

June 27, 1939.

R. M. WOHLFARTH

2,164,169

OPTICAL PROFILE GRINDING MACHINE

Filed July 21, 1938

2 Sheets-Sheet 1

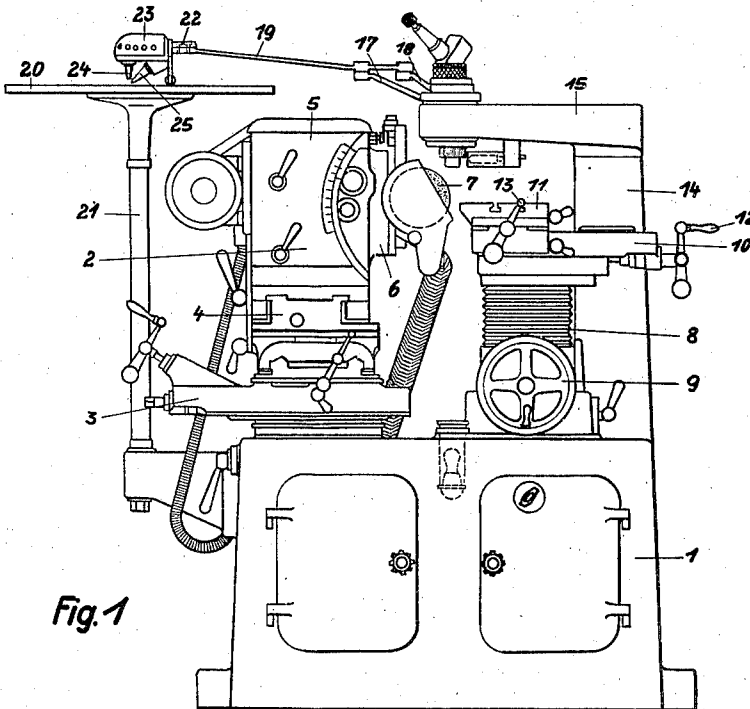


Fig. 1

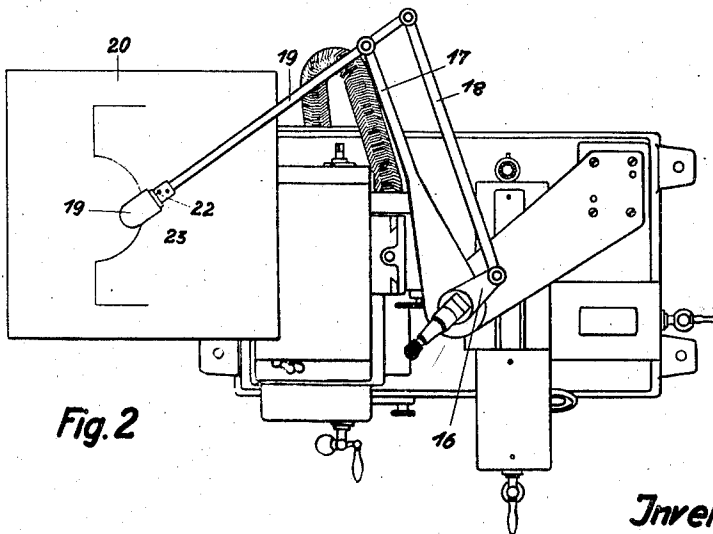


Fig. 2

Inventor
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2 Sheets-Sheet 2

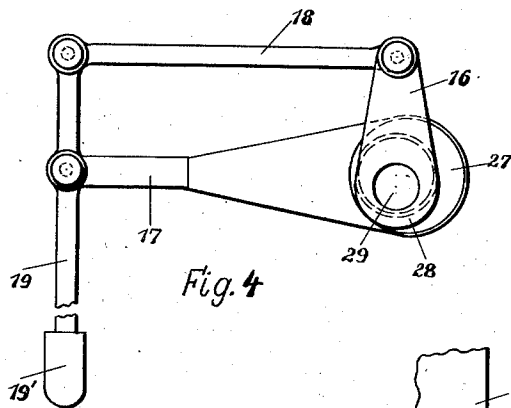


Fig. 4

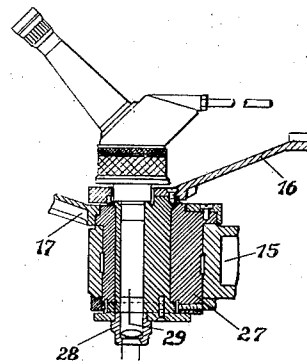


Fig. 5

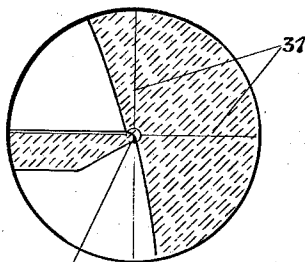


Fig. 6

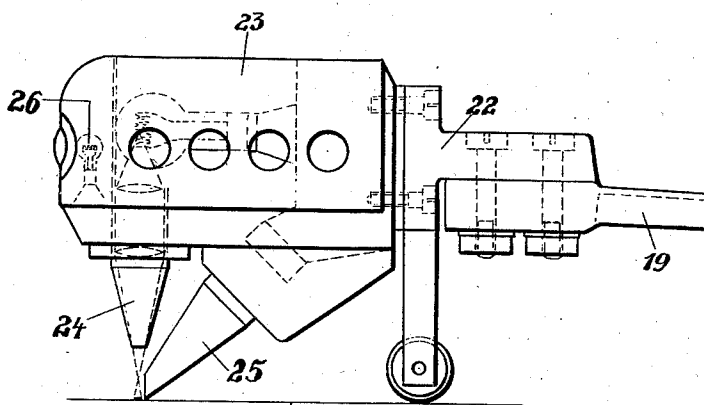
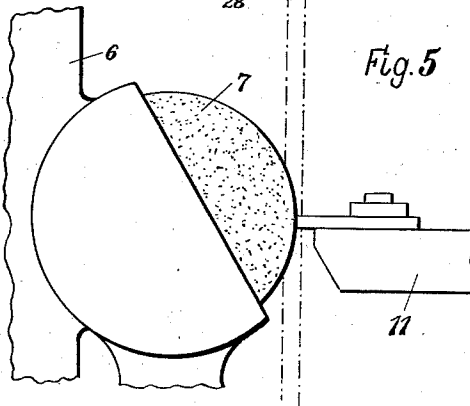


Fig. 3

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UNITED STATES PATENT OFFICE

2,164,169

OPTICAL PROFILE GRINDING MACHINE

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Application July 21, 1938, Serial No. 220,438
 In Germany September 24, 1937

12 Claims. (Cl. 51-165)

My present invention refers to optical profile grinding machines.

These machines are used for grinding of form-gauges and form-tools. During the grinding the grinding-wheel is moved by the operator against these form-gauges or form-tools, and this motion of the grinding-wheel is observed by means of an optical system, for instance a microscope, which is fixed above the point where the grinding wheel makes contact. In order to maintain the axis of this optical arrangement directly and vertically above the place of contact, it is eccentrically mounted in rotatable bushings. Corresponding to the path in which the optical axis is moving, the grinding-wheel is manipulated by the operator and grinds the form-gauges or form-tools.

The motion of the optical system, is effected by means of a pantograph in the shape of a parallelogram. Such a pantograph had been described by K  ppler in the American Patent No. 1,811,940. A link system is rotatably mounted on a fixed pole and a tracing point or pin traces the shape or line of a pattern which is drawn in an enlarged scale on a drawing-board which is fastened to the machine. On this drawing-board the operator guides this tracing point or pin along the enlarged pattern-line a short distance at a time and this act checks the optical system. Whenever the tracing point or pin has been moved into a new position, the grinding-wheel is moved by the operator against the form-gauge or form-tool which is being ground till the axis of the optical system is reached.

The pattern usually is drawn on paper and the pattern-lines are made with pencil or India-ink. The tracing point has consisted of a steel needle-point mounted on the tracing end of the pantograph. As a consequence of the repeated tracing along the pattern-line with the point of this steel needle, the drawing is often ruined after a few tracings. It is often necessary to draw a new pattern for every operation of the machine. This is troublesome, expensive and entails considerable loss of time. Since the operator stands sideways to the drawing board it is difficult for him to trace with the steel point the pattern line accurately and clearly distinct, for his line of vision is in an acute angle to the drawing. Even if the operator tries to be minutely exact it happens that the steel point deviates somewhat from the pattern line, and an error in the position of the steel point is likewise an error on the form-gauge or form-tool which is being ground or shaped.

individual discrepancies and the gradual destruction of the pattern.

In order to prevent this I use a photo-electric cell to trace the pattern lines. This photo-electric cell is enclosed in a box. This box contains in addition an electric lamp to illuminate the point on the line, of the drawing which is being traced, and is fastened to the tracing end of the pantograph. The way of attaching the photo-electric cell and the lamp on the pantograph is another part of my invention. A further object of my invention is the use of an optical or acoustical signal to indicate when the exact position of the tracing point upon the pattern is reached. These and other objects of the invention are explained in detail in the description below, and in the accompanying drawings. In these:

Fig. 1 is a front view of the optical profile grinding machine,

Fig. 2 is a view from above of the optical profile grinding machine and

Fig. 3 is a part of Figure 1, in an enlarged scale.

Figure 4 is a plan view of the pantograph forming a part of the device;

Figure 5 is a view, partly in section, illustrating the eccentric bushings in which the optical system of the device is mounted; and

Figure 6 is a diagrammatic illustration of the appearance of the grinding point in use as observed through the optical system.

The new machine consists of an ordinary grinding machine, an optical device such as a microscope, a pantograph and a photo-electric attachment. A large base 1 supports a grinding-apparatus 2 consisting of a lower plate 3 and an upper plate 4, which plates are arranged crosswise on top of one another. The plate 4 is connected with a gear box 5, on which a grinding carriage 6 is movable up and down, carrying the grinding-wheel 7. Both plates 3 and 4 are controlled by the operator by means of cranks and the grinding-wheel 7 is guided thereby toward the form-gauge or form-tool.

Facing the grinding-wheel 7 a column 8 is mounted on the base 1, a wheel 9 turned by hand moves this column 8 up and down by means of a gear (not shown). Above the column 8 a carriage 10 is mounted which moves to and fro crosswise upon the carriage 10 a table 11 is mounted which may be moved in a right angle to the grinding wheel 7. On this table 11 the said form-gauges or form-tools are held or clamped by means of screws or

It is a part of my invention to prevent these

other clamping devices. The position of the form-gauges or form-tools can be adjusted by the operator with the cranks 12 and 13.

Furthermore part of the frame 1 is an upright 5 14 carrying an arm 15. In a hole of this arm 15 the said optical system is positioned so that its optical axis always may be maintained vertically above the point of contact with the grinding-wheel. This is made possible by fitting into the 10 hole in the arm 15 a rotatable bushing 27 provided with a bore, the longitudinal axis of which is eccentric to the equivalent axis of the hole in arm 15. The bushing 27 is attached to the parallel link 17 of the pantograph. Within bushing 27 a second bushing 28 is rotatably mounted, which is also provided with a bore 29 eccentric to the bore of bushing 27. Bushing 28 is attached to the short arm 16 of the pantograph. In bore 29 is fitted the lower part of the tube of the 20 microscope, while the upper part is arranged on top of bushing 28, as best shown in in Figure 5.

To further assist the operator of the grinding-machine an electric bulb may be contained within base 1, the rays from which, after being 25 rendered parallel by means of a suitable condensing lens, may be projected upon the form-gauge or form-tool clamped on the table 11 and upon the grinding-wheel 7, and ultimately upon the projecting lens of the microscope.

30 The motion of the optical system is effected by a pantograph of the parallelogram type. This pantograph consists of short arm 16, the parallel links 17, 18 and the long arm 19. The short arm 16 holds the optical system to and within a fixed 35 point by means of eccentric bushings fitted into each other. The tracing end 19' of the long arm 19 swings over a drawing board 20 on top of a stand 21 which is fastened to the machine base 1.

On this tracing end is a connecting-piece 22 40 to which a box 23 is screwed. In the inside of this box a photo-electric cell and a lamp are arranged. The lamp serves to illuminate the point which is being observed by the photo-electric cell. This light passes through the tube 45 24 and the reflected rays of the radiated point pass back to the photo-electric cell through tube 25. A second lamp 26 is placed within the box, to give a signal when the electric tension of the photo-electric cell is changed.

50 The connecting piece 22 has a projection which is fitted out with either a roller or a ball, which serve to maintain a fixed distance between the tracing device and the drawn pattern.

The method of operating the optical profile 55 grinding machine is as follows:

The form-gauge or form-tool which is to be ground, is clamped to table 11. The shape of the form-gauge or form-tool to be ground which has been drawn very much enlarged to serve as 60 a pattern is mounted on the drawing board. On this pattern the photo-electric cell is moved to a starting-point.

The lines of the drawing should be very fine, for the adjustment of the tracing point must be 65 effected very accurately. In an enlargement, for instance 50 to 1, a line of a thickness of $\frac{1}{16}$ inch would represent actually (i. e. on the form-gauge or form-tool), 0.0006 inch. This thickness of line is too great for a correct form-grinding. A 70 deviation within a line of a thickness of $\frac{1}{16}$ inch would result in too great an error upon the form-gauge or form-tool to be ground. Usually a greater accuracy is demanded and the lines should be made finer. For the old way of tracing 75 these fine lines are not practical, because the

operator cannot see them well enough and will therefore not always be able to guide the tracing point accurately and the process of grinding is very much slowed up. To correct these shortcomings my present invention introduces a new 5 tracing apparatus—the photo-electric cell. This cell becomes electrically active if it is guided above a line having a thickness of 0.008 inch. This thickness represents on the form-tool or form-gauge 0.00016 inch. The possible error 10 made by the photo-electric cell is accordingly four times smaller than if the pattern were traced by the old style steel point.

The box 23 attached to the free end of the arm 19 is guided by the operator along the pattern- 15 lines, just like the steel point was guided i. e. a short distance at the time. The lamp inside the box illuminates the said lines with great intensity but only at the point which is being traced. When the electric rays touch the black line a 20 great deal of light is absorbed and comparatively few rays pass into the photo-electric cell. These few rays do not generate an electrical current in the photo-electric cell. Whenever the illuminated point of the drawing meets a white area, 25 a great many rays will pass into the photo-electric cell and generate an electric current, strong enough to operate an alarm-signal. The little lamp 26 serves as such an alarm-signal. If this lamp 26 flashes up, the operator notices 30 that the position of the tracing point is not in its correct place and therefore he must adjust it. If the accurate position is obtained the lamp 26 goes out. Then the tracing point is exactly above the line of the pattern and the axis of the 35 optical system points to the very point to which it should be ground.

This point of the form-tool or form-gauge is observed by the operator by the aid of an optical system for instance a microscope. The axis of 40 this optical system is the central point where two lines cross each other at a right angle like an astronomical reticule. The operator watches the edge to be ground on the work-piece through the microscope and guides the grinding-wheel to the 45 point where its grinding edge coincides with the reticule or optical axis. When this point is reached the photo-electric device is moved on the pattern to the next point to be ground. This motion produces a shifting of the pantograph 50 system and a rotation of bushings 27 and 28 so that the optical axis of the microscope is shifted to the corresponding point on the form-gauge or form-tool. This point is now observed by the operator who controls the grinding-disk while it 55 operates against the form-gauge or form-tool until it has been correctly ground at this new point. This process is repeated again and again until the desired shape has been obtained.

Instead of the flashing of an optical signal an 60 acoustical signal may be installed, for instance a bell. This bell would ring when the tracing point is not in its exact position on the black line. The optical or acoustical alarm device can be 65 attached to the box 23 or to any place of the machine, where it can be observed by the operator.

Having now explained my invention in detail I claim:

1. In an optical profile grinding machine consisting of the Universal type, of an adjustable optical system for observing the grinding, of a drawing board which holds an enlarged pattern and of a pantograph in shape of a parallelogram for transferring the said pattern into the line of 75

motion of the optical system by means of a tracing point, a photo-electric cell on the pantograph for tracing piece by piece the lines of the said enlarged pattern, and means for indicating the correct position of the tracing point of the pantograph.

2. In an optical profile grinding machine consisting of a grinding machine of the Universal type, of an adjustable optical system for observing the grinding, of a drawing board which holds an enlarged pattern and of a pantograph in shape of a parallelogram for transferring the said pattern into the line of motion of the optical system by means of a tracing point, a photo-electric cell on the pantograph for tracing piece by piece the lines of the said enlarged pattern, means for holding the said photo-electric cell on the pantograph and means for indicating the correct position of the tracing point of the pantograph.

3. In an optical profile grinding machine consisting of a grinding machine of the Universal type, of an adjustable optical system for observing the grinding, of a drawing board which holds an enlarged pattern, and of a pantograph in shape of a parallelogram having a short arm for holding the said optical system adjustably by means of eccentric bushings and having a long arm for holding the tracing means for transferring the said pattern into the line of motion of the optical system, a photo-electric cell on the pantograph for tracing piece by piece the lines of the said enlarged pattern, a connecting piece for holding the said photo-electric cell on the long arm of the pantograph, and means for indicating the correct position of the tracing point of the pantograph.

4. In an optical profile grinding machine consisting of a grinding machine of the Universal type, of an adjustable optical system for observing the grinding, of a drawing board which holds an enlarged pattern and of a pantograph in shape of a parallelogram for transferring the said pattern into the line of motion of the optical system by means of a tracing point, a photo-electric cell on the pantograph for tracing piece by piece the lines of the said enlarged pattern, means for illuminating the part of the pattern, to be traced and means for indicating the correct position of the tracing point of the pantograph.

5. In an optical profile grinding machine consisting of a grinding machine of the Universal type, of an adjustable optical system for observing the grinding, of a drawing board which holds an enlarged pattern, and of a pantograph in shape of a parallelogram for transferring the said pattern into the line of motion of the optical system by means of a tracing point, a photo-electric cell on the pantograph for tracing piece by piece the lines of the said enlarged pattern, an electric lamp for illuminating the part of the pattern to be traced and means for indicating the correct position of the tracing point of the pantograph.

6. In an optical profile grinding machine consisting of a grinding machine of the Universal type, of an adjustable optical system for observing the grinding, of a drawing board which holds an enlarged pattern, and of a pantograph in shape of a parallelogram for transferring the said pattern into the line of motion of the optical system by means of a tracing point, a photo-electric cell for tracing piece by piece the lines of the said enlarged pattern, means for illuminating the part of the pattern to be traced, means

for indicating the correct position of the tracing point of the pantograph, means for housing the said photo-electric cell and the illuminating—and indicating means, and means for connecting this receptacle to the pantograph.

7. In an optical profile grinding machine consisting of a grinding machine of the Universal type, of an adjustable optical system for observing the grinding, of a drawing board which holds an enlarged pattern, and of a pantograph in shape of a parallelogram having a short arm for holding the said optical system adjustably by means of eccentric bushings and having a long arm for holding the tracing means for transferring the said pattern into the line of motion of the optical system, a photo-electric cell on the pantograph for tracing piece by piece the lines of the said enlarged pattern, an electric lamp for illuminating the part of the pattern to be traced, means for indicating the correct position of the tracing point of the pantograph, a box for housing the said photo-electric cell and the said electric lamp and the means for indicating the correct position of the tracing point and a connecting piece carrying the said box on the long arm, and on said connecting piece means for holding the tracing point in an equal not changing distance from the pattern.

8. In an optical profile grinding machine consisting of a grinding machine of the Universal type, of an adjustable optical system for observing the grinding, of a drawing board which holds an enlarged pattern, and of a pantograph in shape of a parallelogram having a short arm for holding the said optical system adjustably by means of eccentric bushings and having a long arm for holding the tracing means for transferring the said pattern into the line of motion of the optical system, a photo-electric cell on the pantograph for tracing piece by piece the lines of the said enlarged pattern, an electric lamp for illuminating the part of the pattern to be traced, means for indicating the correct position of the tracing point of the pantograph, a box for housing the said photo-electric cell and the said electric lamp and the means for indicating the correct position of the tracing point and a connecting piece carrying the said box on the long arm, and on said connecting piece a rolling projection for holding the tracing point in an equal not changing distance from the pattern.

9. In an optical profile grinding machine consisting of a grinding machine of the Universal type, of an adjustable optical system for observing the grinding, of a drawing board which holds an enlarged pattern and of a pantograph in shape of a parallelogram a photo-electric cell on the pantograph for tracing piece by piece the lines of the enlarged pattern, a lamp for illuminating the part of the pattern to be traced, an electric alarming signal indicating to the operator that the photo-electric cell does not point exactly above the pattern line, a receptacle for housing the said photo-electric cell and the said electric lamp and the means for alarming, and means for connecting this receptacle on the pantograph.

10. In an optical profile grinding machine consisting of a grinding machine of the Universal type, of an adjustable optical system for observing the grinding, of a drawing board which holds an enlarged pattern, and of a pantograph in shape of a parallelogram having a short arm for holding the said optical system adjustably by means of eccentric bushings and having a long arm for holding the tracing means for trans-

ferring the said pattern into the line of motion of the optical system, a photo-electric cell on the pantograph for tracing piece by piece the lines of the said enlarged pattern, an electric lamp for illuminating the part of the pattern to be traced, an electric alarming-signal-lamp for indicating to the operator that the photo-electric cell does not point exactly above the pattern line, a box for housing the said photo-electric cell, the said illuminating lamp, the said electric lamp, and a connecting piece which carries the said box on the free end of the long arm of the pantograph.

11. In an optical profile grinding machine, consisting of a grinding machine of the Universal type, of an adjustable optical system for observing the grinding, of a drawing board which holds an enlarged pattern and of a pantograph in shape of a parallelogram for transferring the said pattern into the line of motion of the optical system, the combination of a photo-electric cell and of the means for illuminating the part of a

pattern to be traced with a drawing of the pattern, which has lines of a thickness of less than one thirty-secondth of an inch.

12. The method of grinding an object to correspond to a pattern which consists of determining a point upon the object to which the grinding is to be carried by positioning a beam of light upon a point of the pattern, observing said point on said object through an optical system and simultaneously manually guiding a grinding means against the object until it has been ground to the point observed, then determining another point upon the object to which grinding is to be carried by shifting the beam of light to another point of the pattern, observing said point upon said object thus determined through the optical system and simultaneously manually guiding the grinding means against the object until it has been ground to this observed point, and then repeating the operation point by point along the pattern as many times as required.

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