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Classic Description
Diagnostic Roentgen

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# CLASSIC DESCRIPTIONS IN DIAGNOSTIC ROENTGENOLOGY

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# Macroradiography

CHARLES A. BREAM

Dr. W. C. Röntgen's preliminary communication, "On a New Kind of Rays," was published on December 28, 1895. He continued his research into the properties of this new ray and, in paragraph 7 of his third communication, he described the use of "soft" tubes and "hard" tubes in order to obtain a better radiographic image of the object examined. Since that time efforts to improve the quality of the radiographic and fluoroscopic images have been made constantly. Investigations of the factors influencing sharpness of the image have been numerous. These studies have been done both theoretically and clinically, and the results when applied to routine clinical radiology have led to improved equipment and accessories.

Every radiograph produces some enlargement of the object. In attempts to discern more detail on routine films, a magnifying glass is often used, but this enlarges everything, including the grain of the film. By altering the geometry of the tube-object and object-film distances, an enlarged image almost any desired size can be obtained. However, to maintain diagnostic detail the use of a very small beam of x-rays is necessary. The first paper describing the investigation of the possibilities of direct radiographic enlargement was written by Profesesor Alessandro Vallebona of Italy and published in 1928. By a simple modification of an x-ray tube then available, he was able to obtain an ultra-thin beam of radiation and produce enlarged radiographs of good diagnostic quality. Interestingly, he used the term microradiography. Results of further clinical investigations in the use of this modified tube, including body section roentgenography, were published by Professor Vallebona.

In the early 1940's, a rotating anode tube having a 1.5 mm. focus and a so-called "fine focus" of approximately 0.3 mm. was developed in the Philips Laboratory. Since then tubes having an even smaller focal spot have been described but have not found use in clinical radiology. The Philips' communication, published in the Proceedings of the 29th Dutch Physical and Medical Congress held at Amsterdam in April 1943, is the first medical article mentioning the fine-focus tube. It is entitled "The Limits of Vision in X-ray Examinations" by G. C. E. Burger. We are indebted to Dr. van der Tuuk of Philips Electronic Tube Division for the exact English translation.

In the more widely known article, "X-ray Fluoroscopy with Enlarged Image", Burger, Combee and van der Tuuk discuss the physical aspects, describe the tube and give preliminary evaluation of their fluoroscopic experience. Credit for the development of the fine-focus tube and its use in medical fluoroscopy must go to these three.

The application of direct radiographic enlargement was essentially neglected until the pioneer work of van der Plaats, published in 1950. His article, entitled "The Technique of Radiologic Enlargement", reviews the physical considerations in fluoroscopy and the technique of direct radiographic enlargement. He very clearly shows the value of this technique in routine clinical radiology.

Publications concerning the advantages and disadvantages of the fine-focus tube in clinical radiology appeared during the early 1950's from many other countries. Several articles comparing the diagnostic quality of direct radiographic enlargement with that obtained by photographic means stated that the latter method was to be preferred. However, rather extensive clinical use has proven that direct radiographic enlargement is of value in obtaining a more detailed evaluation of a pathologic process noted on routine films. Enlarged radiographs are of value in teaching medical students. No extensive use of the fine-focus tube in research and industry has thus far been undertaken, but application of this technique to specific problems in these areas would seem to be practical.

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# Study of a Method of Microradiography*

DR. ALESSANDRO VALLEBONA

*Assistant from the Institute of Radiology and Electrotherapy University of Genoa*

*Director Prof. V. Maragliano*

(Studio di un metodo di microradiografia. *Liguria Medica,* No. 12, 1928.) Transtlated from the original Italian by Claudio Scaetta, Chapel Hill, North Carolina.

To my knowledge, a way of obtaining microradiography, a radiograph of considerable enlargement, has not yet been found. Professor V. Maragliano was the first person to think that such a procedure could be of notable importance; he, therefore, suggested that I should attempt to devise a method of microradiography. The whole problem is to find a source of radiation which is of finely pointed form, since, as we shall see later, if we have such a source, any object situated between the radiographic film and the source itself will retain its clarity of image regardless of the distance it is placed from the film; and by moving back the object from the film we will be able to obtain the desired enlargement. It is well known that the irradiating surfaces of anticathodes of common radiation-producing tubes are rather large, and even if the object is moved back from the film only a few centimeters, this slight removal would cause a blurred image.

First of all, we have thought to create a secondary anticathode. It is well known that an object irradiated by a stream of X-rays becomes, in turn, a source of radiations which are called secondary radiations, so we hit an anticathode with a thread-like stream of X-rays. The thread-like stream was obtained by having the radiations pass through two small holes situated on the same axis, and at a distance of five centimeters from each other. With this method, however, the secondary irradiation was so weak that even by using very long exposures we were not able to obtain an impression on the radiographic film.

Without wanting to abandon completely such a procedure which, if perfected, I believe, could give better results, I decided to follow another course of investigation, that is to say, adopt the principle of the dark chamber, which, as everyone knows, is the principle on which the camera is based.

"If we bore a small hole in the little window of a dark chamber, we see on a screen opposite the hole an inverted image of the luminous or illuminated objects placed at the exterior. This is explained very well by the rectilinear propagation of light; the rays of light originating from the several points of an external object, and having the hole for common section, when falling on the screen illuminate small areas of a shape similar to the shape of the hole, areas which in their ensemble constitute a figure similar to the shape of the object, but an inverted figure, because the beams

* Communication presented to the Congress on Sanitation of the Civil Hospitals of Genoa, Nov. 15, 1928.

of light cross when passing through the hole. The smaller the hole, the neater the image" (Battelli). I shall explain with a number of charts how this principle could be applied to X-rays. The first thing to establish is that the roentgen rays have a rectilinear propagation just like luminous rays.

First of all, let us see what happens in a commonly executed radiograph. In it, the object we wish to radiograph is in close proximity with respect to the sensitive film, and, although the rays are originating not from a point but from a surface, the image is clear as shown in Figure No. 1, which only takes into account the two extreme rays originating from the irradiating surface of the anticathode. Let us now see what happens if we remove the object from the sensitive film, and approach it to the radiating source. In this case, what in optometry is called penumbra will become important. That is to say, around a darker zone called cone of shade there will be a zone of decreasing darkness called penumbra (Figure No. 2). This will cause an image which, although enlarged, is blurred. Therefore, unless we have a tube with an anticathode of finely pointed form, a direct beam of radiations cannot be used to obtain an enlarged image. And even if we are in possession of such a tube, there would always be the secondary rays produced by the glass, rays which would interfere with the clarity of the image. But, if we place between the object we want to enlarge and the anticathode a tiny hole, the result will be (as shown by Figure No. 3) that the rays will cross at the height of the hole, that they will continue their rectilinear advance

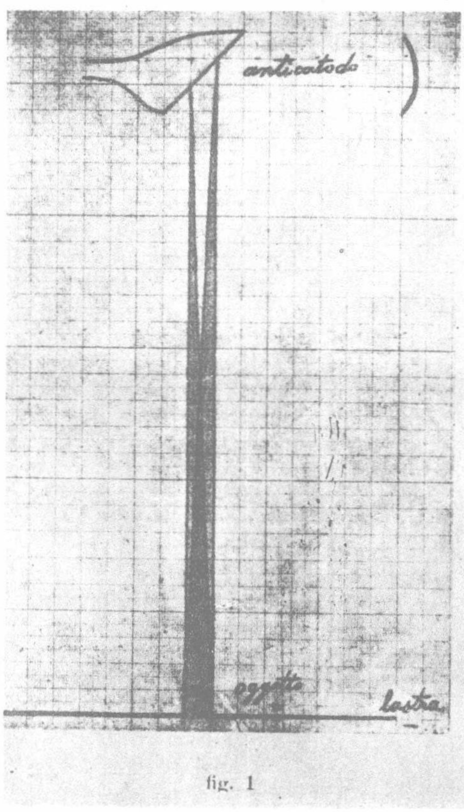


Fig. 1:665

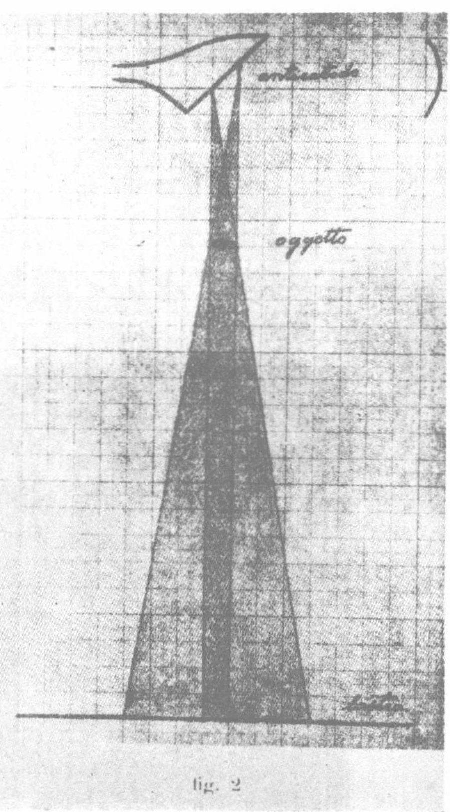


Fig. 2:666

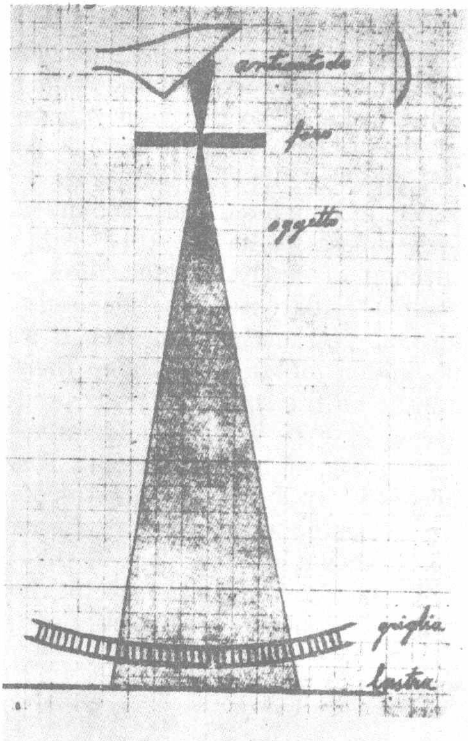


fig. 4

Fig. 4:667

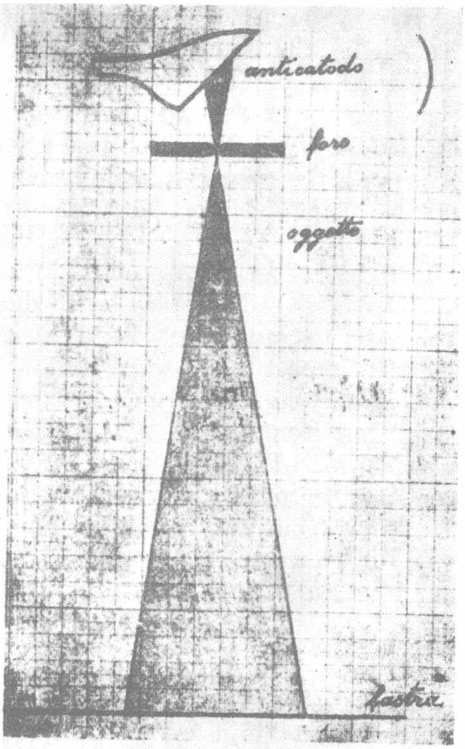


fig. 3

Fig. 3:668

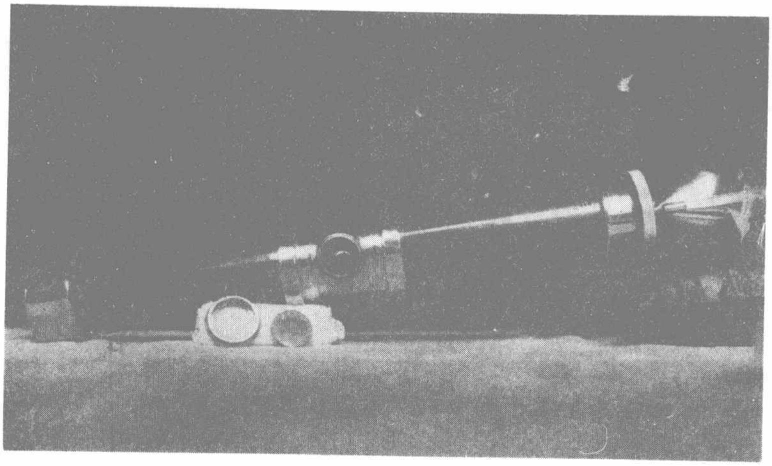

Fig. 5:669

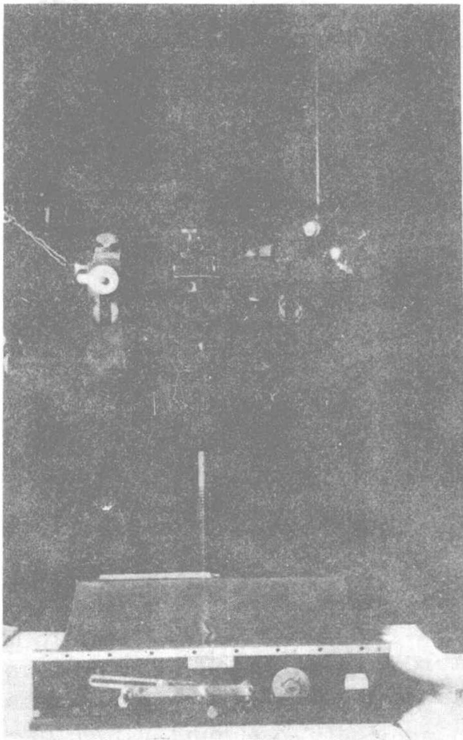

Fig. 6:670

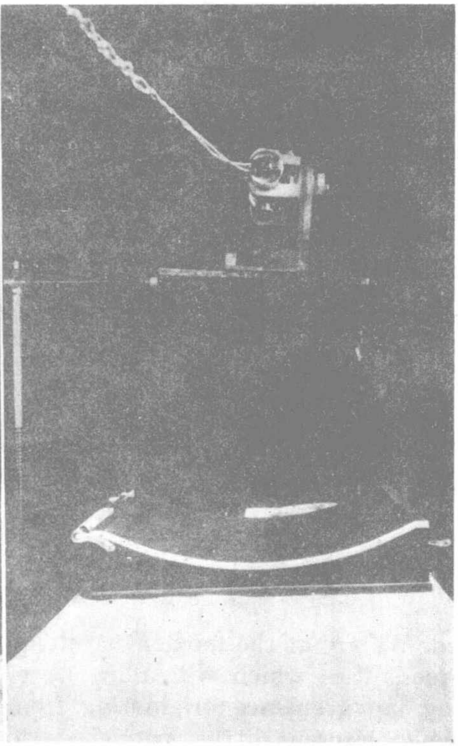

Fig. 7:671

toward the radiographic film, and will reproduce, faithfully enlarged over the image of the anticathode, the object which is placed between the hole and the film. This is the principle on which we think microradiography should be based.

The problem will now be the obtaining of a very small hole which will permit removal of the radiographic film to a greater distance, or permit moving the object closer to the hole itself, and all this while still obtaining a very clear image. For this purpose we bored a very small hole in a brass plate, since lead does not lend itself to such a minute operation. Subsequently we used a very small hole in a platinum plate. The smaller the hole, the clearer the image, but the image will also be less luminous, and, therefore, we will have to either prolong the time of exposure or increase the number of milliamperes. We said that the image of the enlarged object is obtained over that of the radiating surface of the anticathode. Now, this image is rather homogeneous when obtained with small but not tiny holes. But, when obtained by having the rays pass through a tiny hole as we have done in our last experiments, the image is irregular because it shows the exact shape of the radiating surface with points of major emission of radiation and points of minor emission of radiation. Although this fact is interesting from the physical viewpoint because it allows us tc study the characteristics of the anticathode itself, on the other hand it is an inconvenience is not too relevant for bodies having the image of the object on a background which it not homogeneous. This inconvenience is not too relevant for bodies having a certain degree of opaqueness, as one can see from the microradiograph we have

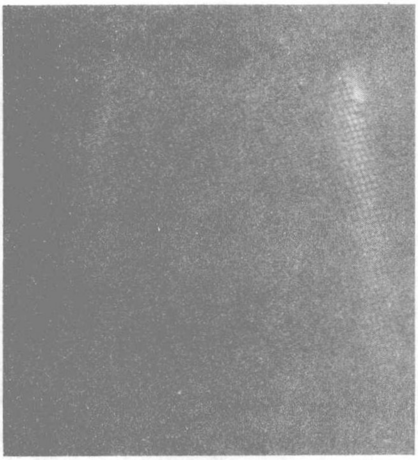

Fig. 8:672

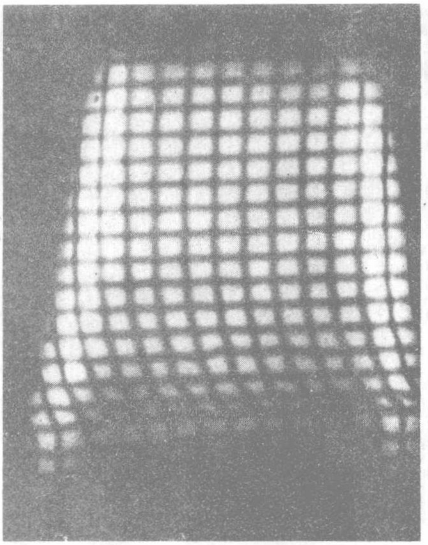

Fig. 9:673

presented. We are at the moment studying certain modalities which will allow us to avoid any inconvenience originating from bodies which present little opaqueness to X-rays.

Another problem we have to face is the problem of the secondary rays produced by the body which is intersected and by the air itself. To eliminate these rays we have used in our first experiments the apparatus

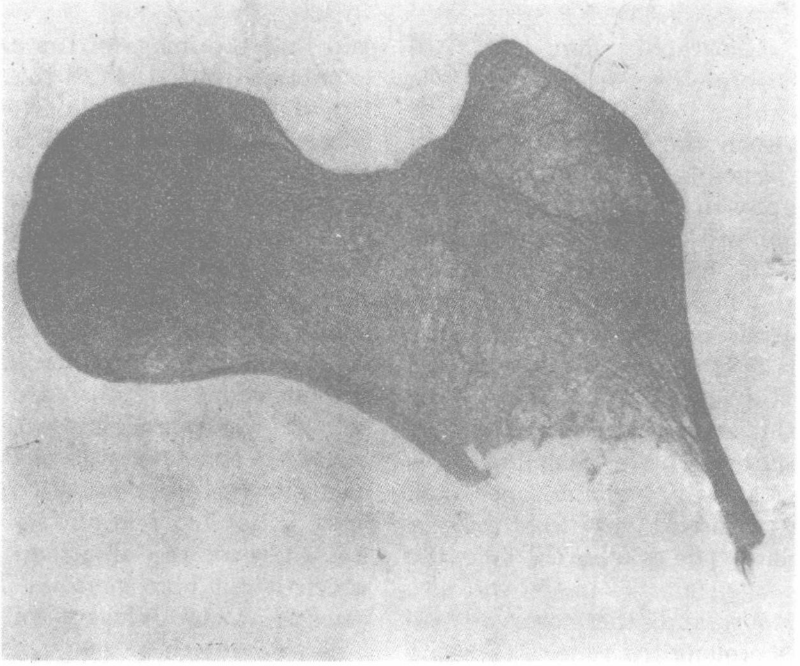

Fig. 10:674