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PETROLOGICAL MICROSCOPES (GERMANY)

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BRITISH INTELLIGENCE OBJECTIVES
SUB-COMMITTEE

PETROLOGICAL MICROSCOPES

(GERMANY)

REPORTED BY

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BRITISH INTELLIGENCE OBJECTIVES SUB-COMMITTEE

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Introduction

Attention was directed to the present condition of the German petrological microscope industry, as regards production and design. Two works of outstanding importance were visited, namely E. Leitz (Wetzlar) and R. Winkel (Göttingen), and one important subsidiary, Steeg and Reuter (Bad Homburg). Apparatus was also seen in some University Departments, and a maker of polarising film was interviewed, also the firm Voigt and Hochgesang, Göttingen.

Production of petrological microscopes at the time of the visit was on a very restricted scale, and although there will no doubt be some expansion, the prospects are rendered uncertain by lack of fuel, labour, etc., and by the fact that the types of instrument manufactured are largely determined by official requirements.

Design, so far as information could be obtained, was not undergoing any great development, the chief relatively new features being the 5-circle universal stages by Leitz and Winkel with the provision optionally of higher stands to accommodate them, and improvements in the reflector prism used on the ore-microscope. The employment of polarising film was under consideration, but supplies were not at present available.

Visit to Messrs. Steeg and Reuter, Bad Homburg

Attention was confined to the mineral-working part of the factory, omitting the section dealing with the mounting of quartz oscillator plates. The team was conducted round the works by Dr. Reuter and members of the staff.

Approximate output (pre-war) stated to be per annum

300	Gypsum and mica plates
50	Quartz wedges (various types)
150-200	Berek compensator plates
1,000	Polarising prisms

Recent production. A trickle of orders for polarising prisms only.

Notes on components.

(a) Polarising prisms. Types: Simple, Ahrens (Glan-Thompson) and a multiple prism (projected).

The simple prism with normal end faces was made to a ratio length/breadth 3 : 1.

The prisms were prepared from cleavage pieces of calcite, cut at right angles to a cleavage face, with length parallel to the larger diagonal. They were cemented by polymerised linseed oil, and were matured in ultra-violet light for four weeks or more.

(b) Nakamura half-shadow plates. Rotation 5 degrees (more than Nakamura's original value). Thickness 0.13 mm. These were mainly used for physical apparatus.

(c) Macé de Lépinay half-shadow wedge (very few made).

(d) Calcite plates for Berek compensators. 0.1 mm. thick.

(e) Gypsum plates 1st order red, 0.06 mm. thick.

Raw materials.

Mica. Short of material, none received during the war.
Quartz. Still using pre-war stocks.
Gypsum. Mid-German material was preferred, but the locality was worked out. Next, Sicilian (Girgenti). No supplies for some years and still working on old stocks. As substitutes quartz had been tried but was more costly, and cellophane, but the latter was not sufficiently regular.
Calcite. Stocks were low with no prospect of cheap supplies. Localities from which suitable material had been available were Ohio, New Mexico. Material from South Africa and South America was only one per cent. usable.
$NaNO_3$. Only sub-parallel crystals had so far been available.
LiF. Large single crystals had been made by Dr. Pohl of Göttingen.

Manufacturing methods.

Gypsum plates. A block 1 cm. thick was polished on the outside (cleavage) faces and ¼ in. glass plates were cemented to these faces with white bees-wax and a small proportion of balsam. The gypsum was then cleaved with a knife (under water) and the process repeated down to ½ to 1 mm. thickness. The plates were then ground with pumice powder and polished with green chromic oxide.

Calcite. A number of cleavage pieces were mounted on a plate that was pressed upward against the saws with parallel movement by a "letter balance" linkage and counterweight. The saws were tensioned brass strips (18 in. x ¼ in. x 1/50 in.) fixed parallel in a reciprocating frame and fed with emery (? carborundum) abrasive in water.

For grinding and polishing, the pieces were mounted in groups with colophony or bees-wax and moved by hand over silk or pitch laps, with carborundum or chromium oxide.

A special jig for holding the prisms was formed from a glass block, ground to the correct angle and tested by goniometer.

Quartz. Cutting was by vertical, circular, diamond saws made by Ernst Winter u. Sohn, Hamburg. Lubrication with paraffin. Diameters were from 10 to 60 cm., some with sintered diamond edges. Smaller saws, e.g. 4 cm., (0.1 mm. thick) were nicked and charged with diamond; these were made on the premises, of copper or soft iron.

Grinding. A diamond sintered grinding wheel 3 in. in diameter running vertically over a mechanical bed, was used, with chucks of the desired angle, the final adjustment being checked on a small contact goniometer with micrometer screw operating a contact arm. Also on machines of usual type, with horizontal rotating laps, the specimens mounted on mechanically reciprocated chucks.

Rock sections. It was intended to resume production shortly. A new grinding machine of standard type with 8-10 horizontal rotary laps and reciprocating chucks was in readiness. Slices were made about ⅛ in. thick with diamond saw and mounted on glass sides cemented to the chuck for the final grinding.

General. Dr. Reuter anticipated the eventual replacement of calcite prisms by polarising film, but he thought a nicol analyser would be essential. He was experimenting with multiple calcite prisms made from small waste pieces of spar.

Stocks.

Calcite: a few kilograms, equal to about six months pre-war production.
Gypsum: Do., about a year's pre-war production.
Quartz: About 1,000 kg. small Brazilian crystals, including piezo-electric stock. Ample for present needs since the piezo. business is at present negligible.
Mica: very little good material.

Visit to E. Leitz, Wetzlar

Considerable difficulty was experienced in getting access to the works. Fortunately on one occasion the members of the team were received by Herr Ludwig Leitz and were able to see the assembly of petrological microscopes. On the second visit they were informed by the military officer in charge that the works had been closed for lack of fuel and that no member of the staff was available to show them the machinery, etc. The present account is therefore incomplete especially as regards details of manufacture. Attention was confined to petrological microscopes, and interviews were had with Herr Ludwig Leitz, Dr. M. Berek and Dr. Maennchen.

Output

Before the war this firm made approximately 300 petrological microscopes per annum. Production stopped in 1942 and had now been resumed, but only on a limited scale.

Several models were inspected in the showroom, but these showed no great change in design from those in use before the war. The height of the opening in the limb had in some cases been increased, and a special limb was being fitted to order on stands such as the CM, to take the new 5-circle universal stage. Flat sliding dust-excluding covers were attached over the upper surface of the analyser and Bertrand lens slides.

In the works, other apparatus seen included:-

5-axis universal stage.

This has the outer circle wider than the well-known 4-axis stage, and requires greater clearance. The design was otherwise similar to the latter, with folding arcs to the inner tilting circles.

Ore-microscope MOP.

The reflector unit was now being provided with the Berek 3-reflection prism and with a highly reflecting cover-glass. The dimensions of the reflector were as usual but a collecting lens was supported in front of the polariser on a short bracket, no doubt to increase the aperture. The cover-glass was coated with titanium oxide (?) but this was not done at the factory.

Accessories to MOP, etc.

(1) A special ocular was made with a rotating mica plate for measuring anisotropy. The model seen had only a limited rotation,

but the standard model is to have complete rotation of both the mica plate and the analyser which is contained in the eyepiece. This ocular is intended to be used with the new prism in the vertical illuminator.

(2) The Berek slit microphotometer was demonstrated by Dr. Maennchen. There were no special changes in this model. Attention was directed to the use of the interference figure instead of the object image, on account of its greater intensity.

(3) The reflector unit was examined, as fitted with the new prism and cover-glass (above).

A six-spindle integrating stage of standard type was also seen.

Polaroid.

Both Herr Leitz and Dr. Berek were not satisfied that any polarising film they had so far seen was quite good enough for general use in polarising microscopes.

A sample of a German polarising film, made by E. Käsemann of Coburg was exhibited. This appeared to be superior to common polaroid but not of the best known quality. It was proposed to use more than one thickness of film.

No designs of polaroid microscopes were produced, and there were no such instruments on the bench.

Blooming Plant.

Several units were in operation, each consisting of a large bell-jar, about 2 ft. in diameter. The lenses, etc. were supported above holes in flat trays with feet about 1 ft. high. On the floor of the chamber was a ring of five tungsten boats, for heating the coating material, usually cryolite. The jars were completely enclosed in metal covers. Herr Leitz stated that microscope objectives were not bloomed as this had not been found to improve their performance.

Evacuation was by (1) large "Gaede" type backing pumps, then switched to (2) oil-diffusion pumps backed by smaller "Gaede" type.

Lens mounting and cementing.

Microscope objective lenses were being spun in and centred in their mounts by orthodox methods, using light lathes.

Lens components were at present cemented with canada balsam after edging.

A special machine was in use for cementing and centring, in which the components were spun in order to obtain an even layer of cement and at the same time held in a special self-centring chuck.

Microscope objectives were tested in the microscope on standard test objects, e.g. pleurosigma angulatum.

Visit to E. Käsemann, Unterlauter, near Coburg

E. Käsemann is an engineer who before the war had filed patent applications for polarising film and had also made applications for protection in Great Britain and France but not in America. He originally had a factory in Berlin, but was evacuated, first to Czechoslovakia, then to Unterlauter, where he occupies a temporary factory in village buildings. He stated that he was an electronic engineer and had specialised in making sound film equipment, but he was not making polarising film because his application for permission from the American authorities had not yet been granted.

Output

Nil at present, but Käsemann stated that he had made 40,000 pieces for the German Government during the war.

Käsemann was in possession of excellent Leitz research equipment, and showed a MS. description of a research on polarising films, including American "polaroid" and "polaroid" made under license by Zeiss, with absorption curves determined at the Leitz factory. He was anxious to publish this, possibly in England, but it would not be ready for about two months. He had not so far published any literature other than patents.

He claimed that his film was better than that made by the "polaroid" method (presumably pre-war polaroid). The samples exhibited appeared to confirm this. His examples in particular were practically transparent while the "polaroid" gave a strong chatoyance when viewed obliquely in a strong beam. He claimed to have attained an absorption ratio of 99.5, which seems lower than that for polarising film seen in England, but the samples shown were very effective when crossed, and the colour of the transmitted light was good. His process, consisted in stretching a cellulose hydrate film and dyeing it with cotton dyes. He showed a mount of "polaroid" film (pre-war) which had, at x 700 magnification, a parallel linear structure to which he attributed the chatoyance. But the

lineation seemed to be of a "ropy" nature and not to be due to minute crystals of herapathite. Käsemann was aware of, but had not any experience of, the use of coloured cobalt compounds for this purpose. He had never supplied Zeiss with polarising film. The film was stable up to about 100 deg. Celsius.

The satisfactory use of the material was demonstrated on a polarising microscope, and about a dozen very successful stereoscopic pictures were shown by means of a double lantern, the observer wearing polaroid spectacles. A special reflecting screen was necessary, to avoid getting an appreciable amount of depolarised light in the image.

He stated that he believed the fees due on his British patent had recently been paid and that the patent would therefore be still in operation.

Visit to R. Winkel, Göttingen

The manager, Herr Sickhart (formerly of C. Zeiss, Jena), Dr. Ehringhaus and Dr. Flugge were interviewed.

The output of petrological microscopes was at present nil, and only a few incomplete ones could be seen. These included a 6M stand, not of the latest type, part of an ore-microscope, a five-axis universal stage (without hemispheres) and an Ehringhaus compensator. Polaroid was said to be made by Zeiss-Ikon, Dresden, they did not know under what patents. "Bernauer" film was red at extinction and was made from herapathite grown in parallel orientation. Prof. Ehringhaus did not consider any he had seen to be sufficiently good for the best microscopes.

The firm had no blooming apparatus, all work of this type having in the past been sent to Jena. They did not think it worth while to make bloomed microscope objectives.

For ore-microscopy the reflector had a metal mirror in place of the prism.

A Winkel 5-circle stage and microscope were seen in use at the Mineral Department of the University (Prof. Correns). The stage, which was designed about 1943, had the Winkel small metal divided circles on the axes in place of the Wright arcs; the additional circle is a narrow ring of non-corrodable steel, without concentric movement. The height was lower than that of the Leitz stage, the clearance between stage and limb required being about 6.9 cm.

Supplies of nicol prisms were said to be exhausted, so that further petrological microscope production was dependent on external supplies. Negotiations were at present in hand to obtain these from Messrs. Steeg and Reuter, since no other manufacturers were known in the British and American Zones.

Since no petrological stands were being manufactured, some attention was given to the production of biological stands, and optical equipment was examined. The factory was crowded with lathes, etc. and had evidently been used for general production of parts such as gear wheels as well as optical equipment. Most of the machines were idle.

General Microscope Manufacture

Stand
Foot - machined from iron casting
Limb - light alloy
Tube - brass
Rack - brass: pinion - steel.

No special features were observed in the machines in these shops.

Lens polishing and grinding

No new principles were noticed in the methods employed. Large hemispherical and front lenses for microscope objectives were worked singly. It was stated that this was standard practice and not the consequence of small scale operation. Lenses were also ground and polished in blocks on multiple machines similar to those in use in the U.K.

Testing of single lenses (optical inspection)

The R.I. of all material when received was checked on a Fuess goniometer and lens figures checked in the usual way by test plates. No special apparatus for this purpose was observed. It was stated that in consequence of these controls it was unnecessary to check focal lengths, and no focometers were seen.

Edging

Lenses were centred on chucks to which they were attached by shellac and then ground to diameter.

Mounting

Microscope objective lenses were being mounted in their cells and spun true on small lathes; the separations being adjusted by turning the required amount of metal from the lens fitting. The measurement of the cell depth by a dial gauge was noted. Mounting was by screw-in cell.

Objective testing

Objectives were tested on microscopes by the use of an Abbe test plate to examine chromatic aberration and centring. It was stated that no adjustment was made for spherical aberration since accurate control in the preceding processes rendered this unnecessary.

Ehringhaus Compensator

This consists of two plates each 1 mm. in thickness, of quartz (or calcite) having the crystal axes approximately in the plane of the plate and mounted so that the plates are superimposed with their axes at right angles.

Fluorite

This could not now be obtained for the manufacture of fluorite and apochromatic objectives.

Dr. Flugge (interrogated by Mr. B.O. Payne)

Late of Emil Busch, Rathenow, where he was chief computer with 16 assistants. Sometime co-editor of Zeits. für Instrumentenkunde. He was employed by this form for seventeen years. At present he was the only computer employed by R. Winkel, and was engaged on the computation of anastigmatic spectacle lenses. He had computed optical systems of most types with the exception of aspherical ones. He had no specialised knowledge of polarising films or of polarising microscopes.

Visit to Voigt und Hochgesang, Gottingen

This firm, widely known for rock sections and preparation of wedges, etc., were only operating on a very restricted scale. Five persons in all were engaged in a small factory where rock sections only were at present being prepared by essentially manual methods. The proprietress, Fr. E. Rumenapf, hoped to continue the making of sections especially for teaching, etc., on a greater scale and to resume the manufacture of rock-cutting and grinding machines.

It was clear that this firm's position in no way corresponded to that of Steeg and Reuter in relation to Leitz. As already mentioned, R. Winkel were trying to get calcite prisms made for them by Steeg and Reuter.

Description of Photographs

Apparatus in use by Messrs. Steeg and Reuter, Bad Homburg.

I. Saw for cutting calcite prisms. "Letter-balance" linkage and counterweight for pressing the table (1) upward against the saws (not seen).

II. Do. Saws tensioned in a reciprocating frame, above the table (1) with some calcite rhombs (2) in position.

III. Conoscopic Apparatus. For checking the orientation of faces ground on pieces of quartz. (1) Opening with lamp behind. (2) Prism (behind screen). (3) Glass table for piece of quartz. (4) Mirror and lenses.

IV. Contact Goniometer. For final adjustment of chucks from grinding machines. (1) Horizontal contact arm, adjusted by micrometer screw (3), read by lens (4).

V. Diamond grinding wheel with mechanical feed.

VI. Diamond Saws.

VII. Multiple spindle grinding and polishing machine. For rock sections. The slides are attached to chucks (not shown) which are held under the reciprocating arms (one of which is lowered to the running position). Circular laps (not shown) of usual type are fitted to the rotating spindles.

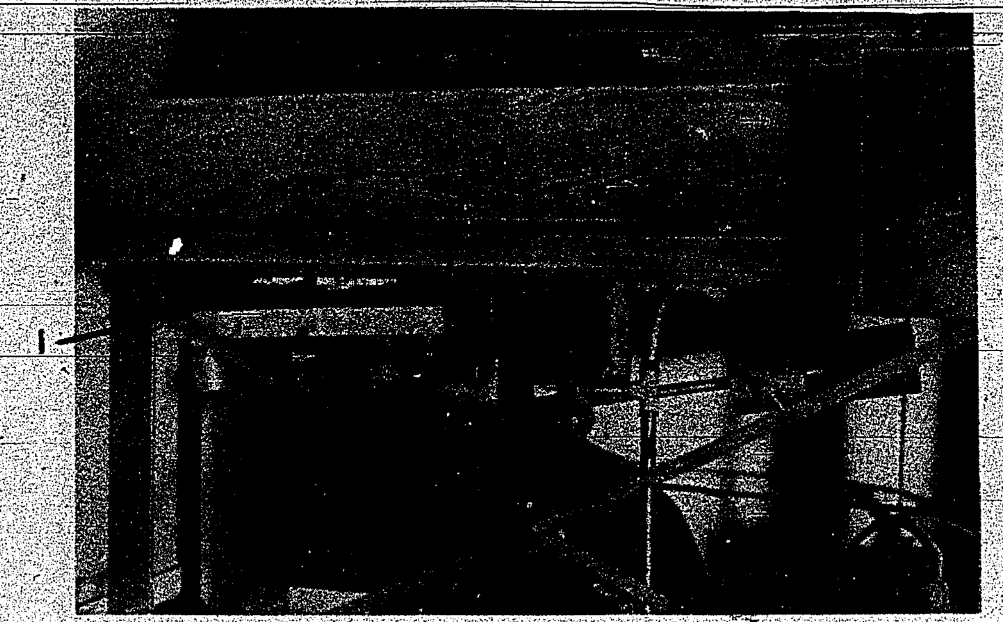

FIG. 1

Saw for cutting calcite prisms

"Letter-balance" linkage and counterweight for pressing the table (I) upward against the saws (not seen).

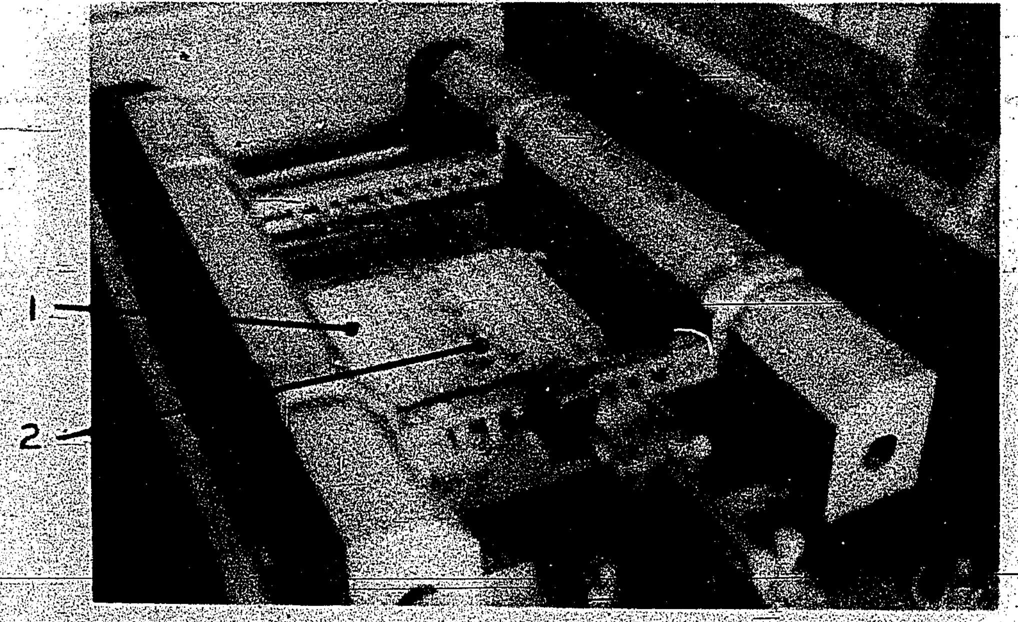

FIG. 2

Saw for cutting calcite prisms

Saws tensioned in a reciprocating frame, above the table (I) with some calcite rhombs (2) in position.

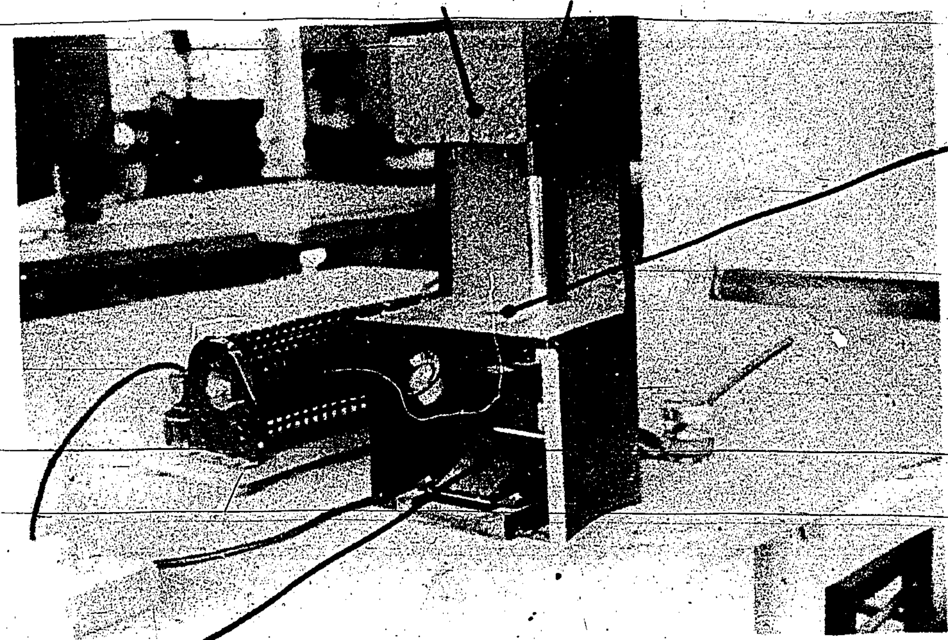

FIG. 3

Conoscopic apparatus

For checking the orientation of faces ground on pieces of quartz. (I) Opening with lamp behind. (2) Prism (behind screen). (3) Glass table for pieces of quartz. (4) Mirror and lenses.

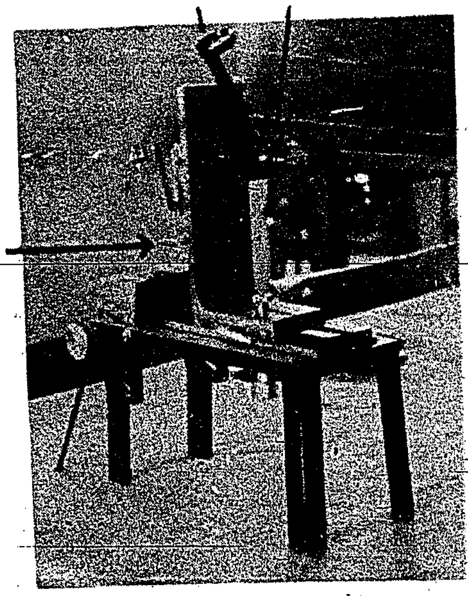

FIG. 4

Contact goniometer

For final adjustment of chucks from grinding machines. (I) Horizontal contact arm, adjusted by micrometer screw (3), and read by lens (4).

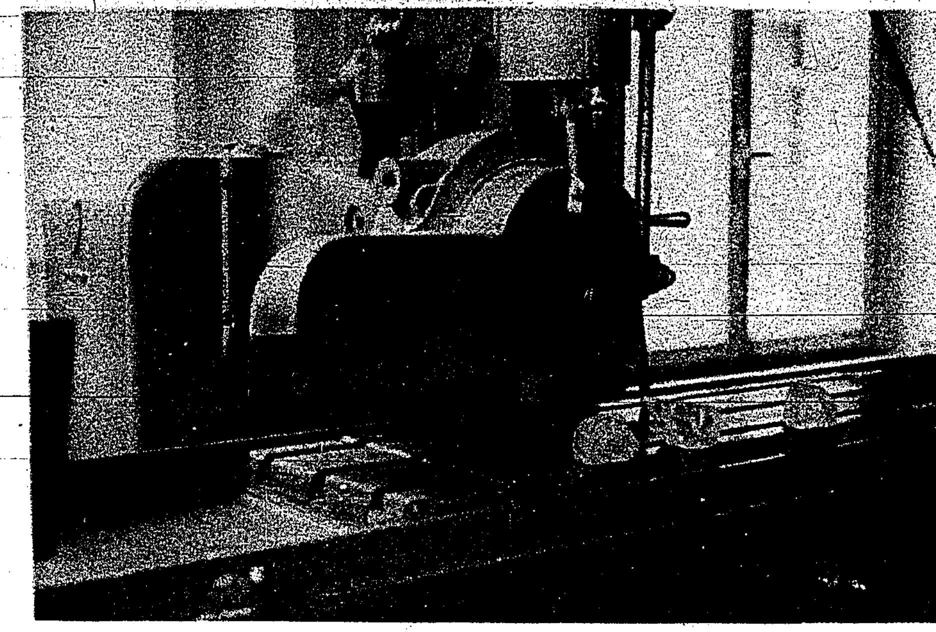

FIG. 5

Diamond grinding wheel

With mechanical feed.

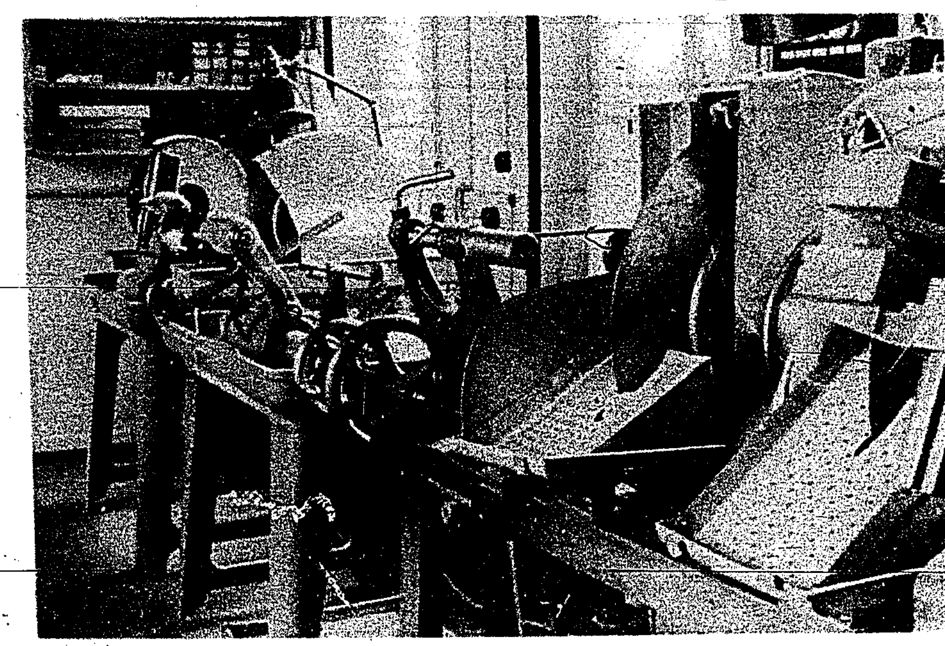

FIG. 6

Diamond saws

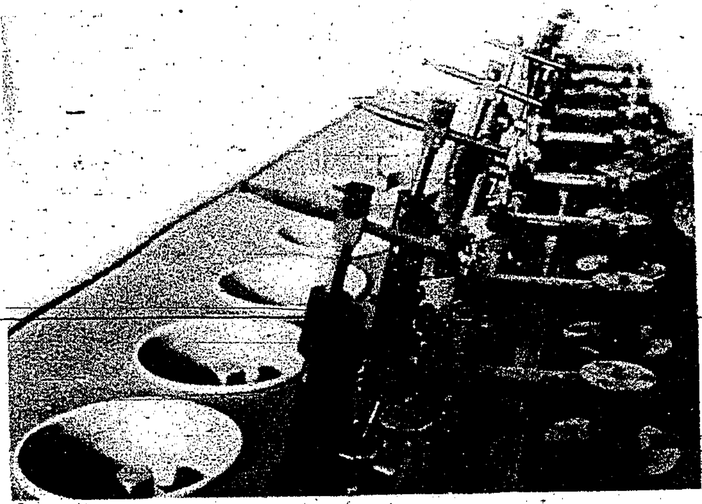

FIG. 7

Multiple spindle grinding and polishing machine

For rock sections. The slides are attached to chucks (not shown) which are held under the reciprocating arms (one of which has been lowered to the running position). Circular laps (not shown) of usual type are fitted to the rotating spindles.

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