 inch square roentgen-ray beam on the fluorescent screen.

THE VIDICON FACEPLATE

The selection of the type of pickup tubes used for the television camera and also the design of the head amplifier depend upon the degree of illumination produced on the vidicon faceplate by the roentgen-ray image focused through a proper optical system from the observation screen of the image intensifier. Figure 10 shows the result of our measurements, using the substitution method. As may be noted, the relation of the respective changes between the illumination on the vidicon faceplate and the thickness of a plexiglass phantom, with 3 ma. and various kilovoltages applied to the roentgen-ray tube, can be expressed in an exponential function. A plexiglass phantom with a thickness of more than 10 cm. must be considered extremely unfavorable as regards the sensitivity of the vidicon type television pickup tubes.

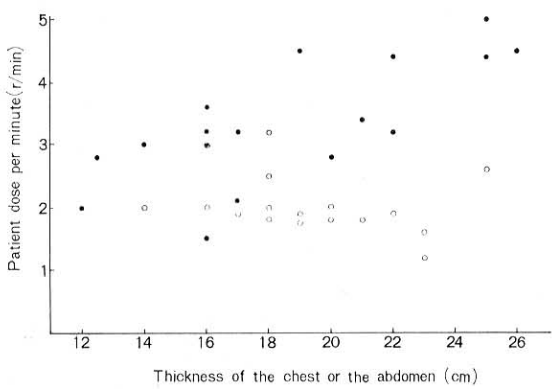

FIG. 8. Sharp contrast between the distribution of the patient dose in telefluoroscopy of a pulmonary field and that of an abdomen in relation to the change of the thickness of the patient's body.
○—Patient dose in telefluoroscopy of the lungs.
●—Patient dose in telefluoroscopy of the alimentary tract and gallbladder.

TELEFLUOROSCOPY AND TELEROENTGENOGRAPHY USING THE X-RAY TELEVISION SYSTEM

One of the most interesting characteristics of the x-ray television is that the radiologists can freely carry out teleroentgenography by using the monitor under conditions of routine fluoroscopy, while they perform telefluoroscopy with the same monitor. The technical factors for teleroentgenography are as follows: f=2.8; 35 mm.

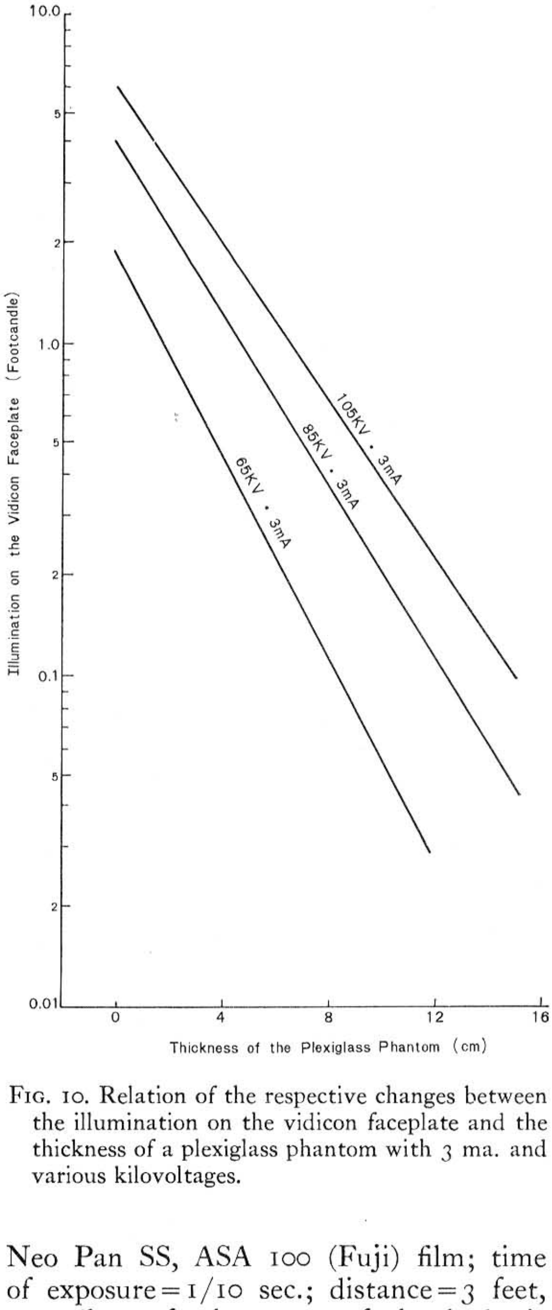

FIG. 10. Relation of the respective changes between the illumination on the vidicon faceplate and the thickness of a plexiglass phantom with 3 ma. and various kilovoltages.

Neo Pan SS, ASA 100 (Fuji) film; time of exposure = 1/10 sec.; distance = 3 feet, regardless of what part of the body is examined. Figures 11 to 13 illustrate indirect teleroentgenograms made by using the television monitor. It may be noted from these illustrations that the range of the x-ray television system is similar in teleroentgenography to that in telefluoroscopy, since both methods of examination are carried out under quite identical technical conditions and all regions of the body can be examined. However, it must be admitted that there is some difference in the ease of the examination depending on which part of the body is examined, as shown in Table III. This table was compiled from clinical experience with about 150 cases examined with x-ray television from October to November, 1959.

CINEROENTGENOGRAPHY USING THE X-RAY TELEVISION SYSTEM

Telecineroentgenography was performed by photographing the roentgen-ray images on the television monitor with a 16 mm. cinecamera (Arriflex) in the control room. The factors for telecineroentgenography were as follows: f = 5.6; Fugi x-ray film for fluorography; 15 frames/sec.; distance between the monitor and the cinecamera, 3 feet. Kilovoltage and milliamperage were the same as for telefluorography. Hence, the patient dose received during telecineroentgenography was equal to that received during telefluoroscopy, that is, 2–5 r/min. (Table IV). The regions examined by telecineroentgenography were the pulmonary fields, heart, aorta, trachea and bronchi after bronchography, the esophagus, small and large intestines after the ingestion of a barium meal, the sigmoid colon and large intestine after a barium enema, and the gallbladder after cholecystography using telepaque. Figure 14 shows clearly that telecineroentgenography using the x-ray television system is of definite diagnostic value in these regions.

DISCUSSION

Construction Problems. X-ray television units are roughly classified into two types depending on the kind of pickup tube employed. This is either the vidicon or the image orthicon. An example of the former is the Philips unit[1] and of the latter are Janker's[3] and Marconi's units. There are two fundamental reasons why we have adopted the vidicon camera system. The first is that the device with this system can be operated by radiologists without the

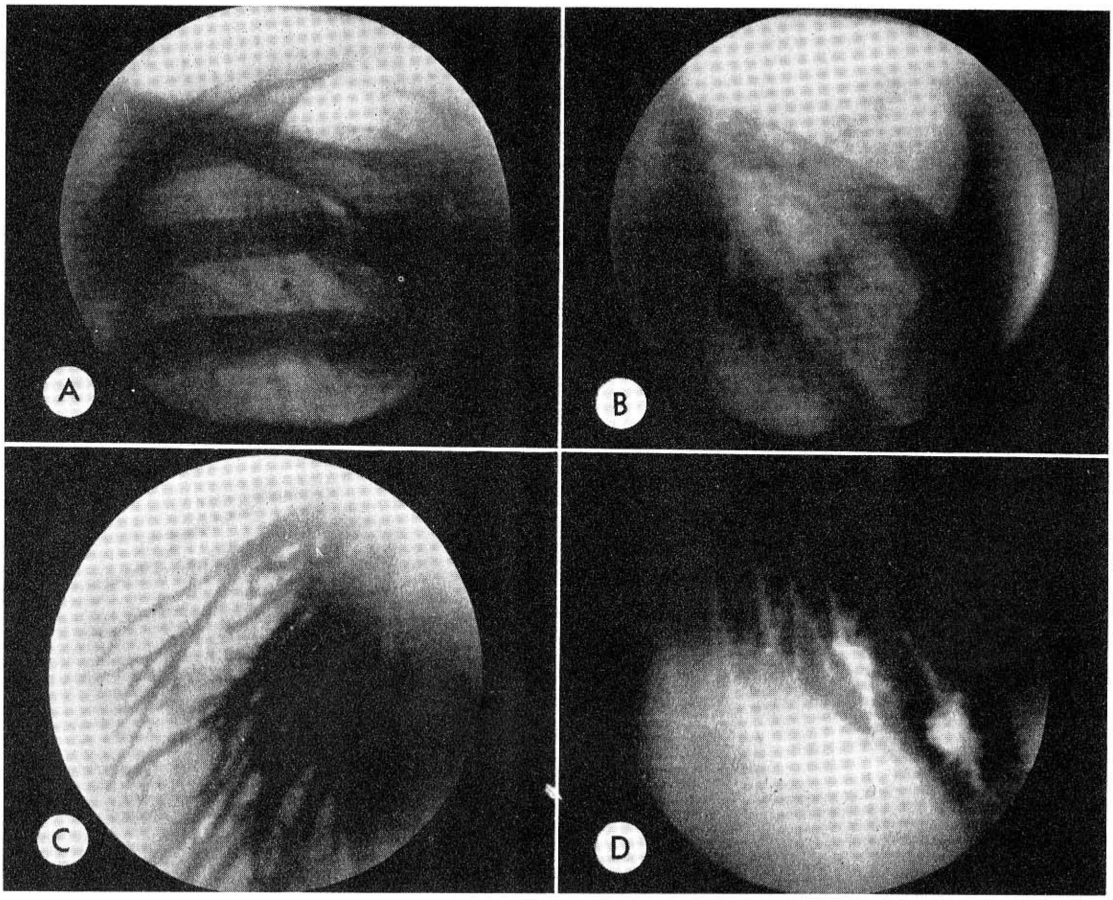

Fig. 11. Teleroentgenograms of the pulmonary field using the television monitor. (*A*) Upper region of the right lung field. (*B*) Lower region of the left lung field. (*C*) Normal bronchial tree. (*D*) Deformed bronchial arborization due to chronic bronchitis.

need of electronic engineers. Secondly, the signal to noise ratio of the televised roentgen-ray image is far better than that of the image orthicon camera. The image orthicon camera is, as is well known, extremely sensitive in comparison with the vidicon; therefore, it is capable of catching the image on the conventional fluorescent screen without the aid of the image intensifier, the use of which is indispensable to the vidicon camera. However, a comparison of Janker's[3] data with those of the authors' (Table I) shows that the combination of the image orthicon camera and the conventional fluorescent screen leads to conspicuous deterioration in detail perceptibility, while the vidicon-image intensifier system is by no means inferior to the image orthicon-image intensifier system in the detail perceptibility. Under the circumstances we undertook a study of the x-ray television system by means of the vidicon-image intensifier combination. The sensitivity of the vidicon camera was not always satisfactory in the last few years, so the image orthicon camera has been temporarily used. It is our impression that the range of the image orthicon camera, in the future, will prove useful in particular problems.

Perceptibility Problems. These deal primarily with the focus size of the employed roentgen-ray tube. We have used a roentgen-ray tube of 1.0 mm. focus in our experiments. However, we found that a smaller focus of 0.3 mm. in size will give

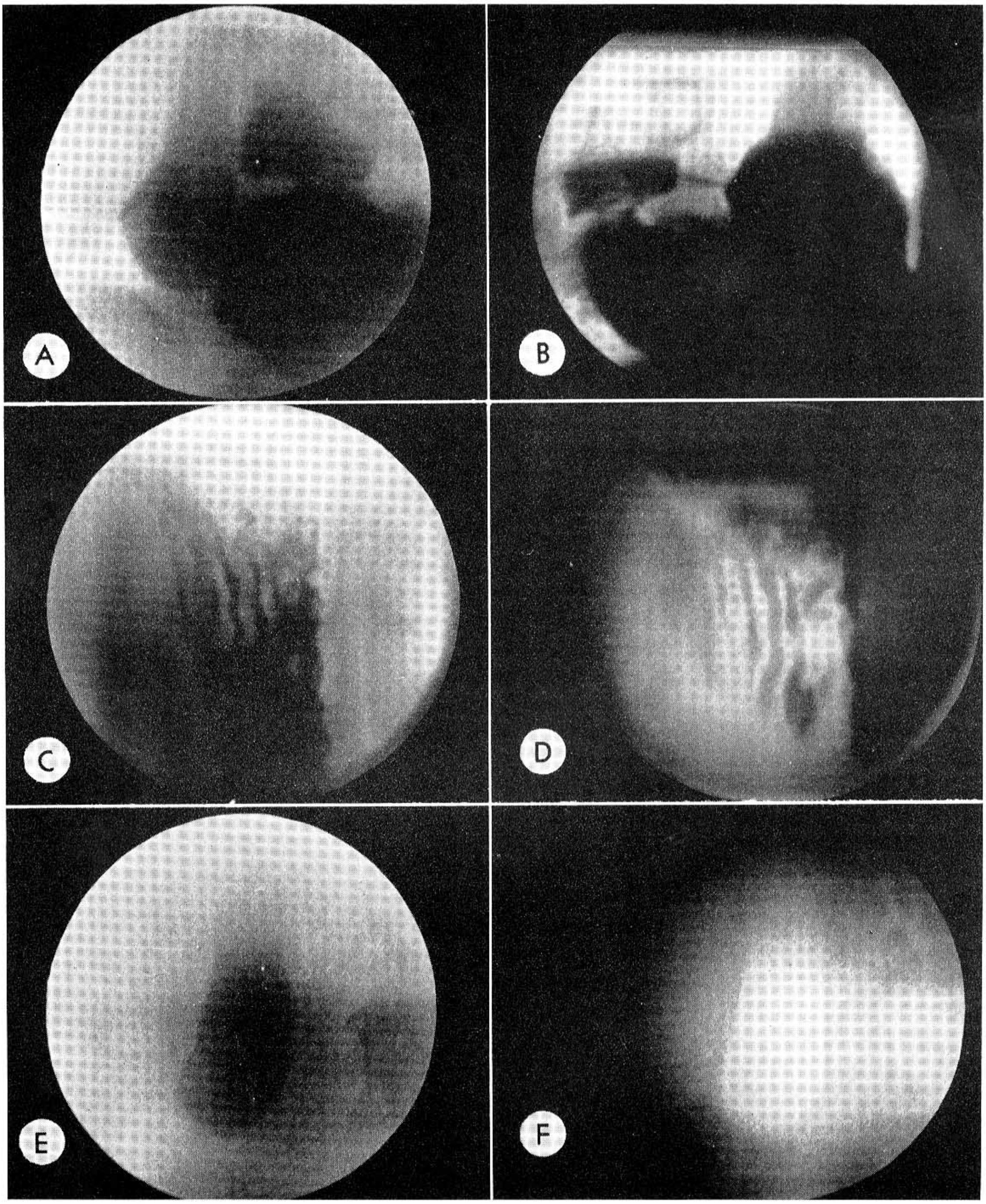

FIG. 12. Teleroentgenograms of the alimentary tract and gallbladder. (*A*) Prepyloric antrum, duodenal bulb and gallbladder. (*B*) Stomach and duodenal bulb. (*C*) Relief pattern of a stomach (positive view). (*D*) Relief pattern of a stomach (negative view). (*E*) Gallbladder (positive view). (*F*) Same gallbladder (negative view).

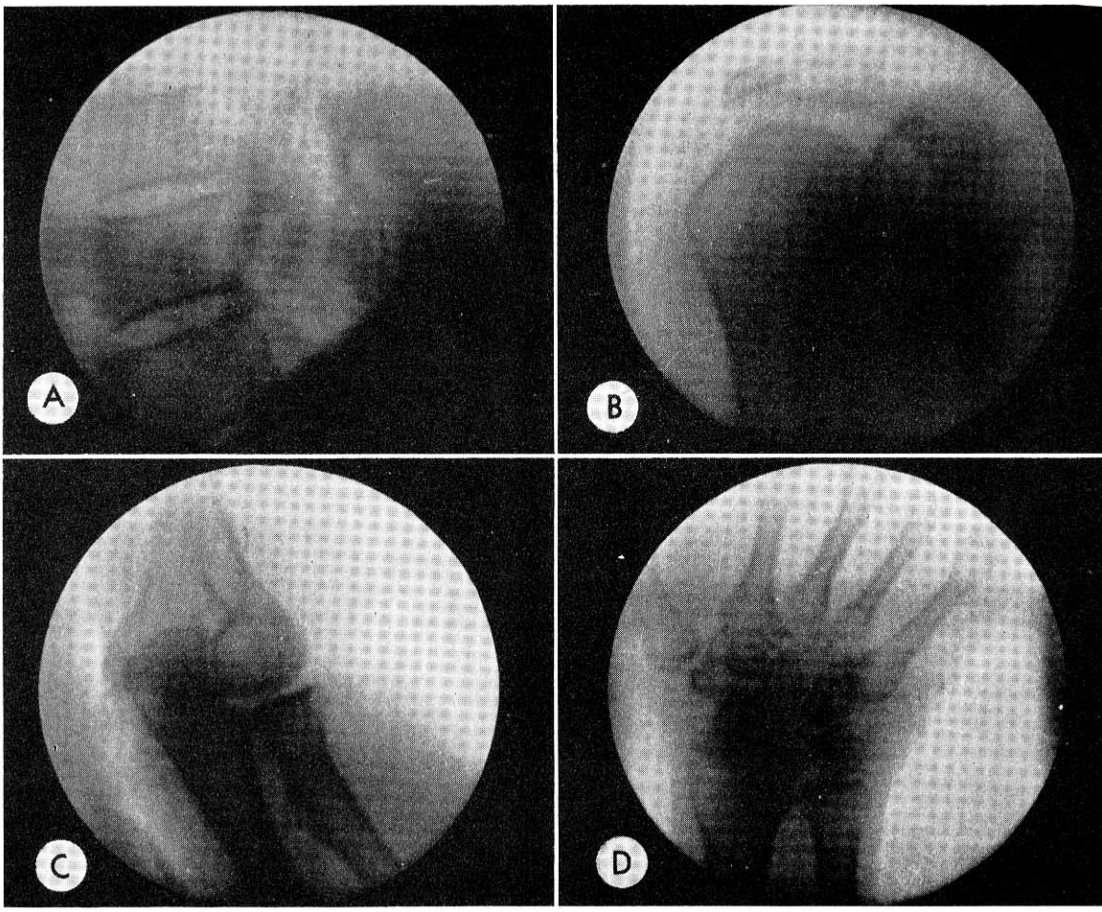

Fig. 13. Teleroentgenograms of bones. (*A*) Dorsal spine (lateral view). (*B*) Shoulder joint. (*C*) Elbow joint. (*D*) Wrist joint.

better detail perceptibility. Secondly, there is a slight difference in detail perceptibility depending on the direction of the object to the scanning lines of the television monitor (Table I and Fig. 5). With our present equipment, the difference in detail perceptibility is 0.1 mm. This is inherent to the 525 line square scanning system. We hope to adopt a 625 line system and thereby eliminate this difference.

Sensitivity Problems. Although our x-ray television system has a wide range of diagnostic possibilities in most regions of the body, it is, to an extent, limited. We were not able to get sufficiently clear images of the bony structures of the hip joint, head, upper dorsal spine and of the lateral view of the lumbar spine. Also, it was hardly possible to diagnose the lesions in the digestive tract of men who had an abdominal thickness above 25 cm. (Table III).

In order to overcome these difficulties, we feel that the following factors may prove helpful: (1) increase in milliamperage, (2) employment of a more sensitive vidicon tube in low brightness level, and (3) improvement in the efficiency of the optical component between the image intensifier and the vidicon camera. Usually, we employ a current of 2–3 ma.; however, we were able to get extremely clear images on the television monitor by temporarily increasing the milliamperage to 6 ma. without changing the kilovoltage (Fig. 12*B*). Our x-ray television unit is now under reconstruction with these points in mind.

TABLE III

CLASSIFICATION OF THE ORGANS OR REGIONS OF THE BODY ACCORDING TO THE EASE OF FLUOROSCOPY USING X-RAY TELEVISION

Ease of Fluoroscopy	Organs or Regions (nature of examination)	Direction of Roentgen-Ray Beam
Extremely easy	Lung	Posteroanterior, oblique
	Trachea and bronchi (bronchography)	Posteroanterior, oblique, lateral
	Heart and aorta	Posteroanterior, oblique
	Esophagus	Oblique
	Sigmoid colon and colon (barium enema)	Posteroanterior
	Cervical spine	Posteroanterior, lateral
	Middle and lower portions of a dosal spine (except D10 and D11)	Lateral
	Bones of extremities Shoulder joint Elbow joint Wrist joint Knee joint	Posteroanterior, oblique
	Bladder and urethra (cystourethrogram)	Posteroanterior, oblique
Easy*	Stomach Duodenum Small and large intestine (oral method) Gallbladder	Posteroanterior, oblique
	Lumbar spine	Posteroanterior
Rather difficult	Hip joint	Posteroanterior,
	Head	Posteroanterior, lateral
Difficult	Dorsal spine	Posteroanterior
	Upper dorsal vertebrae	Lateral
	Lower dorsal vertebrae (D10–D12)	Posteroanterior, lateral
	Lumbar spine	Lateral

* Clearness of fluoroscopic images as to these regions is influenced by the thickness of the abdomen. Hence, in general, the ease of telefluoroscopic diagnosis based on the thickness of the abdomen is as follows: under 20 cm. thick-easy, 20–24 cm. thick-moderately difficult, over 25 cm. thick-difficult.

In a future report, the experiences with the new unit and its diagnostic capability will be described. The timely introduction of the storage tube will make it possible to store electronically these extremely dis-stinct images for any length of time without further radiation to the patient.

Effective Visual Field. The size of the effective visual field in the x-ray television unit of the vidicon tube and image intensifier system is limited by the diameter of the image intensifier. We now use a 5 inch image intensifier; however, it will be replaced by an image intensifier of a larger

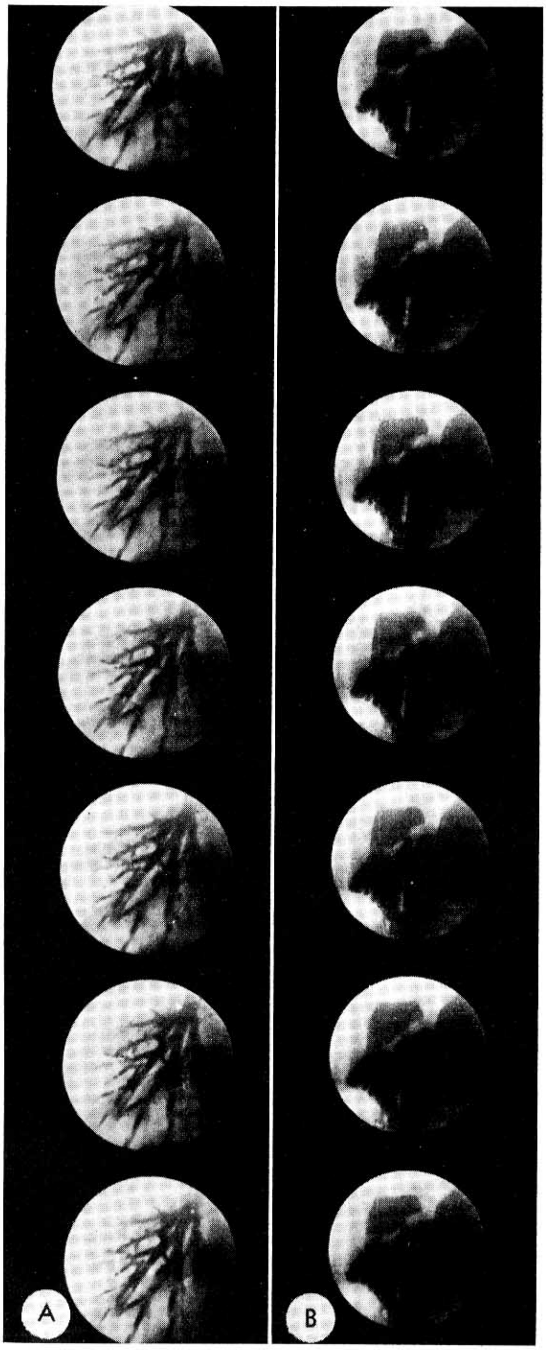

Fig. 14. (*A*) Telecineroentgenograms of a normal bronchial arborization, and (*B*) of the stomach and duodenum.

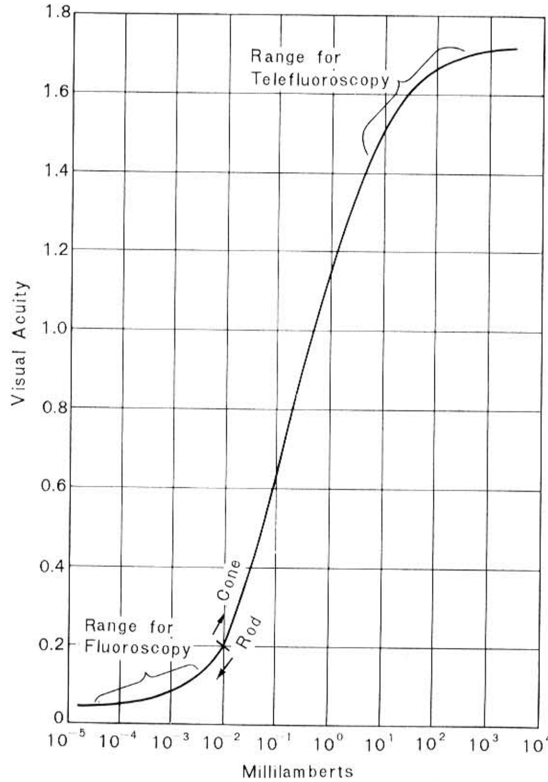

Fig. 15. Relationship of visual acuity to illumination; the brightness of the conventional fluorescent screen was in the order of 10^{-4}–10^{-3} millilamberts. Sharp vision is impossible at this low level brightness because observation takes place by means of the rods, localized at the peripheral parts of the retina, while with high brightness levels used in telefluoroscopy, observation is by the cones, situated at the central zone of the retina.

diameter. The 5 inch image intensifier is apt to be insufficient in clinical use and radiologists expend a great deal of work and time because of inevitable traveling of the visual field. Too, the necessary additional radiation exposure may bring about unfavorable effects. For these reasons an image intensifier of over 9 inches in diameter is recommended.

EVALUATION

Telefluoroscopy. Roentgen-ray images on the television monitor are very much superior to those on the conventional fluorescent screen in both brightness and sharpness. This means that the value of fluoroscopy—more exactly telefluoroscopy—is greatly increased in the domain of roentgen diagnosis. Hitherto, not only the inexperienced but also an experienced radi-

TABLE IV

RADIATION DOSE IN CONVENTIONAL CINEFLUOROGRAPHY AND IN TELECINEFLUOROGRAPHY

Method	Area	Authors	Kilo-voltage	Milli-amperage	Dose (r/min.)	Frames per sec.
Image Intensifier	Chest	Feddema	70	10	9	32
	Esophagus	Allcock and Barridge	95–120	6–17	13.5–42	16.6
	Stomach	Philips advertising	120	12	18	16
	Duodenum and small bowel	Feddema	120	11	20	16
Image Intensifier plus Orthicon	Chest and stomach	Janker	90	2–4	5–10	25
Image Intensifier plus Vidicon	Chest	Matsuda, Nagaoka, Takai and Ninomiya	65–70	2	1.5–2.5	15
	Esophagus		75–80	2	3	15
	Stomach, duodenum, and intestine		75–100	2	3–5	15

ologist would hesitate to make a positive diagnosis of diseases of the chest or digestive tract by fluoroscopy alone, without study of roentgenograms of those patients. Owing to the fact that there is 100,000 times as much brightness as on the conventional fluorescent screen (Fig. 15),[2] telefluoroscopy—fluoroscopy using the television monitor—is carried out by the cone-vision of the retina, while conventional fluoroscopy requires the rod-vision. This is probably the most important reason for the remarkable improvement of detail perceptibility in telefluoroscopy. When the detail perceptibility of the roentgen-ray shadow by means of telefluoroscopy becomes comparable to that of conventional roentgenography, it is possible that telefluoroscopy may replace direct roentgenography.

Indirect Roentgenography and Cineroentgenography. One of the greatest advantages of the x-ray television system is that the operator can freely take photographs of various organs of patients by means of a lens-shutter system camera or a cinecamera by using the x-ray television monitor during the course of fluoroscopy with complete protection against exposure to radiation. The authors again wish to emphasize that this type of indirect roentgenography, including telecineroentgenography, was performed with the same kilovoltage and milliamperage that they used in conventional fluoroscopy. This has an important bearing on the decrease of the patient dose in roentgen diagnosis. Telecineroentgenography—cineroentgenography using the x-ray television monitor—was performed at 15 frames per second because pictures are transmitted at 30 frames per second in our closed circuit television system.

Radiation Exposure of Patient and Radiologist. As regards radiation exposure, a line must be drawn between the dose received by the radiologist and that received by the patient. The radiologist and x-ray technician who are in the control room are completely protected against radiation throughout the course of fluoroscopy, roentgenography or cineroentgenography with the x-ray television monitor. However, since the tilting table which we now use is not remotely controlled, an operator is left in the examination room to select the visual field of the image intensifier, to roentgenograph directly and to tilt the table. We plan to remedy this by employing a fluoroscopic table operated by remote control.

The patient dose in telefluoroscopy, teleroentgenography and telecineroentgenography, regardless of whether the single or combined technique is used, is by no means greater than that in conventional fluoroscopy, but the relative patient dose in telefluoroscopy is greater than that in fluoroscopy using the image intensifier. For example, factors of 60 kv., 2 ma. for the chest and 75 kv., 2 ma. for the stomach and duodenum are adequate for obtaining clear images in fluoroscopy of patients who have a 20 cm. thickness of the chest and a 22 cm. thickness of the abdomen by using an image intensifier. In comparison, 75 kv., 2 ma. for the chest and 80 kv.–100 kv., 2 ma. for the abdomen are required in telefluoroscopy. Telecineroentgenography seems to have advantages over cinefluorography when the image intensifier is used (Table IV). In fact, cineroentgenography employing the x-ray television monitor appears to be one of the most useful techniques in the domain of roentgen diagnosis.

SUMMARY

The data concerning the construction and the diagnostic capability of an x-ray television system which is employed in clinical practice are presented. The advantages of this system to roentgen diagnostic procedures such as fluoroscopy, indirect roentgenography and cineroentgenography as well as the radiation exposure of the radiologist and the patient are discussed. Its contribution to definitive and efficient roentgen diagnosis is emphasized.

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