PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A
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On the Formation of Definite Figures by the Deposition of Dust

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VI. *On the Formation of Definite Figures by the Deposition of Dust.*

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When trying some experiments which had an object other than that described in the following communication, it was noticed that a fine powder when allowed to settle on a slightly warmed plate produced figures which were remarkably clear and definite. So striking and peculiar were these figures, and so simple were the conditions of their formation, that a careful study of them was undertaken. These figures are so clear and sharp that it is easy to obtain exact photographic records of them, an important point, for, at present, it does not seem possible to offer a simple explanation of the complicated relationships which exist between the external conditions and the figures formed. Sensitive as these figures are to outside influences, the forms they assume are very characteristic of different conditions, are perfectly constant, and are easily produced.

The general method of obtaining these figures is as follows:—The plate on which the figure is to be deposited is best supported on three pins about 1½ to 2 inches high, and the dust most convenient to use is that made by burning magnesium ribbon. It is kindled and allowed to burn in a receiver. A circular glass dish with straight sides, about 4 inches high and 9 inches in diameter, is a convenient form of vessel to use; and if the vessel be large enough (there should be about 2 inches between the plate and the inside of the receiver); the shape and the material of this dust containing vessel is not of much consequence. After the magnesium has burnt out, this receiver is allowed to stand for a minute or so, and it is then placed over the plate on its stand and allowed to remain there for six to seven minutes. On removing it a clear and definite figure will be found to have formed on the plate.* If the plate has been a square one, then a cross consisting of four rays, each starting from a corner and meeting, but not necessarily joining, in the centre, is produced. If the corners be varnished or covered by a small piece of tinfoil (fig. 1) the cross is still formed.

* A photograph of the figure was obtained by placing the plate on a varnished black background, illuminating it by an arc lamp, so that the beam of light fell upon it at an angle of about 30 degrees, and the camera was placed directly in front of the plate. Process plates were used, and the exposure was from two to two and a-half minutes.

If the plate be triangular in form, then three rays are formed, again each starting from an angle (fig. 2), and if the plate be an octagon, then a star with eight rays is produced (fig. 3). An angle in a plate always tends to give rise to a ray. This is often very fine at the point, and thickens considerably afterwards. If a flat circular plate is used, then no deposit takes place, but if it is concave, a uniform deposit over

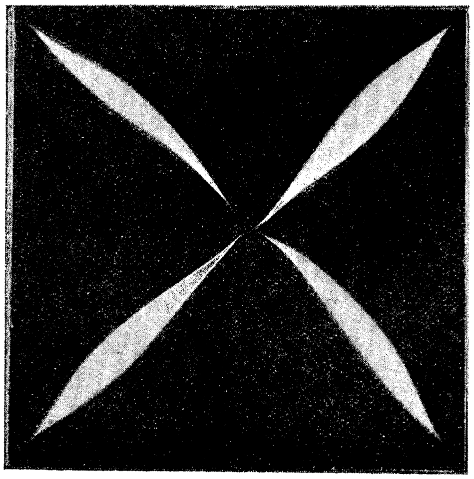

Fig. 1.

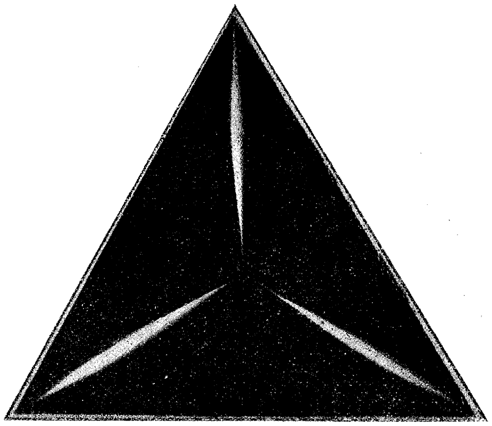

Fig. 2.

the whole of it occurs, and if it be convex, then little or no deposit is formed, if any, it is in the form of a star. When an oblong rectangular plate is used, then the rays similar to those formed on a square plate are produced, but they do not meet, but

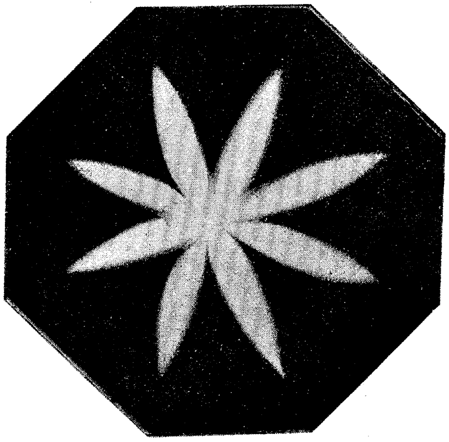

Fig. 3.

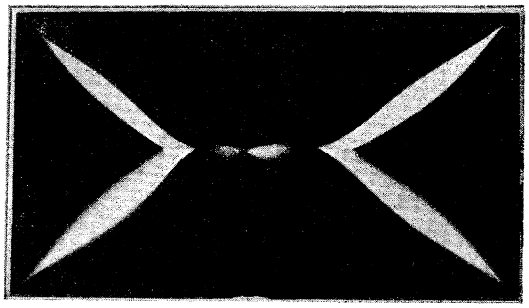

Fig. 4.

are, as it were, drawn asunder, and remain at each end of the plates, being however often connected by a thin straight line (fig. 4).

In all cases, the angles of the plate determine the figure formed on it. With regard to other general points connected with the formation of these figures. The nature of the dust used is not a matter of importance, it may be composed of organic or inorganic matter; the spores of a fungus, or magnesia, or the dust from ashes or fumes of ammonium chloride. In fact, the necessary condition is that the dust be very fine, then always the same figure is formed. The product formed by burning magnesium is, however, the best form of dust to use. It is easily obtained, and has a silvery whiteness in appearance, which gives distinctness to the figures. With regard to the plate on which the figure is to form, its composition, like that of the dust, is of no importance; the shape determines the figure, not its constitution. Glass, for several reasons, is the best material for the plate, but copper, zinc, silver, antimony or other metal may be used, or ebonite, celluloid, black india-rubber, cardboard, &c., in fact, the receiving surface is not necessarily a solid substance; mercury in a square vessel will have deposited on it a figure similar to that on a piece of glass of the same size and shape, and, still more, the surface of the glass plate may be coated with oil, gum, copal-varnish, &c., and the cross will form as if they were not present. Obviously, with regard to the visibility of the figures formed, the nature of the plate is of considerable importance; on some substances the figures are more easily seen than on others. In the following experiments glass plates have been used, except when mention is made to the contrary.

Passing from the materials used to the active agent in producing the figures, namely heat, it should be stated that there are many different ways of applying it, and different results are produced. The simplest way is to pass the plate two or three times over the flame of a small Bunsen or spirit lamp. If it be a glass plate, a good indication of sufficient heating is when the condensed moisture disappears—it is of little importance whether the heated side or the other one is uppermost—then the plate is enveloped in the dust atmosphere by placing the receiver, filled with dust, over it, and leaving it there for the six or seven minutes. To obtain a figure in its simplest form and as dense and clear as possible, it is necessary that the plate be equally warmed all over; a convenient way of doing this is to lay the plate on one of copper, heated to about 20° C., for about half a minute, or an ordinary air or water bath will answer the same purpose. As long as the plate and the surrounding dust atmosphere have approximately the same temperature, the deposit formed is nearly uniform; there is only a slight appearance of any figure, but as soon as any rise of temperature occurs, then a figure begins to appear. At first the indications are very slight, and occur only round the edge of the plate; but as the temperature is raised, the figure spreads over the whole of it. A figure may also be developed by having the plate at a lower temperature than that of the surrounding atmosphere, provided that the plate is not below 17° C., but the figures produced in this way are slight and imperfect and disappear altogether when the plate is 6° below that of the atmosphere. In order to determine roughly the temperatures of the plate and its surrounding atmosphere, a receiver, of the same shape and size as the glass one, was made of asbestos cloth and covered with cardboard; in the top of it a hole was made, and a delicate thermometer introduced. A few of the results obtained will show the nature of the alterations produced by differences of temperature between plate and surrounding atmosphere. When filling the receiver with the magnesia smoke, it should be turned round over the burning magnesium, so as to render the whole of the inside of as uniform a temperature as possible, and before placing the receiver over the plate, after the combustion is over, it should be allowed to stand for about a minute, so that any coarse particles may settle. First, with regard to cases in which

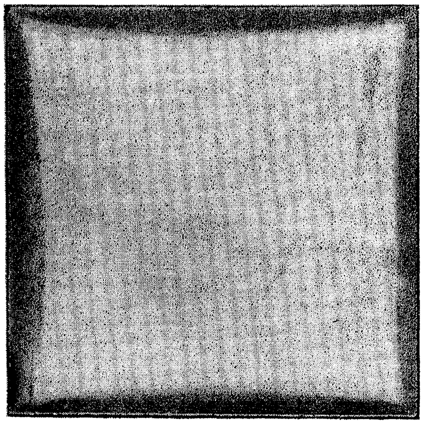

Fig. 5.

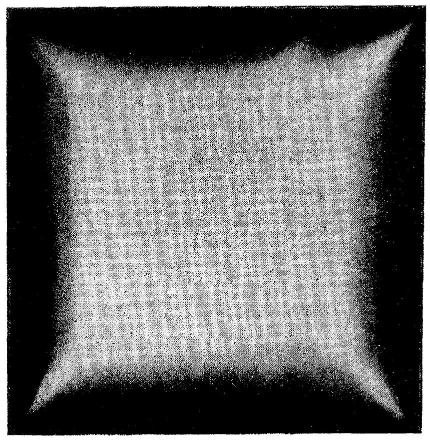

Fig. 6.

the plate is lower in temperature than the surrounding atmosphere. If the plate be at a temperature of 19° C., and the maximum temperature of the dust atmosphere be 24°, then a nearly uniform deposit is produced, but at the corners of the plate there is a short line of deposit, and along the sides there is somewhat less deposit (fig. 5). If the plate be warmer, 20·6°, and the atmosphere 24°, then the above characters are

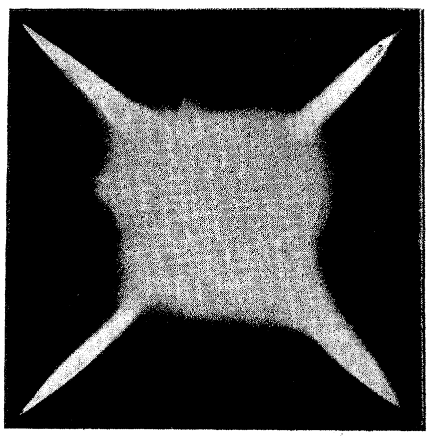

Fig. 7.

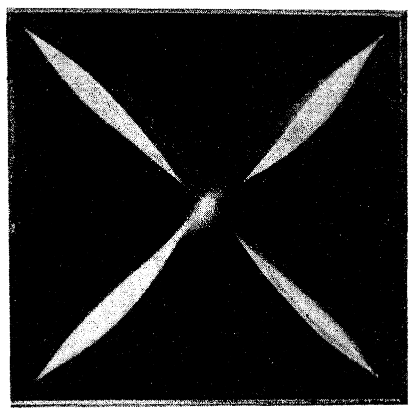

Fig. 8.

still further developed and a bag-shaped deposit is formed (fig. 6), and this is characteristic of what takes place when the plate is below the temperature of the atmosphere, but sufficiently warm to act. When the plate is slightly warmer than the dust atmosphere, 1·8° for instance, then again a figure is produced similar in character to the last one, but a further development of it (fig. 7). If the plate be made warmer and warmer, and the surrounding atmosphere kept nearly at the same temperature, then the figure gradually alters and becomes more perfect. If the difference of temperature between plate and atmosphere be about 5°, there is only a small amount of deposit on the central part of the plate, and the four rays are well developed. When the difference of temperature is about 12°, then a good clear cross is formed, its only imperfection being a slight fuzz in the centre (fig. 8). At a difference of temperature of 100° or 120°, the same figure, a cross, is formed, but the amount of dust deposited is less than at lower temperatures. Hence, whether the difference of temperature between plates and atmosphere be very considerable or very slight, the same effect is produced. A thick piece of glass held in the hand for 30 seconds and then placed in the dust atmosphere will have a figure deposited upon it, but the amount of deposit will be small and the figure faint. The figures form best between certain limits of temperature, and when there is a marked difference between the

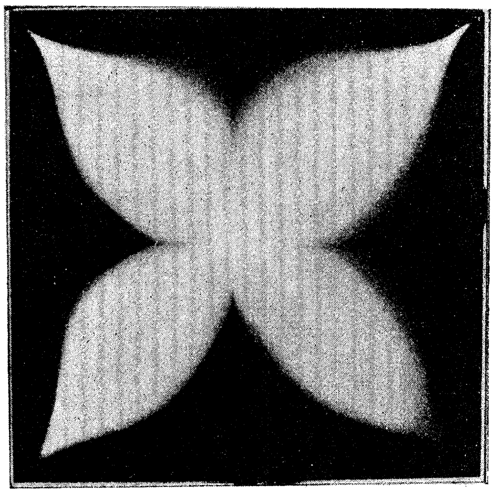

Fig. 9.

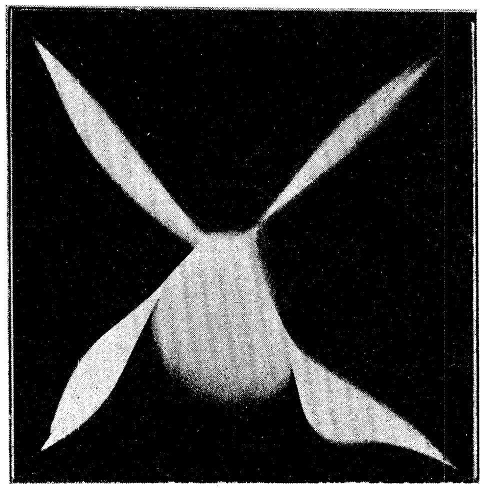

Fig. 10.

plate and the surrounding atmosphere. They are very sensitive to change of temperature; in fact, to get a perfect cross or other figure, both plate and atmosphere must each be uniformly heated. If, in addition to uniformly heating a plate, a warmed body be placed below it and kept there during the time that the dust is depositing, there is a considerable increase in the amount of deposit and a modification of the figure formed; for instance, if a copper cylinder, 12 millims. in diameter and 14 millims. high, heated to 55°, be placed 30 millims. below the centre of a square plate, then the figure shown in fig. 9 is produced. If a piece of glass be only warmed by holding it in the hand, and is then placed immediately below the plate, but not touching it, a marked and peculiar effect on the cross is produced, as seen in fig. 10. If this heating below the plate be increased, either by raising the temperature of the small copper cylinder, or by using taller cylinders, so as to bring the source of heat nearer to the plate, the amount of deposit is increased, and ultimately the figure of the cross disappears, and there is uniform deposit over the whole of the plate. On still further increasing the heat below the plate the reverse action sets in, and the amount of deposit decreases. These changes will be described in detail later on. Some experiments made with a Bunsen lamp show how these figures are affected by radiant heat, and the singular effects which it produces. The flame of an ordinary Bunsen burner was placed on a level with the plate and allowed to burn while the deposit was being formed. When the flame was at a distance of 12 inches from the centre of the plate, the cross was distorted, as shown in fig. 11, the heat having travelled not only the 12 inches to the plate, but also passed through the glass of the receiver containing the fumes. In the next experiment the lamp was removed to a distance of 16 inches, then less distortion took place. At a distance of 21 inches the effect produced was still visible (fig. 12), and even with the lamp at 26 inches the

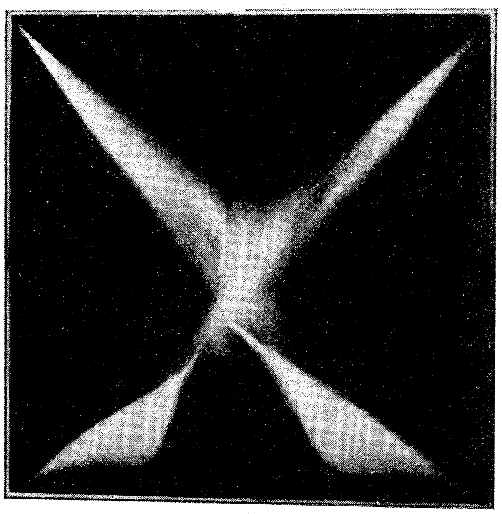

Fig. 11.

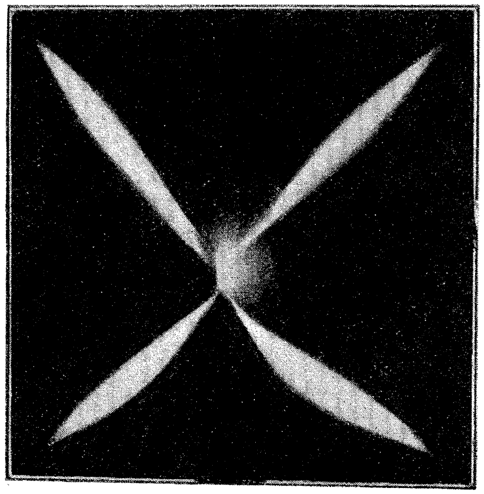

Fig. 12.

two rays nearest to it are slightly thickened and distorted (fig. 13), but at 30 inches no effect was produced. Another experiment of a little more definite character was tried. A small copper cylinder, 95 millims. in diameter and 100 millims. high, was filled with boiling water and placed at a distance of 12 inches from the centre of the plate outside the fume vessel; the cross was affected as before, the nearest rays were shortened and bulged out. A small candle burning at a distance of 8 inches from the plate is also sufficient to distort the figure which is being produced upon it.

It has already been shown that by increasing the heat below a plate the amount of deposit is increased; but if this heating be carried on to still higher temperatures, the phenomena are reversed, and less and less deposit occurs. If the copper cylinder used in the former experiment be heated to 200°, and be placed below the centre of the plate, no deposit forms immediately above it. The same effect is more readily produced, and at a lower temperature, if the plate is in absolute contact with the warmed copper cylinder, and it may be mentioned here, that the only way of obtaining the cross on the square glass entirely free from all fuzz at the centre, is by using as a source of heat a metal plate, and placing on it another thin piece of metal about 1 inch in diameter, and allowing the centre of the glass plate to rest upon it. If the copper cylinder under the plate be heated to about 150° C., and the plate

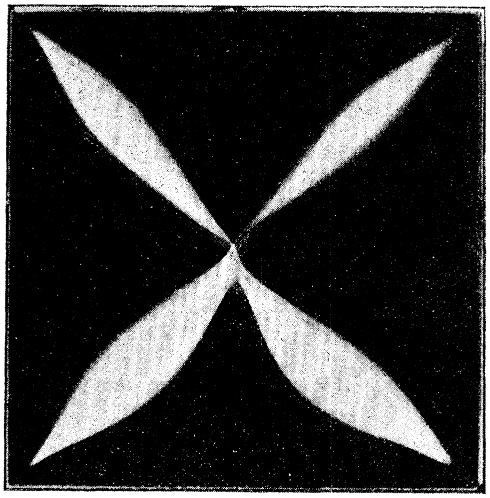

Fig. 13.

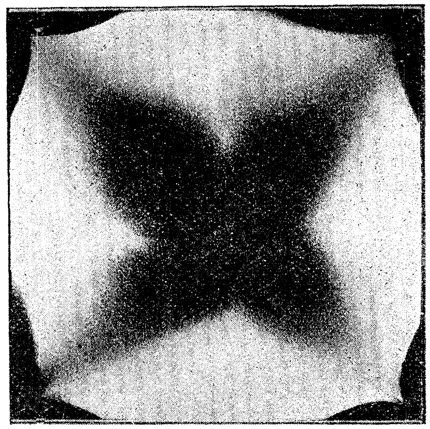

Fig. 14.

rests upon it, no deposit occurs immediately above it, and this open space assumes the form of a cross (fig. 14). That dust does not deposit on a sufficiently heated surface has long been known; but it is interesting that in this case the portion

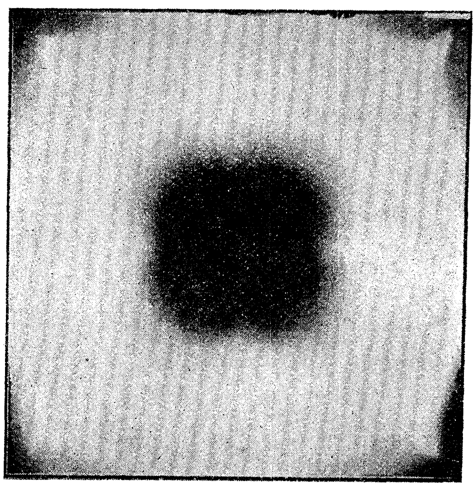

Fig. 15.

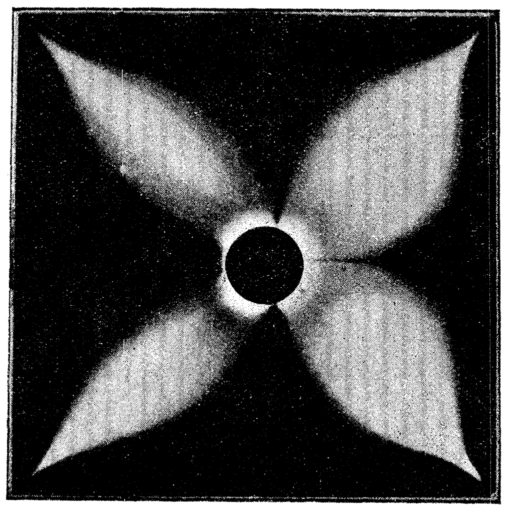

Fig. 16.

where there is no deposit should be in the shape of a cross. If the copper cylinder be heated as before and the plate not heated, but placed on it at an ordinary temperature, then there is an open space, square in general form—possibly the former cross filled up—formed, and in the centre there always appears a very small white

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cross, and over the rest of the plate, except at the corners, there is an even deposit of dust (fig. 15).

Other curious results are produced if the copper cylinder, heated to about 130°, be placed on the upper side of the heated plate, instead of the under one. Then a cross is formed, but it is very much broadened out, and a deposit of dust has formed round the base of the cylinder (fig. 16). If the plate be not heated, but the hot cylinder put upon it, then a modified effect, shown in fig. 17, is produced, and lastly, again reversing the heating, putting a cold cylinder on a heated plate, the cross is well formed, and a curious deposit, square in shape, is found round the base of the cylinder (fig. 18). All these forms are readily and constantly produced when the centre of the plate is heated or cooled as above described. It will now be obvious why three wires form the best kind of support for the plates on which a symmetrical figure is to be formed. If a large solid support be required, a cork is probably better

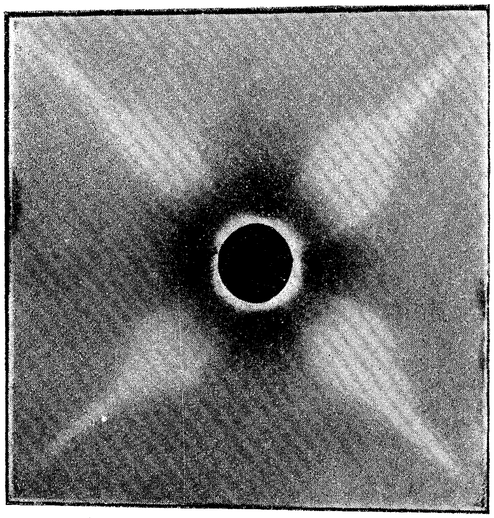

Fig. 17.

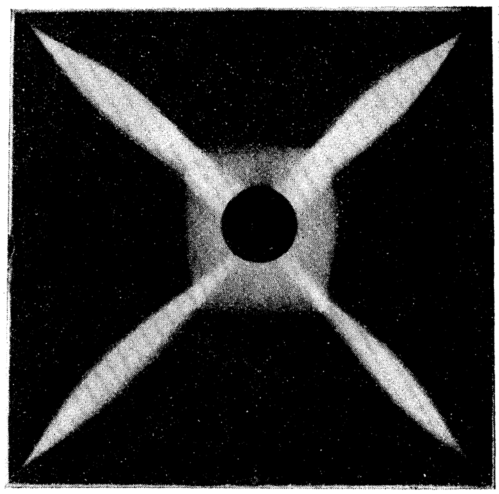

Fig. 18.

than anything else, but a cork heated to 100° C. caused, when supporting a square plate, a uniform deposit to take place over very nearly the whole surface.

There is still another condition which affects the formation of these figures, and that to a very considerable extent: it is whether the plate on which the deposit is forming be horizontal or not. If not horizontal, the figure always has a tendency, as it were, to slide down the plate. The smoothness of the glass is not essential to this effect, for if a copper plate be painted over with lampblack and a little shellac in alcohol, which gives it a rough surface, identical figures are formed. Fig. 19 shows the deposit formed if the plate is placed on a slope of only 2 degrees, but if the slope be increased to 5 degrees, then the deposit assumes the form shown in fig. 20, and if the slope be 15 degrees, then the deposit has the form shown in fig. 21. These three figures show in an interesting way the great effect which the slope of the plate produces. There is another way by which the formation of these figures may be controlled and altered to a remarkable extent, and which should throw light on the mode of their formation. It is by the proximity to the plate of other bodies. For instance, if a piece of glass or metal as long as the plate and 10 millims. wide be fixed against it so as to project above it, then an even deposit forms under its shadow. If holes are

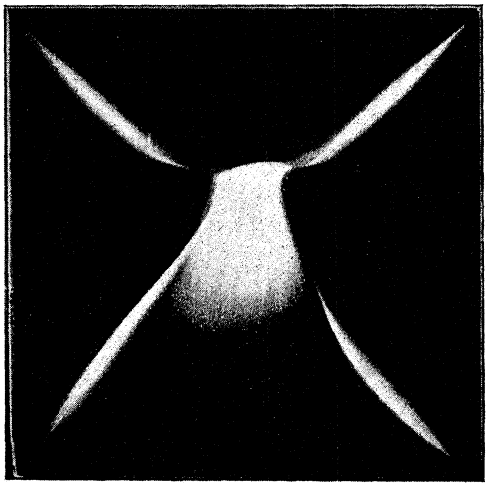

Fig. 19.

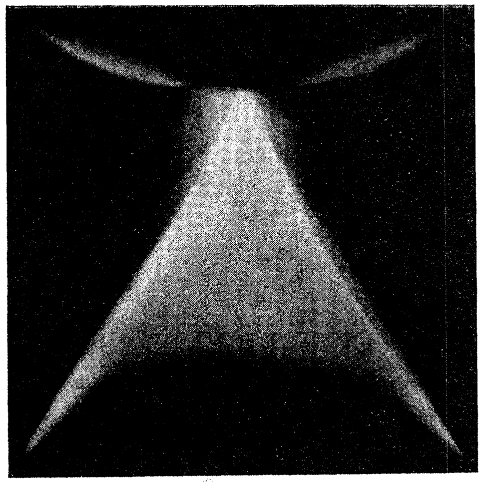

Fig. 20.

cut in this screen, no deposit takes place on the glass in front of the holes. Fig. 22 shows what happened when a square glass had a piece of metal with holes cut in it pressed against it. In front of each opening in the screen there is a clear space on the plate. Another curious, but very complicated effect is produced by cutting a

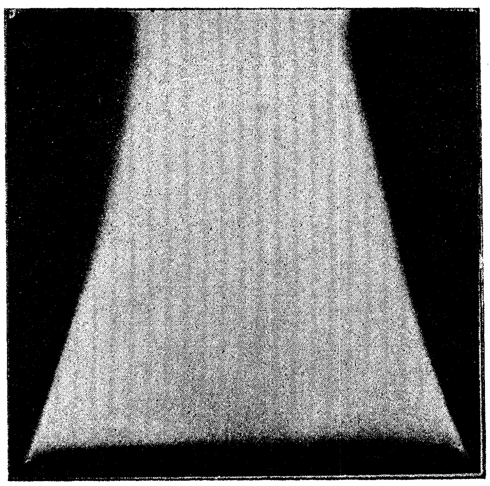

Fig. 21.

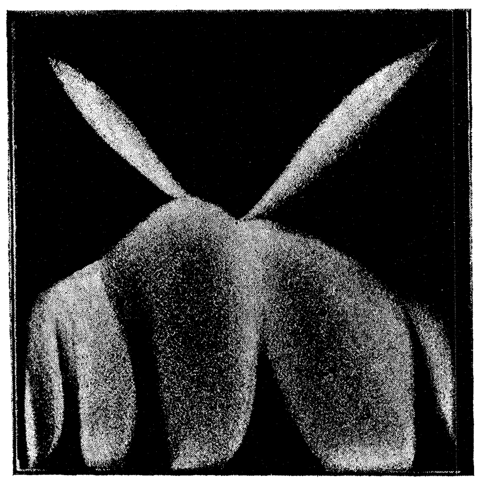

Fig. 22.

re-entering angle out of a square of copper. It is difficult to follow how the deposit can form in the way shown in fig. 22A.

Bearing on this same point is the fact that if a warmed plate be placed on the floor of the vessel in which it is exposed to the dust, instead of being raised above

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it, no figure, only an even deposit is formed. Now, if in place of a screen extending the whole length of the plate a small one be set up, a piece of glass 5 millims. wide, for instance, the same kind of action occurs, the plate immediately behind the screen is protected, and there a deposit of dust forms, of a curious rounded shape (fig. 23).

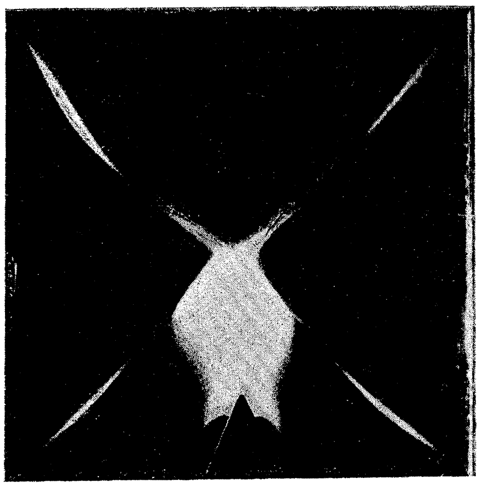

Fig. 22A.

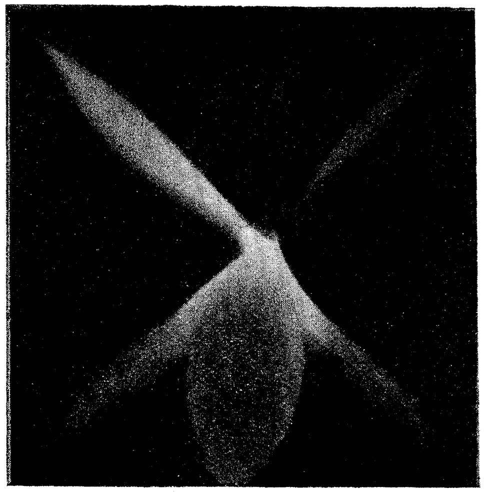

Fig. 23.

A still narrower obstruction may be used. The effect produced by a pin fixed against the plate is shown in fig. 24, and fig. 25 shows the effect of a fine human hair. In neither of these cases does the deposit commence at the obstruction, but a little way

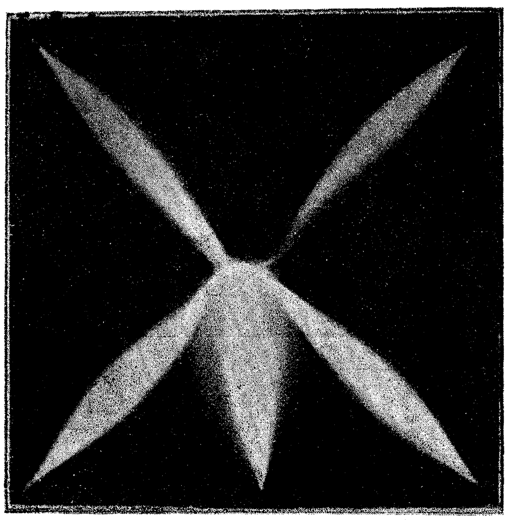

Fig. 24.

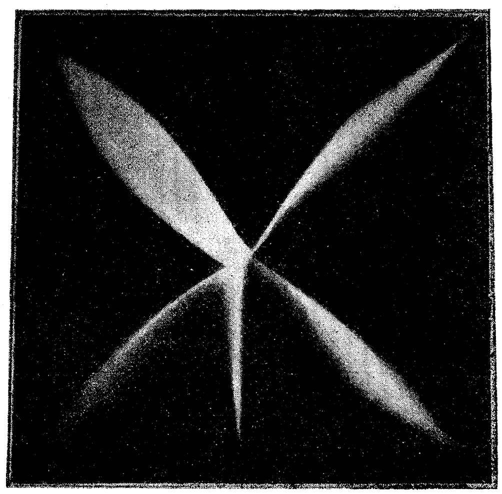

Fig. 25.

from it. A piece of thin wire acts exactly in the same way as a hair. Experiments were then made to ascertain what effects altering the position of the pin would have on the figure produced, and it was found, that as long as the pin is in contact with the plate, its height above it does not affect the deposit formed. In all these

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cases, a considerable amount of deposit was formed, commencing at an appreciable distance from the pin. The pin was then lowered, so that the edge was immediately below the plate; when it was 2 millims. below, it produced a considerable amount

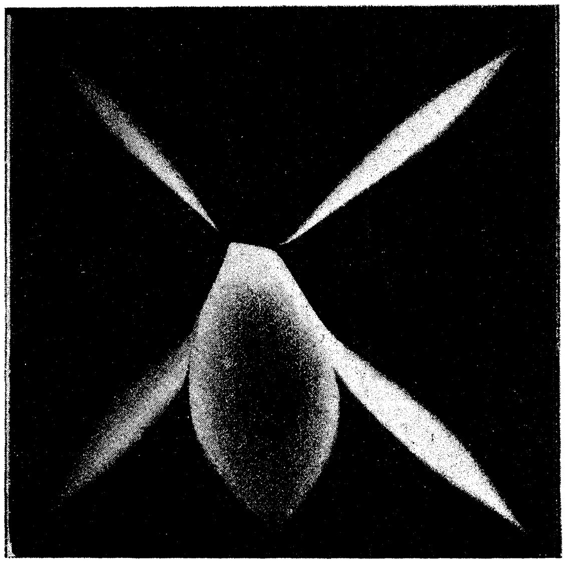

Fig. 26.

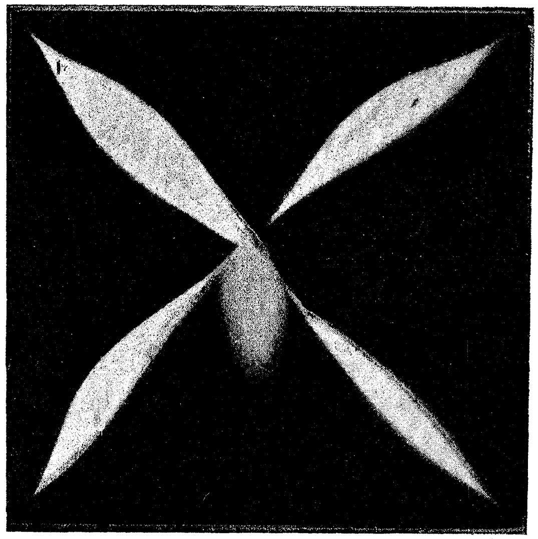

Fig. 27.

of deposit; when 4 millims. below, the amount was much diminished, and when 8 millims., only a trace of deposit was formed. It was found that as the pin

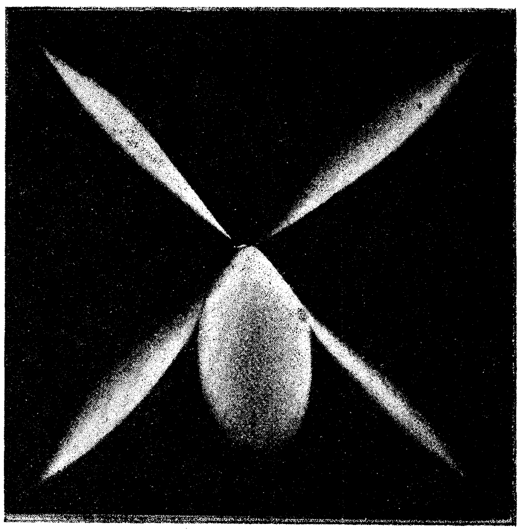

Fig. 28.

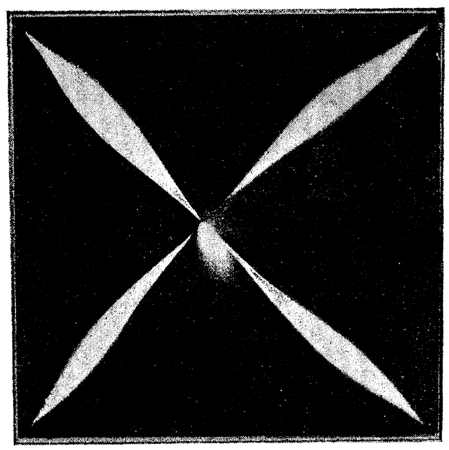

Fig. 29.

receded, so did the deposit recede from the edge of the plate, becoming at the same time smaller in amount.

Fig. 27 shows the deposit formed when the pin was 3 millims. away, and still at the level of the plate. Fig. 28 is the figure formed when the pin was 6 millims. from the

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plate, and fig. 29 is the effect produced when 8 millims. away; but when the pin was 10 millims. away, no effect was produced. If the pin does not touch the plate, as it did in the former case, its height again does not affect the deposit formed. If the pin be placed at a lower level than the plate, and at different distances from it, it is still able to produce a deposit on the plate, as was proved by trying it at a constant distance of $1\frac{1}{2}$ millim. below the level of the plate, and at distances of 2, 4, 6, 8, and 10 millims. from the plate. At 2 millims. a considerable amount of deposit was formed, and the amount gradually diminishes and recedes from the edge of the plate as the distance increases. At 2 millims. from the plate, the deposit is nearly up to the edge. At 4 millims. it commences at 18 millims. from the edge, at 6 millims. at 27 millims., at 8 millims. at 30 millims., and at 10 millims. there is no deposit formed.

If the pin be placed at a still greater depth below the level of the plate, it is still able to produce a deposit on the plate, the deposit, of course, becoming less as the

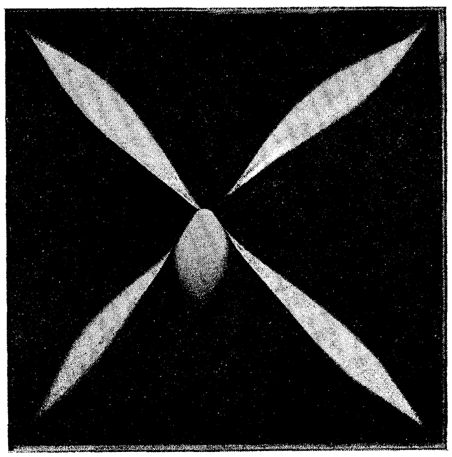

Fig. 29A.

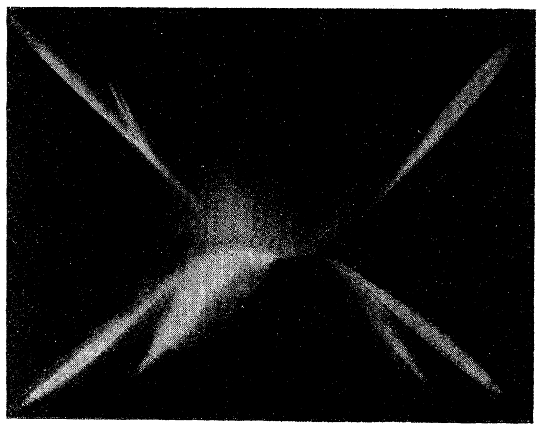

Fig. 30.

depth increases. At 4 millims. below the level of the plate, and 2 millims. away from it, a small deposit is formed (fig. 29A), and even when it is 6 millims. below, a visible deposit is formed at the centre of the plate. The amount of deposit produced by a pin on the same level as that of the plate, may be equalled, but apparently is never exceeded. It has already been shown that no deposit takes place on warming and exposing to dust a circular plate, but if a pin be placed at different distances from it, and either above or below it, deposits are produced similar to those formed on any other shaped plate.

It is certainly remarkable that a pin so far from the plate and so much below it should be able in so definite a way to affect what is taking place upon it.

There still remained another way in which the pin could be presented to the plate, namely, by holding it above the plate. If a pin 50 millims. long be held 6 millims. above and 3 millims. beyond a plate it produces no effect on the figure, but if the pin be simply lowered, so that it is only 4 millims. above the plate, then a slight deposit at the centre is formed, and when the pin was only 2 millims. above the plate and still 3 millims. from it, increase in the deposit occurred. In all these cases with the pin supported from above much less deposit was formed than when the pin was pointing upwards.

If the pin be bent at a right angle, it produces on the plate a deposit similar in form and amount to that produced by a vertical pin at the same distance from the plate.

This action of any neighbouring body on the dust deposit is shown by any rough edge which the plate itself may have. If, for instance, a glass plate be used and it has been cut in the usual way, in addition to the figure which is dependent on the shape, there will be certain lines of deposit darting out in different directions; these are produced by small splinters of glass attached to the edge. Fig. 30 shows this on an oblong glass and fig. 31 on a circular glass. If the edges of the plate be carefully

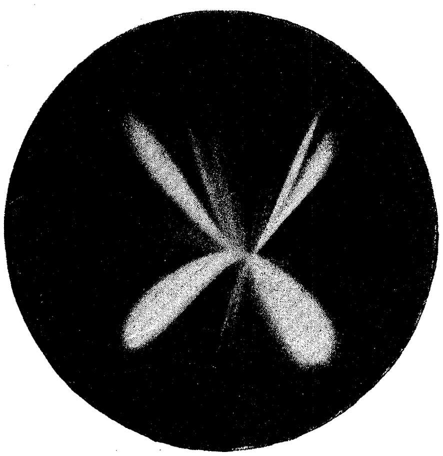

Fig. 31.

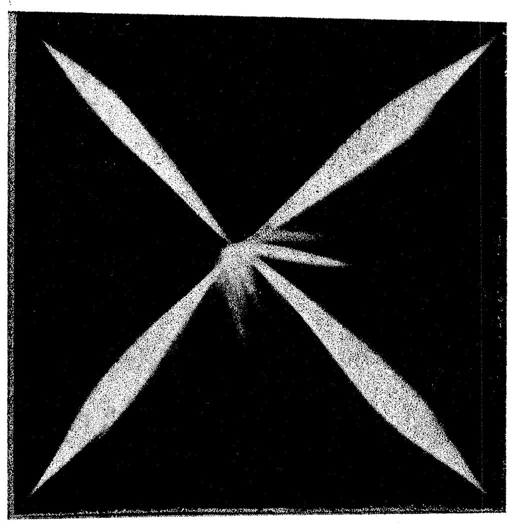

Fig. 32.

ground, then these lines of deposit cease to be formed. Fig. 32 shows a square glass, two of whose edges were left rough and the other two were ground.

There are many curious alterations in the forms of the figures produced by placing on the plate obstructions to the flow of these lines of dust. For instance, taking again a square plate, if a strip of glass 1 millim. high and 1 millim. wide be placed across one corner of the plate and then the cross be developed, it has no effect, the cross forms as if no obstruction were there, but if the strip be 7 millims. high, then a marked effect is produced. In front of the strip the ray retains its usual form, but on the other side and round the centre there is a great widening-out of the ray and a slight banking-up of the dust against the sides of the glass strip. This effect of the obstruction strip is shown in fig. 33. If the strip be even 20 millims. high it acts in the same kind of way. If a strip 5 millims. high and 30 millims. long be placed parallel with the edge of the plate, and nearly at the centre, the cross is altered in a remarkable way, shown in fig. 34.

The following figures show the effect which other forms of obstruction have on these dust figures. A glass ring 4 millims. thick and 0·75 millim. high was placed at the centre of a square plate, and produced no alteration of the cross (fig. 35). Then a ring 1·5 millim. high was used, and it produced but little effect (fig. 36);

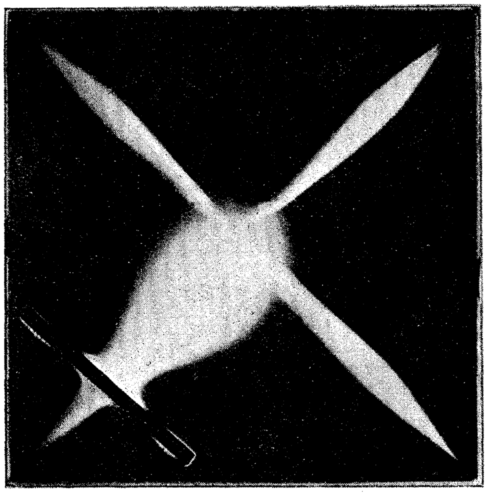

Fig. 33.

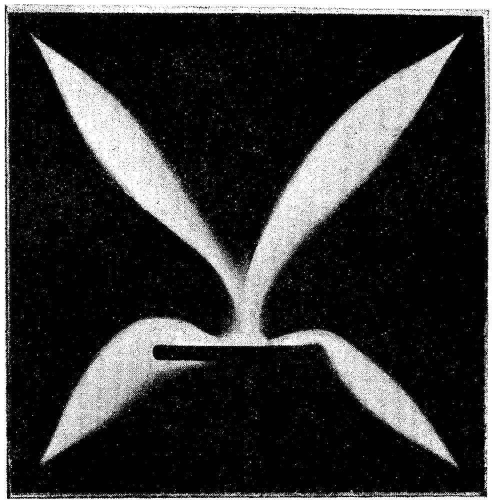

Fig. 34.

but when a ring 3 millims. high was used, then the central part within the ring became to a considerable extent thickened, and much deposit was formed (fig. 37), and when the ring was 5 millims. high an even deposit was formed inside the ring, but the rays of the cross outside were not affected (fig. 38). The effect of offering

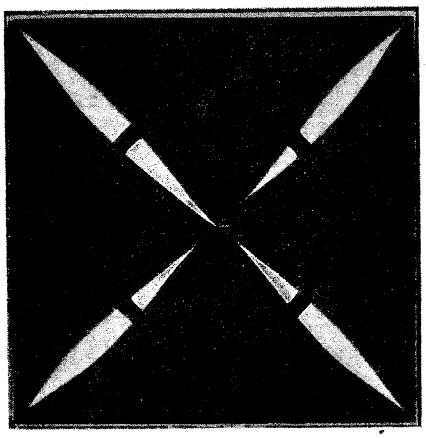

Fig. 35.

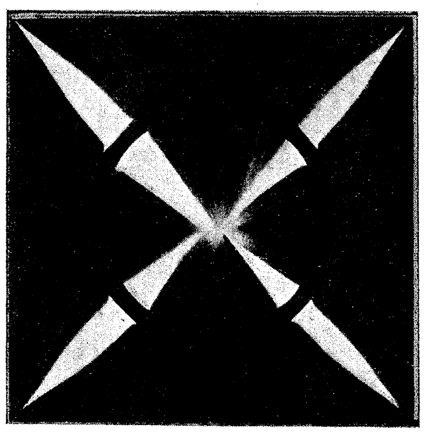

Fig. 36.

obstructions of different kinds to the flow of these dust currents was further tested by supporting from above, instead of from below, a strip of glass longer than the square plate on which the deposit was to be formed. When this is hung against the side of the plate, a dense deposit takes place all along this edge, but when the screen extends about 10 millims. on both sides beyond the plate, the deposit stops at

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4 millims. from the edge of the plate at both ends, and is conical in form. If the strip had been of the same length as the plate, the deposit would have reached, as shown in former experiments, very nearly the whole length of the plate. If the hanging screen be raised 2 millims. above the plate, then in place of a long line of

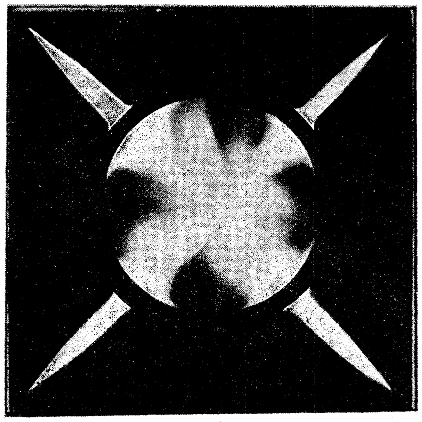

Fig. 37.

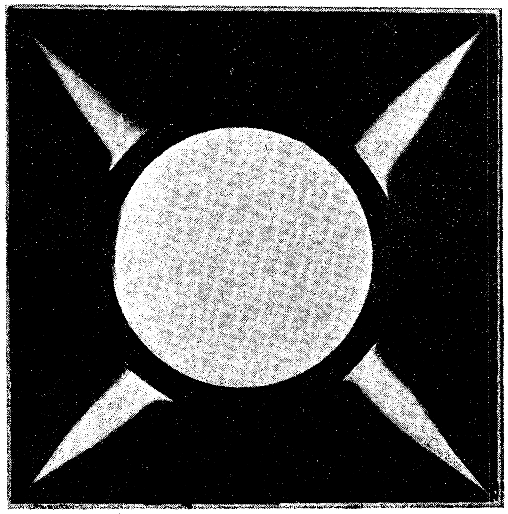

Fig. 38.

deposit there is a line of clear space some 7 millims. wide, and at the ends are delicate curved lines extending to the corners of the plate, and beyond this open space there is the conical deposit as in the former case (fig. 39). In raising the screen so that it was 4 millims. above the plate, the depth of the clear space increased and was now

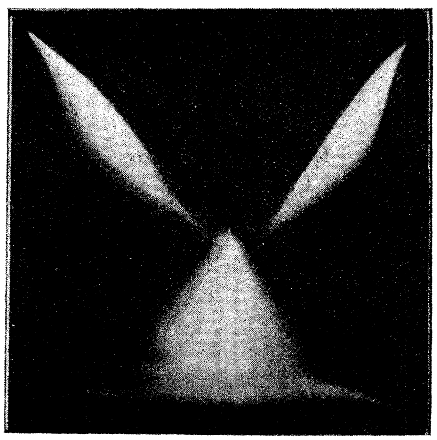

Fig. 39.

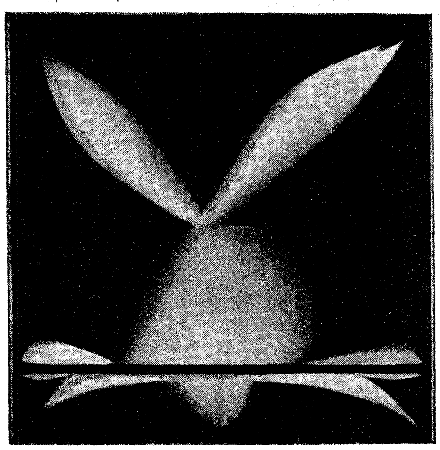

Fig. 40.

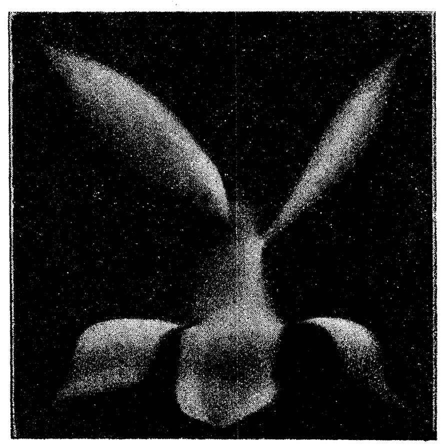

Fig. 41.

12 millims. from the edge. When the screen was 6 millims. above the plate, the clear space became strongly curved, and at the top of the curve was 20 millims. from the edge of the plate, and when 10 millims. above the plate the normal rays of the cross were well developed, and a well defined but slightly distorted cross was formed,

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so that the hanging screen at this height exercises but little influence on the figure formed below it. The same hanging screen was now allowed to rest on the plate, but at a distance of 15 millims. from the edge, and a pin was placed against the edge of the plate. Fig. 40 shows well the different actions which came into play, that of the pin, of the corners of the plate, of the screen, and of the broken corner producing a forked ray. The hanging screen was now raised to 3 millims. above the plate, the current now passed under it, and gave the curious picture (fig. 41) with distinct side wings.

Another way of offering obstruction to these dust currents was to place above the plate on which the deposit is to take place, other plates at different heights, and of varying sizes, some larger and some smaller than the plate which is to receive the figure. First taking the case of placing a plate larger than the one on which the deposit is to form above it, the large one was $7\frac{1}{2}$ inches by $4\frac{3}{4}$ inches and the smaller was 3 inches square. The upper part was supported on vulcanite pillars, so far from

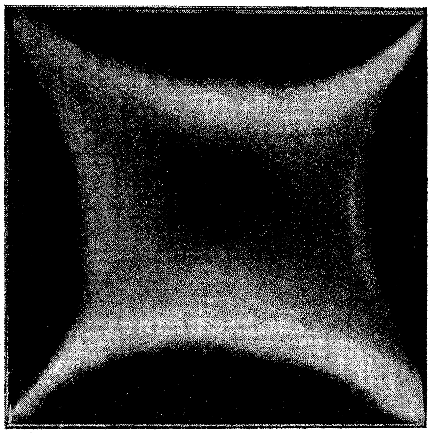

Fig. 42.

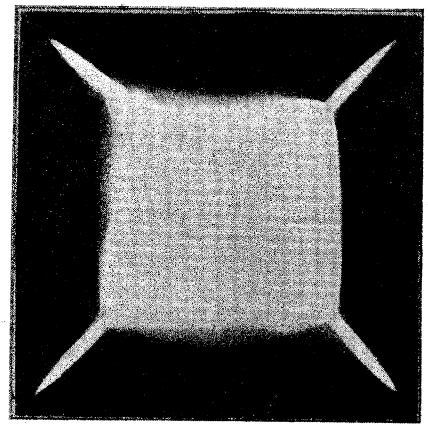

Fig. 43.

the plate as not to influence the figures formed. It was found that when the distance between these plates was 1 millim. no deposit took place; but when this distance was 5 millims. a deposit did take place, covering most of the curved outline, and passing into each of the corners, but less deposit occurred in the middle of the figure (fig. 42), and was apparently an early stage of the cross. If the distance between the two plates be 10 millims., the amount of even deposit is less, and when the distance is increased to 15 millims. a considerable change has occurred, and fig. 43 is formed, the cross still further developed, and when the distance between the plates is 20 millims., then a perfect cross forms.

If the upper plate, in place of being larger, is of the same size as the lower one, different results take place. Plates $3\frac{1}{4}$ inches square were used, and the upper one was suspended above the lower one. When the distance between the plates was 1 millim., again no dust entered, but when it was 2 millims. there was a small amount of deposit at each of the corners, and when 3 millims. a considerable increase of deposit occurred, but it was still limited to the corners (fig. 44). When the distance between the plates was 4 millims., a further inroad of dust took place, and when 5 millims., the centre is the only part without deposit, but from the entrance of the dust being principally at the corners, a rough cross, formed by absence of dust, and pointing to the centre, is distinguishable (fig. 44A), and at 7 millims. there is an even deposit.

Fig. 44.

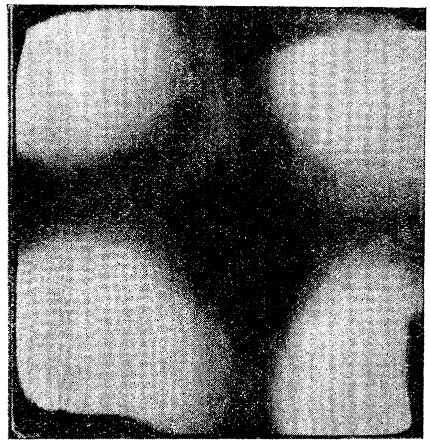

Fig. 44A.

In the next set of experiments the covering glass, in place of being as large as the lower glass, was only a strip 14 millims. wide and 190 millims. long, and $1\frac{1}{2}$ millim. thick. It was supported on vulcanite pillars which did not influence the depositions

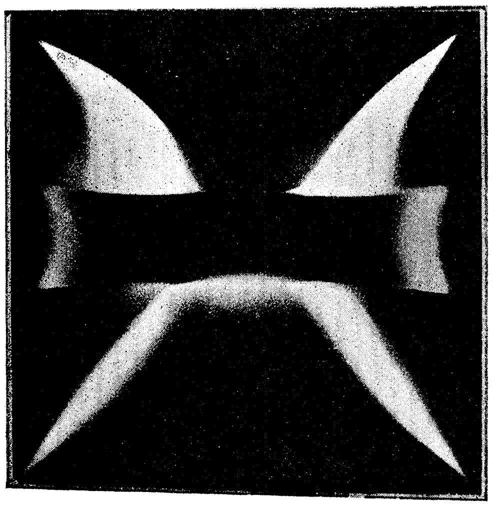

Fig. 45

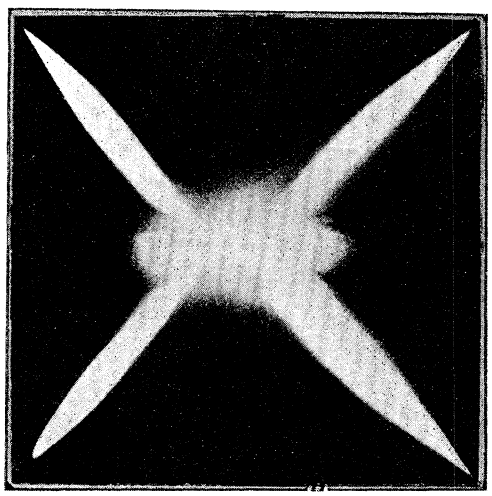

Fig. 46.

of the dust. When this strip was 1 millim. above the plate no deposit took place; when 2 millims. above the plate a small amount occurred, and this was at a distance of 7 millims. from the edge of the plate, and of a curved form, of course, under the strip (fig. 45). The strip was now raised to a height of 3 millims., and the amount of deposit not only increased, but receded further from the edge of the plate, and was

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now 12 millims. from it. On still further increasing the distance between the strip and the plate, the amount of deposit goes on increasing and travels nearer the centre. When raised to 4 millims. above the plate the deposits have met in the centre, and when the height between the plates is 7 millims., then the deposit is 15 millims. from the edge, and when 10 millims. above the lower plate the deposit is 18 millims. from the edge, and is central to the large cross (fig. 46). At a distance of 15 millims. the strip no longer produces any effect, the ordinary large cross forms.

In order to ascertain whether any figure could be formed by a dusty atmosphere when in motion, magnesium was burnt in an asbestos tube, while a current of air was being drawn through it. The asbestos tube was attached to a glass tube, 32 millims. in diameter, and in this tube pieces of glass of different lengths were introduced for the figures to form on. It was found that a peculiar and characteristic figure was always produced. It consists of a multitude of dust streams which unite into a single stream, as shown in fig. 47. If the tube be wider, the same picture is formed by increasing the amount of air drawn through the tube. It may also be stated that if the dust atmosphere be violently disturbed by means of a stirrer, while the dust is settling on the plate, it produces no alteration of the figure which is forming without the stirrer comes very close to the plate.

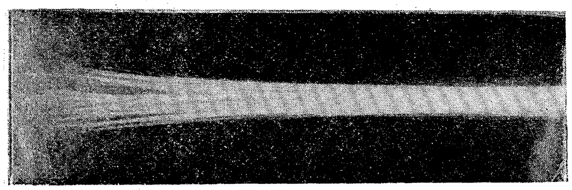

Fig. 47.

This figure, formed in the tube, is probably of a somewhat different character from the previous ones, for it forms quite as readily when the plate is not warmed as it does when it is warmed.

When the dust is obtained by burning magnesium, the magnesia formed undergoes some curious changes. The figure when first formed lies loosely on the plate, the slightest friction will remove it. If, however, it be left exposed to the air, it loses its silvery whiteness and becomes more and more attached to the glass, so that after about a week or fortnight the figure may be lightly rubbed without its being removed. Again, the magnesia itself undergoes a change of form immediately after its production. If the dust be collected at once, that is, while the magnesium is still burning, and be examined under a microscope, it will be seen that it is made up of small separate irregular-shaped particles about 0·005 millim. long (fig. 48); but if the dust be collected after the combustion is over, and it has stood for one or two minutes, then its form is different, for it now

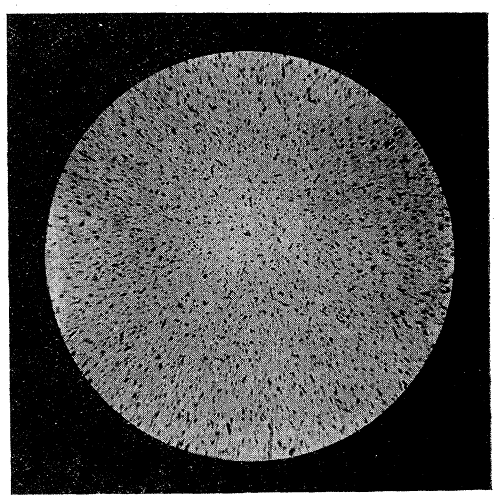

Fig. 48.

consists of particles strung together and having a distinctly fibrous structure (fig. 49). It is in this form that the dust exists when forming pictures. It has already been stated that magnesia dust, if allowed to deposit on mercury, forms the ordinary cross; on the contrary, if it be allowed to deposit on water at about 17°, or on a

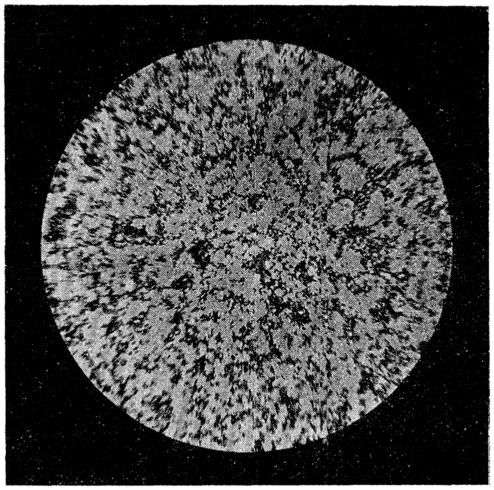

Fig. 49.

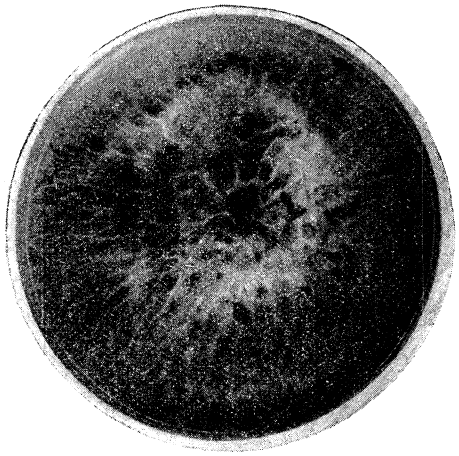

Fig. 49A.

mixture of water with a little alcohol or glycerine, then the deposit which forms on the surface breaks up, as the dust sinks, into a figure having a cellular form (fig. 49A).

As before stated, other powders than magnesia act in the same way. For instance, a figure, corresponding exactly with those described as produced by the action of a

Fig. 50.

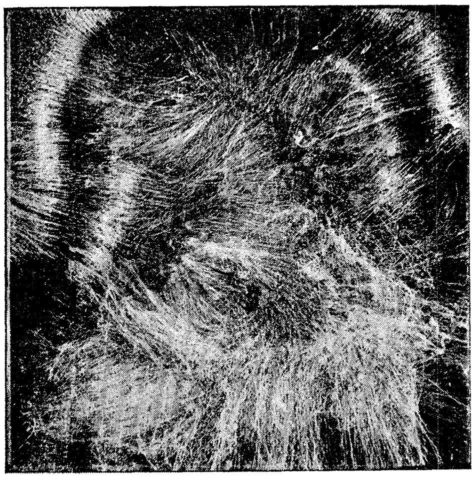

Fig. 51.

pin, and magnesia, is also produced with fine fungus spores, dust from ashes, or ammonium chloride.

It is interesting to note that if the warmed glass be rubbed with a piece of flannel, and then exposed to the dust, in place of a fine even deposit a very strongly fibrous one forms (fig. 50). Even small specks of dust in this fibrous form act very strongly in the same way as the pin or rough edge of a glass in inducing deposits to take place. If the plate be charged with negative electricity, then a deposit much finer in character is produced (fig. 51).

It is remarkable that these figures deposited by a dust-laden atmosphere, should be so sharp in outline and definite in form. They originate, no doubt, in the currents set up by the warming of the plate, but that these feeble currents should so completely and persistently prevent the deposition of dust at certain places, and determine its precipitation at others, was hardly to be anticipated. Especially may reference be made to the singular action of the pin both near and at a distance from the plate, and the apparently complicated way in which obstructions act in altering the form of the deposits. The formation of the figures taking place as readily on copper or other metals, as on glass or ebonite, indicates that the phenomena are not purely electrical.

It is hoped that by the foregoing records and descriptions of these singular figures, physicists may be enabled to explain their formation.

I wish to record that this investigation was carried out in the Davy-Faraday Laboratory at the Royal Institution, also that my best thanks are due to my assistant, Mr. Olaf Block, for the important aid which he has given me.

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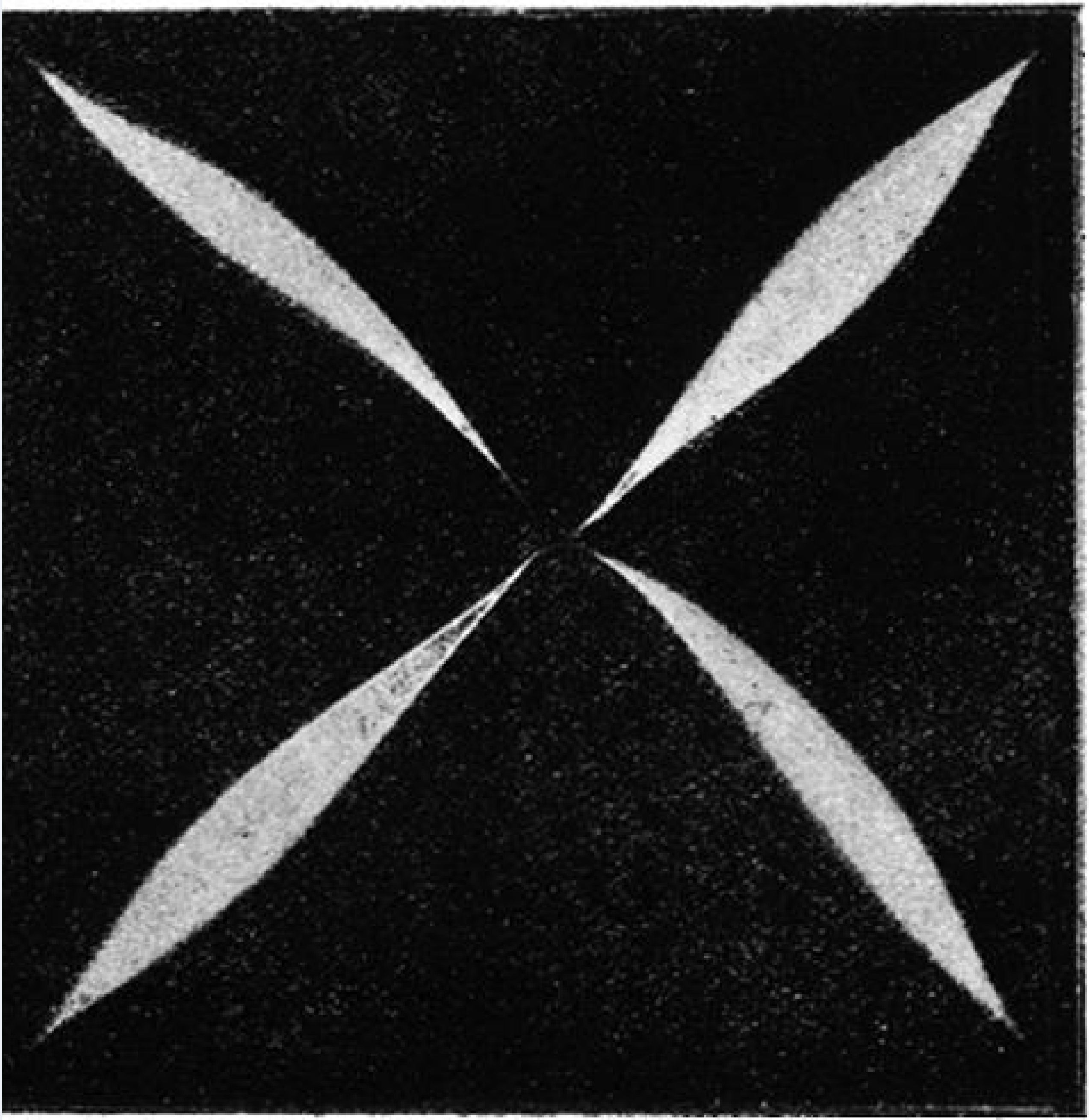

Fig. 1.

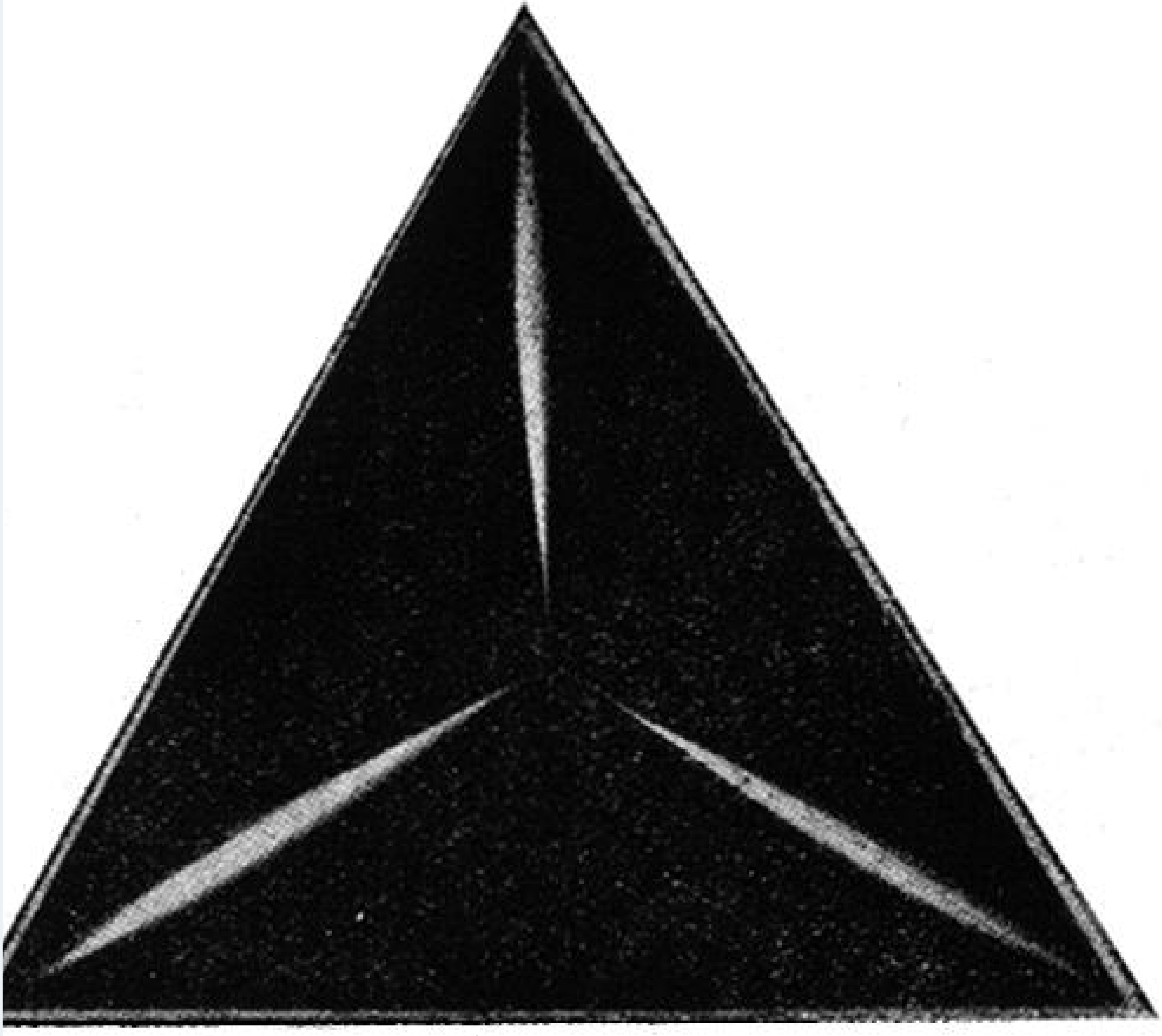

Fig. 2.

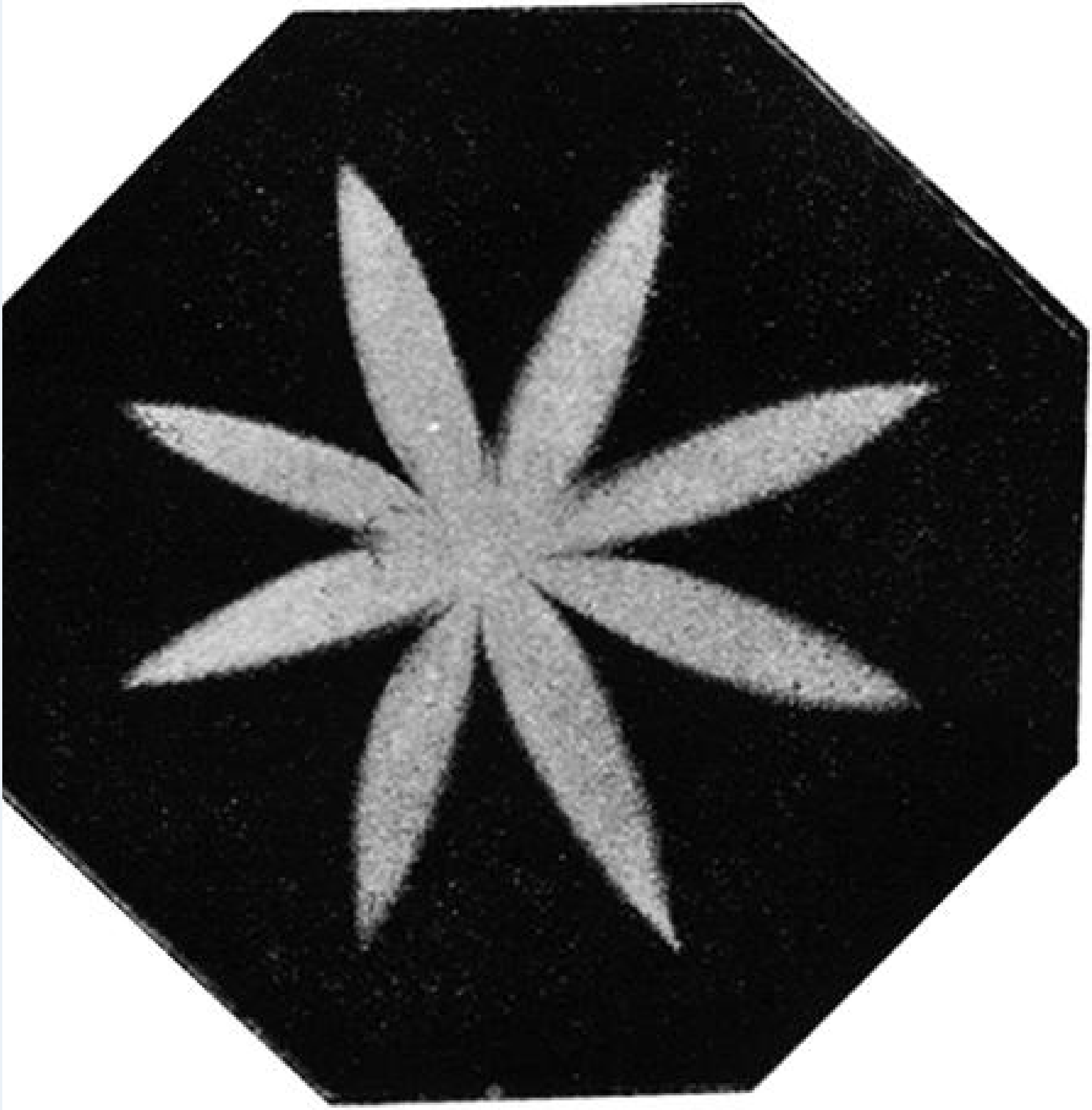

Fig. 3.

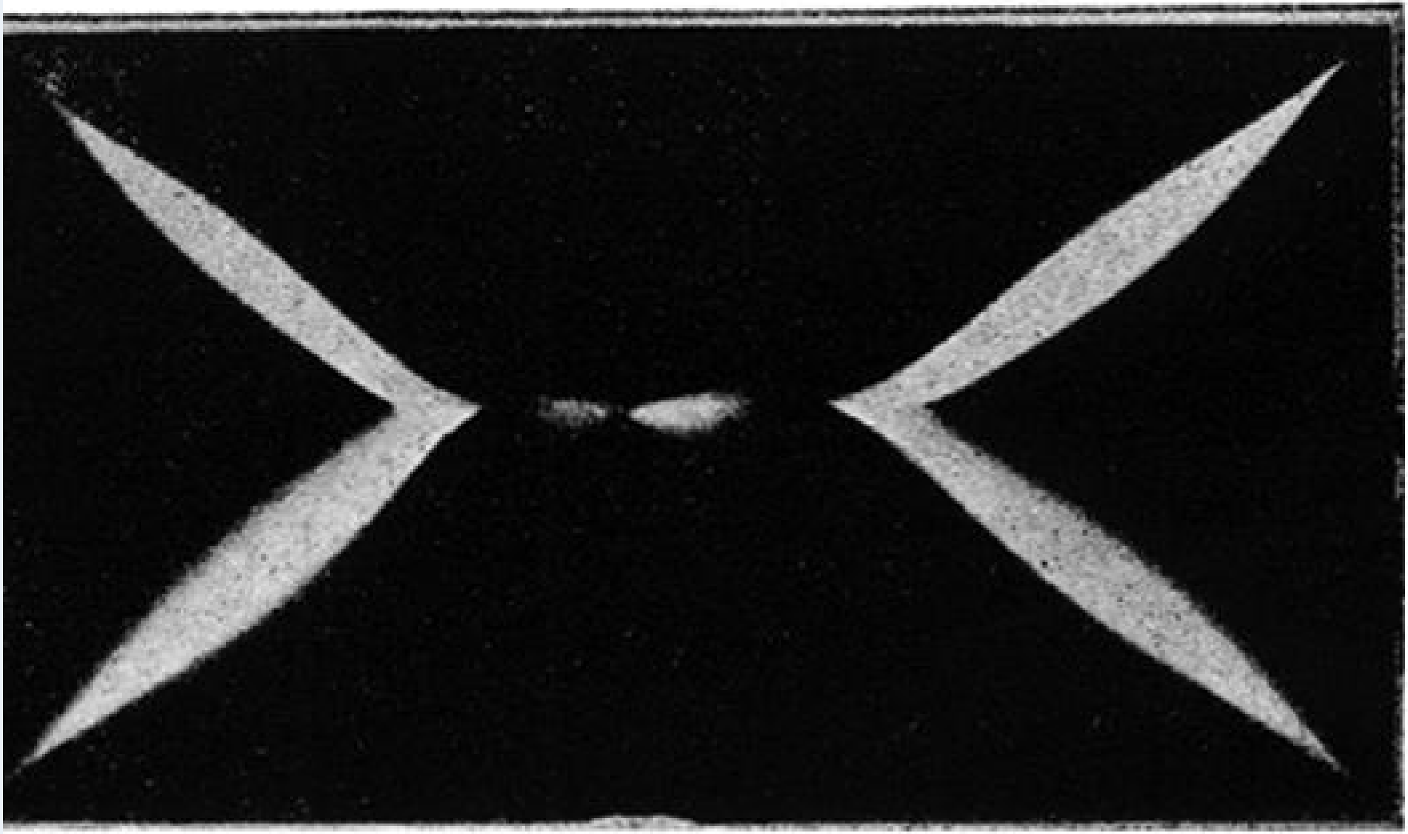

Fig. 4.

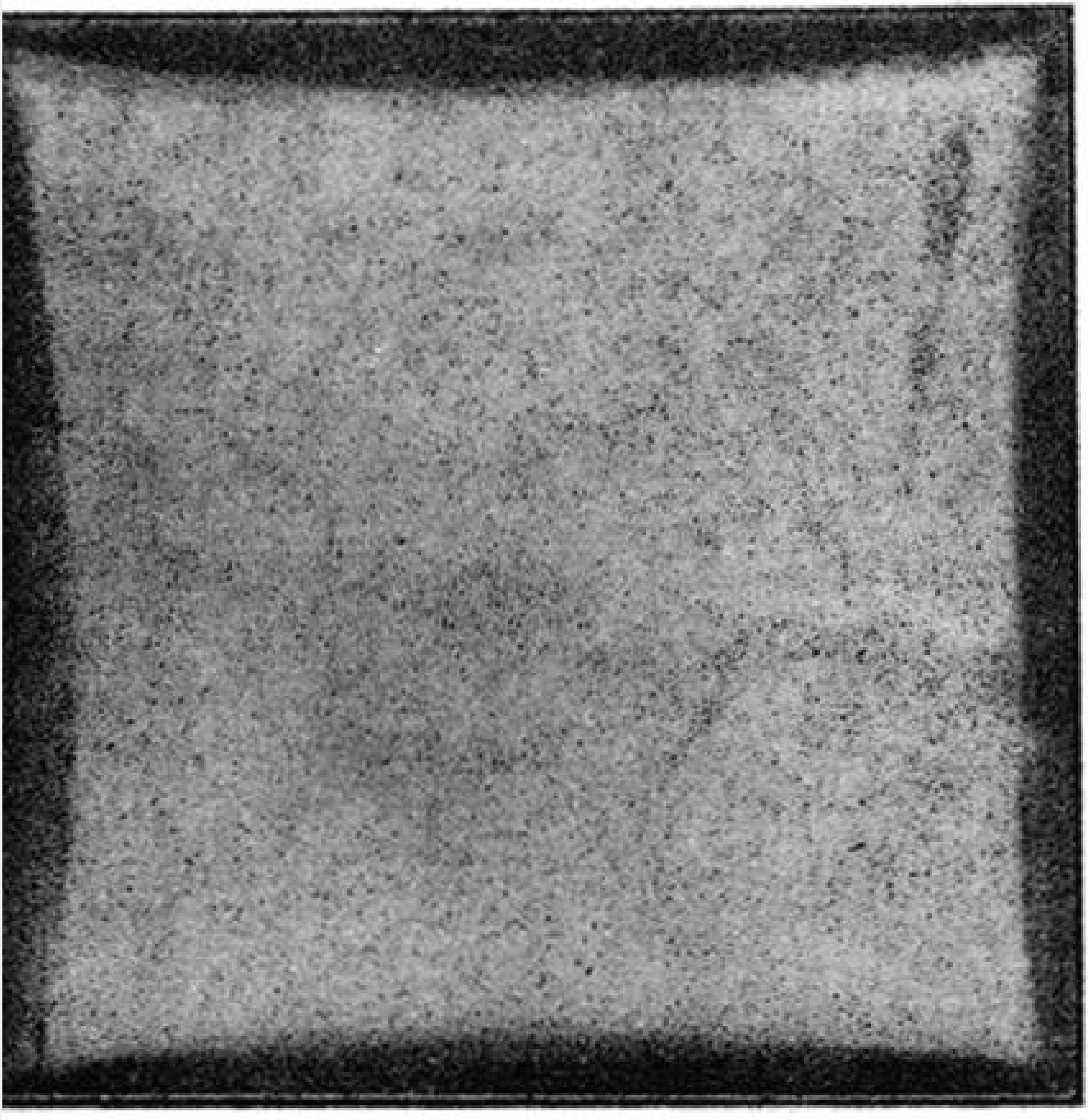

Fig. 5.

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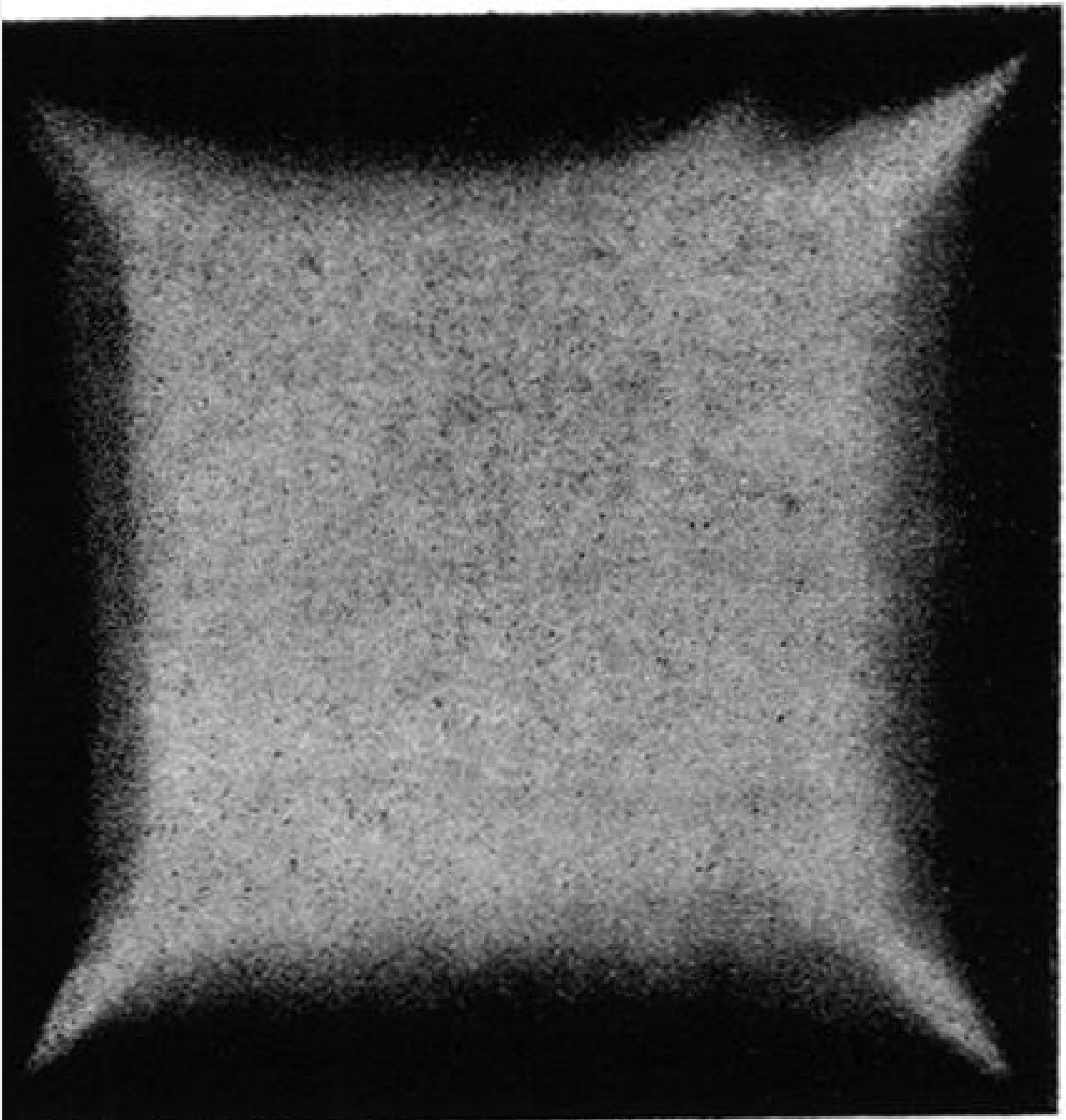

Fig. 6.

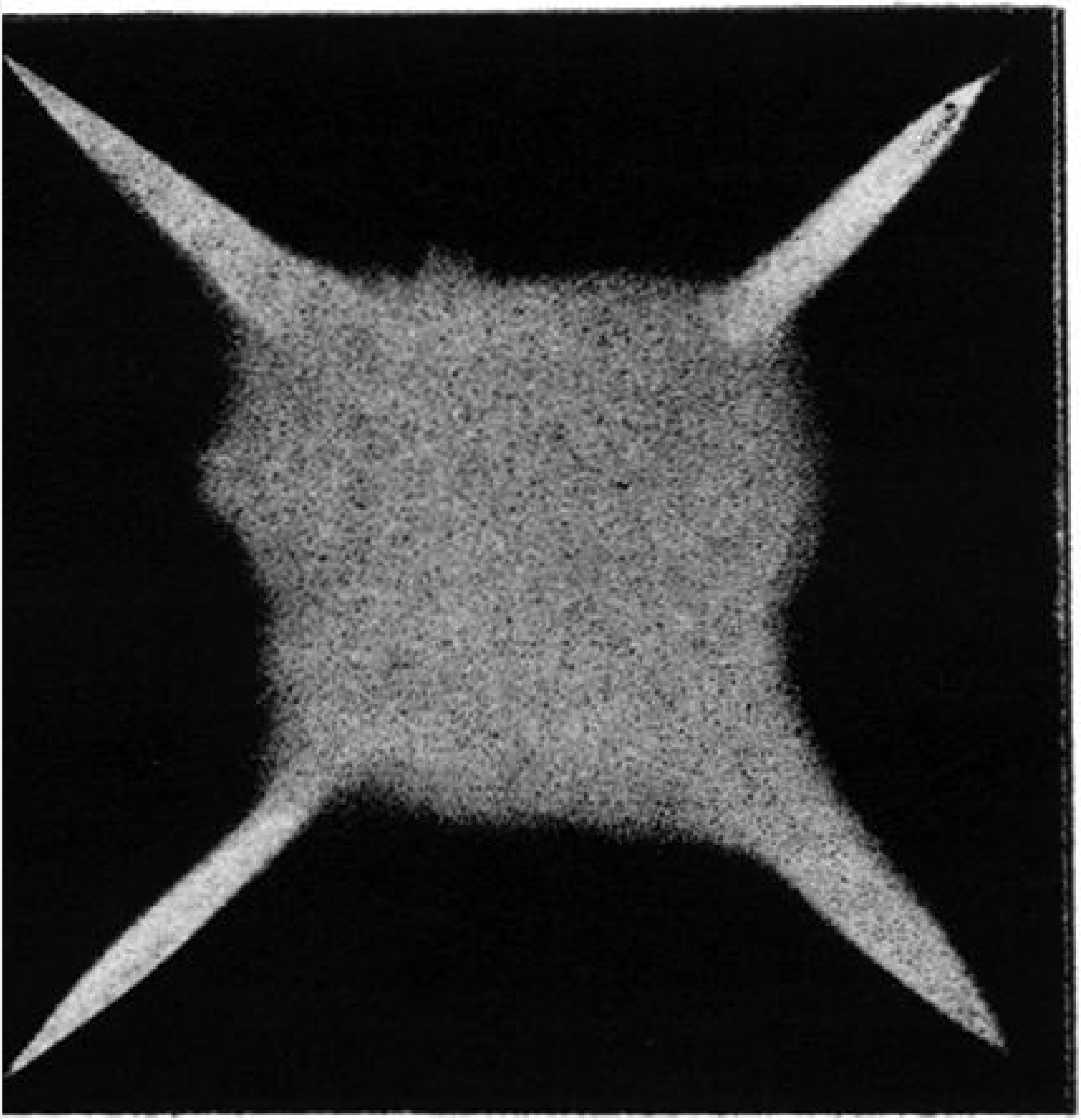

Fig. 7.

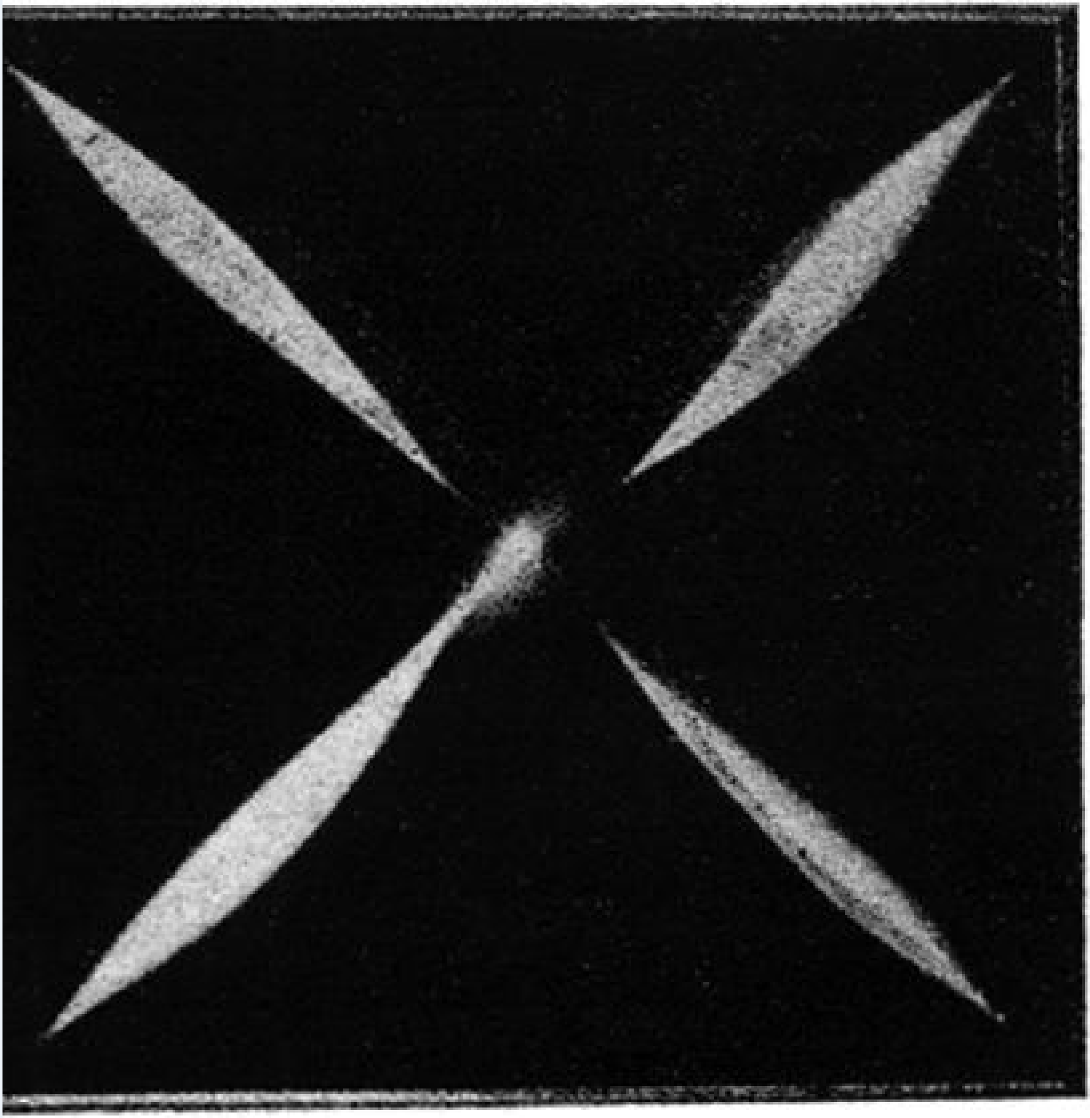

Fig. 8.

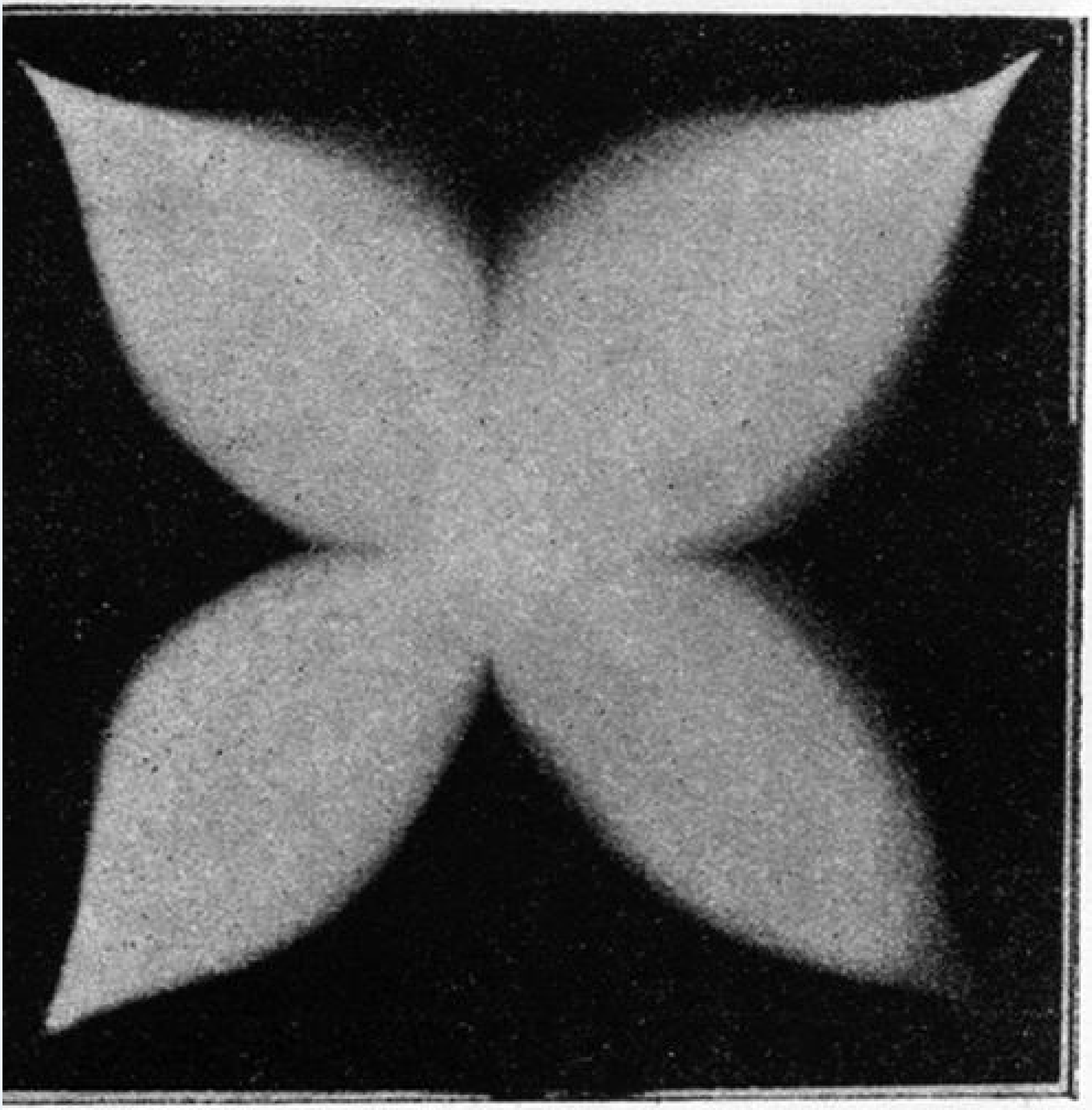

Fig. 9.

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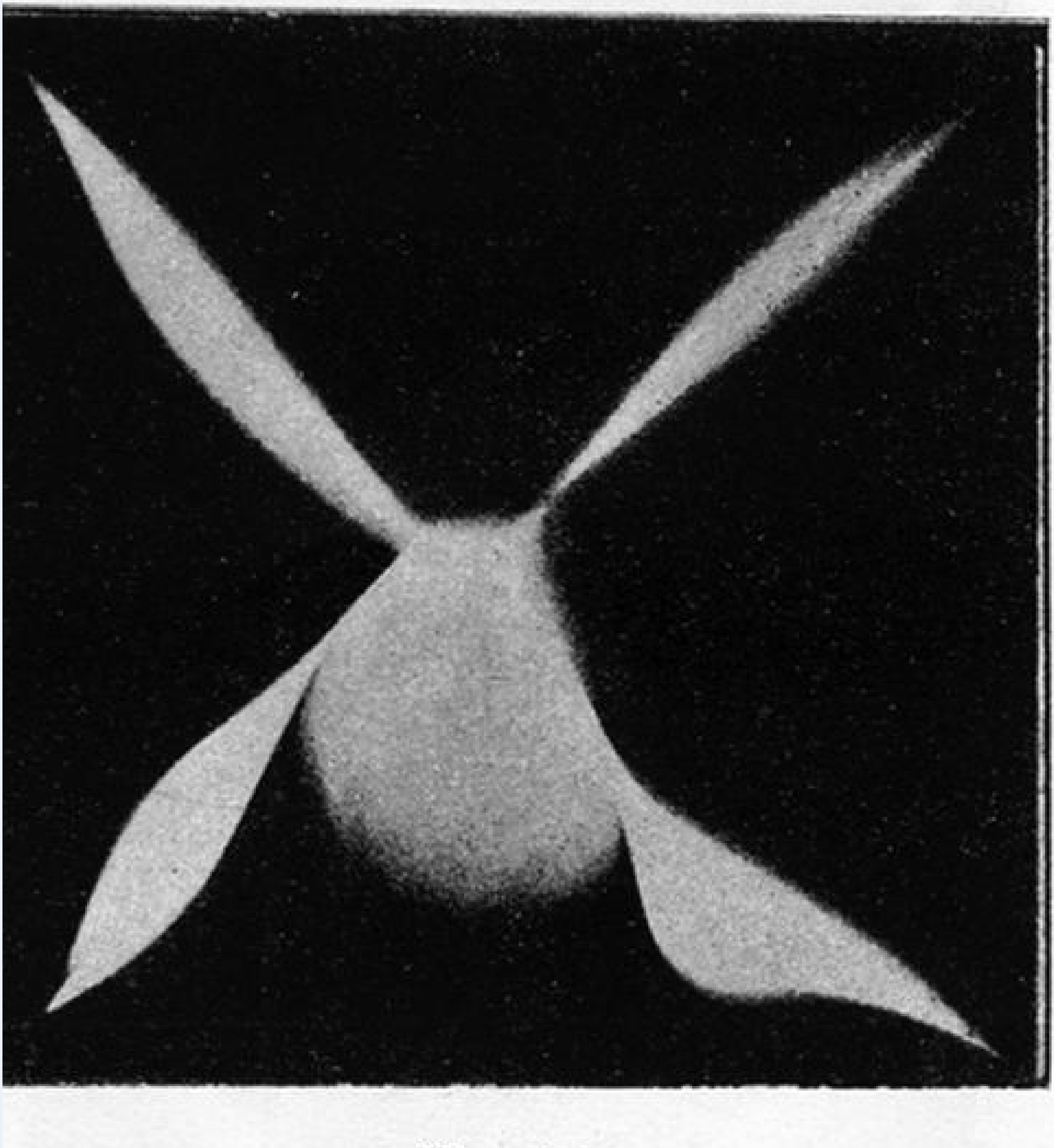

Fig. 10.

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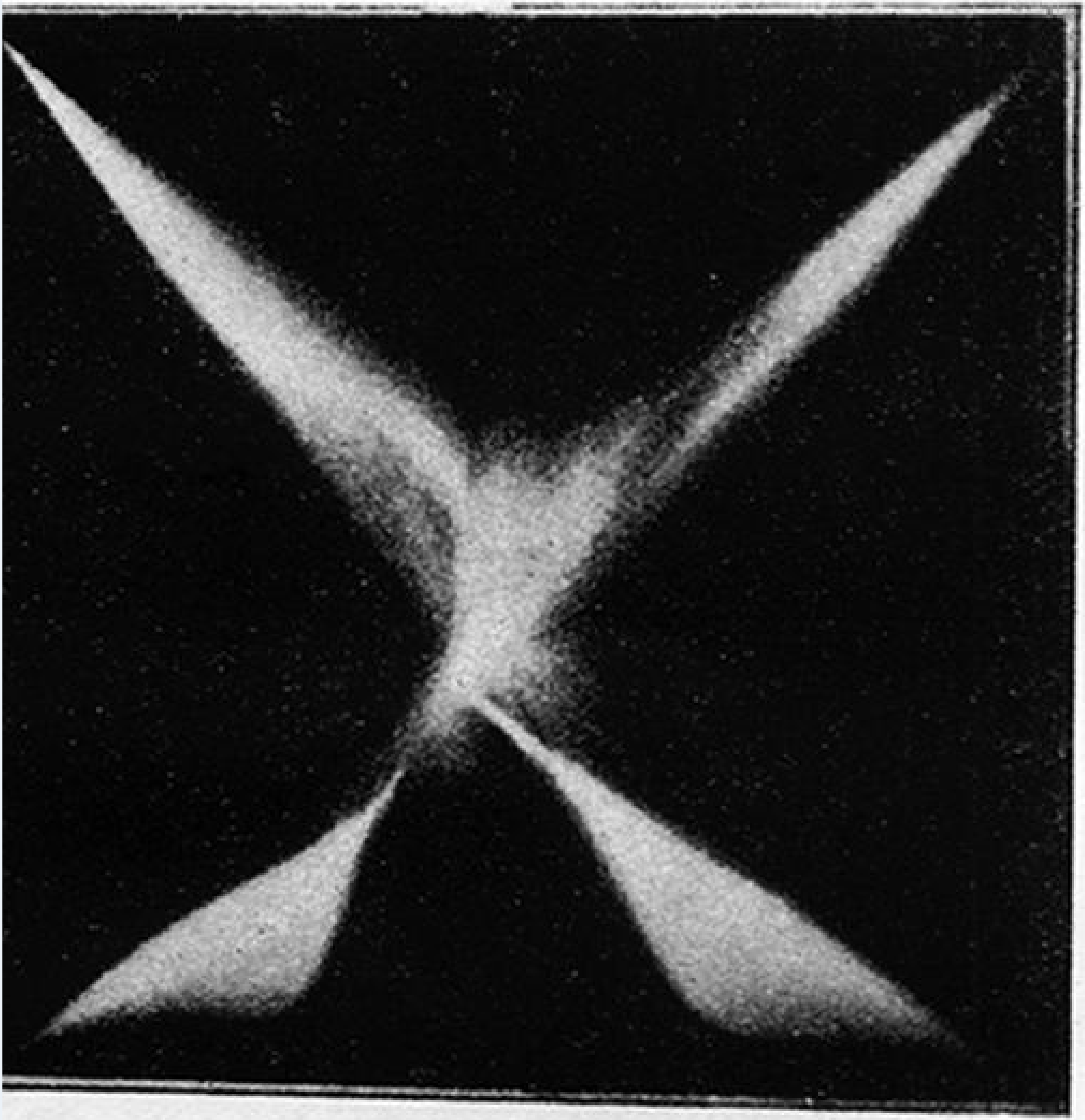

Fig. 11.

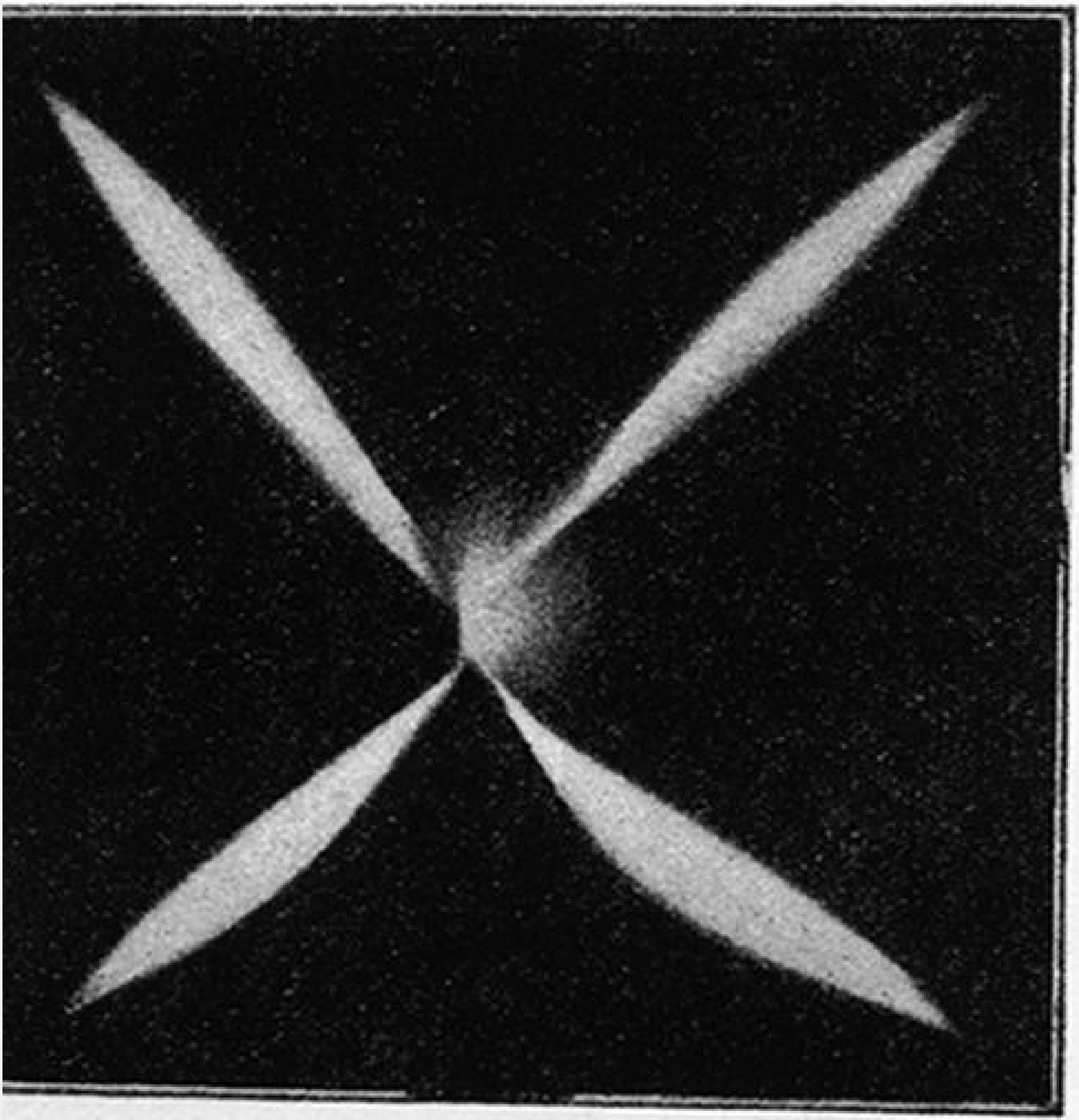

Fig. 12.

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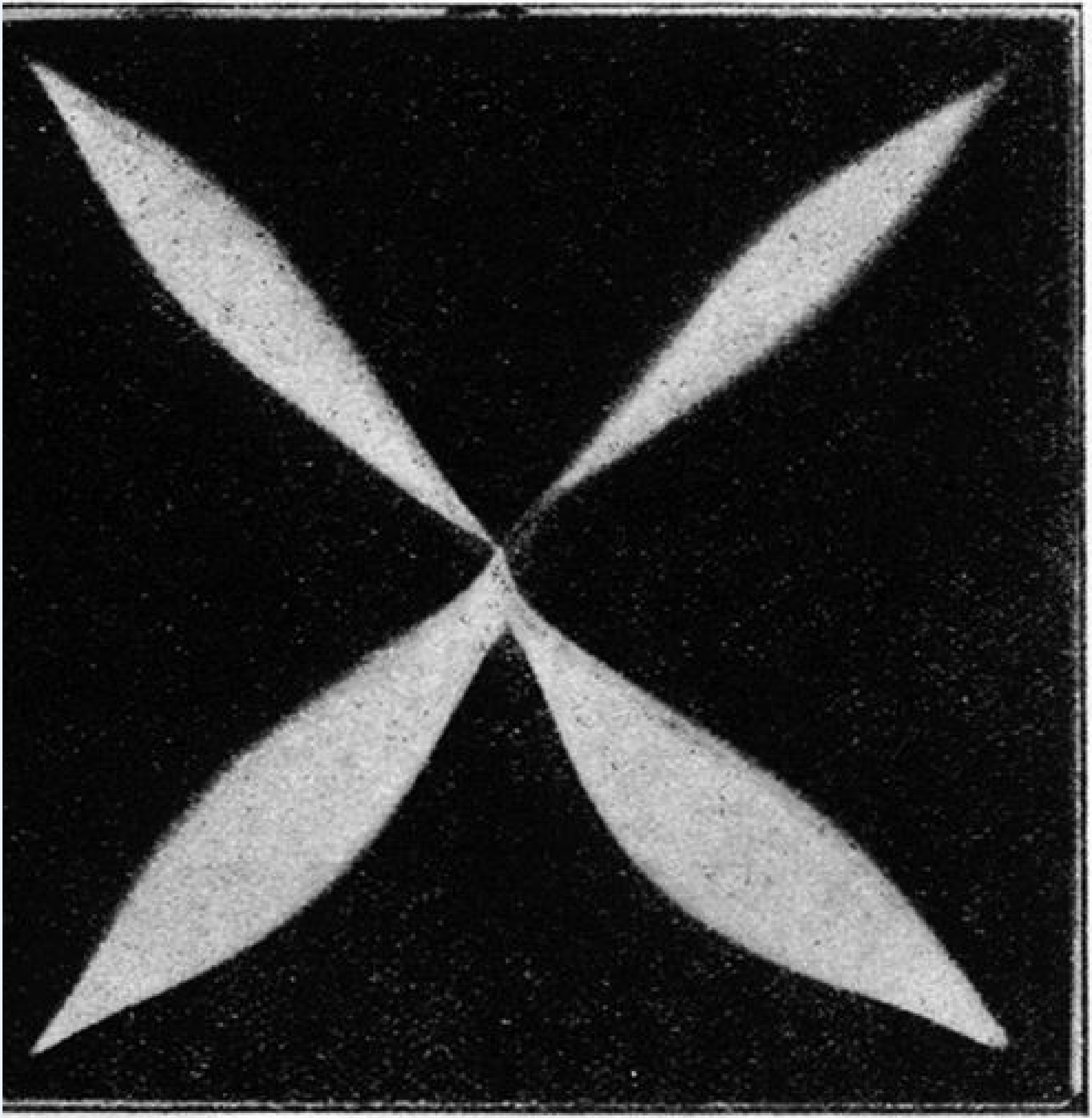

Fig. 13.

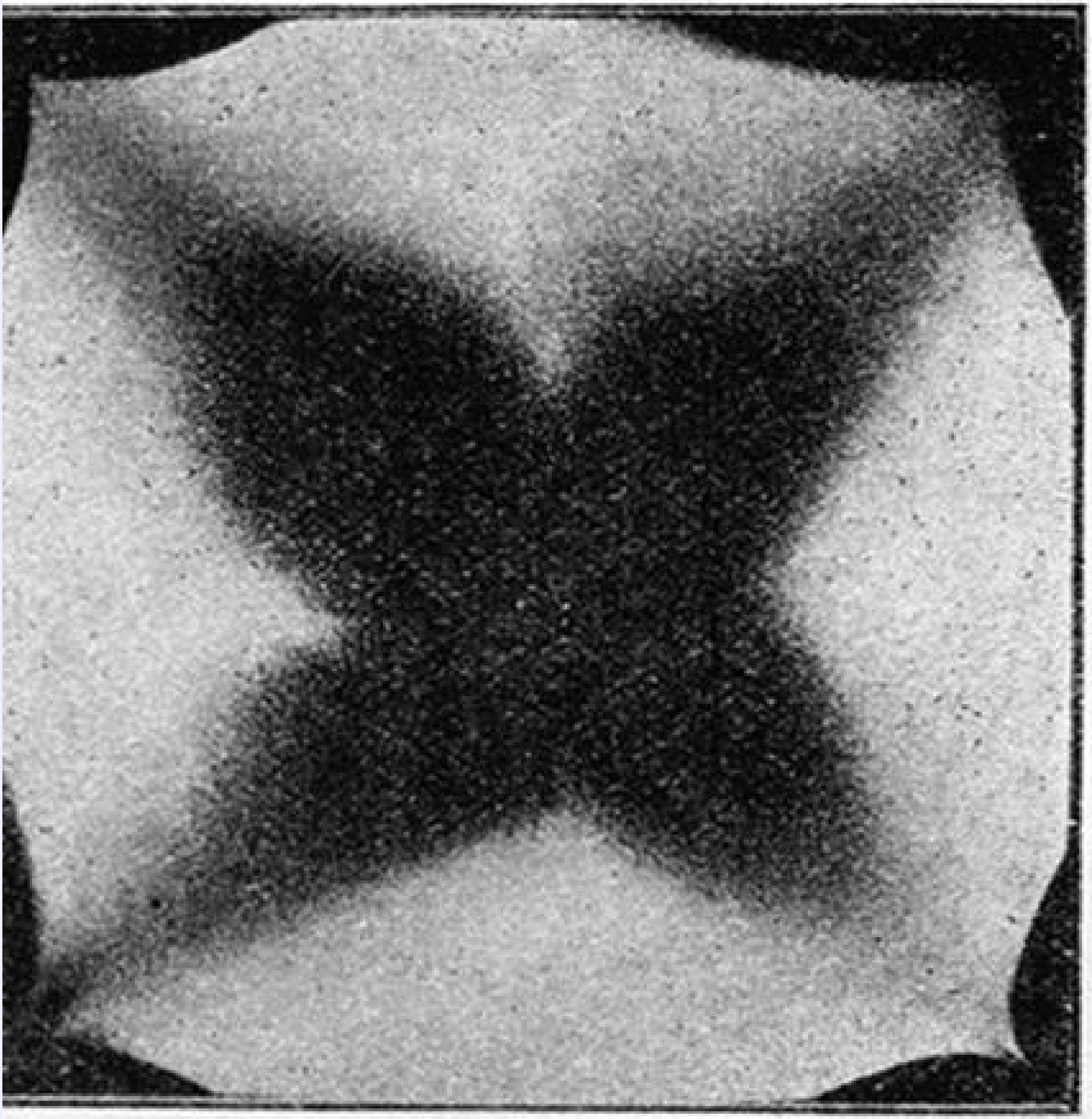

Fig. 14.

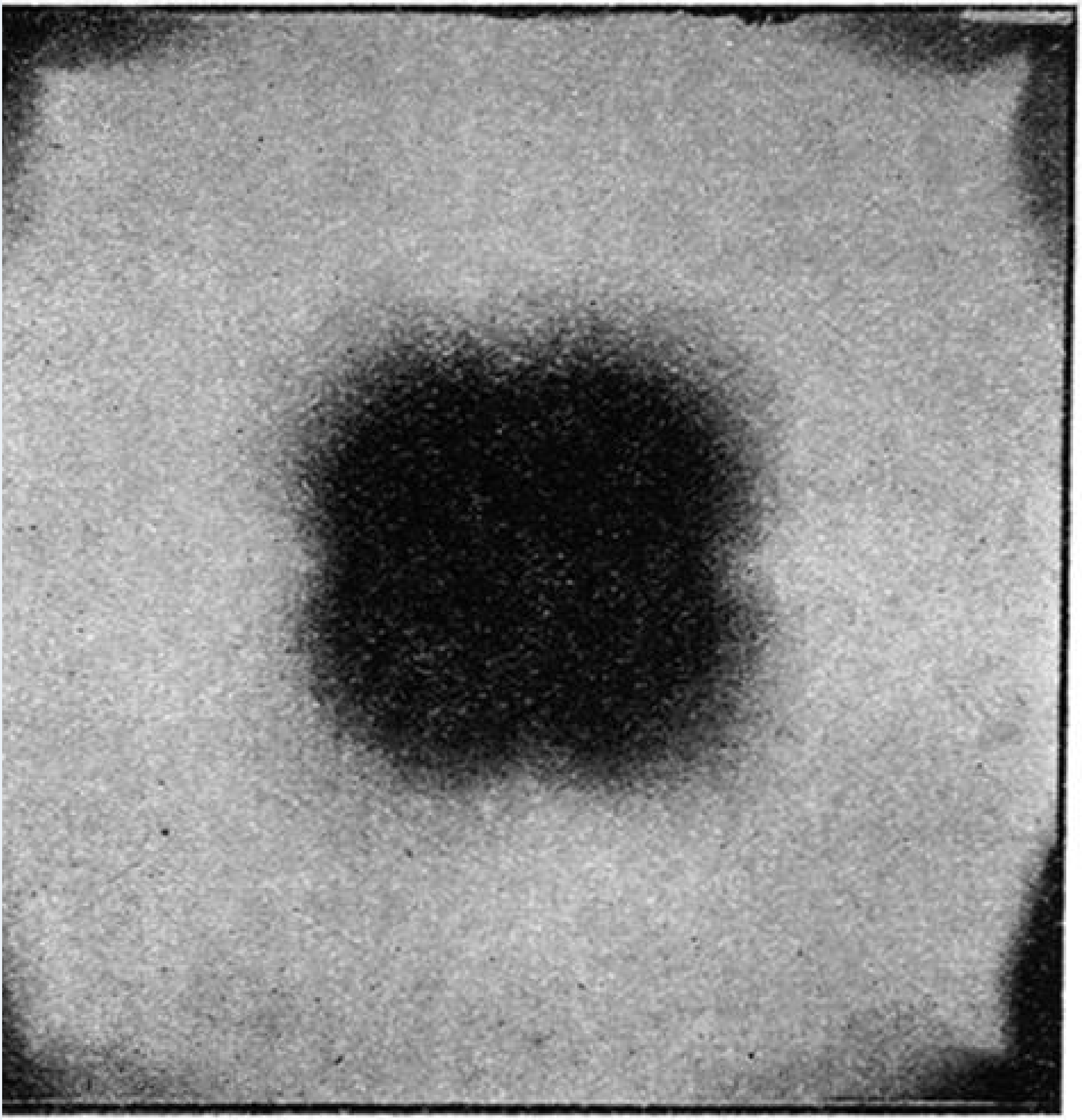

Fig. 15.

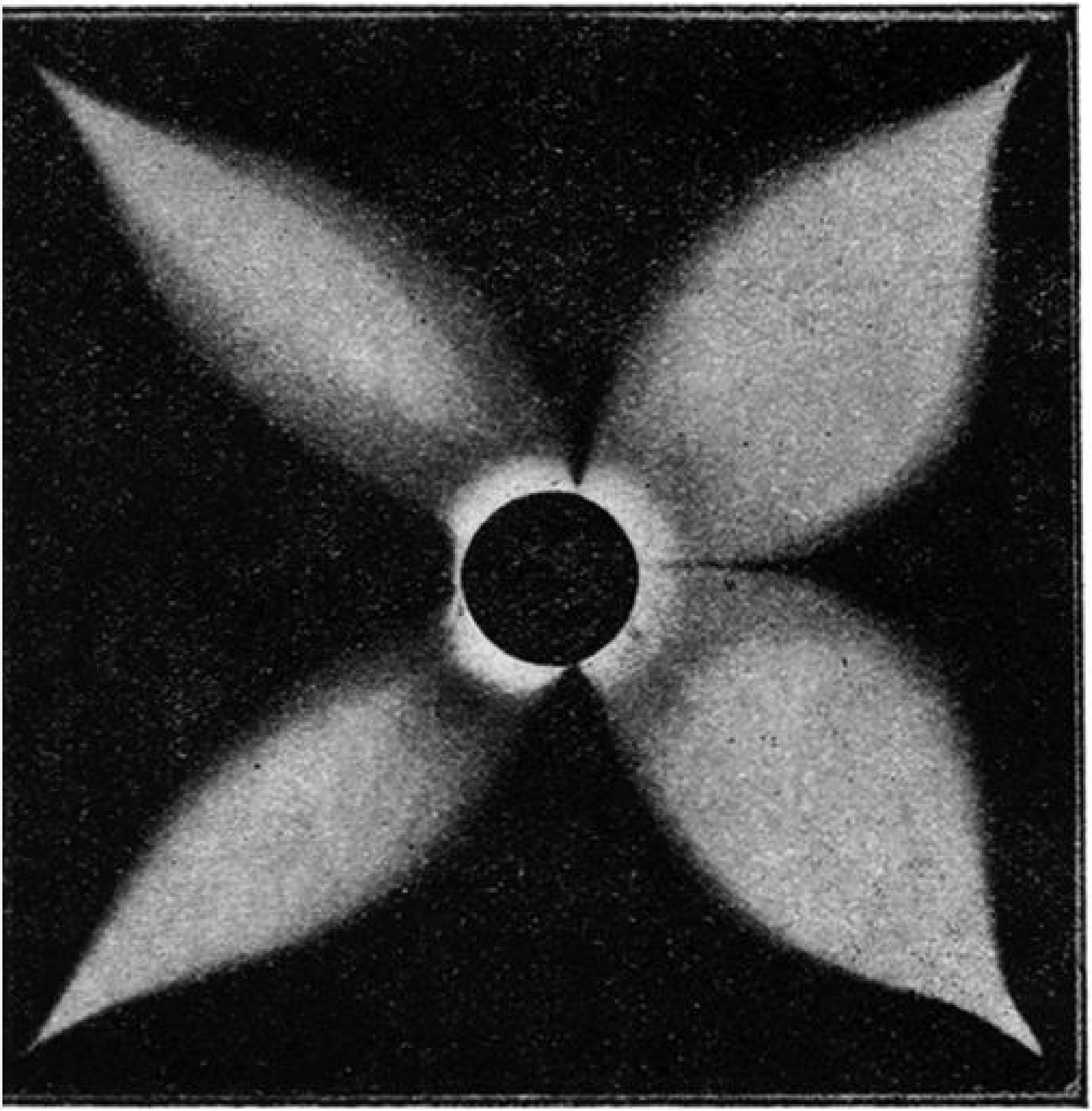

Fig. 16.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A

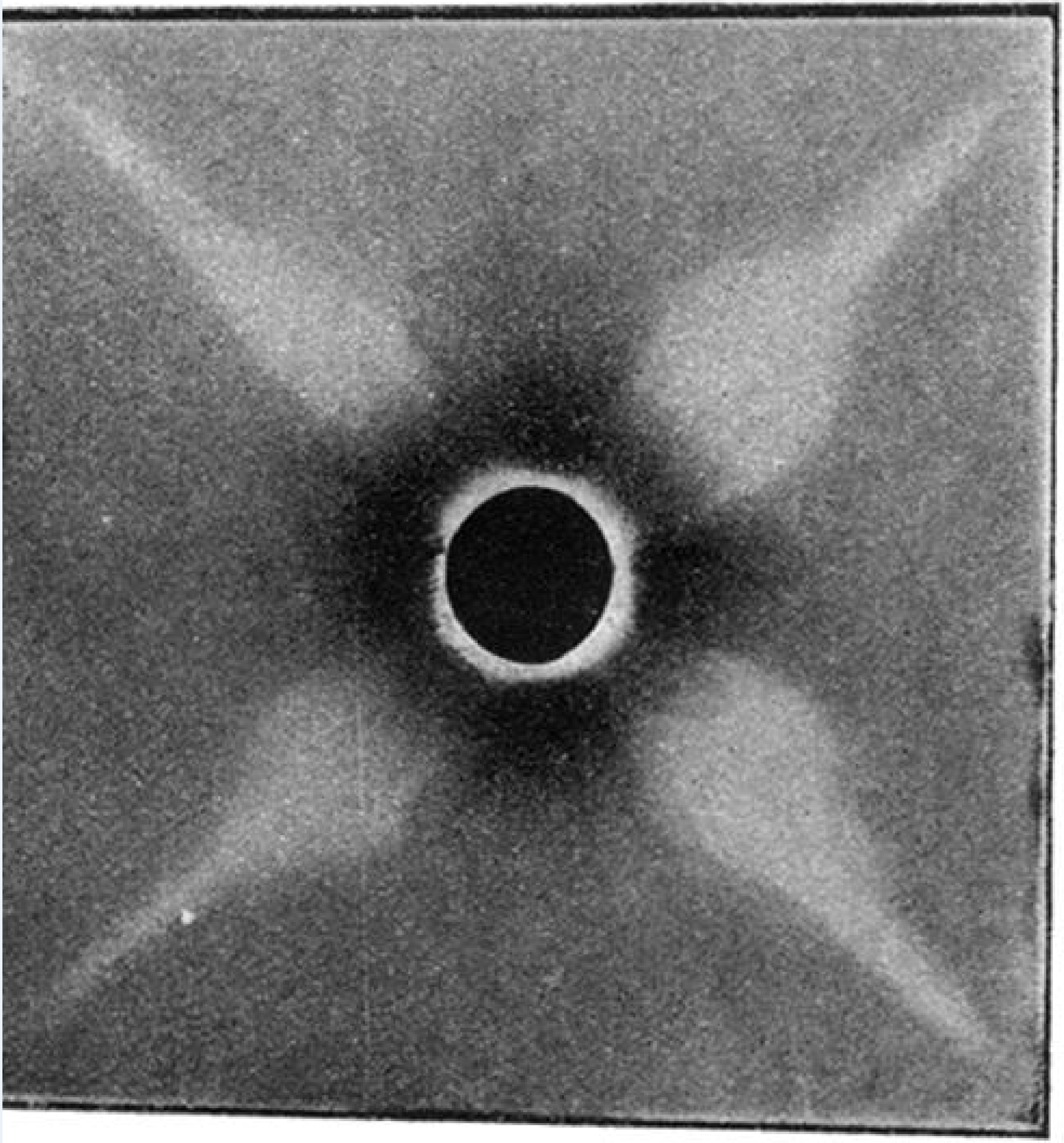

Fig. 17.

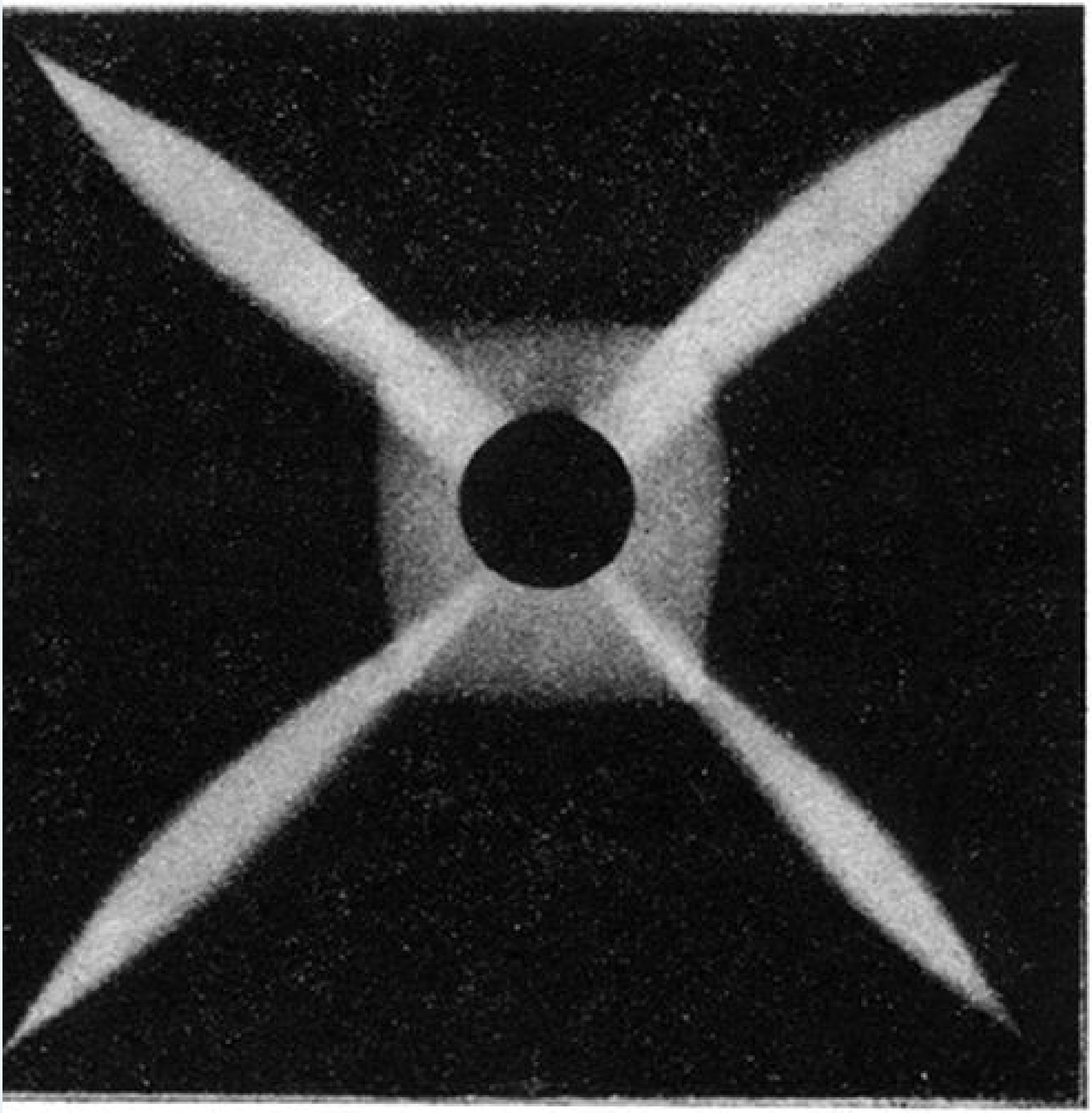

Fig. 18.

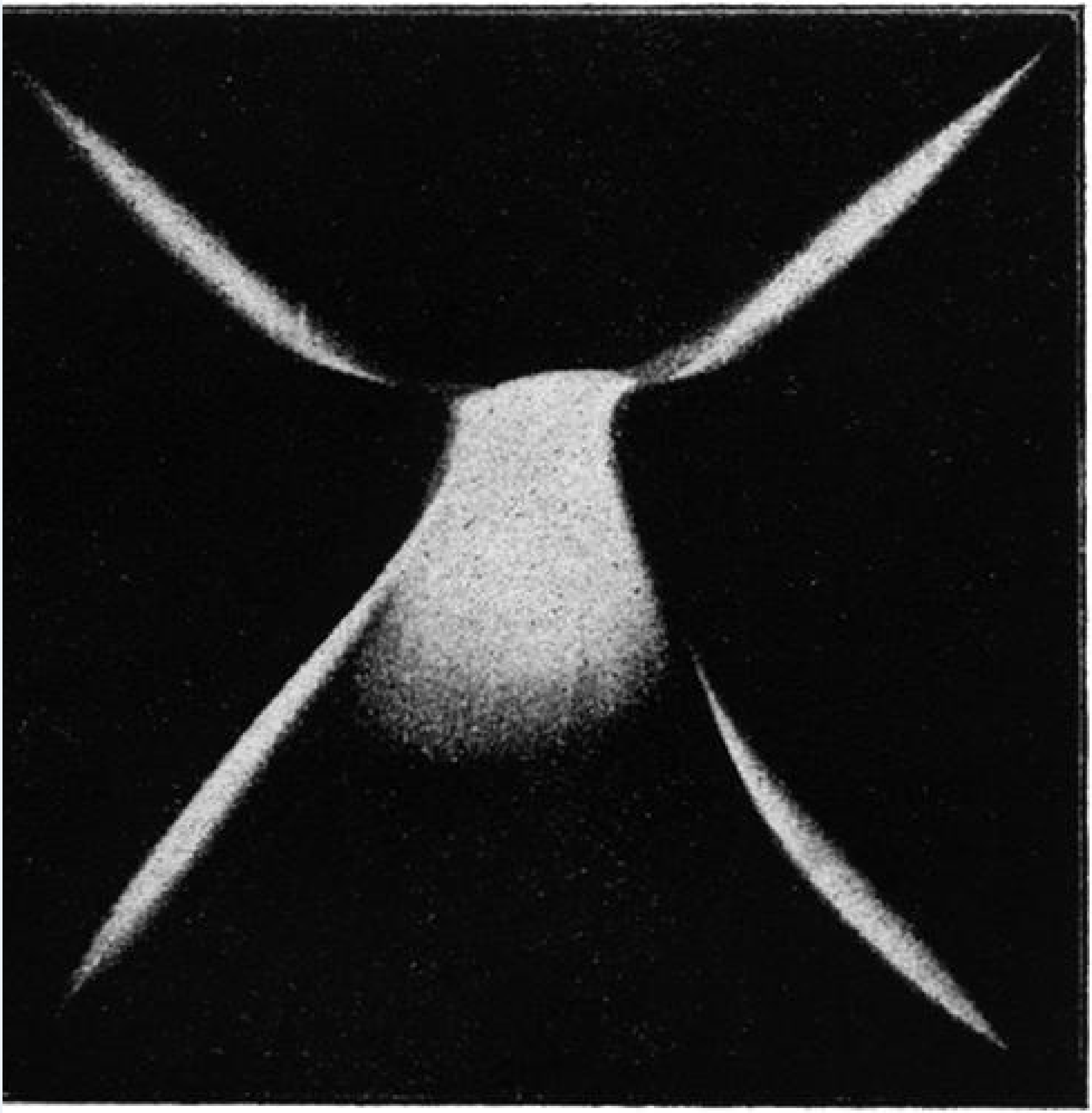

Fig. 19.

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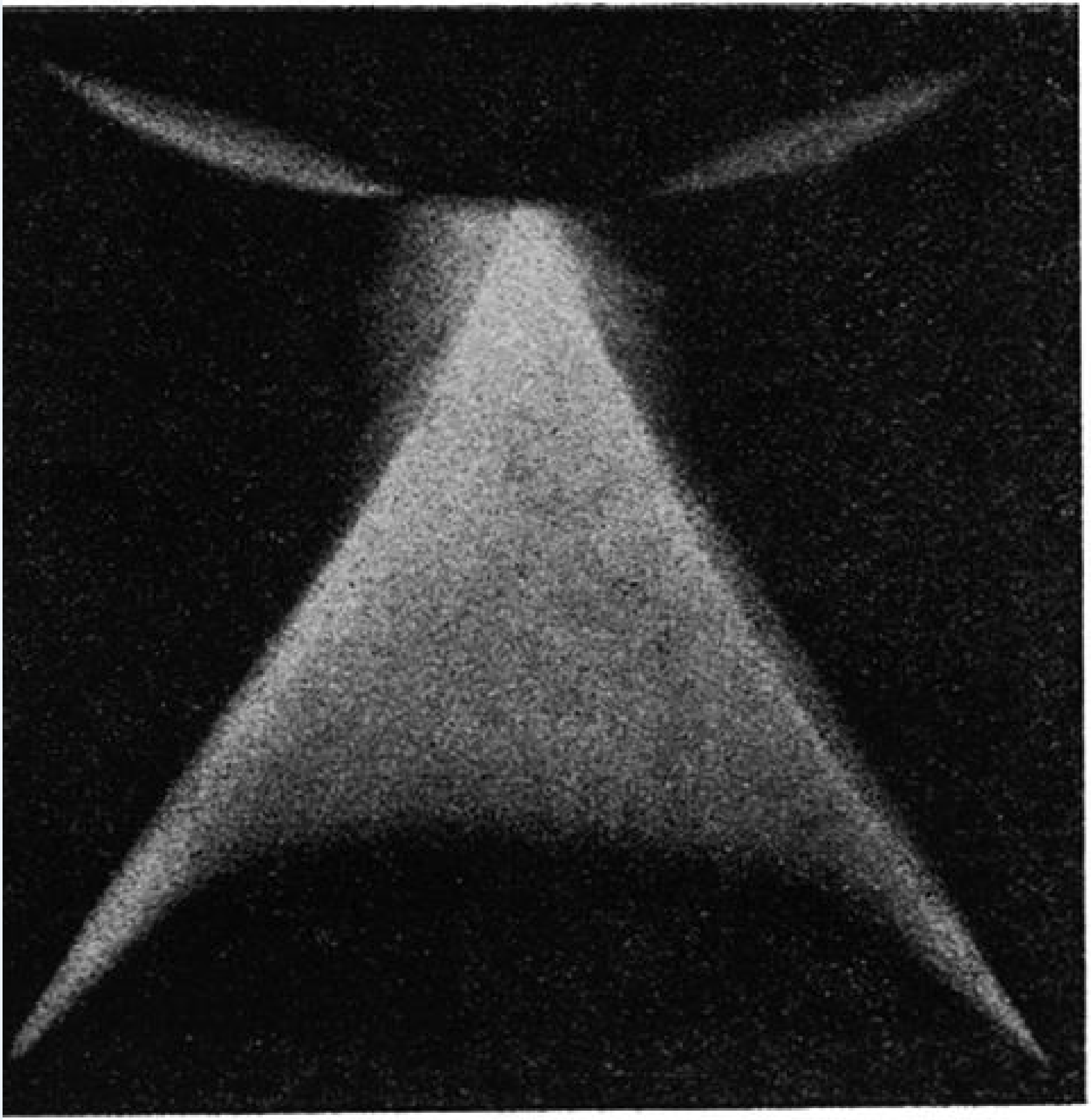

Fig. 20.

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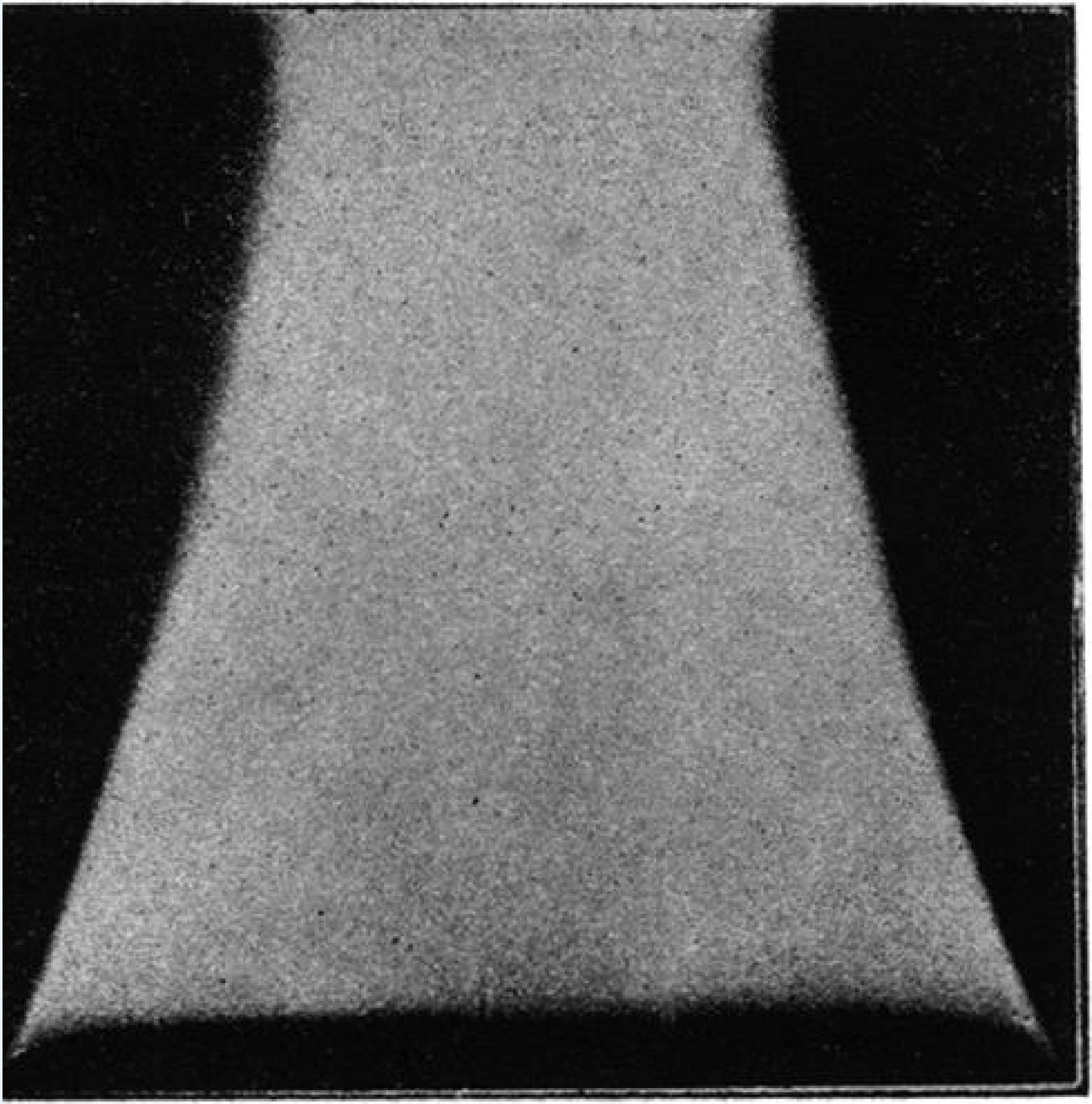


Fig. 21.

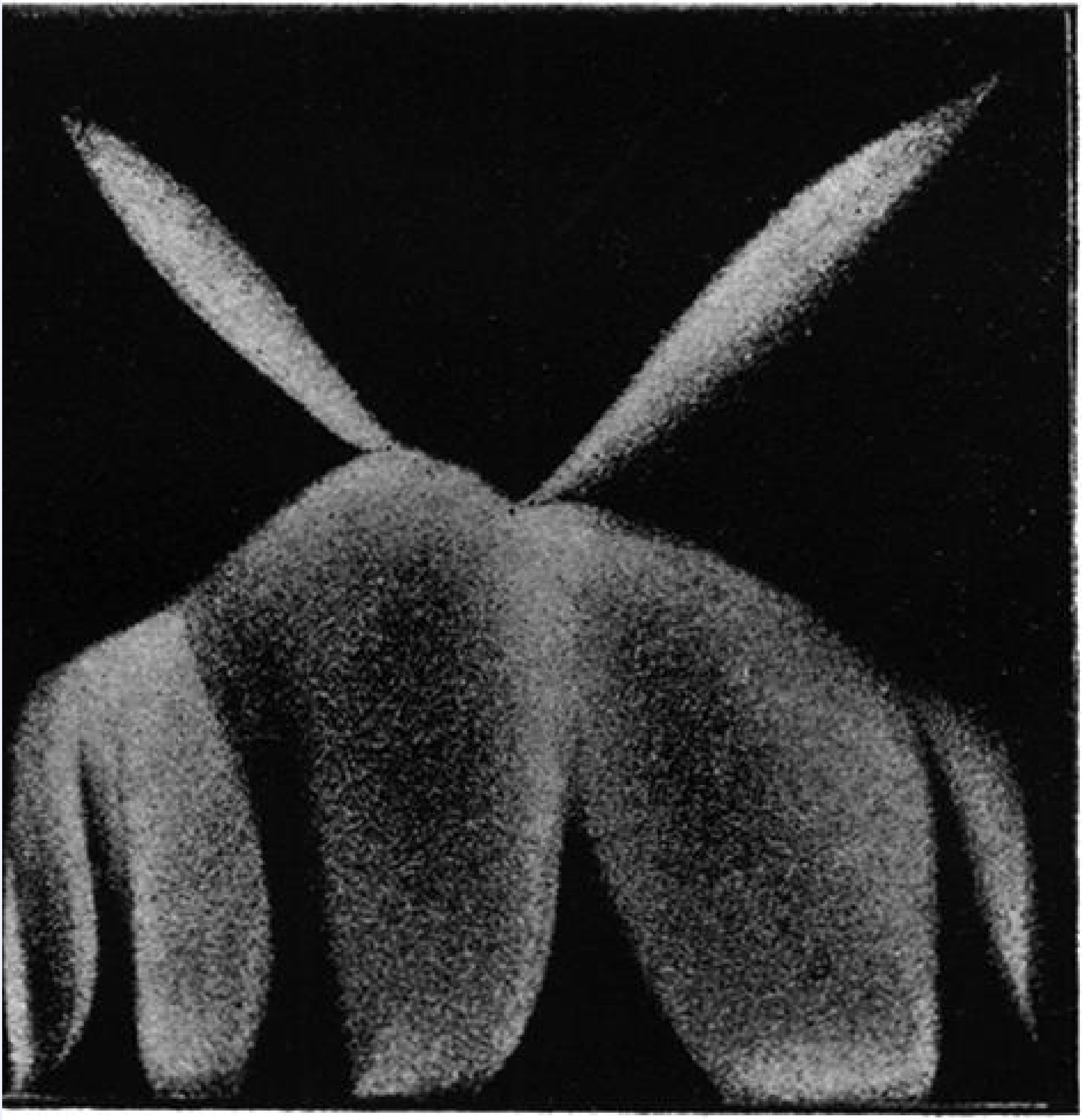


Fig. 22.

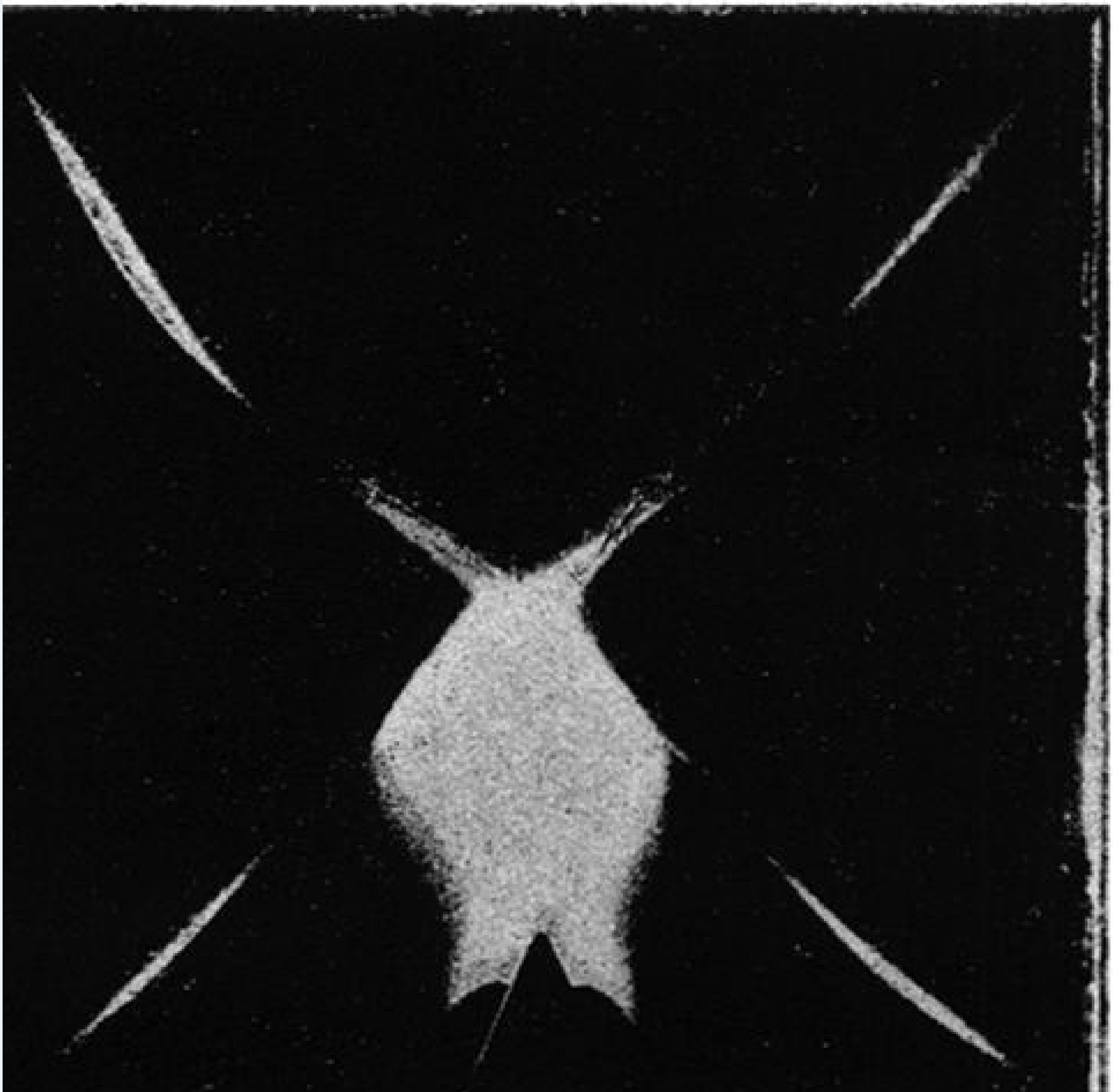
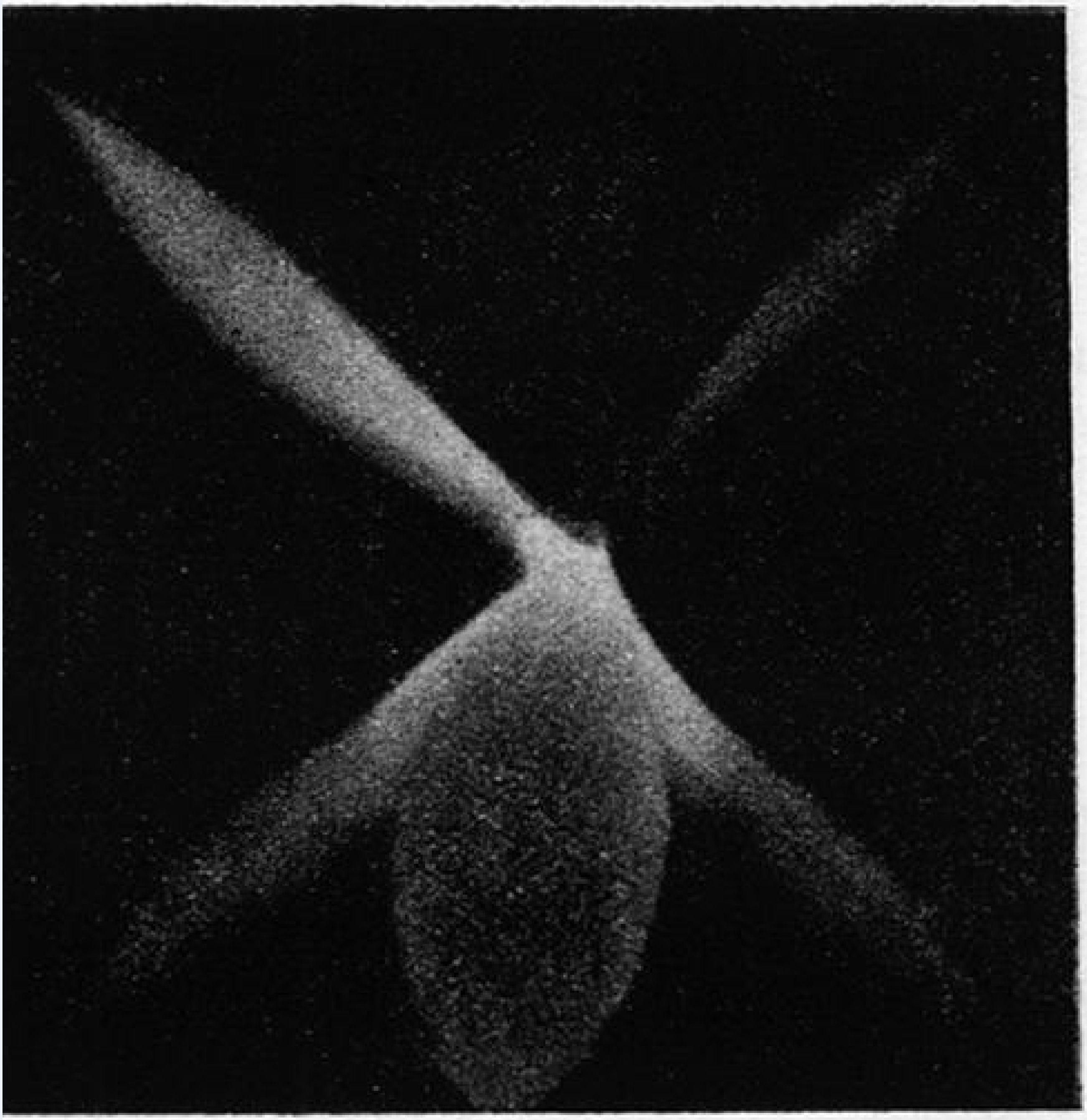


Fig. 22A.



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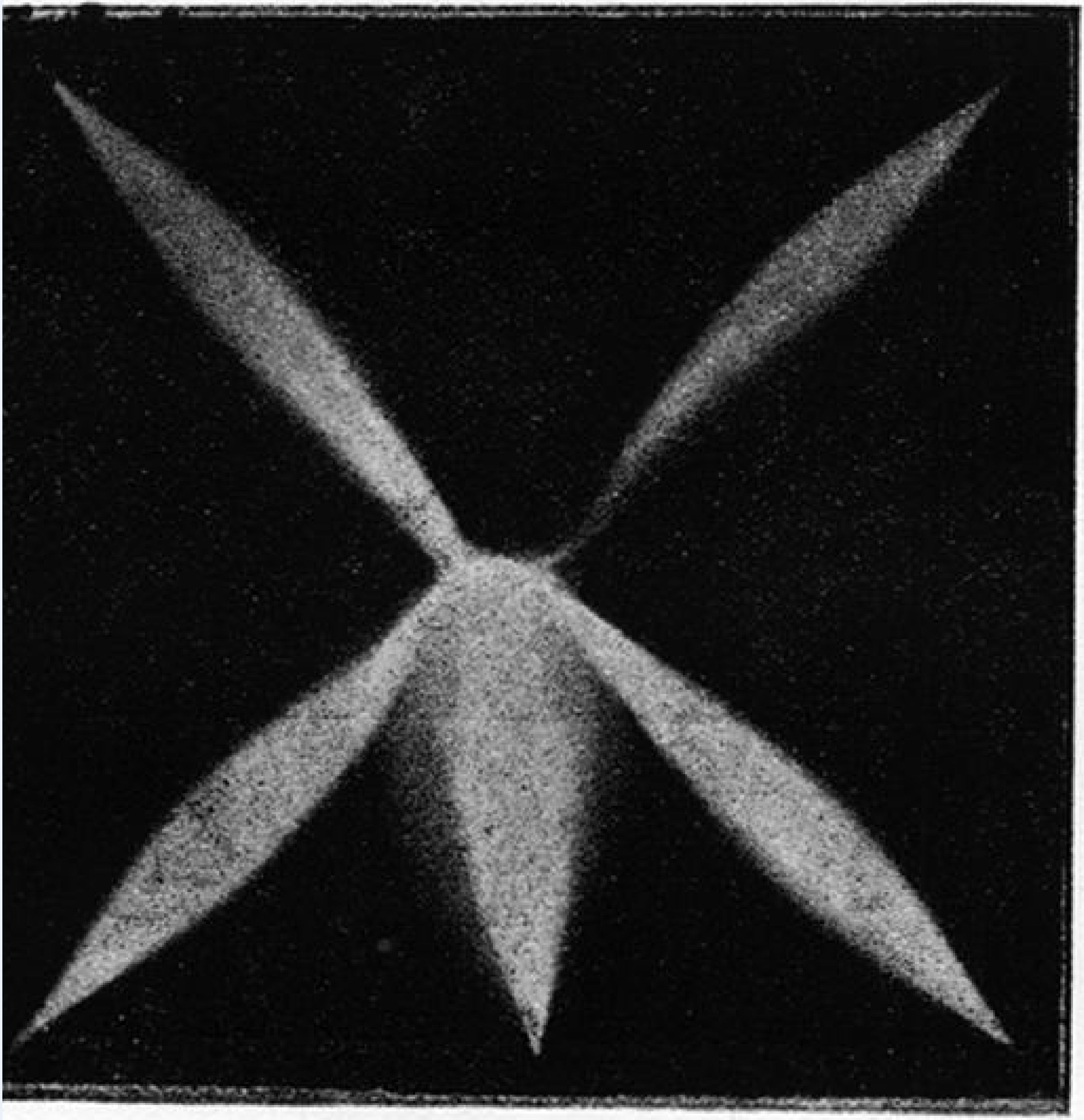


Fig. 24.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY

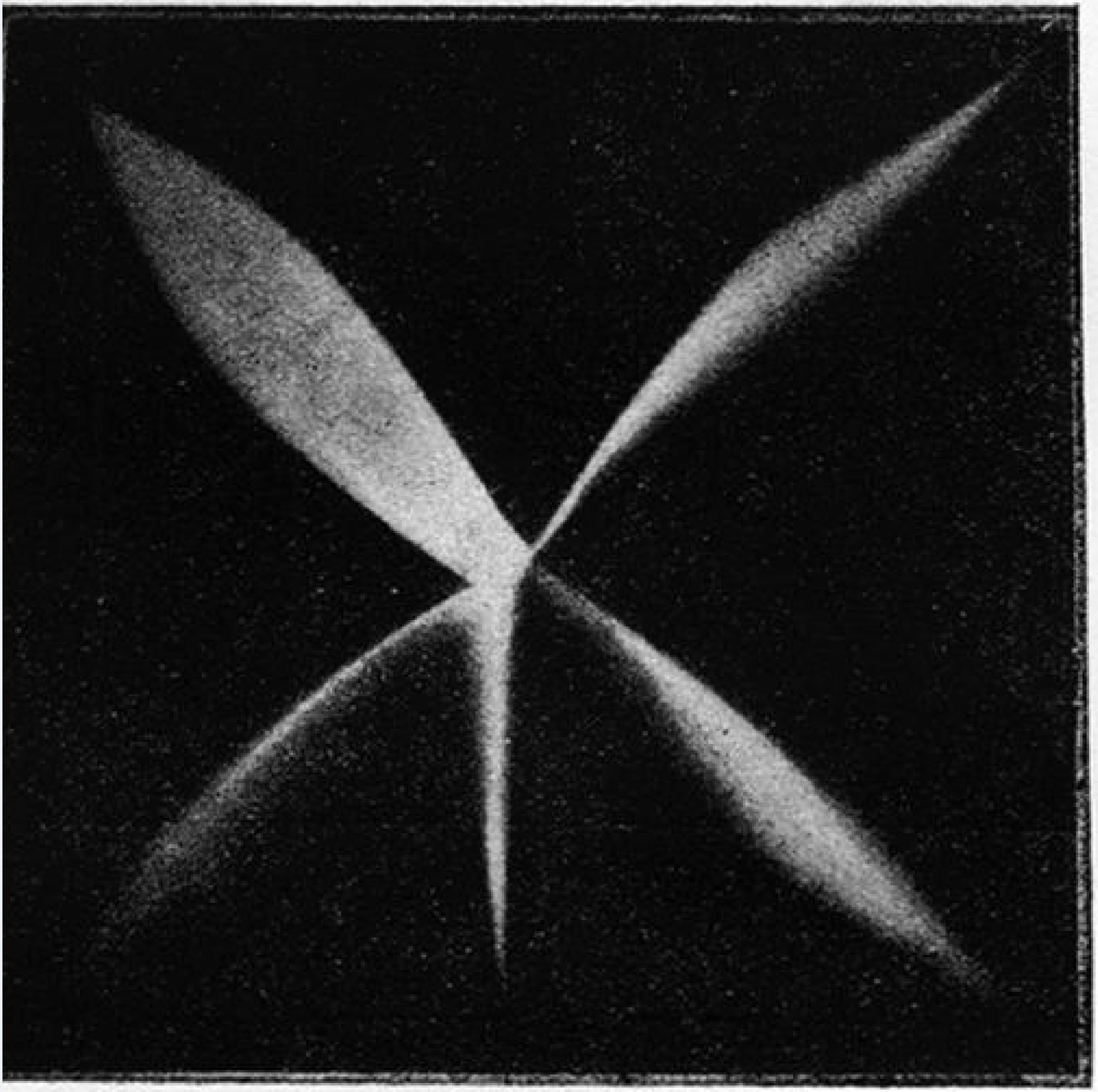


Fig. 25.

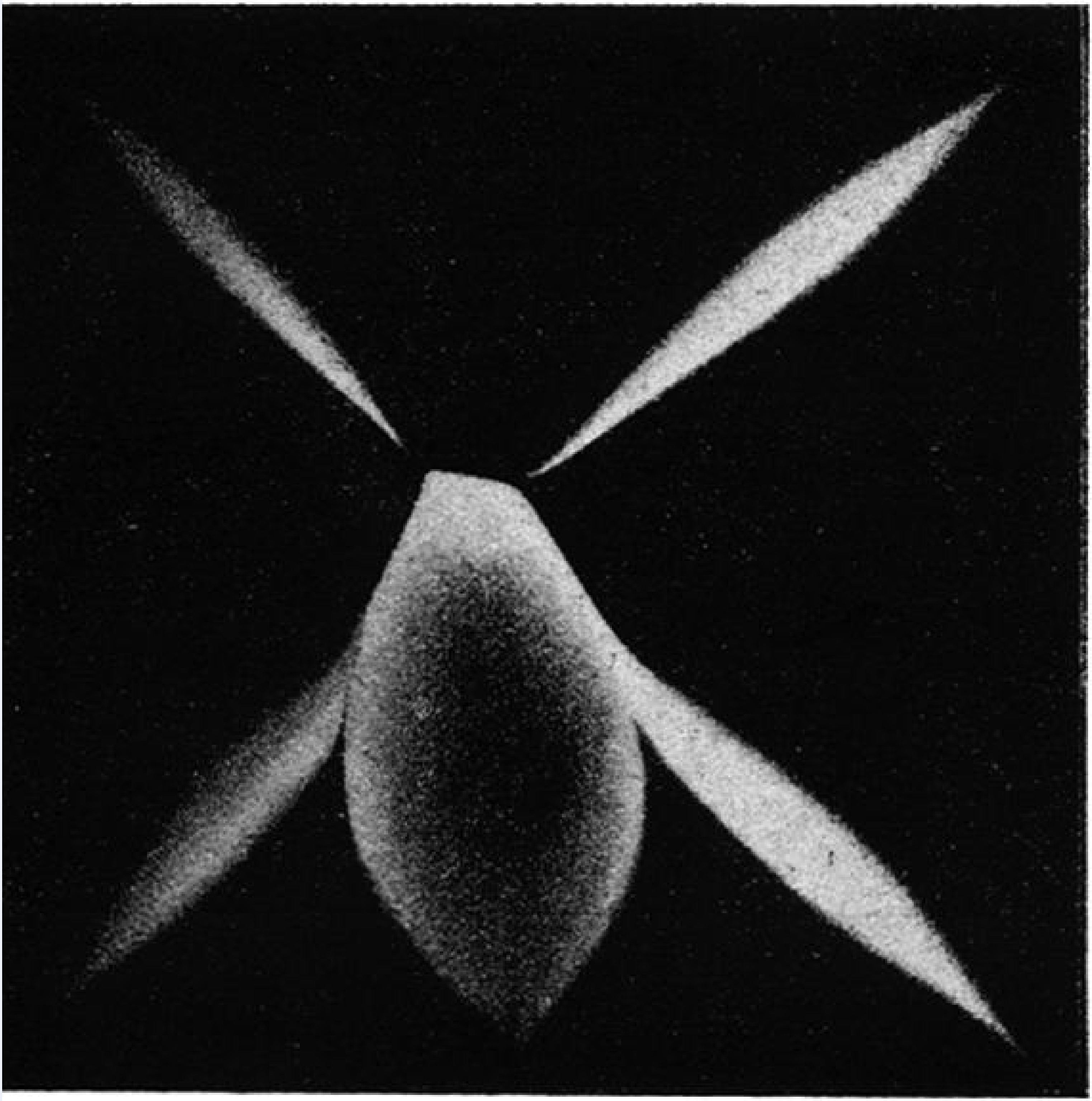


Fig. 26.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

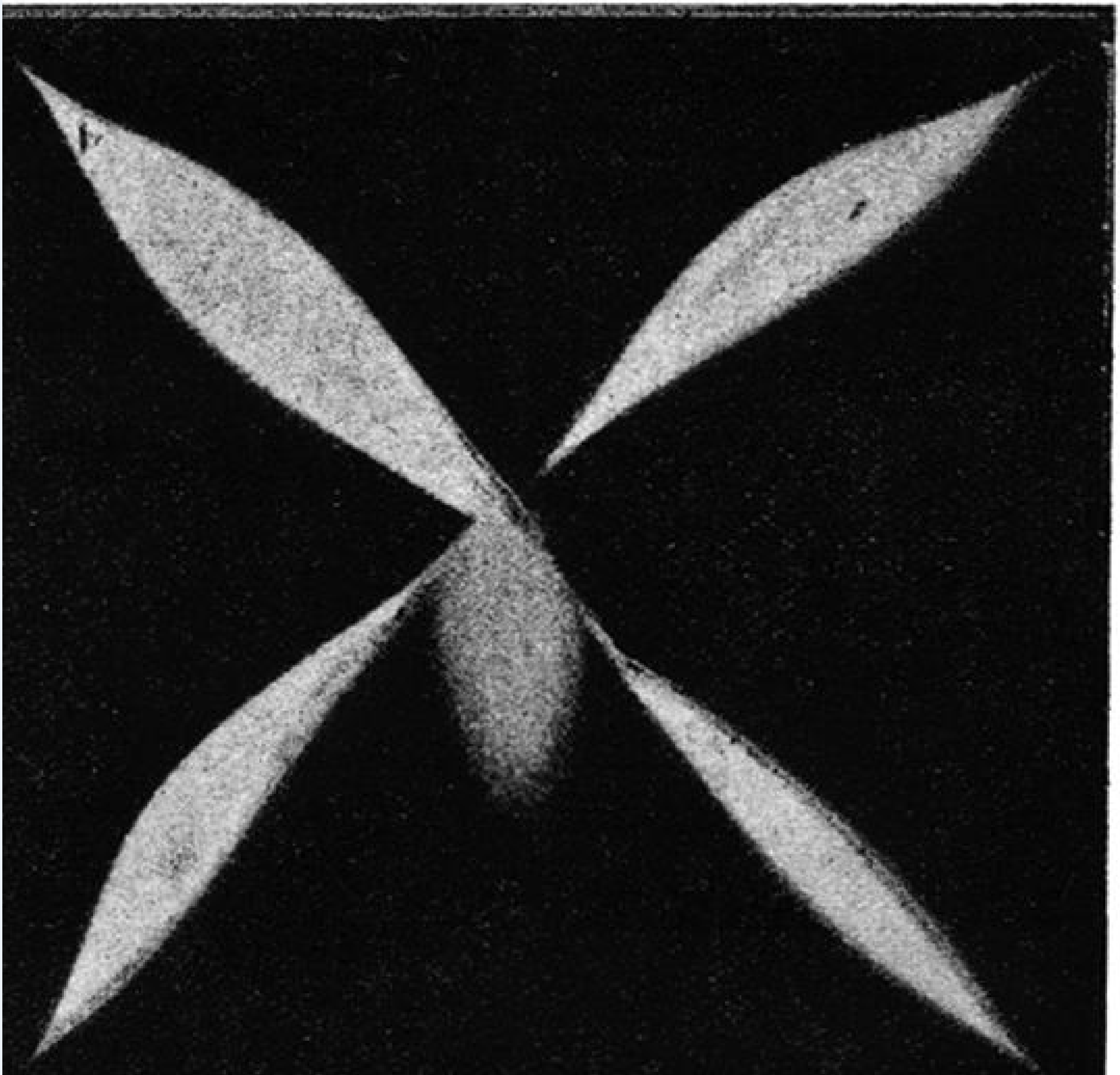


Fig. 27.

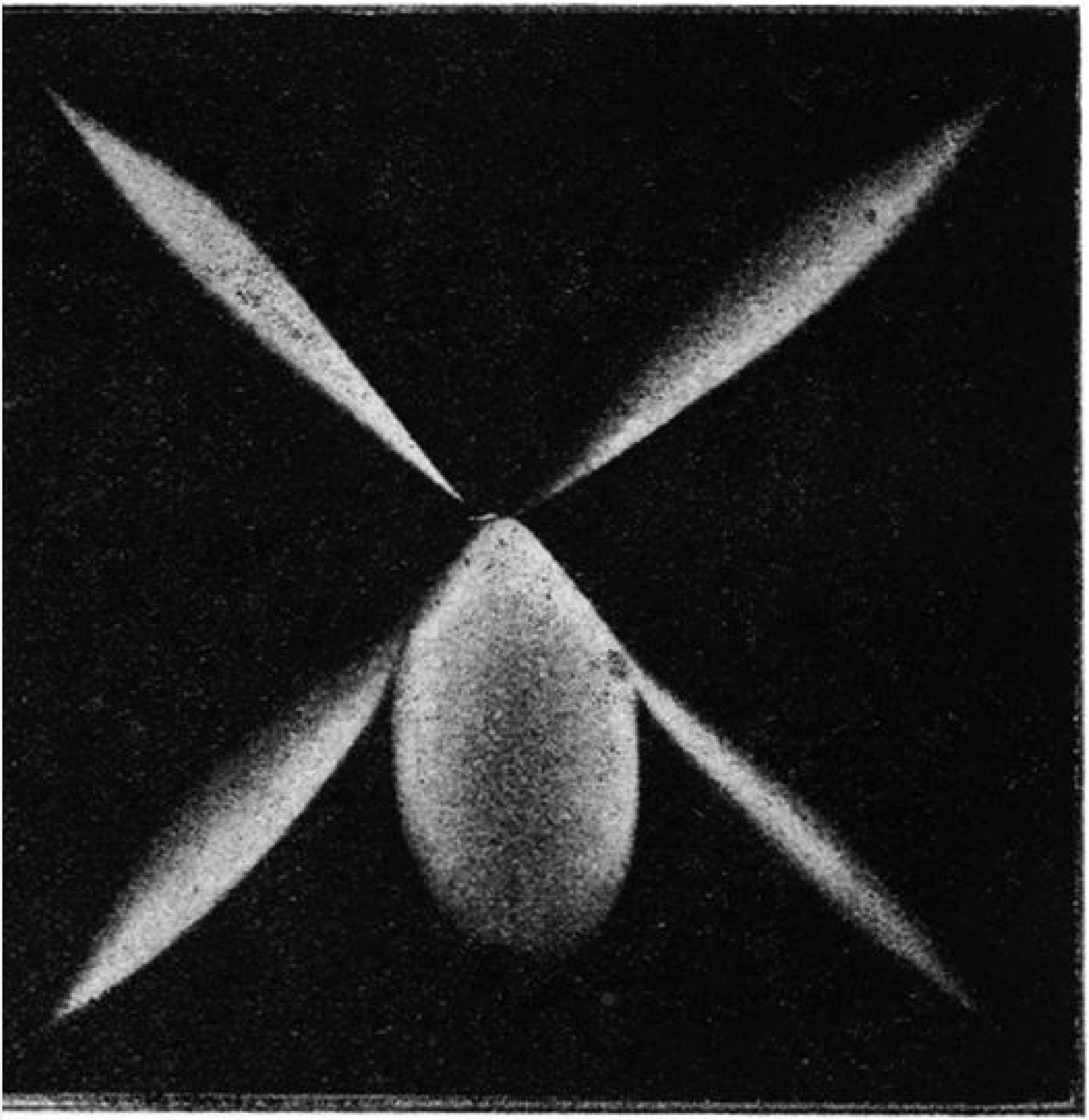


Fig. 28.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A

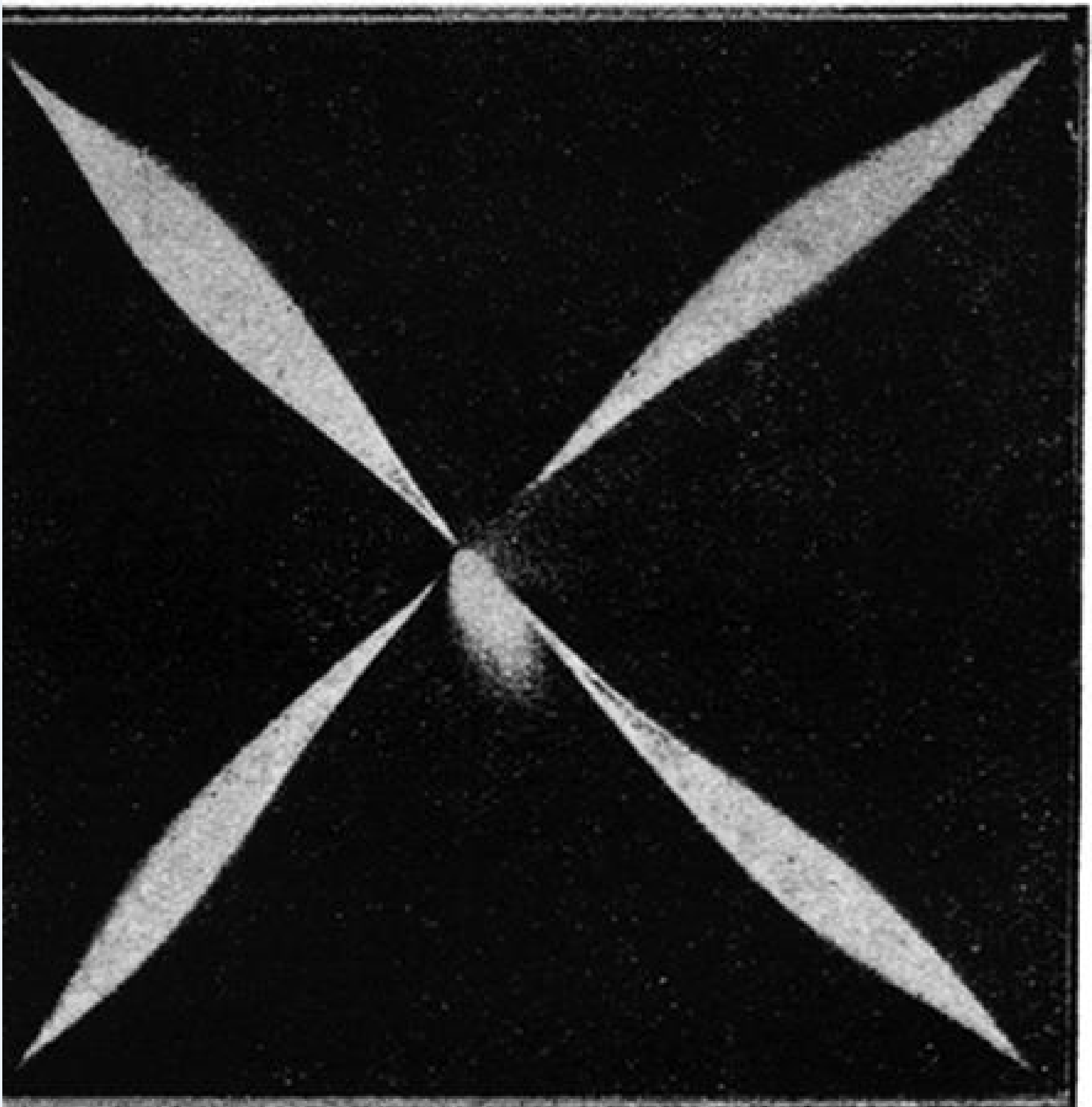


Fig. 29.

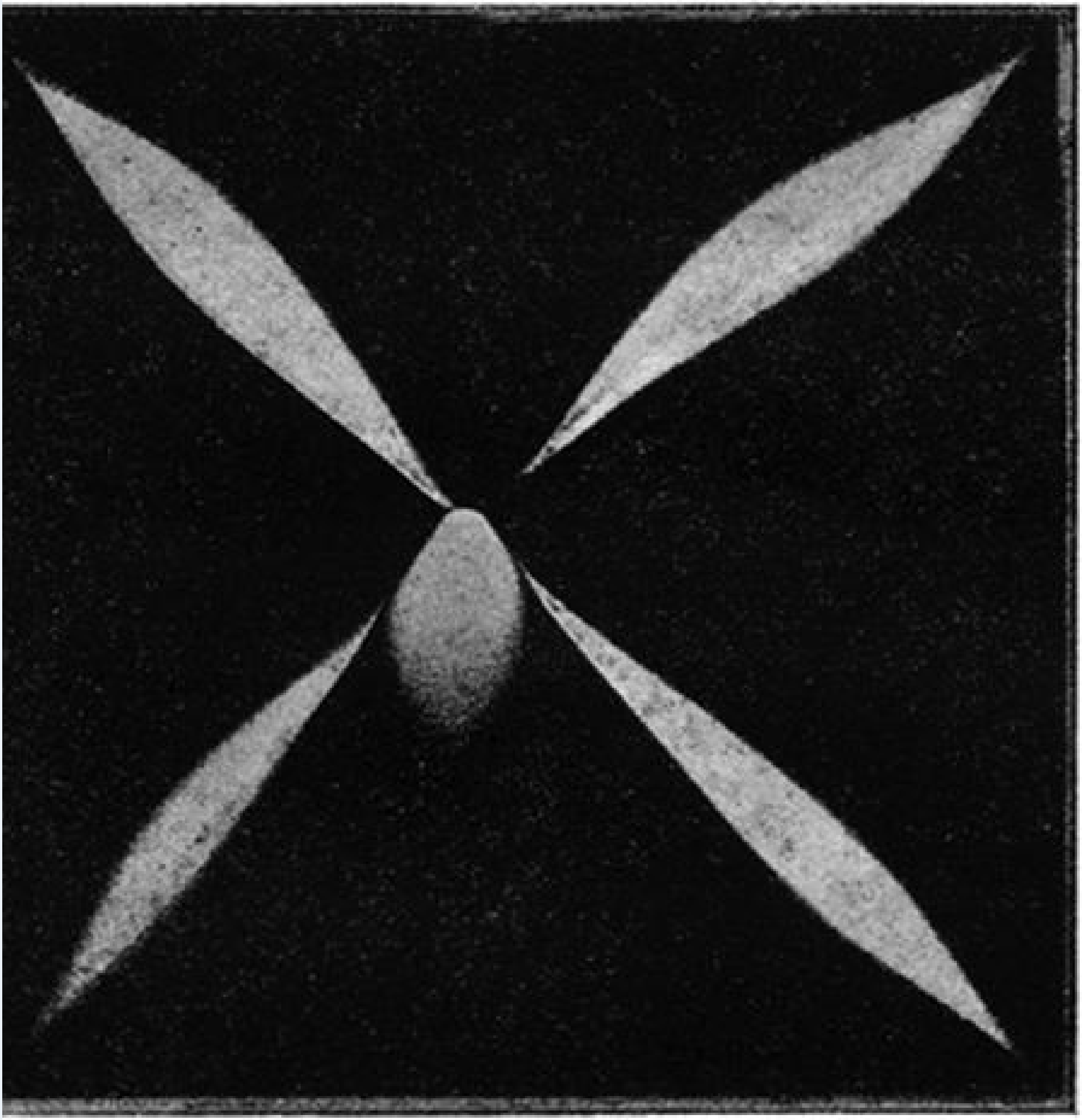


Fig. 29A.

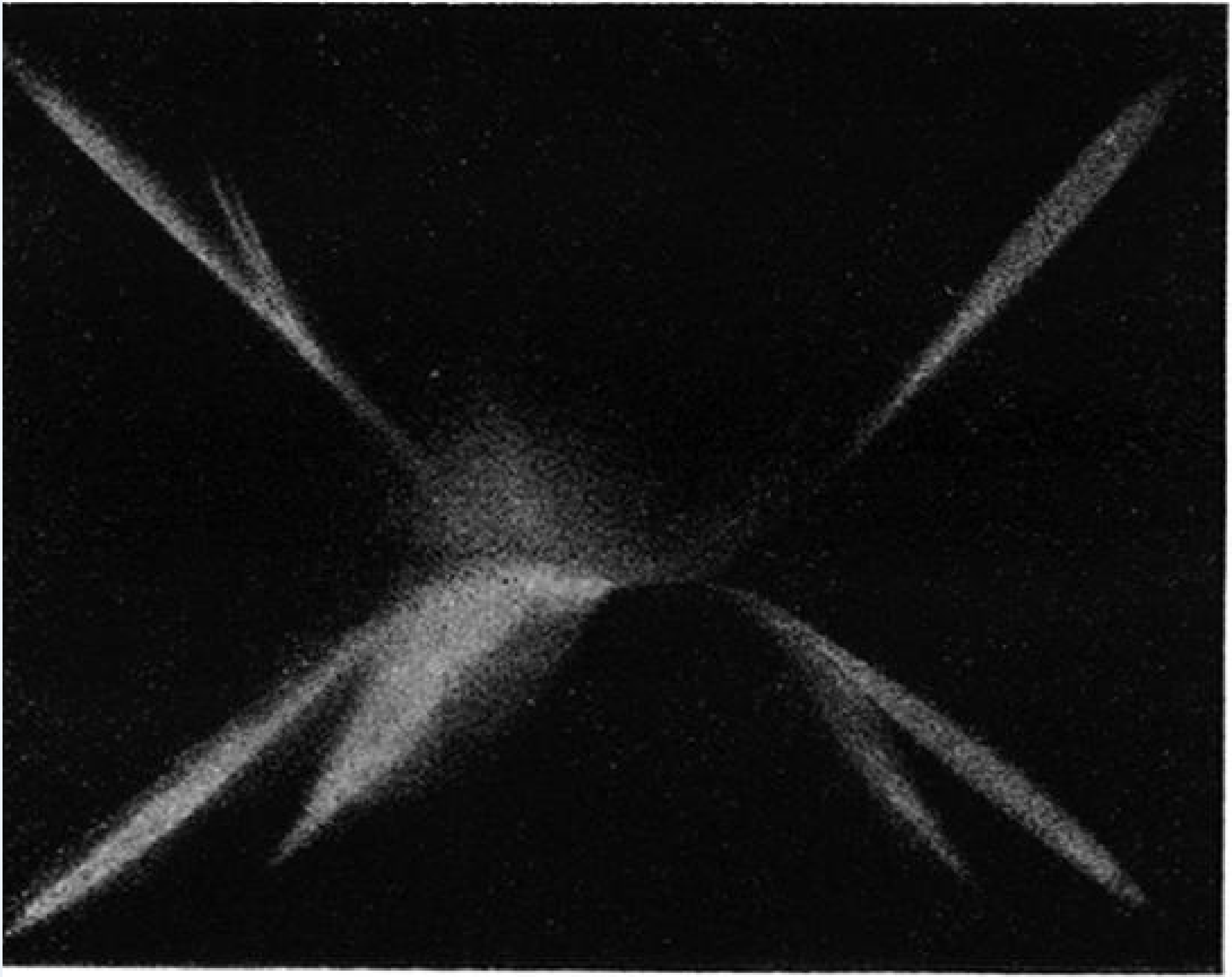
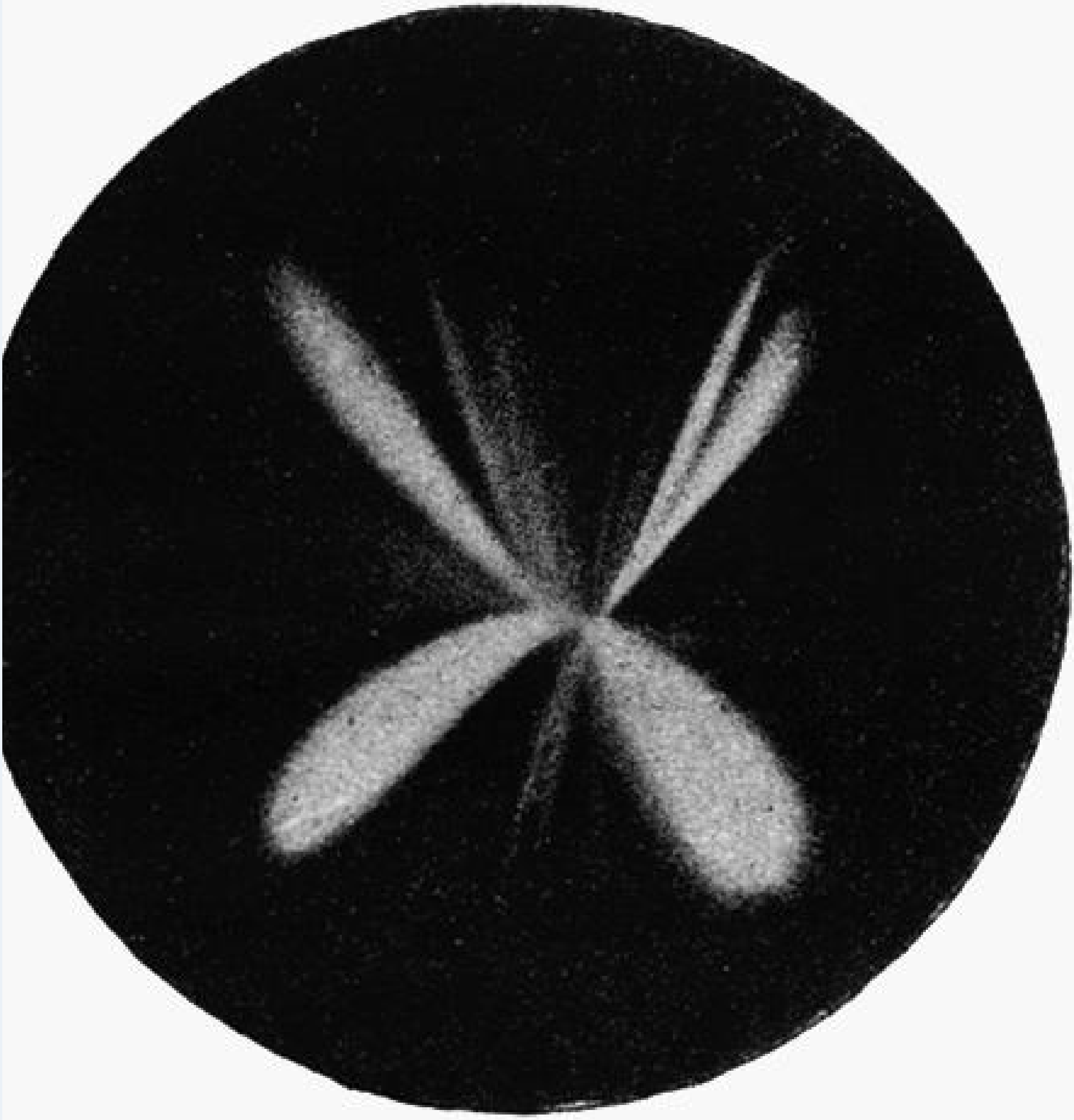


Fig. 30.



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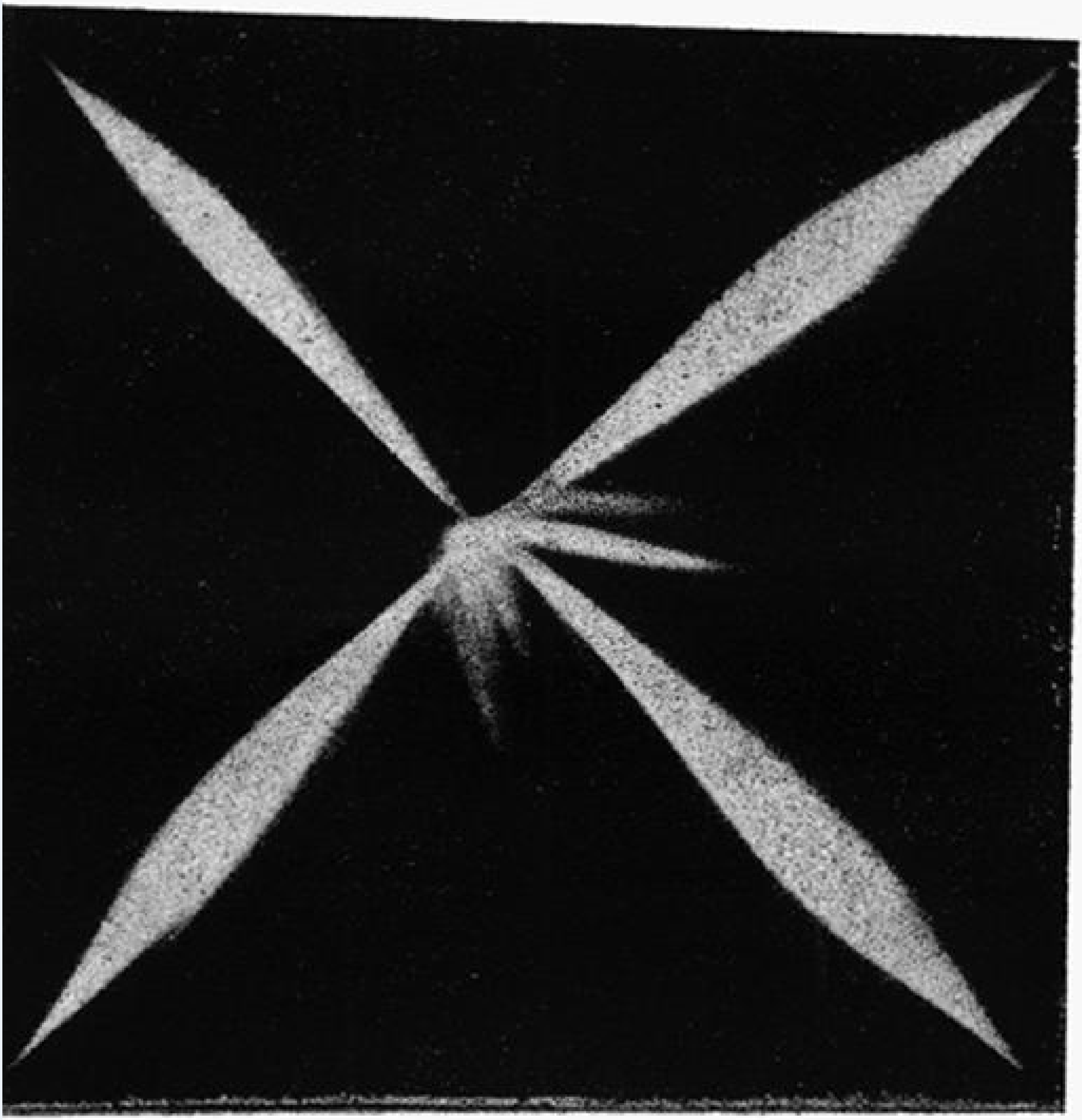


Fig. 32.

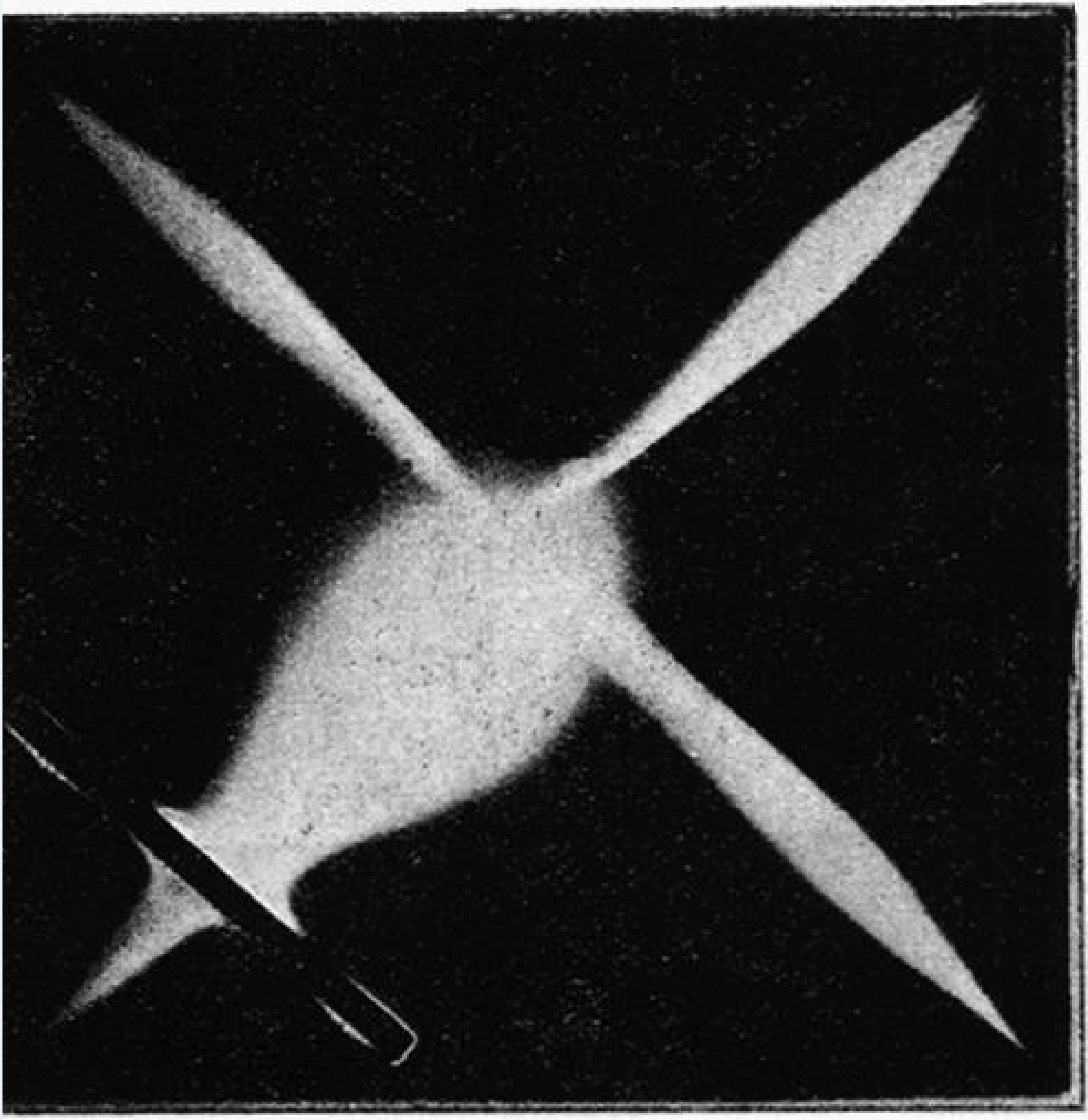
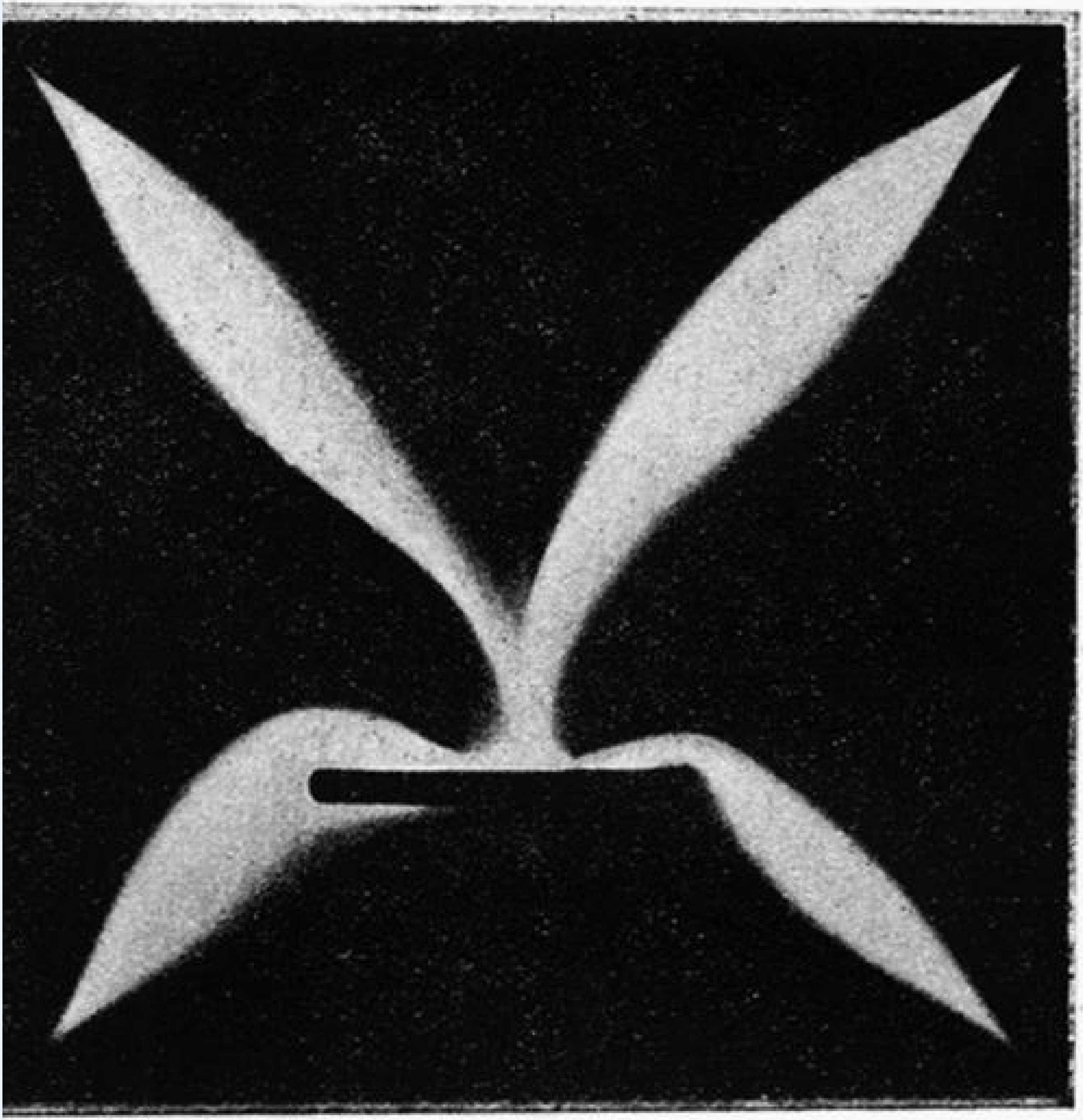


Fig. 33.



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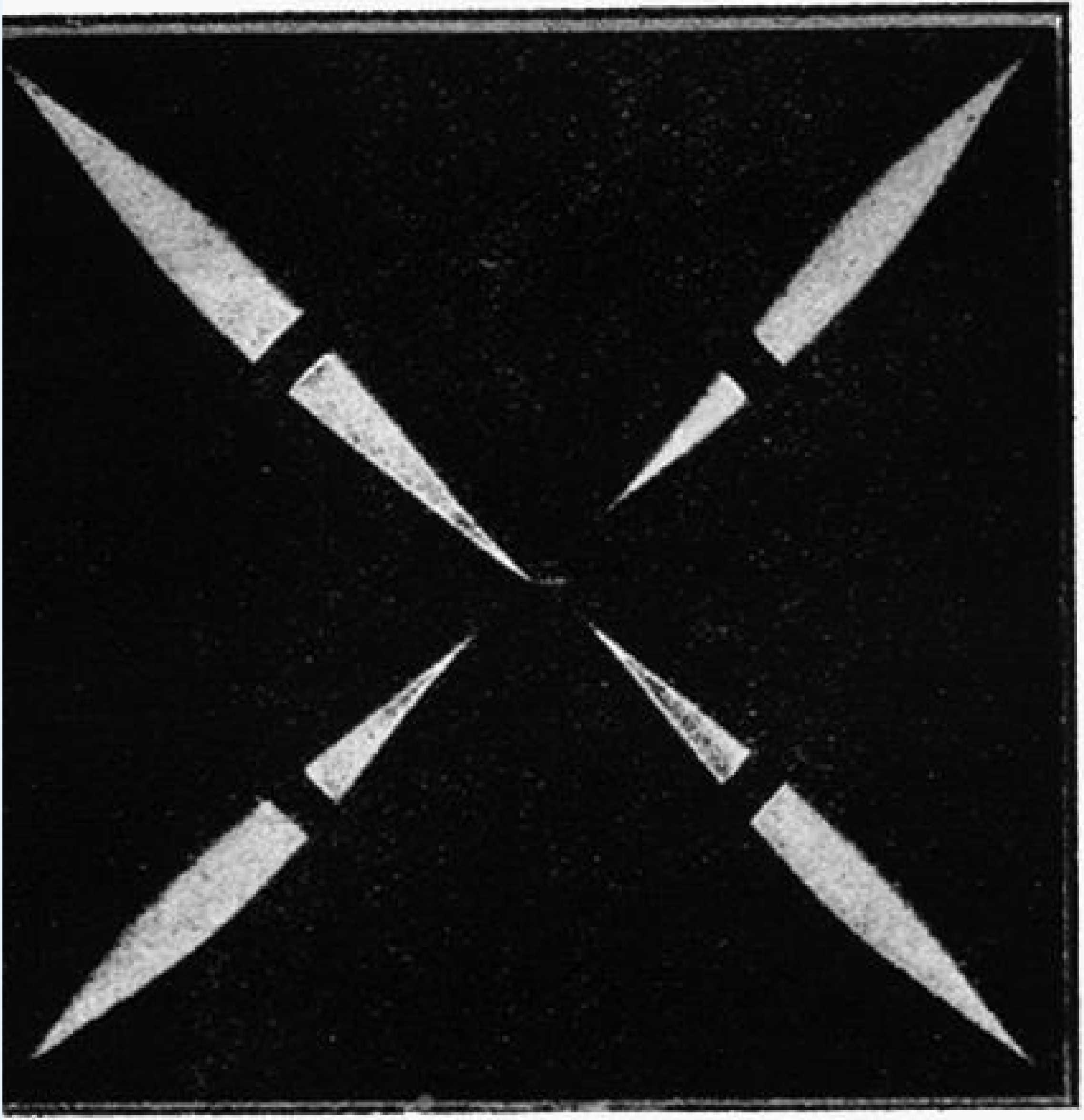

Fig. 35.

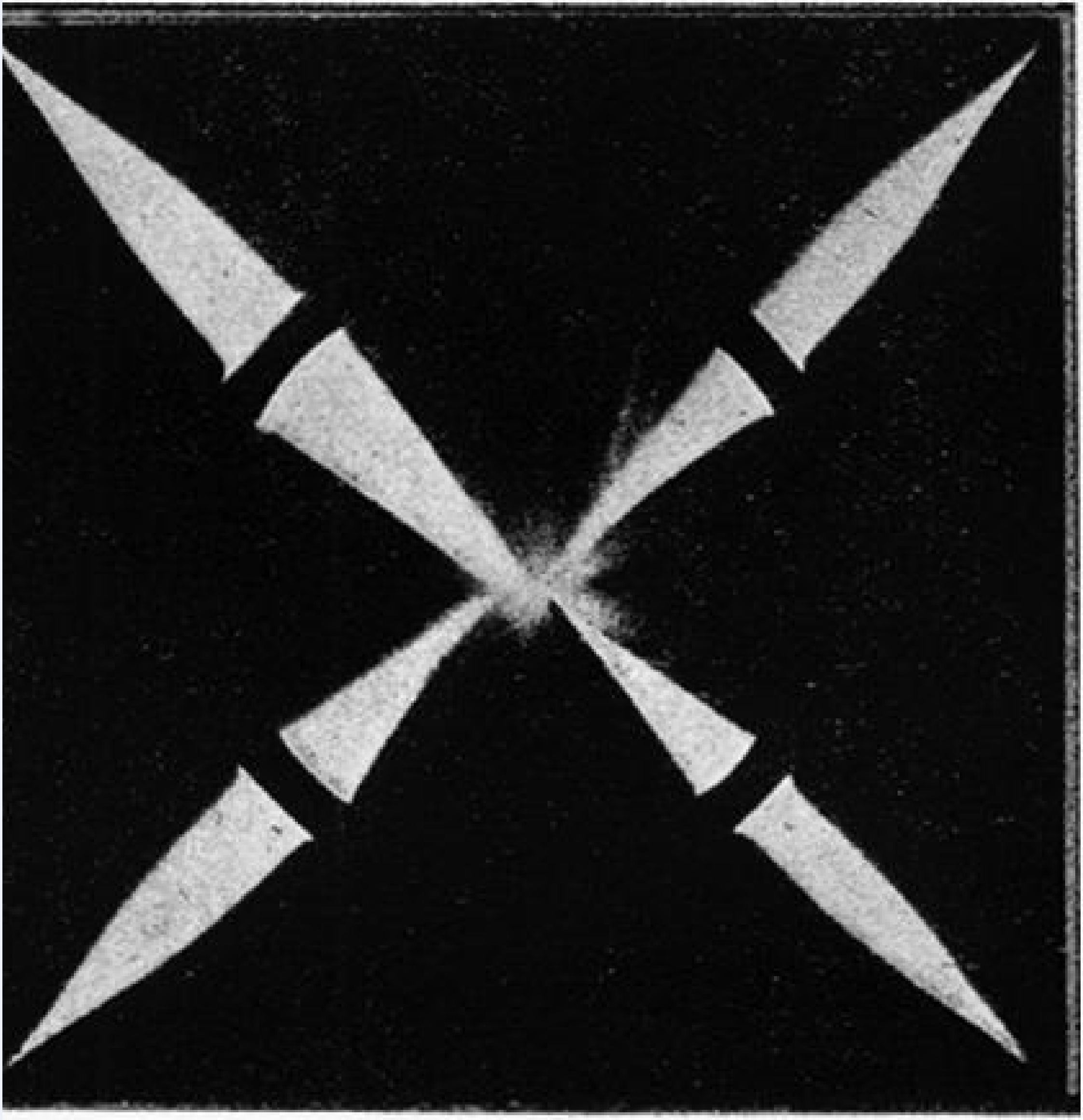

Fig. 36.

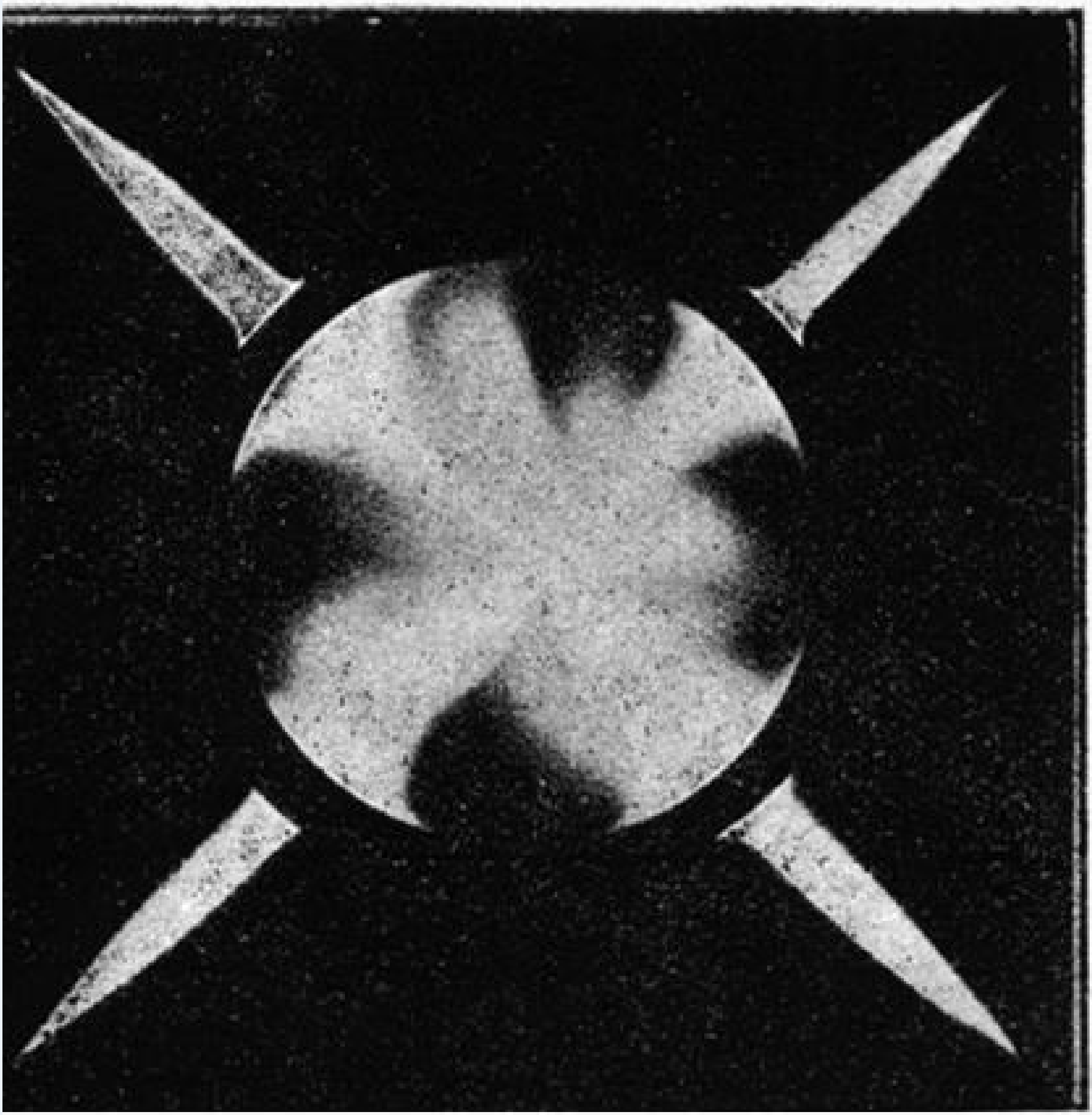

Fig. 37.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY

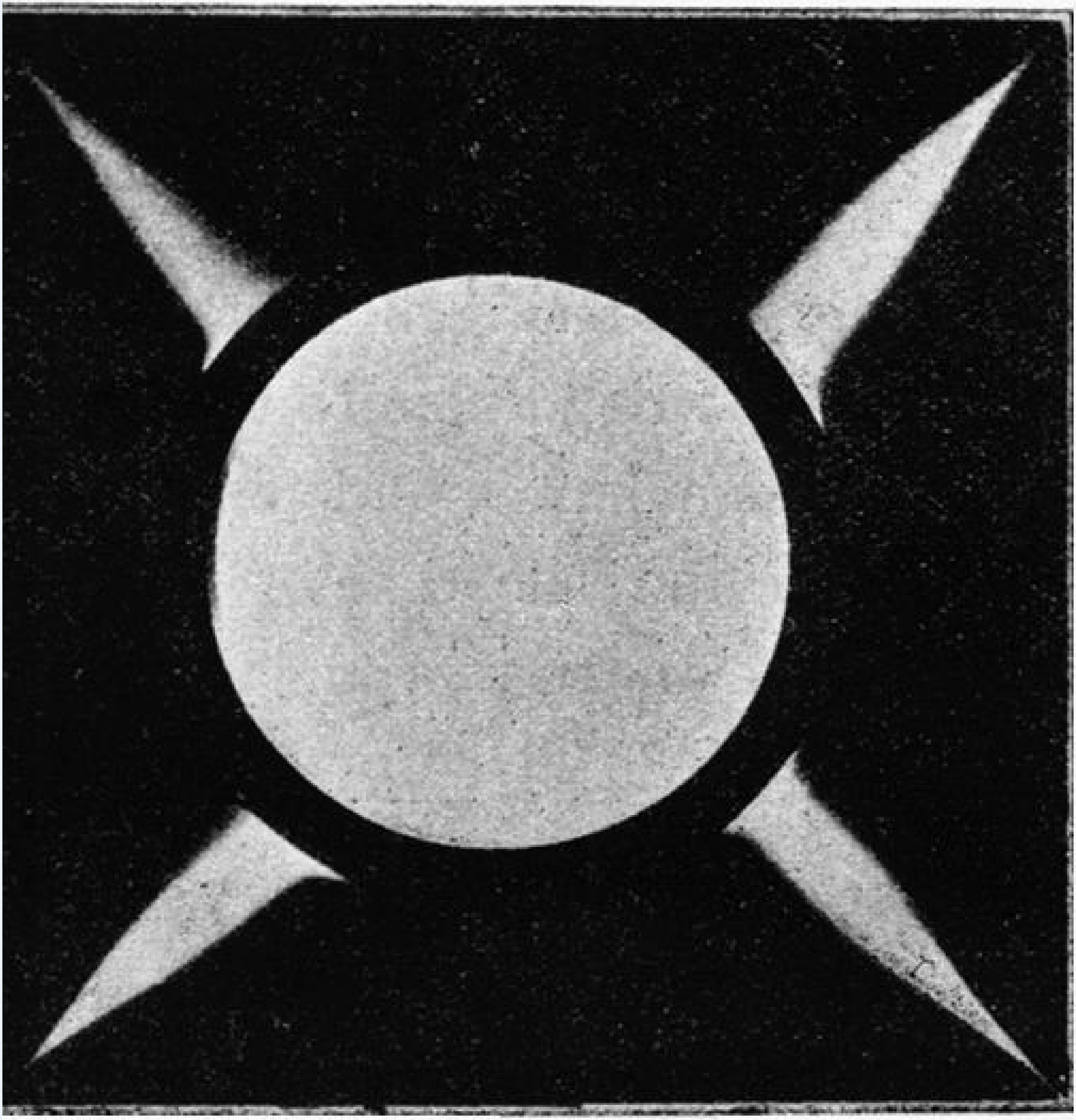

Fig. 38.

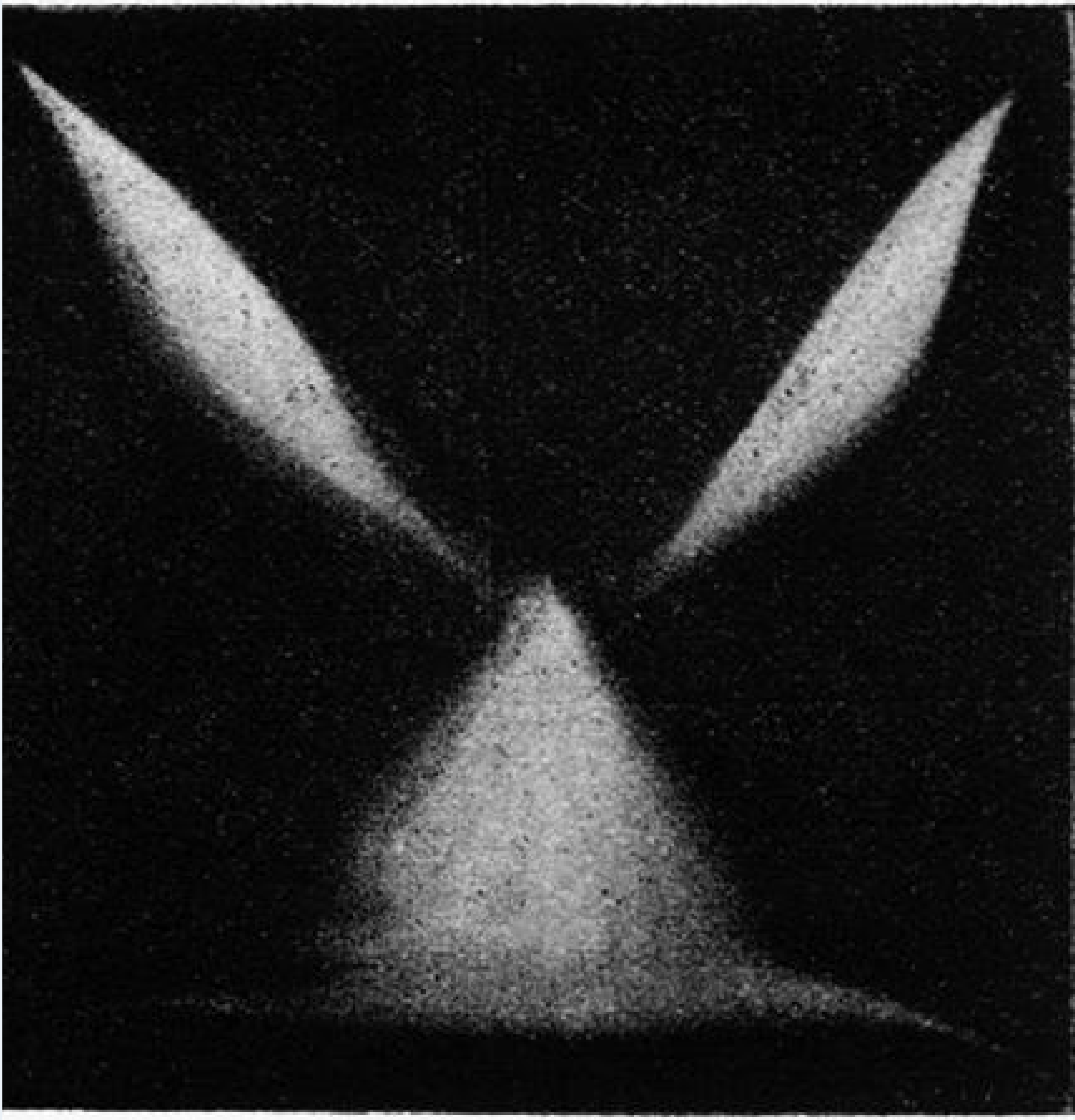

Fig. 39.

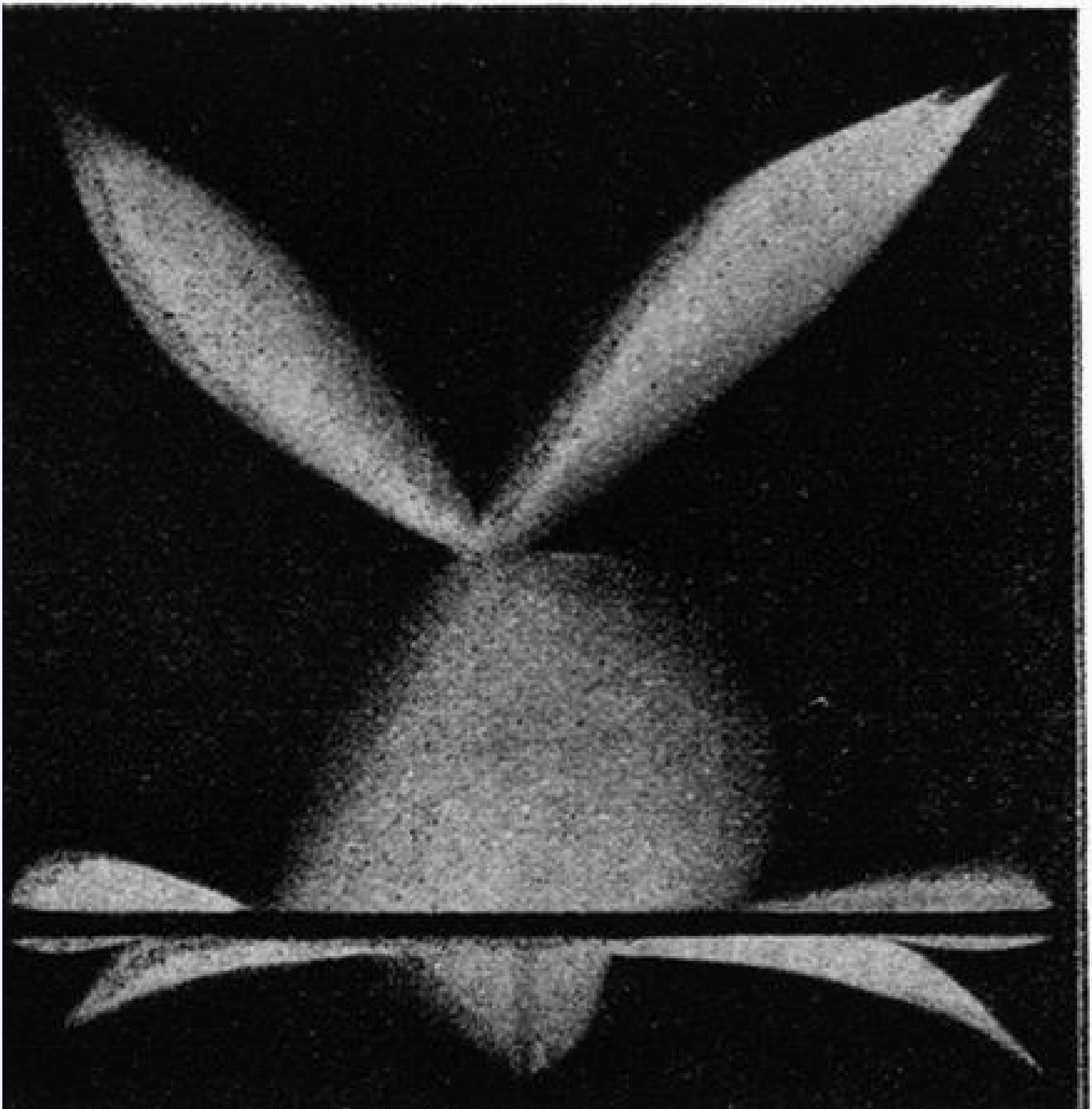

Fig. 40.

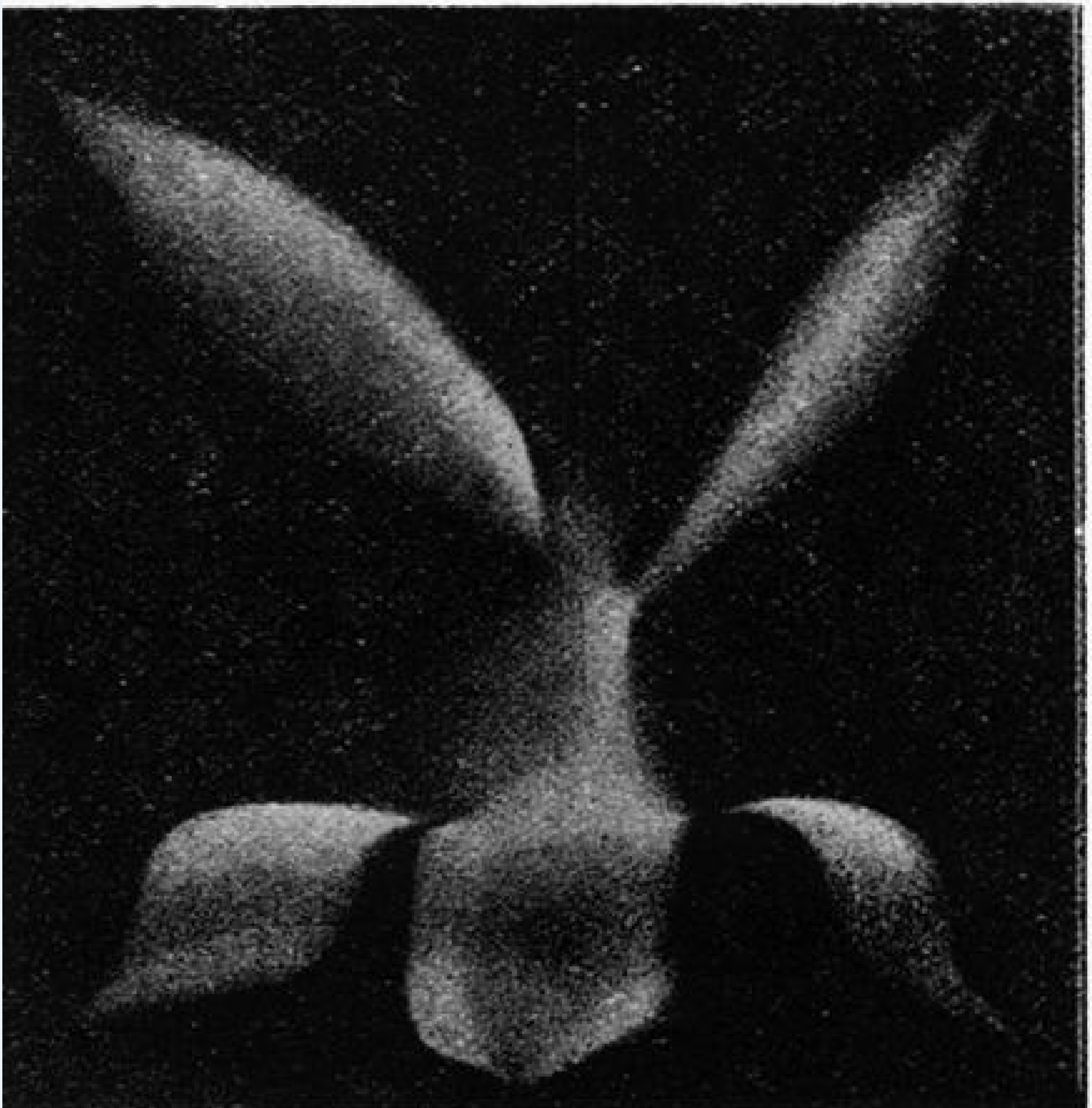

Fig. 41.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY

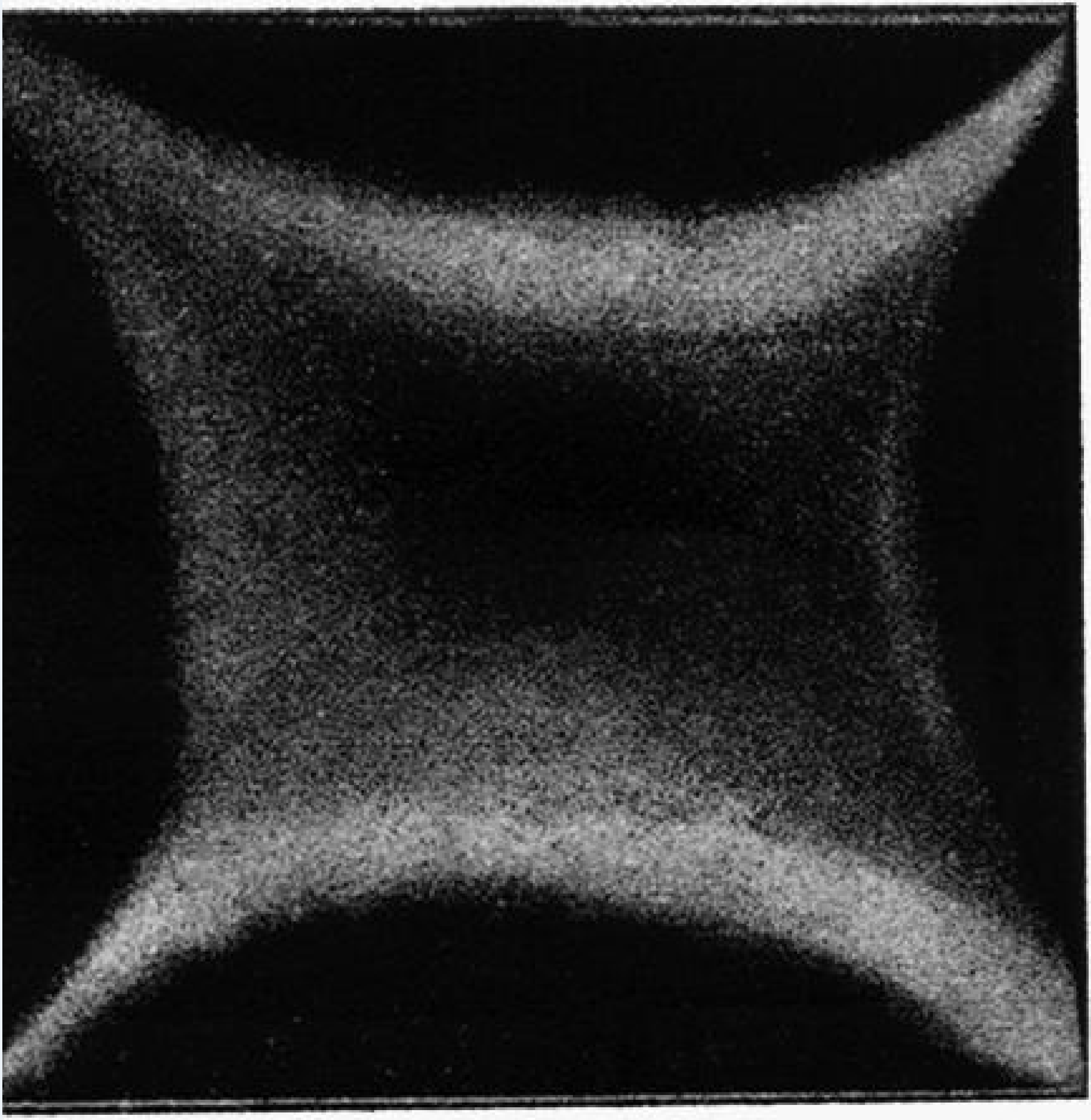

Fig. 42.

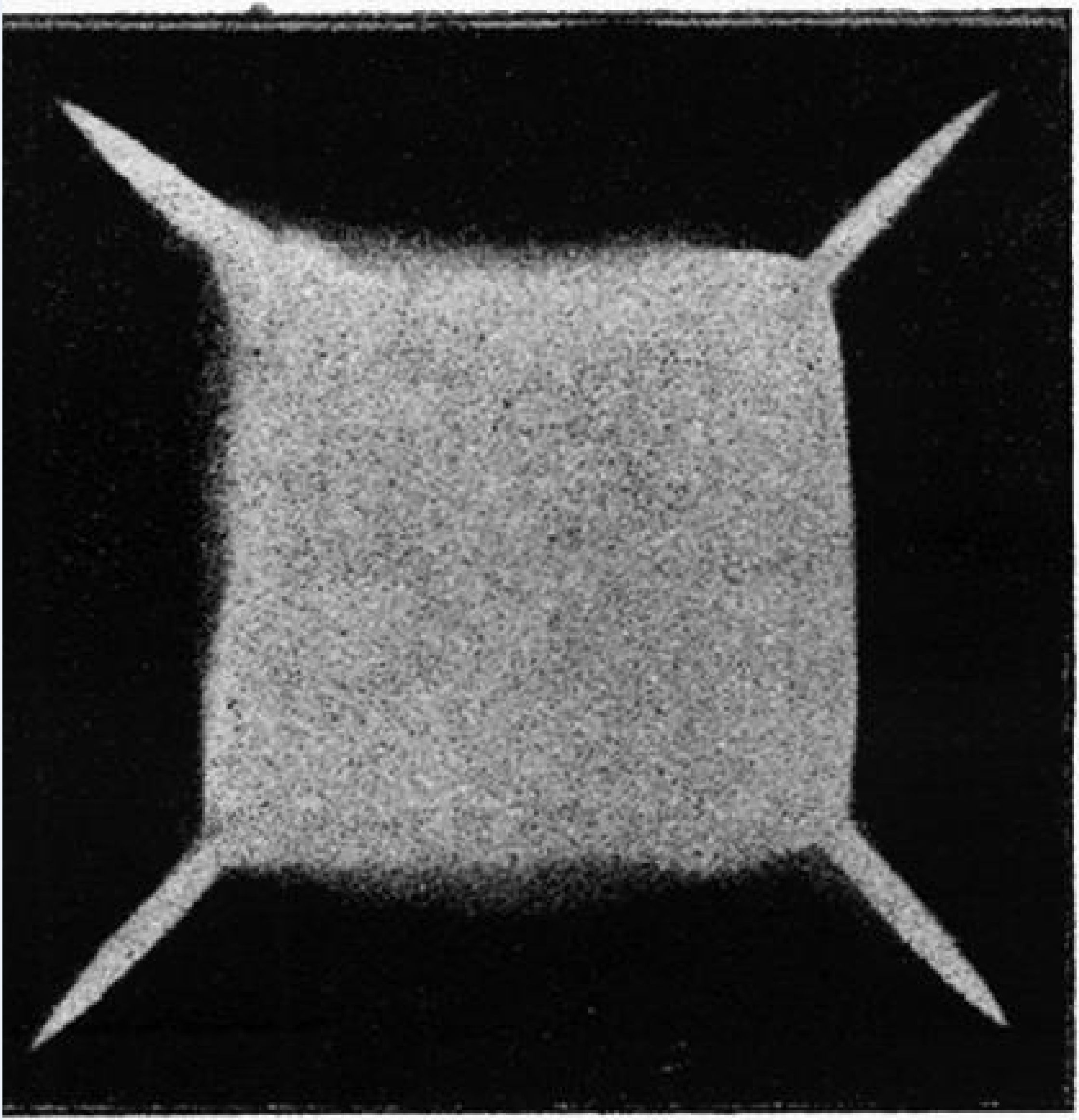

Fig. 43.

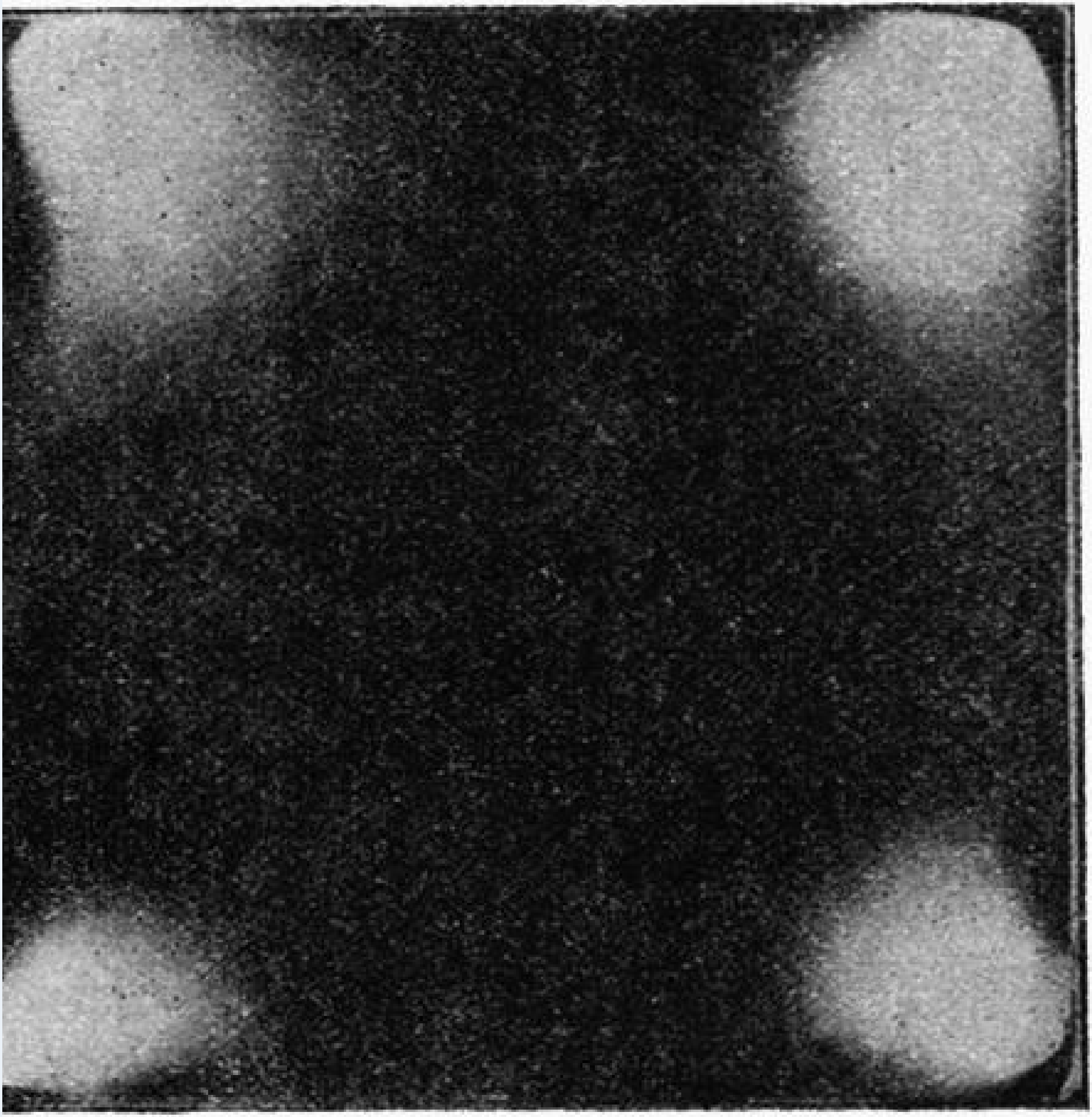

Fig. 44.

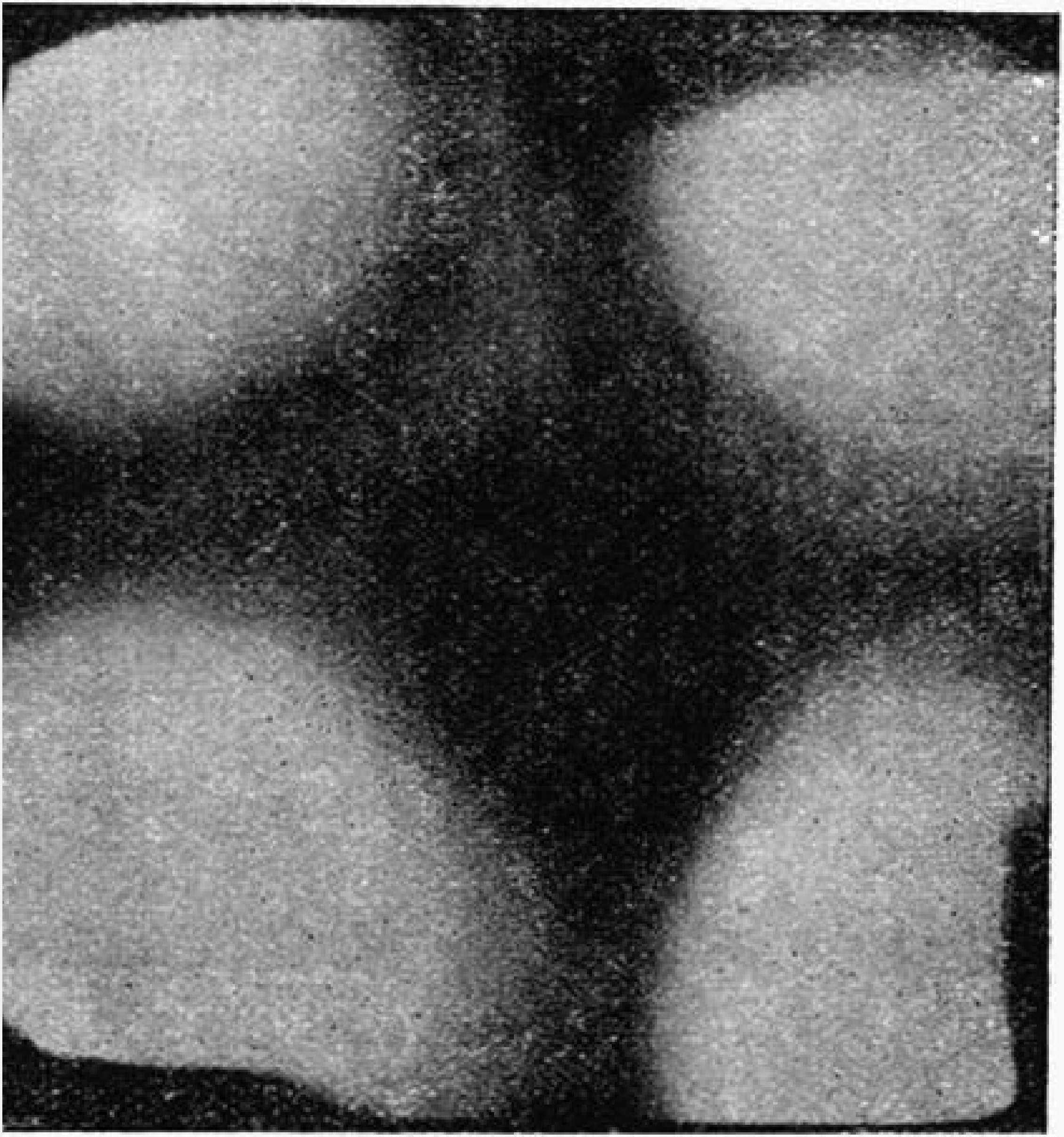

Fig. 44A.

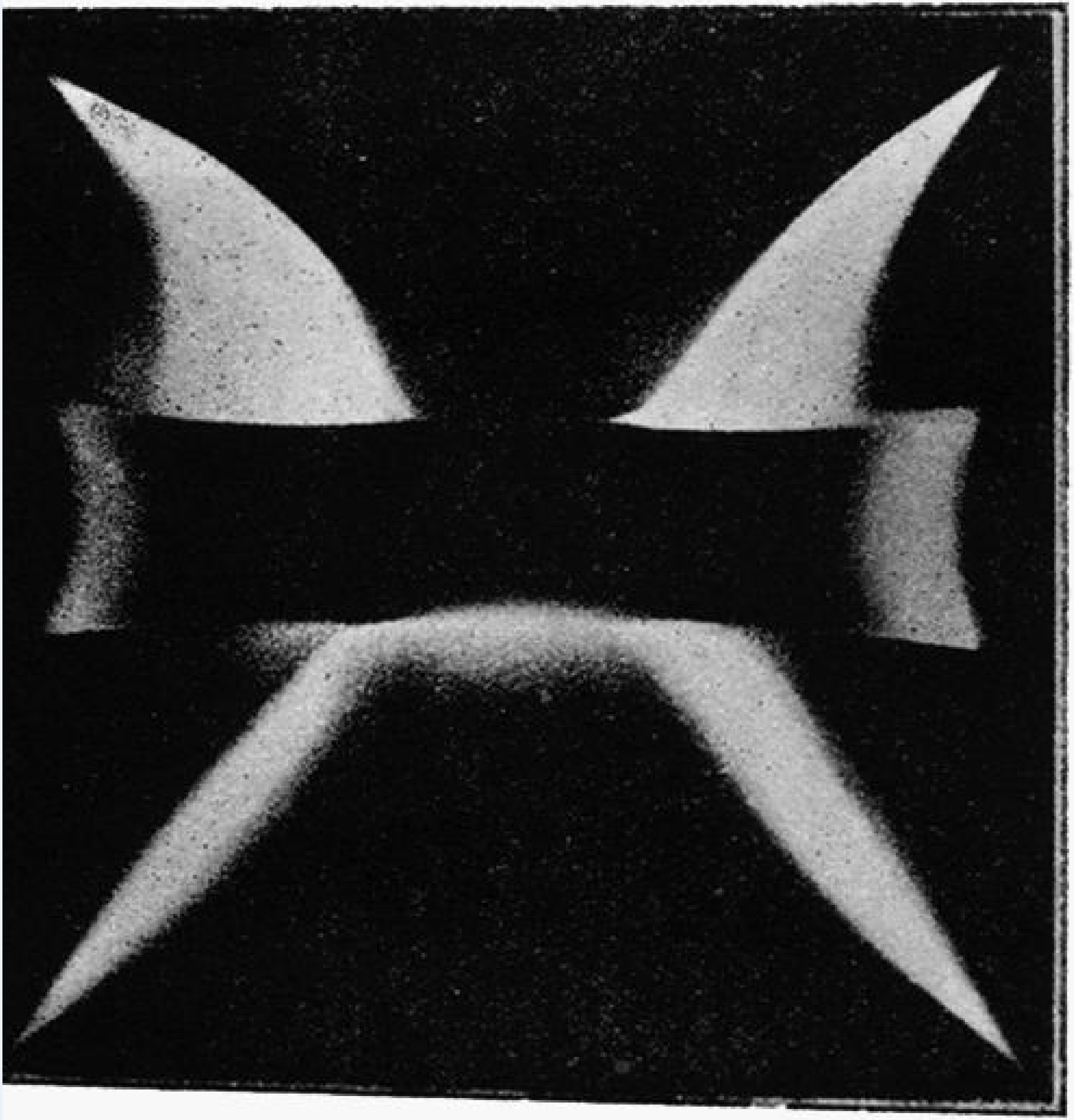

Fig. 45

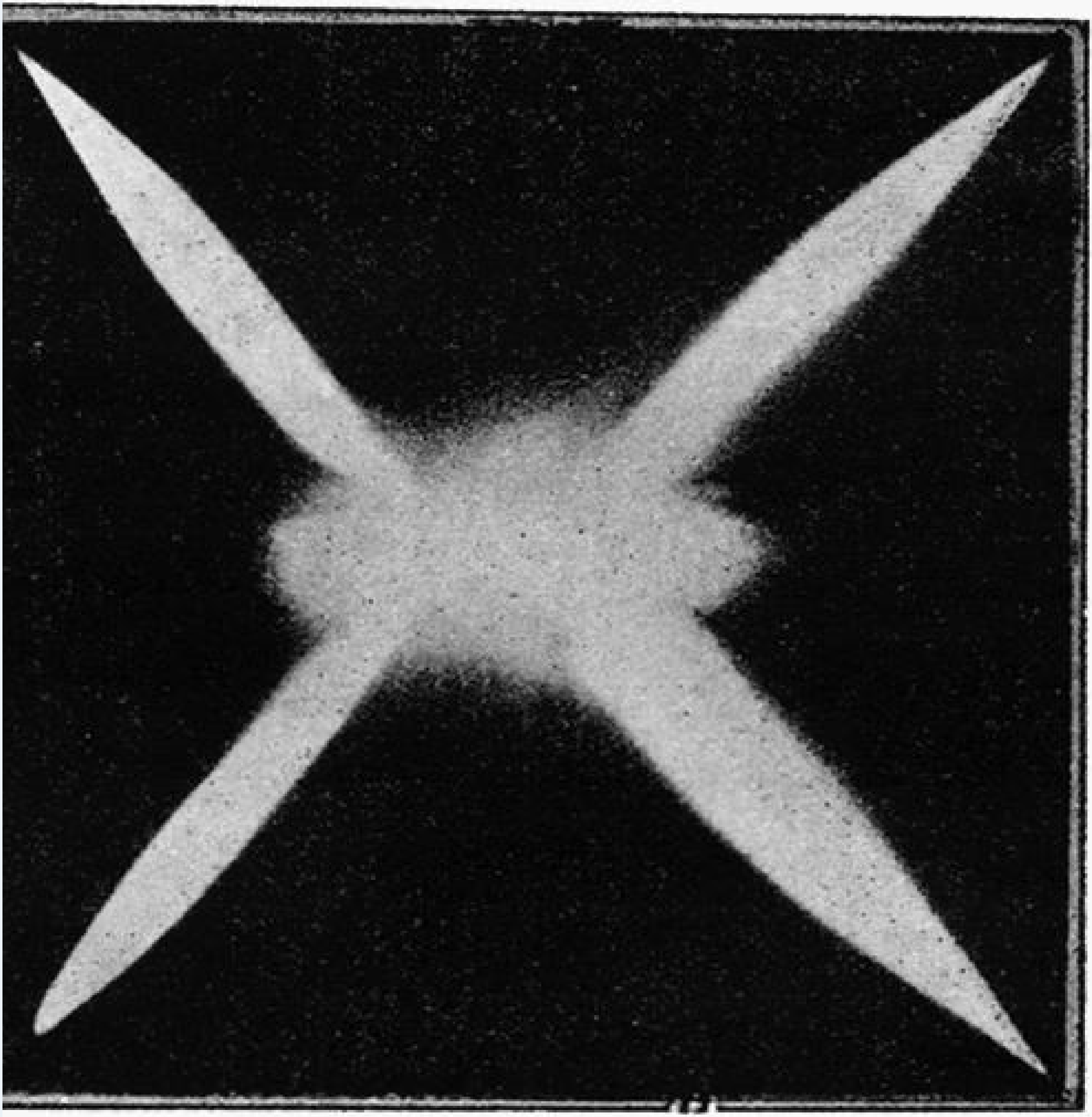

Fig. 46.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY

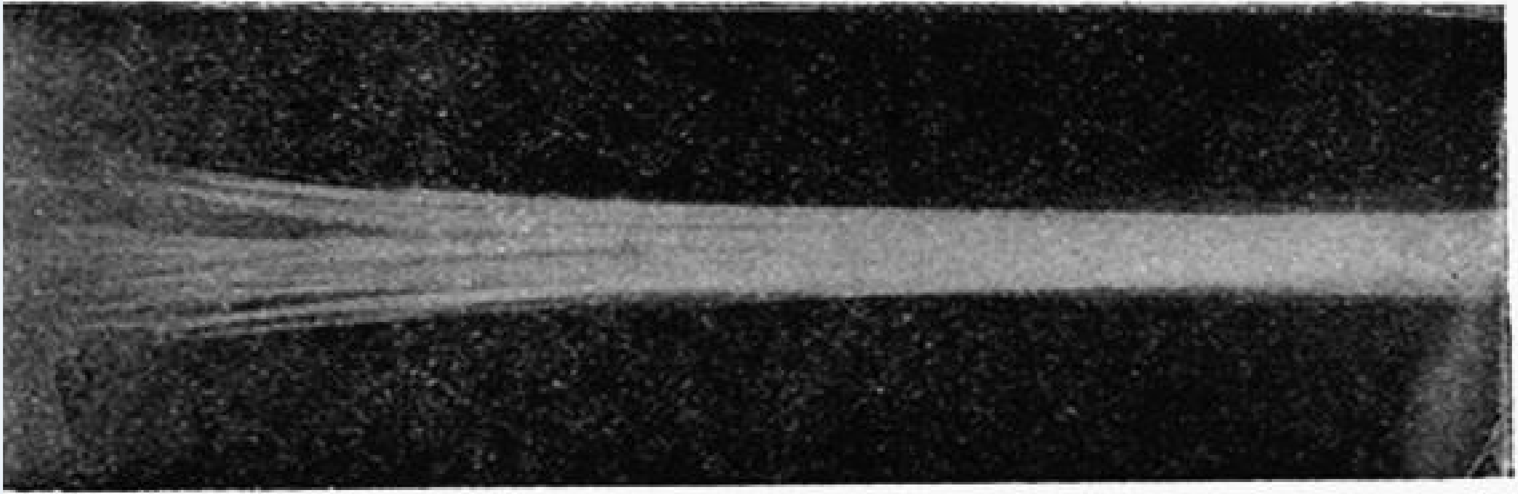

Fig. 47.

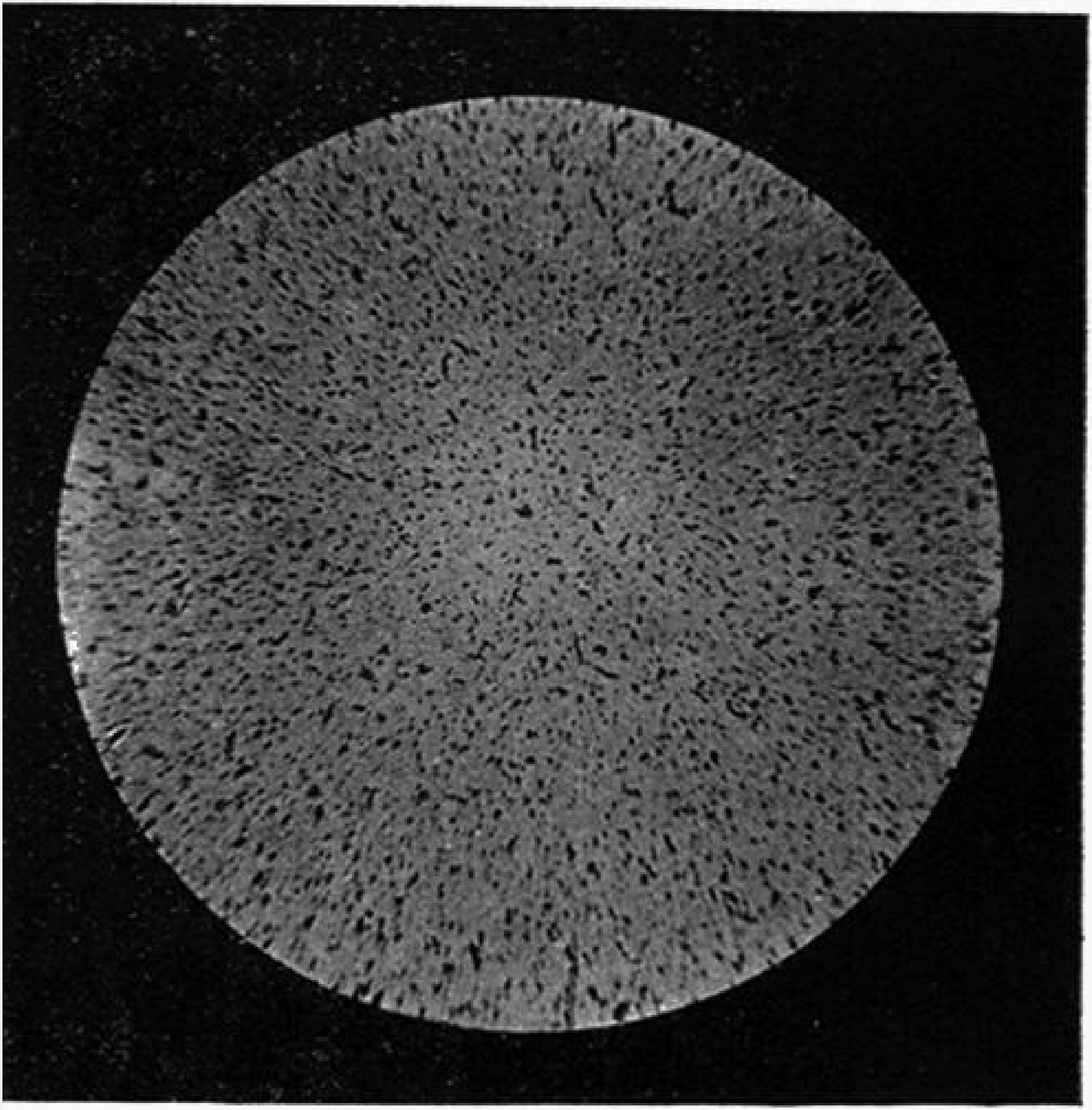

Fig. 48.

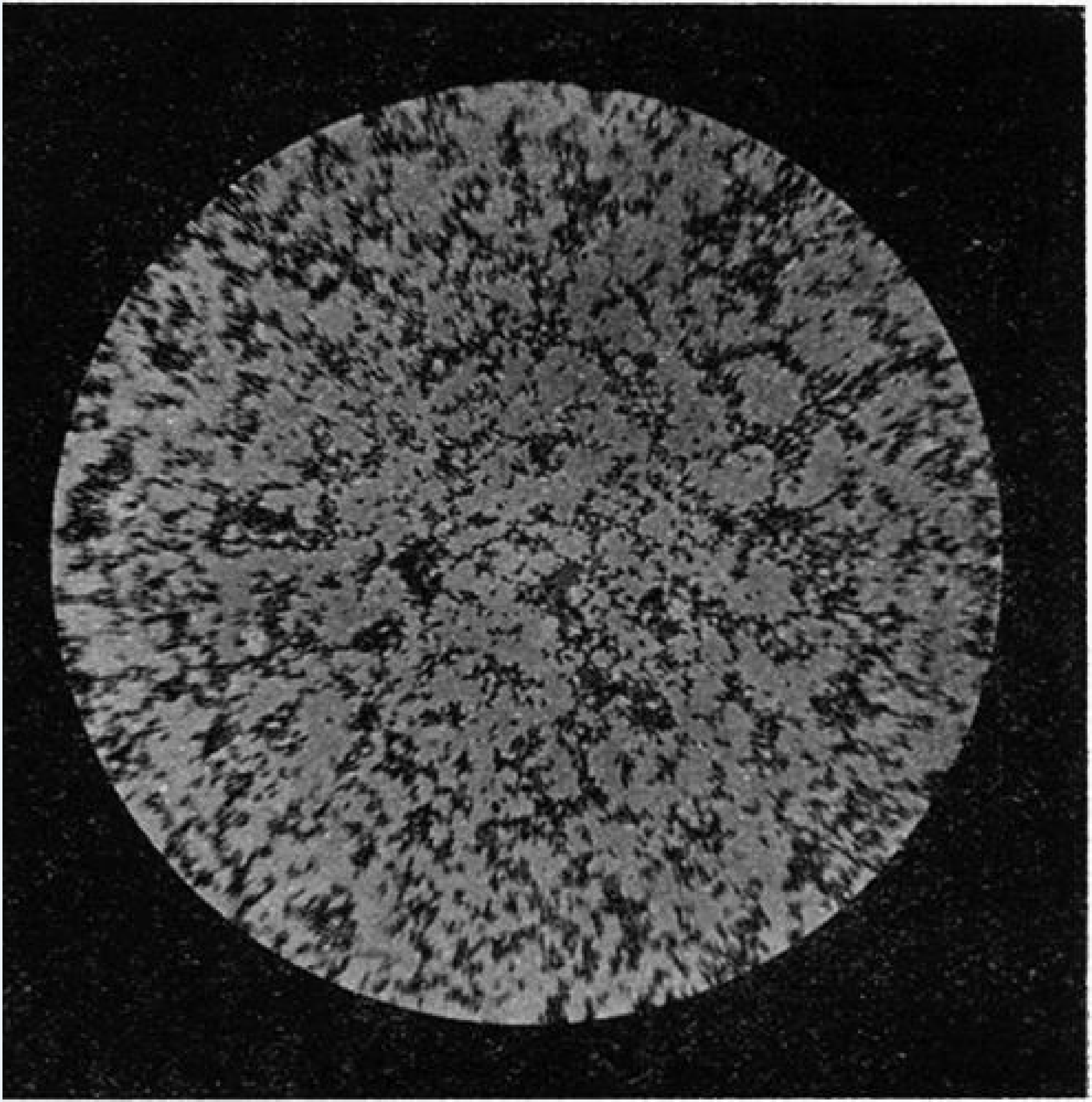

Fig. 49.

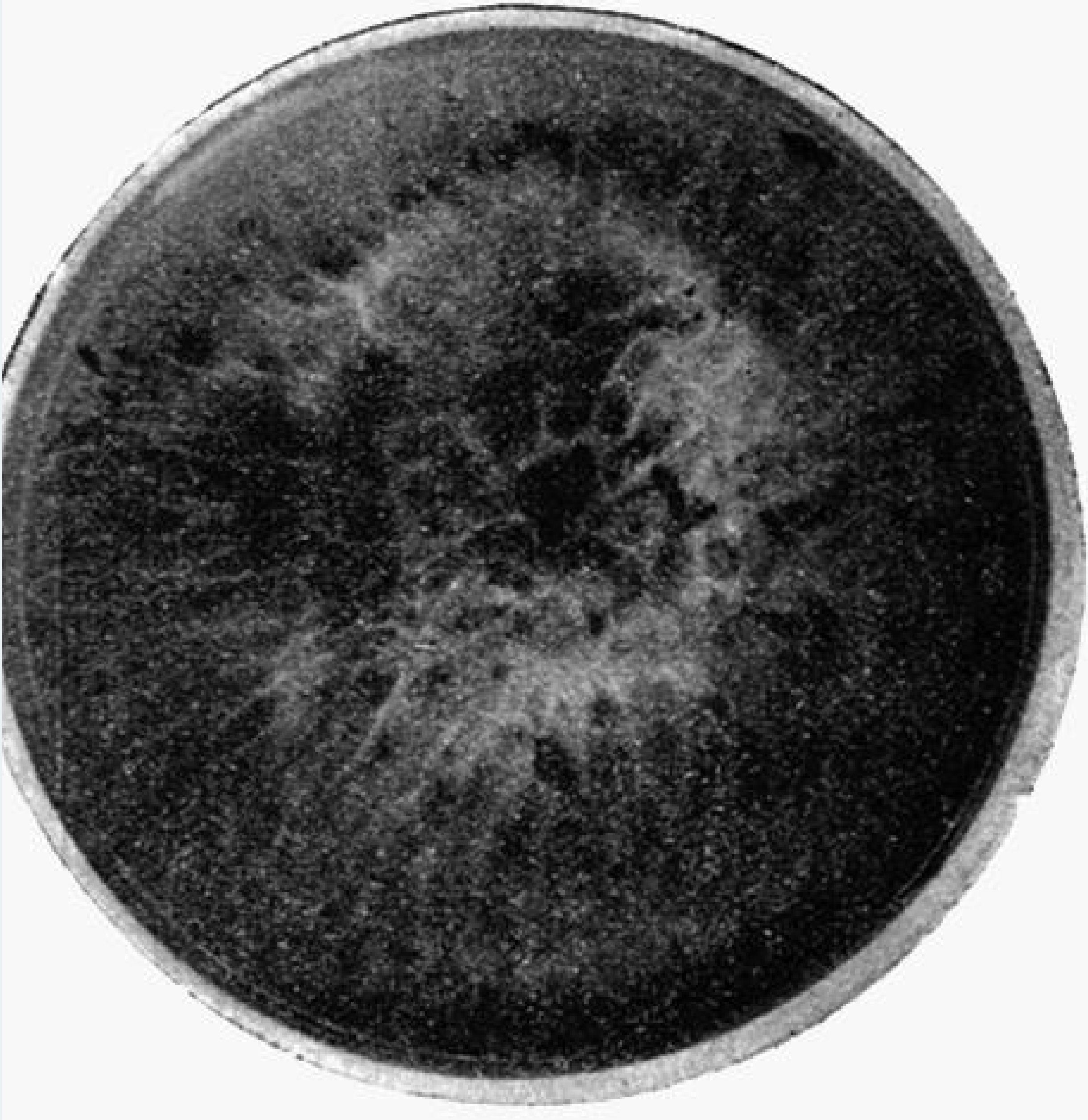

Fig. 49A.

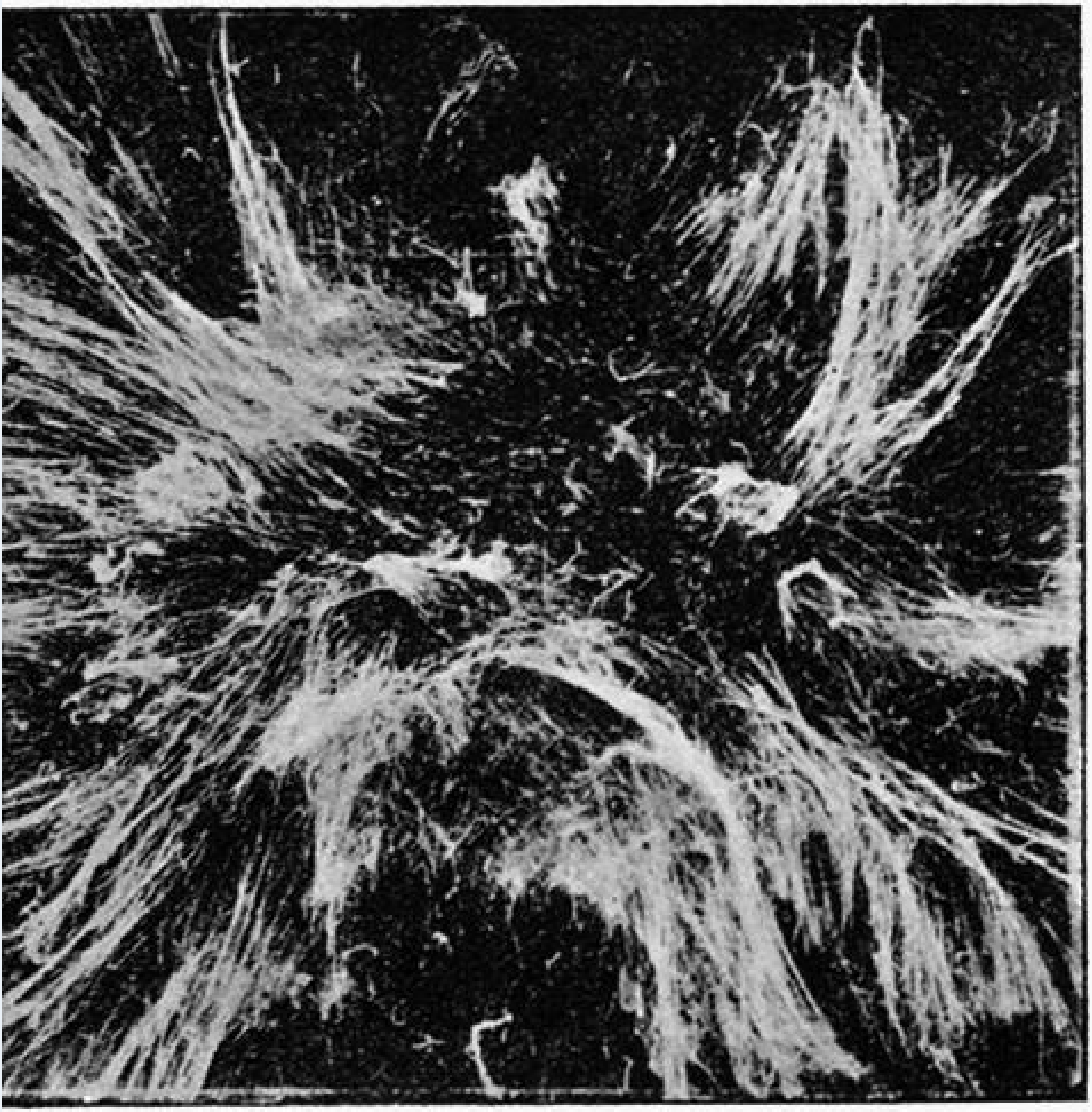

Fig. 50.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY

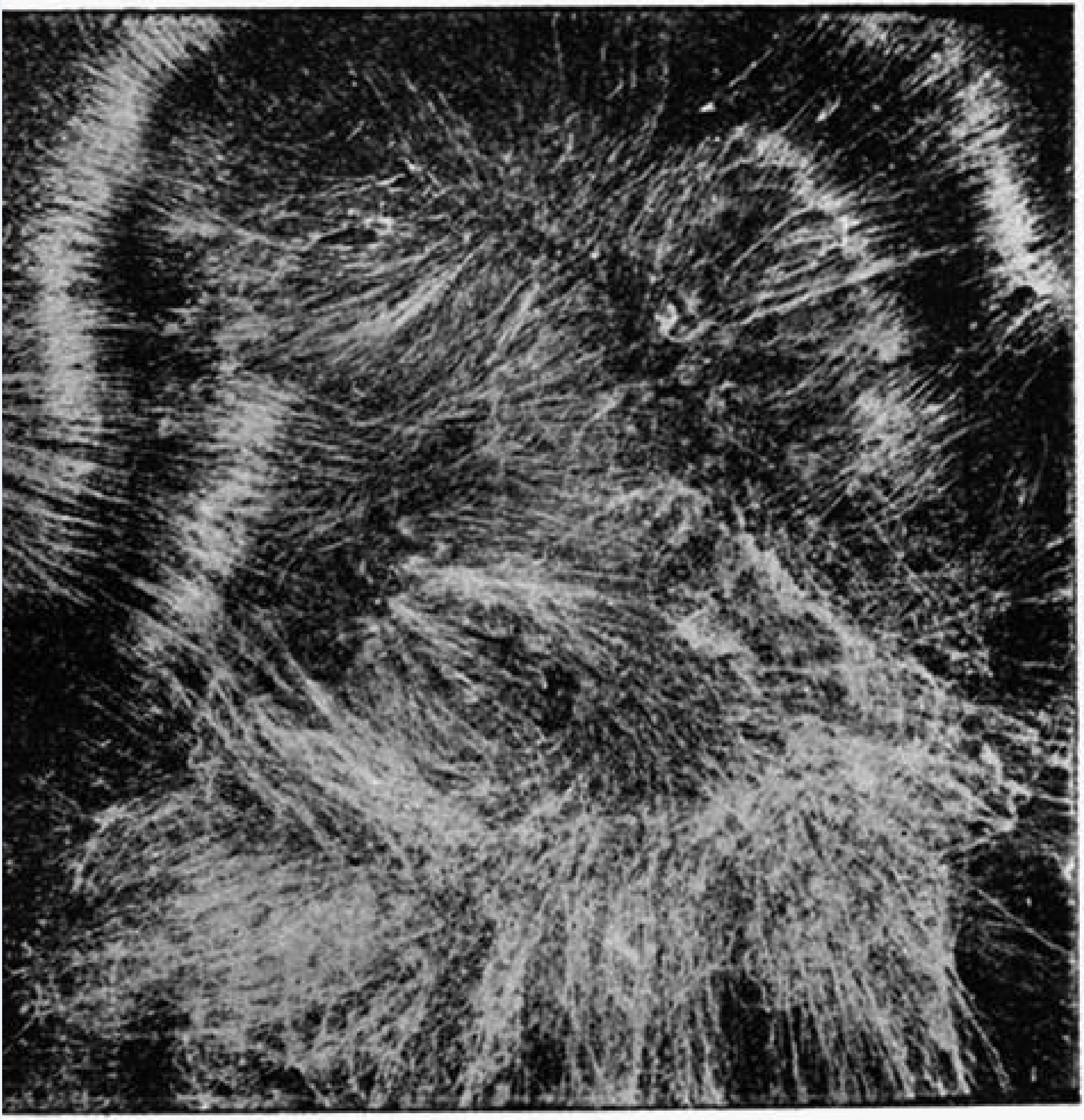

Fig. 51.