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2,248,446

OPTICAL PROFILE GRINDING MACHINE

Filed June 10, 1939

2 Sheets-Sheet 1

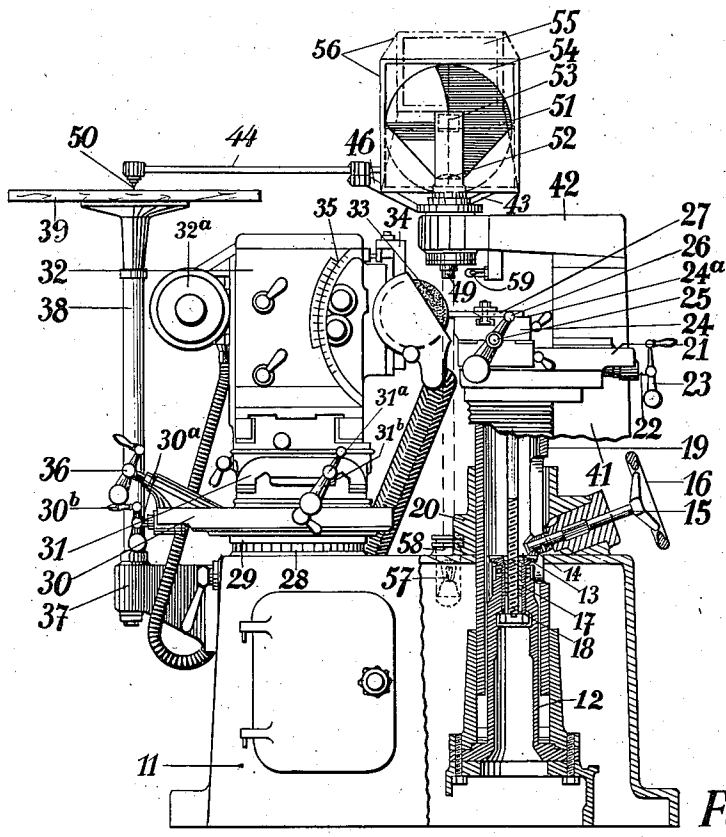


Fig. 1

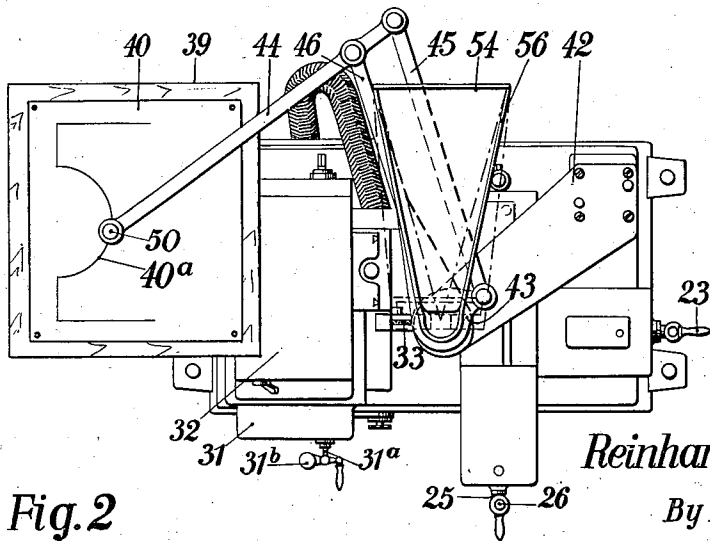


Fig. 2

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By his Attorney

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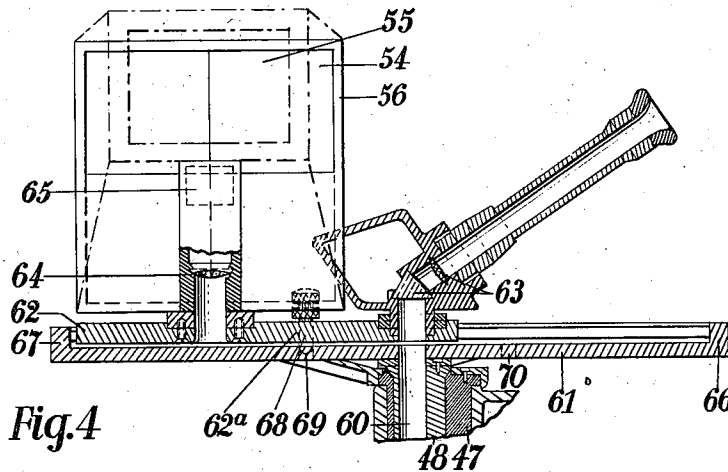


Fig. 4

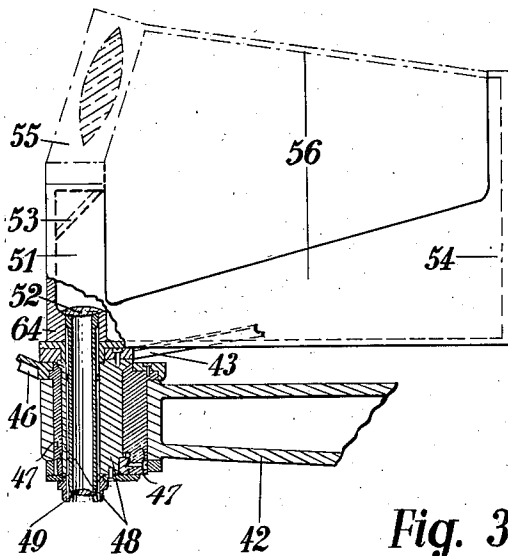


Fig. 3

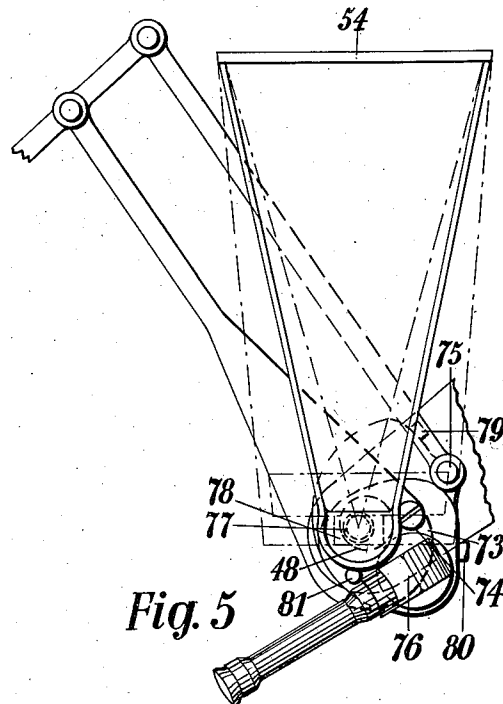


Fig. 5

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[Signature]

UNITED STATES PATENT OFFICE

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OPTICAL PROFILE GRINDING MACHINE

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6 Claims. (Cl. 51-165)

The present invention refers to an optical profile grinding machine on which form-gauges and form-tools, etc., are ground by causing a grinding-disk to grind the form-gauges or form-tools to their actual shapes which shapes are represented by the lines of a very much enlarged drawing.

Generally we distinguish between two kinds of optical profile grinding machines. In the first the pattern line is traced piece by piece by means of a pin, and this motion is transferred by means of a pantograph to an optical system which serves for watching the piece to be ground at the grinding point. The axis of the optical system is always brought to the exact position above the grinding point and the grinding wheel is guided so that it grinds to that place or point which is observed by means of the optical system. Heretofore the optical system has been in the form of a microscope. If the tracing of the pattern is done with great exactness, which can be satisfactorily accomplished by means of phototechnic methods, this foregoing method guarantees an absolute exactness in the profiles to be ground dependent upon the accuracy of the pantograph mechanism. The optical enlargement of the microscope does not directly affect the exactness of the operation at the point of grinding. It serves only to observe the point of grinding.

In the second kind of optical profile grinding machine the outline of the entire form-gauge or form-tool to be ground is projected on a screen in shape of a picture. On this screen the profile-lines are drawn in an enlarged scale and the projected picture of the form-gauge or form-tool can be compared with the profile-lines drawn in enlargement. Here one sees as a shadow on the screen, even if vanishing at times, the grinding wheel which is operating on the form-gauge or form-tool in a steady vertical up and down motion, and therefore it is possible to follow up the operating of the grinding wheel on the form-gauge or form-tool and to continue the grinding until the outlines of the picture coincide with the profile lines drawn on the screen.

Since in this second method optical enlargements are used it can happen that the lines of the shadow are distorted. Furthermore the exactness of the method depends on how carefully the operator services the machine. The adjustment of the picture on the screen must be done by the operator so that the outlines of the picture appear sharp and clear at all times. This adjustment however depends more or less on the good eyesight of the operator.

This adjustment is of extreme importance because an enlargement on the screen is obtained only in the position of the sharpest adjustment, which enlargement corresponds to the profile line drawn in enlargement on the screen. And there remains still the lack of clearness, due to the diffusion of the screen.

If the kind of optical profile grinding machine fitted with microscope as its optical system assures absolute exactness of the making of the profile when the grinding is done fairly slowly, even if the adjustment of the microscope is not made with the greatest exactness, then the grinding process in the kind of optical profile grinding machine fitted with projection apparatus as its optical system proceeds perhaps somewhat faster, but at the expense of absolute exactness.

The present invention brings forth an optical profile grinding machine in which are incorporated the advantages of observation by both kinds of optical systems, while the disadvantages are avoided, i. e. the rather slow work under observation by microscope and the less exact work under observation by projection apparatus.

In my invention I am using an optical profile grinding machine in which the axis of an optical system, passes along and traces the desired shape of the form-gauge or form-tool under the guidance of a mechanical device, which is made to follow a drawn pattern.

In order to accomplish the above process it is the first object of my invention to provide the said machine with means to observe the point of grinding by optical projection. For this purpose I use an illuminating device of great intensity of light, the rays of which pass through a set of optical lenses upon a projection plane or screen.

A second object of my invention is to provide the said machine with a new and useful device which allows observation of a given point of grinding by means of two kinds of optical systems, i. e. observation by microscope or observation by means of optical projection, each kind of observation being used independently of the other at the choice of the operator. Therefore on a slide or turntable used as a frame is mounted the upper part of a microscope and also the upper set of lenses of the apparatus for optical projection. This frame can be shifted into two positions so that either the upper part of the microscope, or the upper set of the lenses of the apparatus for the optical projection device (which ever is desired) can rest over the lower part of the optical system.

Other objects of my invention are explained as they occur in the following description and in the drawings appended.

In the drawings

Fig. 1 shows a front view of an optical profile grinding machine equipped with means for observation by projection,

Fig. 2 shows a view from above of Fig. 1,

Fig. 3 shows a section of the optical system in the pantograph mounting and a view of the projection device,

Fig. 4 shows a section of two upper parts of the optical system mounted on a gangway,

Fig. 5 shows a view from above of the pantograph system and of a turntable with two upper parts of the optical system.

On base 11 there is a structure on which the form-gauge or form-tool is placed. This structure consists of a housing 12 which is fastened to the base and in which is a bevel wheel 13. This wheel can be turned by means of a second bevel wheel 14, which is fastened to the end of a shaft 15. To the other end of the shaft 15 is fastened a hand wheel 16. The bevel wheel 13 is connected with an internally threaded cylinder 17. This cylinder when turned by means of the hand wheel 16 screws a spindle 18 up and down which spindle supports a hollow shaft 19. This shaft moves within the stationary housing 20. On the upper end of the shaft 19 there is a slide 21 which can be moved to the right or left by means of a spindle 22 and a crank 23. Across the slide 21 there is another slide 24 with a table 24a. This slide 24 with the table 24a can be moved to and fro by means of a spindle 25 and a crank 26. The form-gauge or form-tool 27, to be ground can be clamped on top of the said table 24a.

Facing this structure there is a construction on which the grinding-disk is movably mounted. This construction consists of the following parts:

On the base 11 is a stationary platform 28. On this platform 28 is rotatably mounted a gangway 29 on which moves a slide 30 to and fro. This slide 30 is moved by means of a spindle 30a and crank 30b. Across the slide 30 there is another slide 31 which slide moves by means of a spindle 31a and a crank 31b. Upon this slide 31 there is a housing 32 for the gears. At the rear of this gear box 32 there is a driving mechanism, for instance an electromotor 32a which drives the grinding disk 33. This grinding disk 33 is mounted on a slide 34 which slide is mounted movably on the front of an arc-like frame 35 and travels up and down by means of a lever-device (not shown). The gangway 29 and its super-structure, i. e. the gear-box 32 and the arc-like frame 35 and the slides 30 and 31 and the grinding-disk 33 can be turned around on the stationary platform 28 by means of a spindle 36.

Projecting from the side of the base 11 there is an arm 37 supporting a stand 38. On top of this stand 38 is a drawing board 39 on which a drawing 40 is stretched. This drawing 40 shows the shape 40a of the profile to be ground on a very much enlarged scale.

From the base 11 extends upwards a column 41. On the upper end of this column 41 is fastened at a right angle an arm 42 on which is mounted a pantograph system including a tracing device which when moved along the lines of the pattern-drawing, produces a similar motion of the axis of the optical system. This pantograph system consists of a short arm 43 parallel to a

long arm 44 and of two parallel connecting rods 45 and 46. In the free end of the rectangular arm 42 is a hole into which is movably fitted an outer bushing 47. To the top of this outer bushing 47 is fastened the connecting rod 46. Within the outer bushing 47, but excentrically to its center, there is movably fitted an inner bushing 48 to which is fastened the short arm 43. This short arm 43 is connected with the long arm 44 by the connecting rod 45. Excentrically to the center of the inner bushing 48 there is a hole into which is fitted a lower set 49 of an optical system containing the objective lenses. The end of the long arm 44 is provided with a device 50 which traces the contours of the drawing. Over the hole in the bushing 48 is a projection device. This device consists of a frame 51 which carries a set of projection lenses 52, a mirror 53 and a plane or screen 54 upon which to project. It is an advantage to have the projection device provided with an attachment 55 for a magnifying glass. In order to have no light entering from the outside upon the projection device the latter is covered by a casing 56.

The optical profile grinding machine has two illuminating devices. One of them is within the base 11. It consists of a source of illumination 57 and above it a set of lenses 58. These lenses concentrate the rays upon the point of grinding from below and produces a deep shadow on the screen or projection plane 54.

Another illuminating device is attached to the lower side of the rectangular arm 42. It consists of one or more sources of illumination 59 which throw their rays upon the upper side of the form-tool or form-gauge. The collected rays of this device are of such intensity that they reflect towards the optical system and then produce a projection of the form-gauge or form-tool at the screen or plane.

The machine functions as follows:

After having clamped the form-tool or form-gauge on the work-table 39 and after having stretched the drawing of the pattern desired on the drawing board 34, the tracing device 50 on the end of the long arm 45 of the pantograph is moved from a starting point to a further point to be ground. The pantograph system moves the axis of the optical system to that point of it to which the work-piece is to be ground, in other words the axis of the optical system marks the position of the point to which the form-tool or form-gauge is to be ground. This point is observed simultaneously by means of the projection device. On the screen or projecting plane this fixed point and the central point of the image are one. It can be marked by a reticule drawn upon the screen or the fixed point can appear projected on the screen or plane. The point of the pattern line traced by means of the tracing device at the free end of the long pantograph-arm, and the actual point on the form-tool or form-gauge fixed by the optical axis, and the central-point of the image on the screen—these three coincide. Now, by illuminating the form-gauge or form-tool from below or from above the image of the unfinished form-gauge or form-tool extends beyond the central point on the screen, and this part which extends must be ground away. For this purpose the grinding disk while rotating moves up and down and must be gradually moved in against the edge of the form-tool or form-gauge by means of cranks until it has ground off the extending parts of the form-gauge or form-tool, i. e. until the

finished point of the workpiece coincides with the fixed point on the screen. Then a further point of the pattern is traced and this process is repeated. In this way the optical axis strikes each time a point on the form-gauge or form-tool which lies besides the last one ground until the repeated grinding operation has finished the desired workpiece.

The ratio of the enlargement of the image on the screen is about 20 to 1; that is to say, the area shown as silhouette on the projection plane is about 20-times greater than the area covered by the objective lenses of the optical system. Observation on such an enlargement does not always satisfy the demands of required exactness. Therefore in addition to the projection device I use a microscope for observing the point to be ground, which is capable of a greater ratio of enlargement than 20 to 1. The dual device for the two kinds of observation are mounted on one and the same frame, each in turn to be used as the upper part of the optical system of either the projection device or the microscope.

For such a device I use a lower part 60 of the optical system fitted into the bushing 48 of the machine described. The head of this bushing 48 is constructed as a gangway 61 for a slide 62 which slide is used as a frame to carry two upper parts of the optical system consisting of an upper set of lenses 63 of a microscope at one end of the frame and also a set of lenses 64 with mirror 65 to complete the device of a projection apparatus on the other end of the frame. On the gangway 61 are two stops 66 and 67 to limit the scope of motion of the slide. If the end of the slide 62 which carries the set of lenses 64 with mirror 65 is moved over the lower part of the optical system until it strikes the stop 66, the projection apparatus is completed, and the spot to be ground may be observed as silhouette on the projection plane. The distance of the plane from the mirror 65 can be adjusted in order to produce sharp and clear images. The slide when in the position to complete the projection apparatus is arrested by means of a tapered pin 68 which passes through the hole 62a in the slide 62 into a hole 70 of the gangway 61.

If the end of the slide 62, which carries the upper set of lenses 63 of the microscope is moved over the lower part 60 of the optical system until it strikes the stop 67 the microscope system of observation is completed. For this purpose withdraw the pin 68 from the hole 70 and move the slide 62 till it strikes the stop 67 and insert the pin 68 through hole 62a into hole 69. The microscope part for observation now rests over the lower part 60 of the optical system (see Fig. 4), and the spot to be ground may be observed by means of the microscope.

Instead of using a slide 62 as a frame on which the upper parts 63 and 64-65 are mounted, a turntable 73 may be used. This design is shown in Fig. 5. The upper end of the inner bushing has been shaped into a flange and united into one piece with the short arm 75. A bolt 74 is screwed into this flange acting as a pivot around which the turntable is rotatorily mounted. This turntable 73 carries the said two upper parts of the optical system, namely: an upper set of lenses 76 to complete the microscope and a set of lenses 77 with mirror 78 to complete the projection apparatus. Each of the two upper parts is mounted on an arc or circle, the axis of which lies in the center of the bolt 74. By turning the turntable 73 either the upper part of the micro-

scope or the upper part of the projection apparatus completes with the lower part of the optical system 60 the desired means of observation.

Two stops 79 and 80 will halt the turntable 73 in its desired position for observation and this position can be secured by means of a tapered pin 81 in much the same way as is used in case of the slide.

The work with an optical profile grinding machine fitted with the dual system of observation described above is as follows:

The mechanical operation of the machine is the same as is described above in the machine with only the projection device. However the observation of the grinding process can be made either by means of the projection apparatus or by means of the microscope. If the projection apparatus is desired the frame supporting the two upper parts of the optical system is brought in the position where the set of lenses with the mirror complete the projection device. Then the silhouette of the point to be ground is projected on the plane or screen and the operator may observe it while grinding the spot to within a fraction of the desired point to be reached. In order to observe the grinding process from now on with a greater exactness the operator shifts the frame which supports the two upper parts of the optical system in the position where the upper set of lenses complete the microscope. The observation of the grinding process can be observed from this point on with a greater exactness because the ratio of the enlargement of the microscope being much greater than that of the projection apparatus it will effect a much greater exactness for the finishing work on the point ground.

In this way the advantages of a machine having only a microscope to observe each individual spot of the grinding process, and of a machine where the entire workpiece is projected on a screen, are combined, while the disadvantages pertaining to each machine when used independently are avoided.

I claim:

1. An optical profile grinding machine for the grinding of form-gauges or form-tools said machine consisting of a base, a structure on which the form-gauge or form-tool is clamped, a construction facing this structure on which the grinding disk is movably mounted, a drawing board on which is stretched a pattern-drawing in great enlargement, a long arm and a short arm and two connecting rods, which parts form a pantograph-system, a tracing device at the free end of the long arm for tracing point by point the lines on the pattern drawing and means mounted on the short arm to watch the path of the grinding-disk on the form-tool or form-gauge and apparatus to complete the means to observe in enlargement point by point the path of the grinding-disk.

2. An optical profile grinding machine for the grinding of form-gauges or form-tools said machine consisting of a base, a structure on which the form-gauge or form-tool is clamped, a construction facing this structure on which the grinding-disk is movably mounted, a drawing-board on which may be stretched an enlarged pattern-drawing, a long arm and a short arm and two connecting rods, forming a pantograph-system, a tracing device at the free end of the long arm for tracing point by point the lines on the pattern drawing, and a set of lenses mounted into the short arm of the pantograph and form-

ing the lower part of an optical system for observing the path of the grinding-disk on the form-tool or form-gauge, an upper part of a projection apparatus which completes the optical system and which under enlargement allows observation point by point of the path of the grinding-disk and illumination devices to illuminate the point of grinding.

3. An optical profile grinding machine for the grinding of form-gauges or form-tools said machine consisting of a base, a structure on which the form-gauge or form-tool is clamped, a construction facing this structure on which the grinding-disk is movably mounted, a drawing-board on which may be stretched an enlarged pattern-drawing, a long arm and a short arm and two connecting rods, forming a pantograph-system, a tracing device at the free end of the long arm, for tracing point by point the lines on the pattern-drawing, and a set of lenses mounted into the short arm of the pantograph and forming the lower part of an optical system for observing the path of the grinding-disk on the form-tool or form-gauge, a set of lenses and a mirror, and a projection plane and a frame which carries these lenses, mirror and projection plane as the upper part of the optical system which upper parts complete with the lower part of the optical system a projection apparatus which under enlargement allows observation point by point of the path of the grinding-disk and sources of illumination to illuminate the point of grinding both from above and from below.

4. An optical profile grinding machine for the grinding of form-gauges or form-tools, said machine consisting of a base, a structure on which the form-gauge or form-tool is clamped, a construction facing this structure on which the grinding-disk is movably mounted, a drawing-board on which may be stretched an enlarged pattern-drawing, a system having a tracing-device for tracing point by point the lines on the pattern-drawing, a set of lenses forming the lower part of means for observing the path of the grinding-disk on the form-tool or form-gauge and a dual device for observation of the point of grinding, having one upper set of lenses which with the lower set of lenses, complete a microscope, and a second upper set of lenses which, with the lower set of lenses, complete a projection apparatus, and illumination-devices for illuminating the point of grinding.

5. An optical profile grinding machine for the grinding of form-gauges or form-tools said machine consisting of a base, a structure on which the form-gauge or form-tool is clamped, a construction facing this structure on which the grinding-disk is movably mounted, a drawing-board on which an enlarged pattern-drawing may be stretched, an arm fastened at right angle on top of the column, an outer bushing rotatably

mounted into the free end of this arm, an inner bushing rotatably mounted within the outer bushing, a pantograph system consisting of a short arm, fastened on top of the inner bushing, a first connecting rod linked on the free end of the short arm, a second connecting rod, fastened on top of the said outer bushing and parallel to the first connecting rod, and a long arm linked to the free ends of the connecting rods and parallel to the short arm, a tracing-device mounted on the free end of the long arm of said pantograph-system, and a set of lenses mounted into the short arm of the pantograph and forming the lower part of means to watch the path of the grinding-disk on the form-tool or form-gauge, a gangway constructed on top of the inner bushing, a slide movably mounted on said gangway which slide carries at one end one upper set of lenses to complete a microscope and at the other end a second upper set of lenses and a mirror and a projection plane to complete a projection apparatus, means to limit the scope of motion of said slide and sources of illumination for illuminating the point of grinding both from above and from below.

6. An optical profile grinding machine for the grinding of form-gauges or form-tools said machine consisting of a base, a structure on which the form-gauge or form-tool is clamped, a construction facing this structure on which the grinding-disk is movably mounted, a drawing-board on which may be stretched an enlarged pattern-drawing, an arm fastened at right angle on top of the column, an outer bushing rotatably mounted into the free end of this arm, a pantograph-system consisting of a short arm which short arm is a part of a flange at the upper end of an inner bushing which inner bushing is rotatably mounted within the outer bushing, a first connecting rod linked on the free end of the short arm, a second connecting rod fastened on top of the said outer bushing and parallel to the first connecting rod and a long arm linked to the free ends of the connecting rods and parallel to the short arm, a tracing-device mounted on the free end of the long arm of said pantograph system, and a set of lenses mounted into the short arm of the pantograph forming the lower part of means to watch the path of the grinding-disk on the form-tool or form-gauge, a turn-table rotatably mounted around a bolt over the flange at the upper end of the inner bushing of the pantograph, which turn-table carries one upper set of lenses to complete a microscope and a second upper set of lenses and a mirror and a projection plane with reticule to complete a projection apparatus, means to limit the scope of motion of said slide, and sources of illumination for illuminating the point of grinding both from above and from below.

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