Dec. 16, 1947. J. C. LULEY 2,432,913

X-RAY ANALYSIS APPARATUS

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FIG. 1.

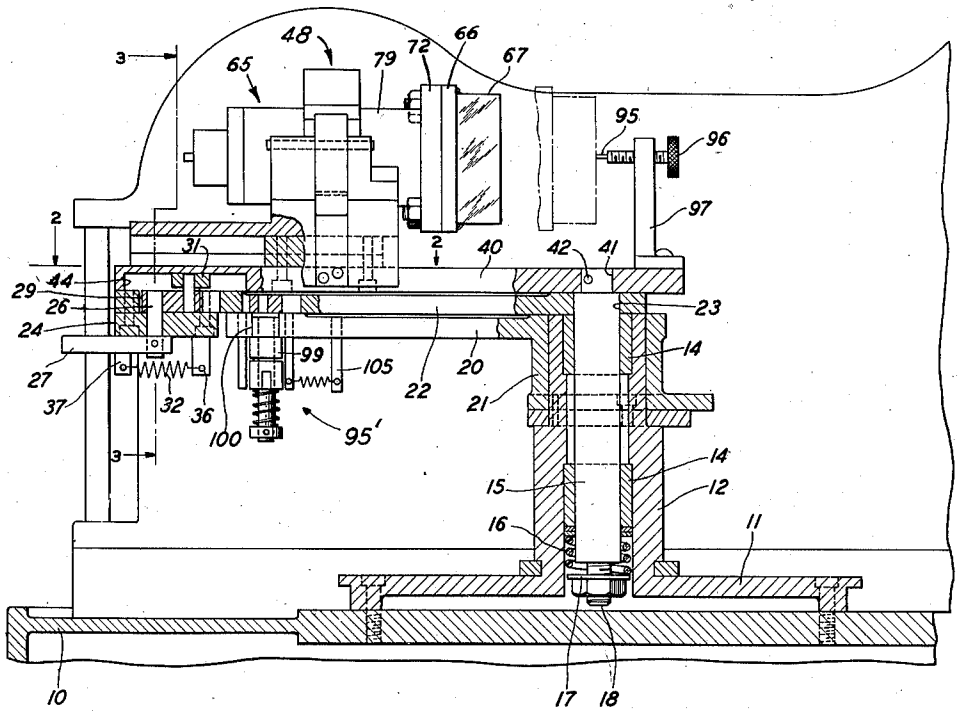
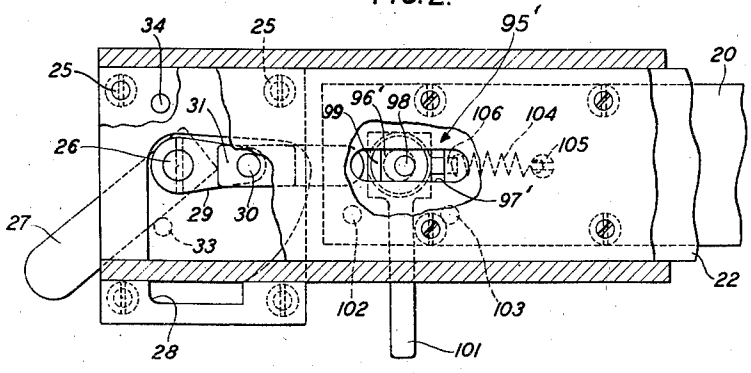


FIG. 2.



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FIG. 3.

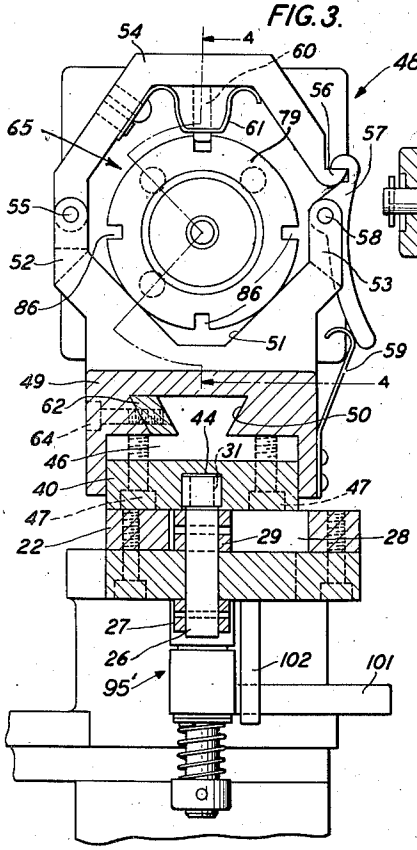


FIG. 4.

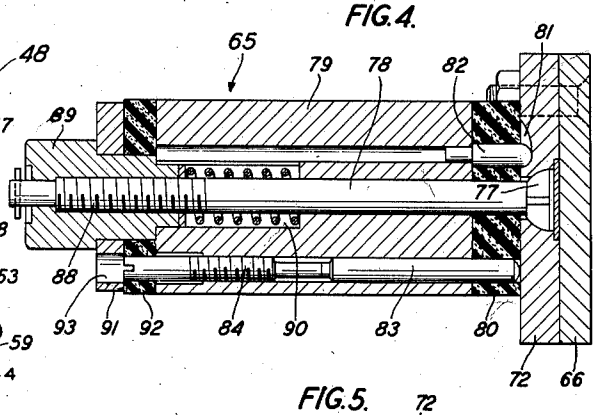
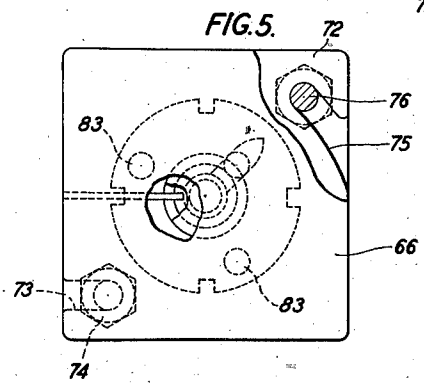


FIG. 5.



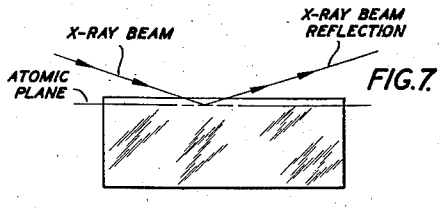
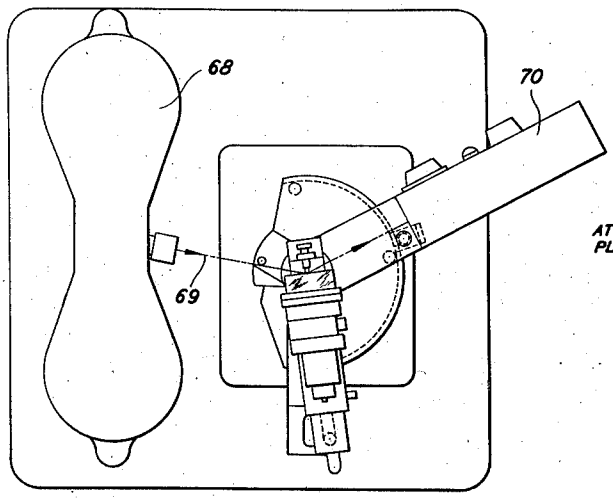


FIG. 7.

FIG. 6.



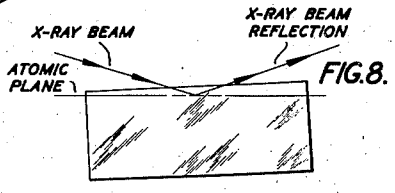


FIG. 8.

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X-RAY ANALYSIS APPARATUS

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Application December 1, 1943, Serial No. 512,415

2 Claims. (Cl. 250—83)

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This invention relates to X-ray analysis apparatus for particular use in the examination of quartz crystals.

The processing of quartz crystals, for the production of quartz crystal plates for use in electrical units of the communication art, includes numerous steps beginning with the mother stone and ending with the finished wafer ready to be assembled in the electrical unit. These steps may vary depending upon the type of unit for which the crystal wafer is desired. This art is so extensive that a complete disclosure thereof would be considered inadvisable. Furthermore, as the various steps may differ, it is thought advisable to direct attention to the co-pending application of Burton E. Baker, Serial No. 491,253 filed June 17, 1943, which illustrates some of the early steps in the process of manufacture for locating the optic axis when mounting the mother stone. Through the aid of additional means as disclosed in applicant's co-pending application, Serial No. 506,906, filed October 19, 1943, certain of the other axes of the mother stone may be located so that the stone, for example, when mounted by the aid of the teachings in the aforementioned Baker application may be cut into sections of desired widths, the cuts extending at chosen angles with respect to certain of the axes of the crystal. Subsequent steps include the cutting of the sections into bars of desired widths and the cutting of the bars into given lengths, depending upon the size of the crystal plate or wafer to be produced therefrom.

The material handling apparatus of the present disclosure was designed for use at this portion of the process following the cutting of the bars into predetermined lengths. Prior to the cutting of the remaining crystal portions into plates for subsequent reduction to wafers through the use of lapping machines, it is necessary to locate the atomic plane in this crystal portion with respect to the physical plane or face of the crystal structure.

An object of the invention is to provide a simple, efficient and highly practical X-ray analysis apparatus for examining quartz crystals.

With this and other objects in view, the invention comprises a unit, for supporting a material, such as quartz crystal, movable on a table to a position where a point in a surface thereof lies in alignment with the axis of the table, means to locate the table with the crystal in any one of a plurality of positions relative to an X-ray beam, and mechanism actuable to further move the table with the unit within given limits relative to the said positions.

Other objects and advantages will be apparent from the following detailed description when considered in conjunction with the accompanying drawings, wherein

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Fig. 1 is a vertical sectional view of the apparatus, portions thereof being shown in elevation;

Fig. 2 is an enlarged fragmentary sectional view taken along the line 2—2 of Fig. 1;

Fig. 3 is an enlarged fragmentary sectional view taken along the line 3—3 of Fig. 1;

Fig. 4 is a longitudinal sectional view of the work or crystal support taken substantially along the line 4—4 of Fig. 3;

Fig. 5 is an end elevational view of the support shown in Fig. 4, portions thereof being broken away;

Fig. 6 is a top plan view of the apparatus, and

Figs. 7 and 8 are schematic illustrations of different types of crystal portions from which crystal plates are to be obtained.

Referring now to the drawing, attention is first directed to Fig. 1, which illustrates a table 10 upon which a base 11 is mounted, the latter having an integral tubular support 12 centrally apertured and provided with bearings 14. A shaft 15 is rotatably supported in the bearings 14 and is normally urged downwardly by a spring 16 carried by a collar 17 which is supported by a nut disposed upon a threaded end 18 of the shaft. A supporting arm 20, having an integral collar 21 disposed and held in a desired adjusted position on the supporting member 12, is rectangular in cross-section and extends laterally from the member as illustrated in Fig. 1. An adjustable element 22 has one end disposed concentric with the shaft 15, as at 23, the other end resting upon the forward end of the supporting member 20 and extending therebeyond, where it is provided with a plate 24 fixed thereto through the aid of screws 25. The plate 24 carries a shaft 26 upon the lower end of which is mounted a hand lever 27. The shaft 26 projects into a cutaway portion or aperture 28 in the forward end of the element 22 and has a lever 29 mounted thereon. A pin 30 is carried by the free end of the lever 29 and has a flat-sided member 31 freely mounted thereon. Means is provided, through the aid of a spring 32, to hold the lever 27 in either one of two positions, controlled by locating pins 33 and 34. One end of the spring 32 is carried by a projection or lug 36 supported by the plate 24, the other end being connected to a lug 37 carried by or integral with the lever 27.

A table 40 rests upon the element 22 and has one end apertured, at 41, to receive a reduced end of the shaft 15 and be fixed thereto through the aid of a pin 42. The table 40 extends the full length of the adjustable element 22 and has an elongate groove or slot 44 in the lower surface thereof which is substantially rectangular in general contour. The member 31 is movably disposed in the groove 44 and through this means, including the associated lever 29, the shaft 26 and the

lever 27, the table may be moved about the axis of the shaft 15 in either one of two positions. A dovetail member 46 is mounted upon the table 40 through the aid of screws 47, and upon this member a clamping or supporting unit indicated generally at 48 is movably disposed.

The unit 48 includes a body 49 formed to straddle the table 40 as well as the member 46, as illustrated in Fig. 3, and is provided with a dovetail slot 50 extending the full length thereof for connection with the member 46 and for movement of the unit in a given path longitudinally of the table toward the axis of the shaft 15. The body 49 has a substantially V-shaped groove 51 therein with vertical projections 52 and 53 integral therewith. A retaining member 54 is pivotally supported, at 55, upon the projection 52 and has a lip 56 formed to be engaged by a latch 57, the latter being pivotally supported at 58 upon the vertical projection 53 and normally urged into closed position through the aid of a spring 59. A locating pin 60, carried by the retaining member 54, and a hold-down spring 61, apertured to receive the pin, to engage the supporting unit shown in Figs. 4 and 5, are also carried by the member 54. As previously stated, the body 49, through its dovetail slot 50 and its overhanging side portions, is slidable longitudinally of the table on the member 46 and, through the aid of screws 64, it may be caused to lock the unit 48 in any desired position relative to the table 40.

Attention is now directed to Figs. 1, 4 and 5, where a material or work supporting unit 65 is adapted to removably receive a mounting plate 66 for an article 67, which in the present instance is a quartz crystal bar. The crystal is fixed to the mounting plate by suitable means, such as cement, and it is through the aid of the unit 65 that the crystal is mounted in a cutting apparatus for cutting the crystal into wafers or plates of desired thicknesses. A standard supporting means for the unit is provided in the cutting apparatus (not shown) but it is important that the atomic plane of the crystal lie in a given position with respect to the cutting element of such an apparatus. Therefore, it is important that the atomic plane of the crystal be previously located with respect to the center line of the unit 65. In some instances it is preferred that the atomic plane of the crystal be parallel with the physical plane or face of the crystal. In other instances it is desired that the atomic plane lie at a given angle, for example, two degrees (2°), with respect to the physical plane or face of the crystal. For this reason the adjusting means through the actuation of the lever 27 is provided, to locate the table 40 with the supporting unit 48 in either one of two positions.

These positions are with respect an X-ray unit 68 positioned to cause projection of an X-ray beam, indicated at 69, in the direction of the arrows (Fig. 6). Associated with the apparatus is also a unit sensitive to an X-ray beam, commercially known as an ionization chamber, 70. The X-ray beam is reflected by the atomic plane in the crystal structure and not by the physical plane or surface of the crystal.

During the previous processing steps to cut the crystal into the various parts to produce the crystal bar 67 these steps have been aided by various means to produce, as in Fig. 7, a crystal bar with the atomic plane parallel with the physical plane or surface of the bar, or the bar illustrated in Fig. 8 with the atomic plane positioned at an angle

of two degree (2°) with respect to the face or surface of the crystal bar. It is necessary, however, regardless of the painstaking efforts to maintain quartz crystal bars with the atomic planes in the desired positions, to continue testing the product after each step of the process to assure the desired final result, as but small variations may produce unsatisfactory crystal plates.

This apparatus prepares the quartz crystal bar for the final cutting operation, the operation wherein the bar is cut into thin wafers or plates. With this in mind, it is necessary to provide means to vary the position of the atomic plane in either instance, with that of Fig. 7, or that of Fig. 8, so that if there should be any variation from that desired, this may be corrected prior to the final sawing of the crystal bar. This variable means is present in the unit 65. The unit includes a head 72 of the contour similar to the mounting plate 66, with a straight slot 73 adapted to receive a mounting bolt 74 of the mounting plate, and an arcuate slot 75 to receive a similar mounting bolt 76. With this formation the bolts 74 and 76 may be loosened sufficiently without the complete removal of the nut portions thereof, the bolt 74 inserted in the slot 73, and through the arcuate movement of the mounting plate with the crystal bar thereon, the bolt 76 may be moved into the slot 75, and by tightening the nut portions of the bolts, the mounting plate may be secured in place.

Through a universal connection 77, the head 72 is supported by a shank or supporting rod 78 in a main body 79 of the unit 65. The head 72 lies adjacent a flexible member 80 and has a recess 81 adapted to receive a fixed pin 82 carried by the body 79 and the member 80. Adjusting pins 83, disposed at spaced positions with respect to each other and the fixed pin 82, are disposed in engagement with the inner surface of the head 72, and through the cooperation of adjustable screws 84, threadedly disposed in the body 79, the pins 83 may be individually adjusted to bring about any desired variation in the location of the crystal bar 67, particularly the atomic plane thereof with respect to the center line of the unit 65. It will be noted, by viewing Fig. 3, that the body 79 is provided with longitudinal slots 86 in its periphery, these slots being disposed ninety degrees (90°) apart and adapted to singly receive the locating pin 60.

Referring again to the supporting rod 78, it will be noted that the inner or left end thereof (Fig. 4) is threaded as at 88 and has disposed a retaining member 89 threadedly disposed thereon, the latter having a reduced portion receivable in a central aperture 90 of the body 79 and, through central apertures in a retaining ring 91 and through an annular flexible member 92. The ring 91 and the member 92 are apertured, the former including apertures 93 to provide access to the ends of the adjustable screws 84, the apertures in the flexible member 92 being to receive the ends of the adjusting screws.

After the crystal bar is mounted upon the mounting plate and the latter secured to the supporting unit 65, this is located in the clamping unit 48. This entire structure may be moved relative to the table 40 to locate a point in the crystal bar 67 in alignment with the axis of the shaft 15. The locating means includes a point 95 of a stop screw 96, the latter being supported in a threaded aperture of a bracket 97 which is mounted upon the table 40.

It has been described that through the actua-

tion of the lever 27, the table with the units 48 and 65 thereon may be moved relative to the units 68 and 70 of Fig. 6 into one or the other of two positions. These positions are fixed, and if the crystals are perfect, that is, if the atomic planes thereof are at the desired locations within the crystal structure, a deflection of the X-ray beam from the crystal into the unit or ionization chamber 70 will give the maximum reading in each instance. It is desirable, however, to determine the degree of variation from the locations desired if such should exist. This is brought about through a variable unit indicated generally at 95' in Figs. 1 and 2. In this structure or unit 95', a rectangular element or block 96' is movably disposed in an elongate aperture 97' of the element 22 and is freely mounted on a pin 98 of an eccentric element 99. The element 99 is supported, at 100, in an aperture in the arm 20 for rotation about an axis eccentric with respect to the pin 98. Through the aid of a lever 101 fixed to the eccentric and adapted to move it rotatably between given limits controlled by stop pins 102 and 103, the element 22 together with the table 40 and the entire mechanism supported thereby, may be moved from one of its selected positions, controlled by the lever 27, a given distance upon both sides of those positions. In the present instance this movement is seven and one-half (7½) minutes from the neutral or given position to determine accurately the variation from a predetermined standard the location of the atomic planes in either crystal structure from that desired. A spring 104, having one end fixed to a pin 105 carried by the supporting arm 20, the other end fixed to a lug 106 integral with the lever 101, normally holds the latter in its neutral position.

In reviewing the operation of the apparatus, let it be understood that if the crystal bar 67 is of the species shown in Fig. 7, the lever 27 will be in the position clockwise from that shown in Figs. 2 and 6, whereas if the crystal bar is of the species shown in Fig. 8, the lever 27 will have been moved into the positions shown in Figs. 2 and 6. The crystal bar selected is secured to the mounting plate 66 and the latter is fixed to the head 72 of the unit 65. The supporting unit 65 is then mounted in the clamping unit 48 and, through the aid of the elongate slots 86, repeated examination may be made of the crystal bar to determine the accurate location of the atomic plane. If necessary, adjustments may be made in the unit 65 to vary the relative position of the crystal bar with respect to the X-ray beam until the desired location of the crystal is made with respect to the center line of the unit 65. During each of these positions of the supporting unit 65 and the clamping unit 48, the crystal is held in the position determined by the locating point 95 of the screw 96. Thus at all times the point of deflection of the X-ray beam is at the axis of the shaft 15, and all adjustments, whether in one position or the other, through the aid of the lever 27 or the finer adjustment relative to each position made through the aid of the lever 101, are made about the axis of the shaft 15 and about the point of deflection of the X-ray beam. The illustrations in Figs. 7 and 8 are exaggerated for the reason that the atomic plane is closely adjacent the physical plane or surface of the crystal bar.

When one bar has been tested and the necessary adjustments made in the unit 65, this bar with its unit may be removed and another supporting unit 65, with another crystal bar and its mounting plate disposed thereon, inserted in the clamping unit 48, supported in the V-groove 51 thereof and held in place by the retaining member 54. The holding of the unit 65 is further made possible through the resilient spring 61 and the locating pin 60. Also, through the aid of the slots 86 the crystal may be tested in the four different positions to accurately determine the location of the atomic plane. This mounting of the unit 65 in place may be accomplished when the unit 48 is disposed away from the locating screw 96. The two units are then moved toward the locating screw until the crystal engages the screw, at which time the desired point of the crystal is located in the axis of the shaft. At this time, depending upon the type of crystal bar to be tested, whether that illustrated in Fig. 7 or that in Fig. 8, the table with the two units 48 and 65 is adjusted accordingly through the operation of the lever 27 and its associated structure. This adjustment, as previously stated, is about the axis of the shaft 15. If, by chance, the operator should not have the proper location of the table and units with respect to the X-ray beam, this extreme variation would be registered in the unit 70 and the lever 27 adjusted to correct this positioning of the mechanism. At this time the lever 101 is actuated in both directions from the normal position, and during the actuation of the lever 101 any variation of the atomic plane of the crystal from that desired may be corrected through the aid of the adjustable screws 84 in the unit 65. This may result in the positioning of the physical plane or outer surface of the crystal bar at an angle with respect to the center line of the unit 65. However, by mounting the unit 65 with the crystal bar in a fixture located at a given position with respect to a grinding mechanism or element, the variation existing in the crystal bar may be corrected so that when it is finally mounted in the cutting apparatus, the location of the atomic plane with respect to the physical plane will be accurate.

Although specific improvements of the invention have been shown and described, it will be understood that they are but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention as defined by the appended claims.

What is claimed is:

1. An apparatus for analysis of quartz crystals comprising an X-ray beam projecting unit, a unit sensitive to an X-ray beam, a table mounted for movement about an axis intersecting an X-ray beam from the projecting unit, a support for a quartz crystal to be analyzed, a clamping unit for removably holding the support, a carriage, upon which the clamp is fixedly mounted, movable radially of the axis on the table between an analyzing position, where an atomic plane of the crystal will reflect the X-ray beam at the said axis, and a loading position with the crystal spaced from the X-ray beam, a fixed position arm parallel with the table, an element interposed between the table and the arm and movable about the said axis, a lever pivotally supported by the element, means movable by the lever to cause movement of the table about the said axis to locate the atomic plane of the crystal in a selected one of a plurality of given positions, means to limit movement of the lever to locate the table with the atomic plane in the given positions, and means carried by the arm, normally holding the element against movement, actuable to move the element given distances in opposing directions to

vary the angular relation of the atomic plane with respect to the X-ray beam to cause maximum reflection of the beam into the said sensitive unit.

2. An apparatus for analysis of quartz crystals comprising an X-ray beam projecting unit, a unit sensitive to an X-ray beam, a table mounted for movement about an axis intersecting an X-ray beam from the projecting unit, a support for a quartz crystal to be analyzed, a clamping unit for removably holding the support, a carriage, upon which the clamp is fixedly mounted, movable radially of the axis on the table between an analyzing position, where an atomic plane of the crystal will reflect the X-ray beam at the said axis, a loading position with the crystal spaced from the X-ray beam, a fixed position arm parallel with the table, an element interposed between the table and the arm and movable about the said axis, a lever pivotally supported by the element, means movable by the lever to cause movement of the table about the said axis to locate the atomic plane of the crystal in a selected one of a plurality of given positions, means to limit movement of the

lever to locate the table with the atomic plane in the given positions, and an eccentric member carried by the arm and connected to the element to normally hold the element against movement, and a lever movable limited distances in opposing directions from a normal position to vary the angular relation of the atomic plane with respect to the X-ray beam to cause maximum reflection of the beam into the said sensitive unit.

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