SKIAGRAPHY OF THE CHEST.

BY HENRY HULST, A.M., M.D.,

Of Grand Rapids, Mich.

I. *Raison d'être.*

Not to leave a single stone unturned is the part of the good diagnostician. Yet, as a result of training or of peculiarity of personal make up, it is a well-known fact that all-around skill in the use of the various methods of investigation is exceptional.

This fatal tendency to one-sided development, together with the comparative newness of Rœntgenology in internal medicine, may serve to account for both the neglect and the too exclusive employment of the Rœntgen rays in the examination of the chest.

To illustrate: Butler (Diagnostics of Internal Medicine, p. 654), while admitting that "Medical fluoroscopy and skiagraphy have proved their usefulness in diseases of the chest," gives it no further attention, because "The very considerable expense of the necessary apparatus, the technical skill required in its management, and the personal training and experience which is requisite before trustworthy work can be done places X-ray diagnosis for the present in the hands of the expert."

But is it not true that all medical diagnosis is a matter of training and large experience, and has not all knowledge and endeavor come down to us through the hands of the expert?

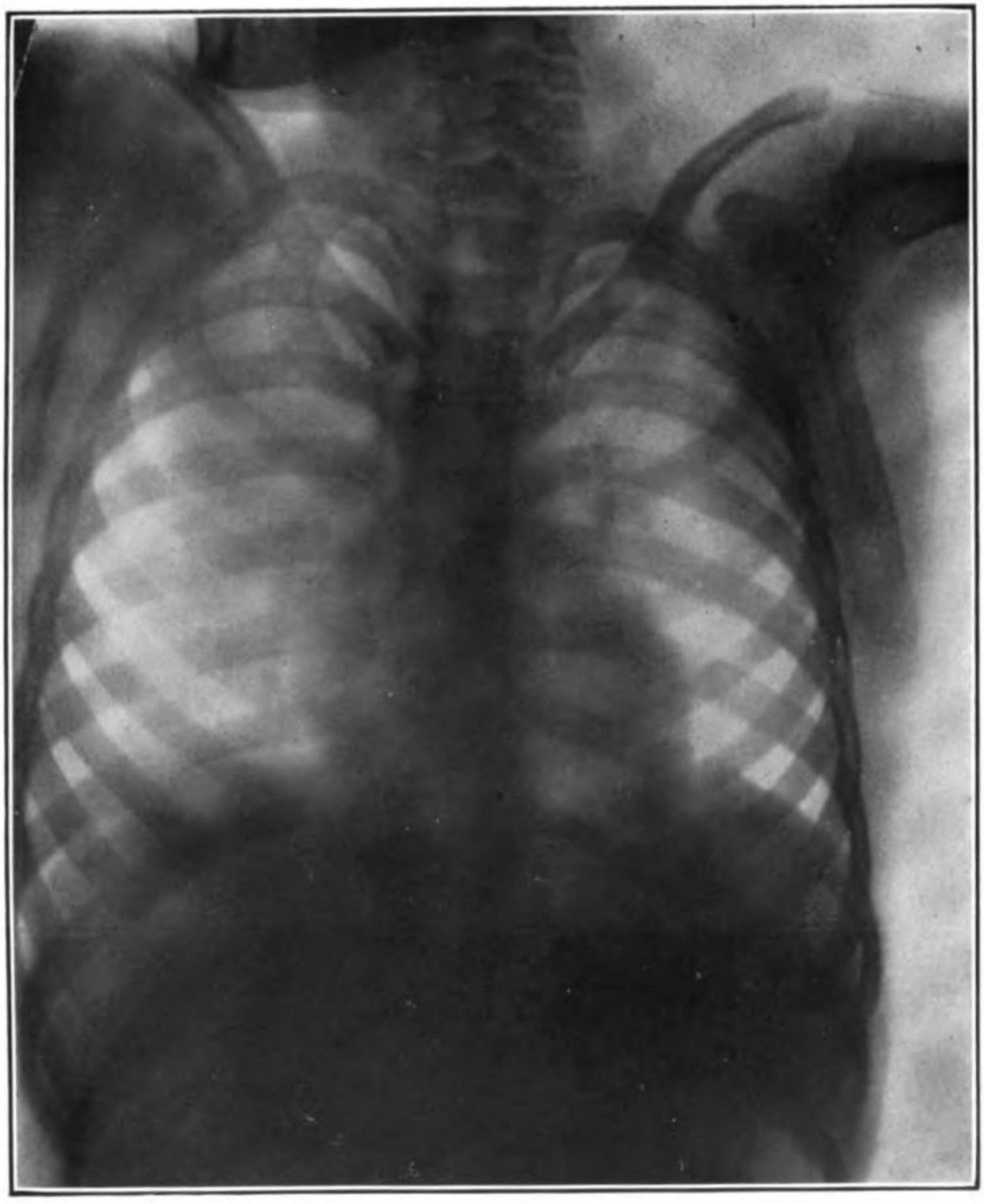
Such, at least, is implied in the opinion of Musser, the author of another late text-book on medical diagnosis, although he devotes but a page or two to X-ray examination of the chest. Musser says: "The use of the large number of instruments that are essential, and the chemical and bacteriological examinations that are made require a great deal of time. Often the diagnosis is a question of hours or even of

days. The patient profits thereby. The bedside labor is great, and, in addition, he must have a laboratory at his command for microscopical, chemical and bacteriological work. The outcome is that the scientific physician must have a clientele limited in number, or else have one or more assistants to aid him in his investigations. Without doubt the latter will soon occur." (Musser: Medical Diagnosis, p. 21.)

One thing seems certain: Mere considerations of expense and skill cannot prevent the general recognition and ultimate adoption of Rœntgen ray examination in medicine if only "The patient profit thereby." And that he does profit thereby cannot be doubtful if he profits by advancement in diagnosis.

"Die Rœntgenologische Diagnostik der Erkrankungen der Brusteingewerde" of Holzknecht and "The Rœntgen Rays in Medicine and Surgery," of Williams, not to speak of other important contributions to the literature of medical diagnosis, have made it imperative for the phthisio-therapist as well as for the general internist to take cognizance of the light the Rœntgen rays throw upon their subjects and have demonstrated the unwarranted dogmatism of Hilderbrand's assertion that "In doubtful cases of phthisis pulmonalis we may safely spare ourselves the trouble of an X-ray examination."

Arriving at the question of the comparative usefulness of skiagraphy and diascopy, it cannot be denied that the latter admits of a wider application in the examination of the chest. Certain data, moreover, are more accessible to fluoroscopy than to skiagraphy. Thus limited excursions of the diaphragm, which now goes in literature under the name of Williams' sign, is decidedly significant in the diagnosis of incipient phthisis and is best observed by the fluoroscope. Parallelo-scopy is the only method for the exact determination of the size and shape of the heart, and the fluoroscope is needed for that. Hence if the choice lay between the two methods I should prefer fluoroscopy. Indeed, a fluoroscopic view of the moving palpitating contents of the chest constitutes at present the nearest possible ante-mortem approach to a post-mortem examination.



Normal Chest

Why then skiagraph the chest at all?

The well-known fact that the photographic plate will show skin eruptions before they are otherwise visible, that therefore, it is more delicate than the eye, is utilized in skiagraphy as it is in dermatology and astronomy. Hence we no longer deem it sufficient to look at a fracture with the screen except for the purpose of general orientation and as a preliminary to a more adequate skiagraphic examination. My reason for skiagraphing the chest is no other, therefore, than that for skiagraphing anything else. That Williams "Is able to detect an abnormal condition of the lungs in early tuberculosis better by means of the screen than by means of the photograph" (Williams, op. cit. p. 120), is not the fault of skiagraphy as such. For general orientation and analysis of the phenomena of motion fluoroscopy is of prime importance, but for bringing out structural detail skiagraphy is far superior, provided the object be at rest. Perhaps this provision was not appreciated as a condition sine qua non by some of the partisans of the fluoroscope. What in case of emergency skiagraphy may accomplish even for recording the phenomena of motion is well shown by the work of Eyckman of Scheveningen, Bewegungs-photographic mittels Rœntgenstrahlen. Fortschritte a. d. Gel. d. Rœngenstr.

By carefully observing this condition of rest, Holzknecht therefore finds, as we should naturally expect, that "A radiogram of the lungs and of the process of consolidation is far superior to the image upon the screen (Holzknecht, op. cit. p.).

Hence its necessary superiority in the early diagnosis of tuberculosis of the lungs.

Unfortunately phthisio-therapists disagree on what constitutes an early diagnosis. Weicker is quoted in the Journal of Tuberculosis to the effect that "The early diagnosis implies the recognition of closed foci in the lungs, which furnish no bacilli bearing sputum." In the same journal Fraenkel says that "No diagnosis of any localization of tuberculosis is complete without the demonstration of the bacillus."

Nor do they agree much better on the means of making an early diagnosis.

Thus Brooks maintains that the "Tuberculin reaction is too promiscuously present in other diseases, uncertain, unacceptable and not entirely without danger," and that "It has been repeatedly shown that the glycerin and proteids of the culture are in themselves sufficient to produce the reaction (Journal of Tuberculosis, Vol. iv., No. 3)."

Tyndal relies upon the ear in auscultation for settling the diagnosis, and Brooks thinks that the thermometer is after all the best instrument in the diagnosis of early phthisis. (Journal of Tub. Ibid).

Weicker, Knopf, Tyndal, Brooks, Von Ruch and others may support Hildebrand in insisting that "Thus far the Rœntgen rays have added nothing in certainty to the older methods;" but their own disagreement on what constitutes a certain early diagnosis as well as on the value of each other's methods deprives their opposition to the new method of meaning.

The objection that when a shadow is found the disease can no longer be considered in its incipiency is valid. But the Rœntgenologist does not claim to diagnose tuberculosis of the lungs at its absolute incipiency; nor does any other method enable us as yet to do so.

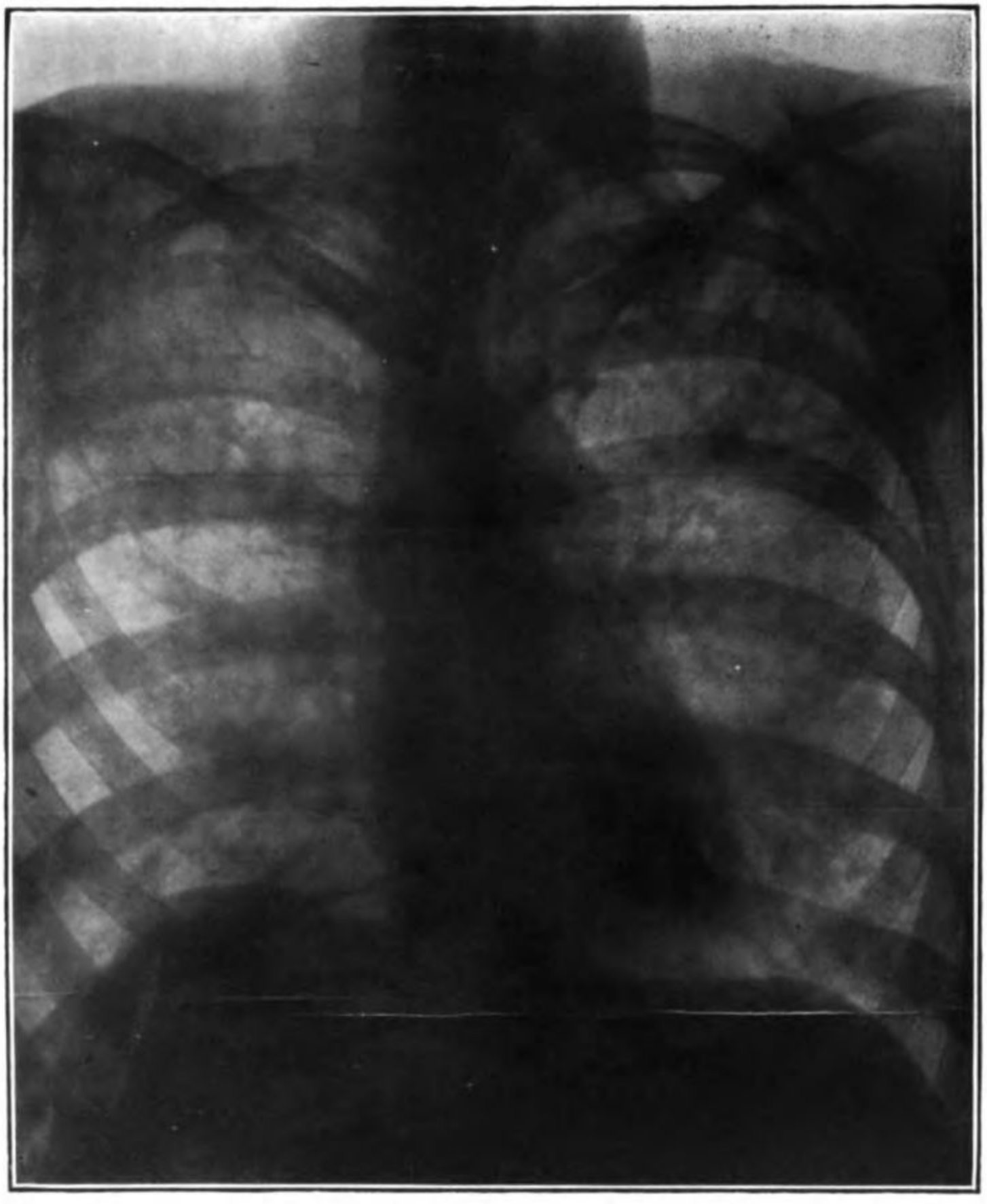
It is by making the diagnosis of the prebacillary stage of tuberculosis of the lungs more certain that the new method adds to its earliness, whereas by aiming too much at earliness of diagnosis we may add to our record of percentage of cures (Goetsch cured 71 per cent., Trudeau 83 per cent., Journal of Tub., Vol. iv., No. 2), instead of rendering the diagnosis more certain.

It is easier to pile up a record on metamedical personal aptitude than on impersonal skiagraphs.

II. *Technique.*

1. Short exposure serves to eliminate to an appreciable extent the fogging due to vagrant rays.

2. By making the exposure while the expanded chest is entirely at rest we avoid the blurring of lung detail produced by the movements of respiration. Time exposure, on the other hand, necessitating respiration, defeats the very purpose



Tuberculosis of Lungs. Time of exposure, one second, without intensifying screen.

of skiagraphy, the bringing out of detail the screen fails to show. To insist, therefore, on absolute inmobility in the case of a hip and to utterly neglect this in case of a chest is strikingly inconsistent. Yet that has been the common practice in this country until quite recently. Thus an American manufacturer boasted only a year ago that his coils would take a chest in 30—40 seconds, which, he says, is 50 per cent. quicker than any others of which he "Has any knowledge."

Yet it is a fact that Mr. Isenthal exhibited instantaneous chests in London as much as three years ago (Archives of the Rœntgen Ray, Vol. v., No. 3).

At the previous meeting of this society last December, Dr. M. K. Kassabian of this city urged the advantage of short exposures and showed a good chest taken in 30 seconds on the installment plan. Upon the same occasion I exhibited my one second and one-half second chests, with and without intensifying screens.

Von Ziemssen and Rieder published in their beautiful atlas, "Die Rœntgographie in der inneren Medicine," the results of one second or shorter exposures in 1901; their first results of instantaneous skiagraphy having been published in 1899.

I adopted the method fourteen months ago. Since then all of my chest work has been done in one second or less.

I use for the purpose an 18-inch Queen coil with a variable inductive resistance and a Wehnelt interrupter energized by the 110 volt direct Edison current.

My plates are ordinary X-ray plates of various manufacture, and I do the developing myself. The tube must be just right, and is first carefully tested, not by a parallel spark gap which is worse than useless, nor by using the hand for a test object, but by means of a Walter skiameter. For a medium sized and very large chest I use a Gundelach Wehnelt tube that will just show six holes in a Walter skiameter. For a small chest a Walter 5 tube is better.

For the sake of obtaining much contrast one or two tungstate of calcium intensifying screens may be used. The use of screens results, however, in the sacrifice of some detail.

SUMMARY AND CONCLUSION.

Skiagraphy of the chest is significant not merely as corroborating the results obtained by the older methods, but as a valuable supplementary method of physical diagnosis.

For the analysis of the phenomena of motion skiagraphy is less applicable than diascopy; but for obtaining pathological detail it is far superior and possesses the advantages of the graphic method.

The object to be skiagraphed should be as nearly at rest as possible; this is as true of the lung as it is of the hip. Momentary exposure (½-1 second) during suspended respiration is long enough. Flash exposure is possible, and we shall come to it in the future.

To skiagraph limited portions of the chest diaphragms should always be used. For this purpose I use my X-ray camera, a modification of Albers-Schönberg's compressionsblende.

To secure more contrast, though at the expense of some detail, the dry plate or film may be sandwiched between really fine-grained calcium tungstate.

A good induction coil is at present the only available instrument capable of furnishing the requisite electrical energy.

The tube must be able to keep its vacuum. A critical tube for a medium-size chest should give a skiametric reading of W. 6 or its equivalent.

The lowest tube that will do the work is the best for the purpose.

INSTANTANEOUS SKIAGRAPHY OF THE THORACIC ORGANS.

MIHRAN K. KASSABIAN, M.D.,
Of Philadelphia, Pa.

Director of the Roentgen Ray Laboratory of the Philadelphia Hospital, Etc.

We are acquainted with the fact that it is by no means an easy matter to produce perfect skiagrams of the thoracic vicera. Especially has this difficulty shown itself in former years, when in order to produce a skiagram, it was necessary to prolong the exposure, resulting in a more or less defective skiagram, entirely due to the cardiac and respiratory movements. With the production of improved X-ray apparatus we are now in a position where the time of exposure has been lessened from one to four minutes, to as many seconds, and even less, with a distinct improvement in the resulting picture.

The production of such skiagrams, independently of the cardiac and respiratory movements, depends directly upon two things: First, upon the employment of an outfit that is as perfect in its construction as possible, and secondly, upon a technique that has proven to be entirely correct. Therefore, to overcome the defect in skiagrams, due to movements during respiration, it is necessary to expose the part and plate to the action of the X-ray momentarily, and this at the end of the inspiration period. In the case of the heart the exposure must obviously be instantaneous, or at least synchronous with the whole or a part of the cardiac cycle.

I shall now consider the apparatus which I employ, and which I have found especially useful to determine the outline and condition of the organs in the thoracic cavity.

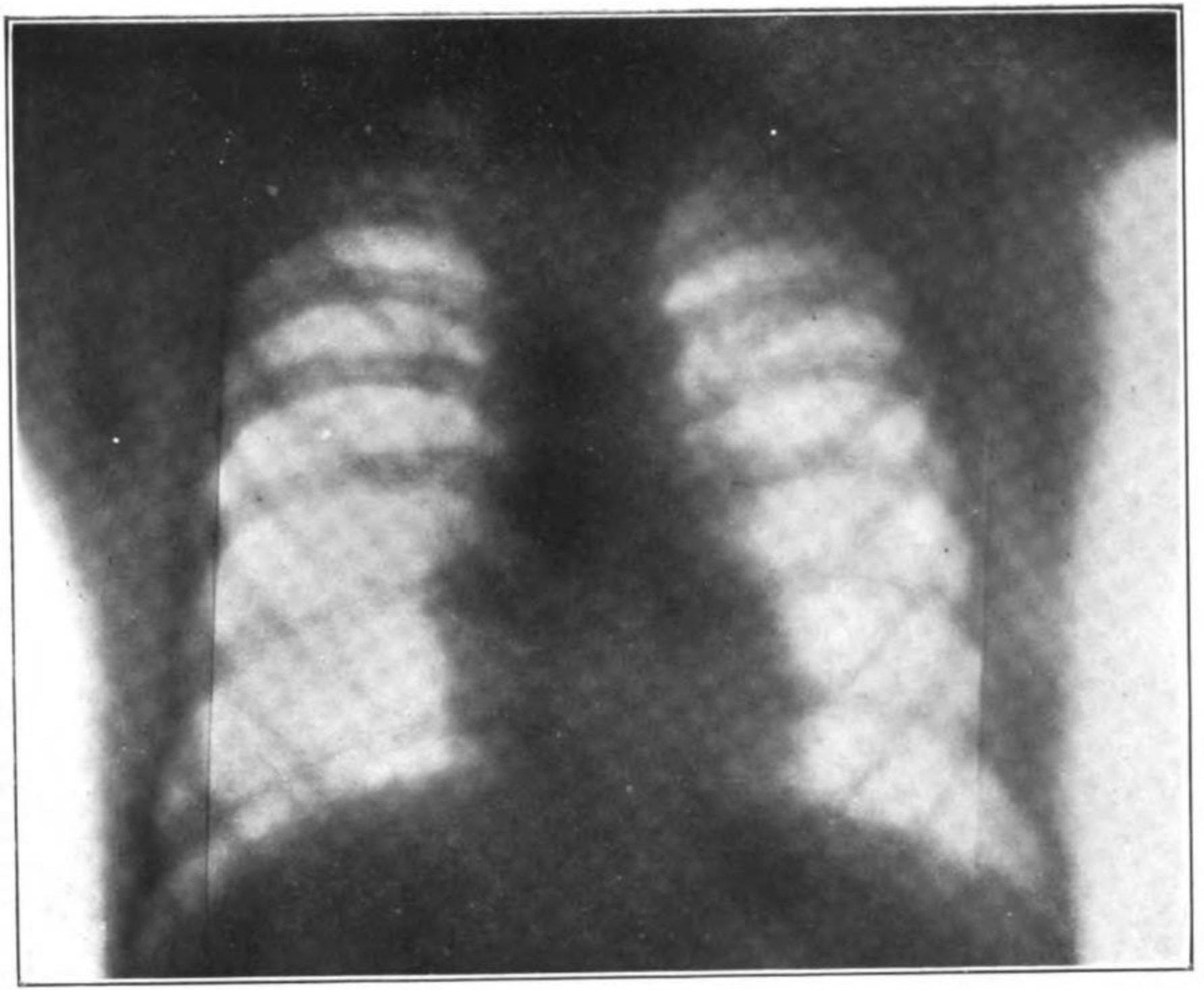
(a) Runmkorff Coil:—This is the most important part of an X-ray equipment, and without it our endeavors, so far as thoracic work is concerned, would only be rewarded with fruitless

results. Some authorities claim that a static machine will do as good work as the coil, but I cannot agree with them, as the results of careful experiments made with both apparatus disprove them. The coil to be employed for the very best skiagrams should be of twenty-inch spark producing capacity.

(b) The next part of the apparatus and without which a coil would be useless, is the interrupter. Of these there are a large number of different patterns on the market. During the past seven years I have tried nearly all of them, arriving at the conclusion that the electrolytic alone gives satisfactory results in rapid thoracic skiagraphy. As the electrolytic interrupter causes a rapid "make" and "break" (from 8,000 to 16,000 interruptions per minute) it exactly satisfies the needs of the coil for skiagraphing the heart and lungs. If the interruptions per second are known by increasing the number the "make" is lengthened in time and frequency and the result is an increased discharge from the secondary coil. The excitation of the tube and penetrability of the rays depend upon the "make" and the number of vibrations of the interrupter, if they be increased the efficiency of a tube and the emanating ray will likewise be improved. From the above it may be inferred that a mechanical interrupter would be unsuitable. The number of interruptions (from 650 to 900 per minute) being by far too few in number to employ with any degree of satisfaction in rapid thoracic skiagraphy. Furthermore the amperage in the electrolytic is greater than that in the mechanical.

(c) Crooke's Tube. For rapid exposure work a tube with a very high degree of vacuum should be used. This means that the power of penetration is also high, a fact which has been proven very essential in rapid skiagraphy of the thoracic organs. The degree of penetrability is best measured by means of the fluorescent screen-hand method.

(d) Intensifying Screen. Many authorities highly recommend the employment of intensifying screens to accelerate the action of the rays upon the exposed plate. I have employed the screens very largely, and have come to the conclusion that they should be used only in those cases where the patient's safety demands the shortest possible exposure.



Normal Chest.

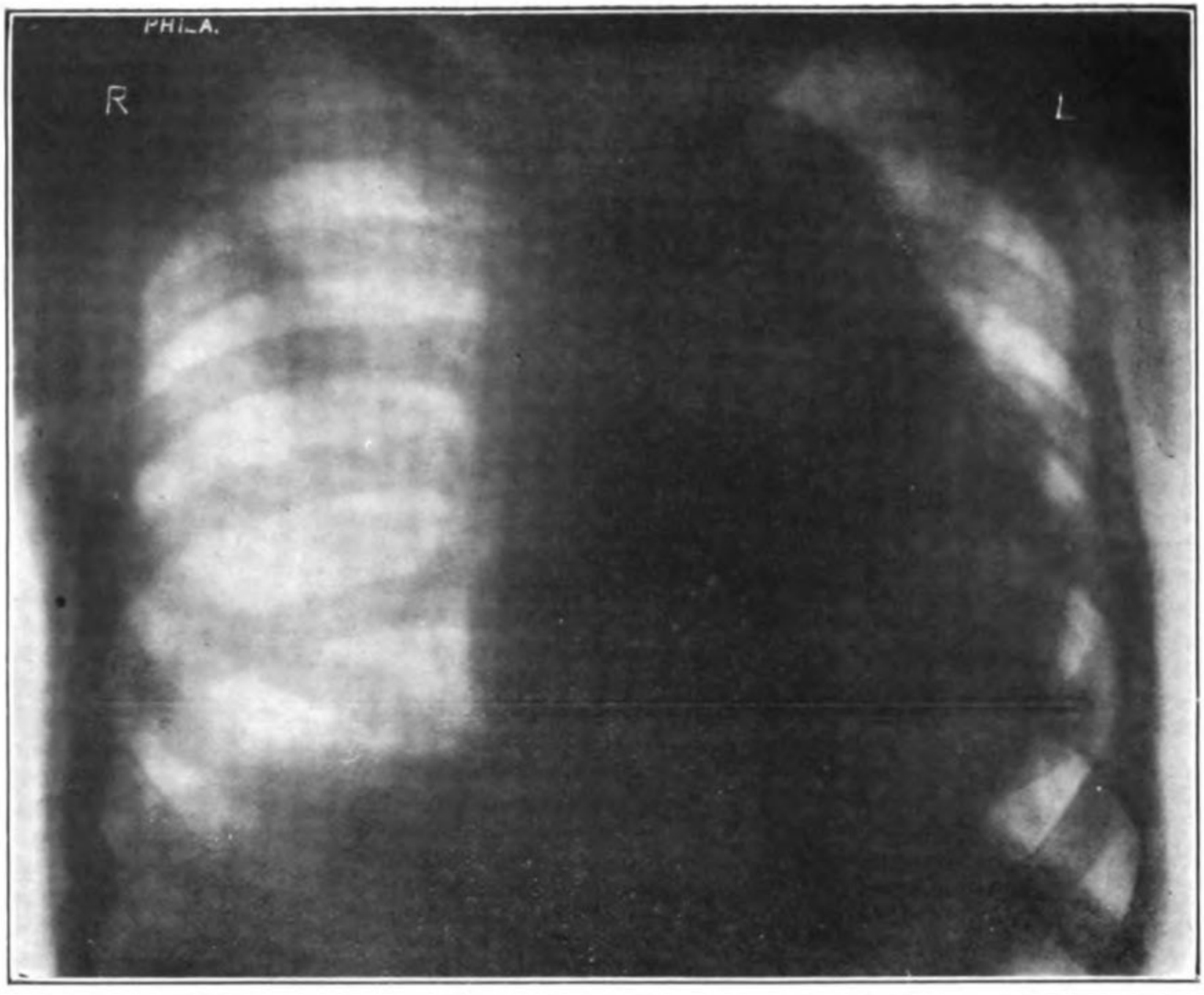
Of the various procedures for accelerating and intensifying the action of the rays upon a sensitive plate, only one has thus far proven to be of any use in my hands, i. e., the approximation of a fluorescent material upon a sensitive plate is very much like ordinary light, in other words, the rays are enhanced in their effect by the fluorescence. In employing intensifying substances, it becomes necessary to bear in mind two factors, namely, the granularity of the fluorescing surface, which greatly reduces the definition of the resulting skiagram, and almost effaces the details of the smaller osseous structures, and the necessity of either using color-sensative (ortho-chromatic) plates, or first color sensitizing ordinary plates, since the best screen (platino-cyanide of barium) fluoresces with a yellowish green light which does not greatly affect ordinary dry plates.

The resulting skiagrams present most excellent results. The advantages of the tungstate of calcium screen are the sensitive dry plate does not have to be first color-sensitized and the cost is very much below platino-cyanide screens.

(e) Sensitive plate. Screens in skiagraphing the thoracic organs to a great extent depend also upon the type of variety of sensitive plate employed by the skiagrapher. The sensitiveness or degree of rapidity with which a sensitized plate is affected by the X-rays bears a close relation to the light sensitiveness under ordinary circumstances. In experiments which I performed several years ago I observed the radiographic and photographic sensitiveness to be about equal up to 80 or 100 measured according to the scale of Driffield. Furthermore, in these experimental investigations I proved that a higher degree of sensitiveness to light had no corresponding parallelism so far as the sensitiveness to the Rœntgen ray was concerned. In skiagraphing the thoracic organs it is essential to use a plate that is "extra rapid" as is manufactured by nearly all of the up-to-date plate makers. The plates which I used in the following experiments were doubly coated with the emulsion but only on one surface, this plate being better by far than the one ordinarily used in photography, or films.

The technique of skiagraphy of the thorax is as important as the style of apparatus used, and this I shall next briefly consider. Without a proper technique the results of thoracic skiagraphy are practically fruitless.

(a) Position of patient. The patient may be placed in either the recumbent, semi-recumbent, sitting or standing position. In order to bring the shadow of the lungs, heart and aorta clearly, the patient should be placed in the ventral-recumbent posture, with arms folded above and over the head. This posture serves to bring the above organs nearer to the plate, hence more distinct shadows are obtained there when the patient is placed in the dorsal-recumbent posture. In the former position, the shadows produced by the scapulæ and vertebræ do not interfere with the shadows cast by the organs. The shadows in the illustrating skiagrams are narrowed down and placed along the edge on each side of the thoracic cavity. In shortened exposures the shadows of the vertebræ are practically obliterated or at least greatly diffused. It goes without saying that the plate is placed under the patient with X-ray penetrating the thorax from above. I employ the dorsal-recumbent position when there is a consolidated area in the posterior portion of the lung, as may be first determined by means of the fluoroscope. This would serve to bring the diseased area nearer the sensitive plate than is the case if the patient were placed in the ventral-recumbent posture. Another instance where I employ the dorsal-recumbent posture is in aneurysm of the aorta (of large size) and especially when there is associated extreme pain which would prohibit the placing of the patient in the reverse position. In this case the tube should be placed under the table, the rays penetrating the thorax from its posterior aspect, with the plate placed above and in touch with the anterior chest wall. Care should be exercised to fasten the plate in such a manner as to prevent accident from moving the patient as may be the case with those afflicted with nervous disorders. Some authorities recommend the standing or sitting position,—these I have never been able to successfully employ, because the major number of cases under X-ray examination are nervous and when a spark



Coil 15 in., 110 volts direct, mechanical interrupter; patient, 150 lbs., prone position. Diagnosis-Aneurysm of Oarta and dilatation of heart, outline of heart is sharp, due to the less muscular action. Time of exposure, 20 seconds, without intensifying screen.

or slight noise is produced they will move causing an unsatisfactory result.

The exposure of the part to the action of the rays, in order to produce a satisfactory skiagram of the thoracic organs, should be made with the lungs filled with air—the patient having been previously instructed to hold his breath.

A number of experiments were conducted at the Philadelphia Hospital, with assistance of Dr. F. C. Johnson. The technique employed is explained in the subjoined cases.

Case 1. A young adult 5 feet, 5 inches in height, weighing 140 pounds, normal lungs and heart; all clothing was removed, patient lying prone with arms folded over head. A special photographic plate 14 by 17 inches in size and an intensifying screen (11 by 14) were placed under the thorax. A 15 inch Ruhmkorff coil, with an electrolytic interrupter was used. Current 110 volts direct. Crooks tube was placed directly over the dorsal vertebræ the anode forming an angle of about 20 degrees with the plate. The tube was distant from the plate about 22 inches; the amount of voltage to the primary coil during exposure could not be registered exactly (25-40 volts) due to the sudden switching on and off of the indicator; amperage about 20-25. The exposure was made while the patient had lungs deeply inflated by air during inspiration. The time of exposure varied between 1½ to 2½ seconds. Developed in Metol Hydroch. developer, came up slowly, continued this process about 25 to 30 minutes, negative has not been intensified in bichloride solution.

The Skiagram. No. 1. The skiagram exhibits, considering that the time of exposure was very short, a great deal of contrast, bones not showing well, on account of being underexposed. The lung, due to the contained air, appears to be emphysematous.

The blurred effect of the ribs is due to a sudden jumping of the patient during the switching off and on of the current. The difference in the shadows may be observed where the intensifying screen was used.

This position is best for skiagraphing the heart, the organ being thereby brought near to the plate, a matter highly essential. The size of the heart as seen on the skiagram is 16

cm. as measured from apex to base. The position is apparently normal. The borders of heart are not sharp being blurred more or less, a condition undoubtedly produced by the intensifying screen.

The longitudinal shadows, three-fourths of an inch in the short axis and six inches in the long axis on both sides of the upper thorax are produced by the respective scapulæ. It may be observed that these shadows do not interfere with those of the ribs and lungs.

The normal position of the diaphragm on the right side is slightly higher than on the left, and there was no movement of it as is normal during respiration. The upper margins, therefore, are clear cut and sharply defined.

DISCUSSION.

DR. GORDON G. BURDICK, Chicago: The subject has been covered thoroughly by both of the essayists and they are deserving of a great deal of credit for the results they have achieved. We in Chicago have done some of this instantaneous skiagraphy and have had a certain degree of success along that line, but as a general proposition we have found that our results are better from prolonged exposure than from an instantaneous exposure. An exposure of from fifteen to thirty seconds is an instantaneous exposure, except so far as the heart is concerned. It seems to me that the tendency at the present time is to make longer exposures. The great percentage of loss in tubes was, perhaps, instrumental in bringing about this change. I know that in my own practice I lost three very valuable tubes in succession in a very short time in attempting to make instantaneous exposures, and as these tubes all cost twenty dollars apiece I found the work to be rather expensive. The question of expense alone will not serve to make this work popular.

Much of the success in instantaneous skiagraphy is due not so much to the X-light as to the developer that is used. There are several developers that will do this work. To me it is very astonishing that Dr. Hulst has succeeded in making hydrochinon do his work. I have not been able to achieve his

results with hydrochinon, nor do I know of anyone else having been able to do so. Hydrochinon is the most peculiar developer I know. It is very slow in action; rarely will an exposure even to sunlight appear before a minute or two after immersion of the plate in the developing solution. It makes very little difference whether you use the carbonate or the bromide, you can continue to use the developer for hours without its showing any disposition to fog. As a general rule you will find that you will get few half tones with a developer of that character. It intensifies the high lights at the expense of the middle tones and your picture will have only shadows and high lights without any of the desirable middle tones.

Amidol, rodinal and metol, when used carefully, are capable of fulfilling the conditions Dr. Hulst mentioned and showed. They require less than one-fiftieth of the exposure, amidol in particular, of any other developer we have. One difficulty with amidol is that when we want to make positive prints we must first intensify the negative in order to impart a little color because the deposit of amidol is rather inclined to blues and does not make a very nonactinic color for printing purposes. None of the yellows or browns or grays are formed in it. The negative always looks nice, but before printing from it we must intensify it so as to impart a little yellow to it. It is only another chance of spoiling the negative before it is completed.

Rodinol, on the contrary, gives us a very nice negative and also a good positive, but it is a liquid developer. For some reason it is not used as much as it deserves. For instantaneous work I fear that you must follow along the lines I indicated. Hydrochinon has astonishing qualities, and it is possible that by putting it into a proper combination you may overcome its objectional features and make it do what otherwise it would not do. It is the most contrasty, most contrary and the slowest developer we have in photography, and if any one has discovered a way of making it do this instantaneous work I would be under great obligations to learn how it is done.

DR. KENNON DUNHAM, Cincinnati, O.: I would like to ask the essayists to bring out in their closing discussions one very important matter. Dr. Hulst stated that the best tube for making these instantaneous skiagraphs is a low tube; whereas, Dr. Kassabian stated that he believes that the high tube is the best. I would like to know just what these gentlemen mean by a high tube and a low tube. The point being that a high tube is made higher or made more efficient by spark gaps and other resistance. Does Dr. Kassabian refer to that as a high tube?

Is Dr. Hulst meaning the same, when he speaks of a low tube?

DR. PRESTON M. HICKEY, Detroit, Mich.: My interest in X-ray work was aroused by the value which I thought I might receive from it in the diagnosis of chest diseases. But I noticed that neither of the authors paid any attention to the value of certain of the shadows that are seen in these instantaneous skiagraphs. It seems to me that we do not yet appreciate the full value of these pictures; that is, we do not yet know how to interpret many of the shadows we see in a rapid exposure of the chest. Take, for instance, these branching shadows down along the spinal column, in fact, all over the chest; it is a question in my mind whether we have there a shadow of the blood vessels, or whether these are the shadows of the bronchial tubes.

To determine this I made some experiments. I injected a cadaver and made a number of exposures. I compared the shadows I obtained there with the shadows obtained in different exposures of the chests of patients and found that they corresponded exactly in size and in direction. I then took a number of lungs from cadavers and filled the bronchi with fine shot and the blood vessels with a thick lead solution. By filling the bronchi with shot I was able to differentiate them from the blood vessels because of the interruptions in the shadow. I found that the lines of the bronchi and the line of the blood vessels followed each other pretty closely.

It is a matter of very great importance to be able to interpret these shadows in skiagraphs of the living chest. The

question naturally arises,—Are these consolidations of the lung tissue? At first I was tempted to consider them as such, but I am no longer of that opinion since I made my experiments as I have indicated. We must compare both sides of the chest very carefully before we make a diagnosis of our findings. Furthermore we must remember that the shadow of the heart will cover up one side and thus break the line of the blood vessels. A corresponding allowance should be made on the other side.

MR. H. SNOWDON WARD, London, England: I wish to thank the officers and members of this society very sincerely for the courtesy extended to a stranger. These two papers are extremely interesting. They bring up one point which appeals especially to me, perhaps because I am a photographer, and in this connection I wish to make a suggestion to those who are dealing with rapid exposures.

Some five or six years ago some experimental work was done in the direction of comparing the sensitiveness of dry plates to the X-ray with the sensitiveness of the same kind of plates to light. Generally speaking, the conclusions were that up to about 100 H. & D. the sensitiveness of the plates to the X-ray under all conditions very closely followed the sensitiveness of the same plates to daylight. But when we got beyond 120 H. & D. from that up to 150, (the greatest daylight sensitiveness we could obtain at that time), we found that there was a very rapid falling off in sensitiveness of the plates to daylight. The plates extremely sensitive to light gave less contrast in the developed negative under extreme exposures to the X-ray than did the plates which were relatively less sensitive to daylight.

I would like to suggest that these gentlemen making rapid exposures should give us, as often as possible, the daylight sensitiveness by some method of distinction in order that we may get a series of data which will, to a certain extent, enable us to compare the daylight sensitiveness with the X-ray sensitiveness. With a given emulsion, if you double its thickness you practically double its efficiency for radiographic work. It is a pity that actual quantitative work cannot be carried for-

ward on these lines. It would require the cöoperation of the emulsion maker and the expert radiographer.

DR. HULST (closing the discussion on his part): I am interested in the developer I am using. I formulated it several years ago, and although I have tried other developers from time to time, yet I have always come back to my own. I find that I can do better work with the hydrochinon developer than with any other. I am very careful about the temperature of the developer. It should not be used too cold because then it is very slow. I have no trouble with it when I use it right. I would like to suggest to Dr. Burdick that one reason why he has trouble with it is that he probably uses old solutions. I never use my solution twice. That is expensive, but I prefer to throw the developer away or use it for less particular work than to use it twice on this instantaneous work. I must say in explanation, however, that I always develop two plates.

The Germans have used glycin. I have used it for other purposes but find it less satisfactory. I have also used rodinal and edinol with acetone sulphite, which works very nicely. But after all I do not think that so much depends upon the developer. Any good developer with any ordinary plate will do. I have used them all and I am convinced that it is not that. It is the way they are used. It is whether the plate has been affected sufficiently by the X-ray and whether you use the developer properly. Of course, it is important not to have the tube too high or too low and to have enough current.

I have found hydrochinon contrasty but not contrary. It is my best friend.

The main reason for rapid or instantaneous work is to place it in the same category as other work. To do that we know that the object skiagraphed should be at rest. We strap people down on the table in order to have them quiet. It is a wonder that we can get any good pictures at all of the lungs in motion. The only way to take a good picture of the soft tissue as of the lungs is to have them at rest, and to do that we must do quick work. You cannot do that with the static machine; it does not furnish enough energy for this purpose. It is better to take five seconds and make sure that we will have a good plate. We must have adequate apparatus and

then we can do the work as quickly as we like, something depending, of course, on the sensitiveness of the dry plate. I believe that the time will come when we will skiagraph the heart beat in all its phases; make a sterioscopic picture of it. There is no reason why we should not get a clear picture of it, because we get that as it is now.

As to the tubes used: Any tube that will stand the current, and possesses good definition, is a good tube and will do the work. I have come to use the Gundelach tube almost entirely. It is the cheapest tube for me to use, but I never use a twenty dollar tube. I use more expensive tubes, and I have broken one hundred dollars worth in one day; but that was long ago and I have gotten over that. You must test your tube first, not with the highest current but with the lowest current. And when everything is just right go ahead.

Talking about one-half and one second exposures, I wish I could clearly and exactly determine exposure time of fractions of a second.

To talk about a high tube and a low tube and a soft tube is like saying a long time and a short time. It really means nothing. We must have a skiameter to tell us what we are doing. With a tube that will penetrate a Walter skiameter six an 18 inch coil is needed for one second chest pictures. But I think that we should have coils that are more powerful. If I had enough of this work to do I would get a forty-six inch coil and see what could be done with it. I have a picture on exhibit which is supposed to show an aneurysm of the abdominal aorta. There is only one picture like that work. It is in Germany and was made with a one hundred cm. spark coil. I showed my skiagraph to Dr. Crane and he agreed it is an aneurysm of the abdominal aorta. An eighteen inch coil was used.

With an inductorium capable of furnishing practically an unlimited amount of energy, it is possible to use a greater range in tubes. Higher tubes can be used to get results for which lower ones are needed with inferior inductoria. The whole business of skiagraphy is a matter of balancing conditions. What you alter in the tube you balance in the coil. What you alter in the coil you must balance in the tube. It is a

knack that is a little difficult at first, but when once you get it it is not so hard, and you will surely get a good picture unless you break the plate.

DR. KASSABIAN (in closing the discussion): The ordinary photographic plate does not give as good results in skiagraphing as the specially prepared plates for this work. Several years ago, I experimented by raying my hand on an ordinary photographic plate and again on a second but specially prepared plate. I exposed both of the plates for the same length of time, and when I examined them I at once observed a marked difference in the shadows of the two plates. Of course, they will answer very well for skiagrams of the hand but they will not be suitable for thoračic, abdominal, or hip cases. If you are skeptical about this, repeat the experiment and convince yourselves.

About the degree of vacuum of the tube:—This is a much disputed question, and in this connection let me say that if the operator is thoroughly familiar with his apparatus, if he knows the voltage and amperage of current in his primary coil, the distance at which his tube should be placed from the part, the spark lengths of the secondary coil, etc., his work will usually be entirely satisfactory. I do not recommend testing the tube with the fluoroscope. It is very injurious to the hand and this is the reason why so many of us are suffering with dermatitis. For thoracic, belly and hip cases the vacuum of the tube should be very high, in fact as high as is possible to get. For other parts of the body a lower degree of vacuum will suffice. The higher the degree of vacuum the more will be the penetrative power of the rays and the less the absorption by the tissues—hence a lessened time of exposure. In order to make it more useful to the profession at large we should keep accurate records of everything we do. Every skiagrapher should have a big record book or sheets that can be bound or filed away, and every time he makes a skiagram he should put down the full history of the case, the technique he uses, the apparatus used and everything that would be of value to others. We cannot memorize all this. I originally recommended using a little book in which I noted the voltage and amperage, the length of exposure, position of

patient, whether it was a success or a failure, etc. If we say, "I have exposed for so many minutes" without giving all the other details, our information will not be of much service to any one else, as it is incomplete. The only satisfactory way consists in keeping a complete record and whenever we report a case in societies or in journals the complete history and all those other data that I have mentioned should be enumerated. In that way we obtain the full benefit of other operators' experiences.

Instantaneous skiagraphy is not at the present time as successful as we expect it will be in a short time and I hope that the time will soon come when every one will be able to take the excursions of the diaphragm, the lungs, the heart, etc., in a few seconds, or in even the half of a second. This is an important and direct step to the methods of taking skiagrams in rapid succession, of such organs above mentioned, and their reproduction in kinetoscope fashion. I have devised an apparatus whereby this will be possible, and as soon as the method is fully complete I shall demonstrate it to our members.