

March 11, 1941.

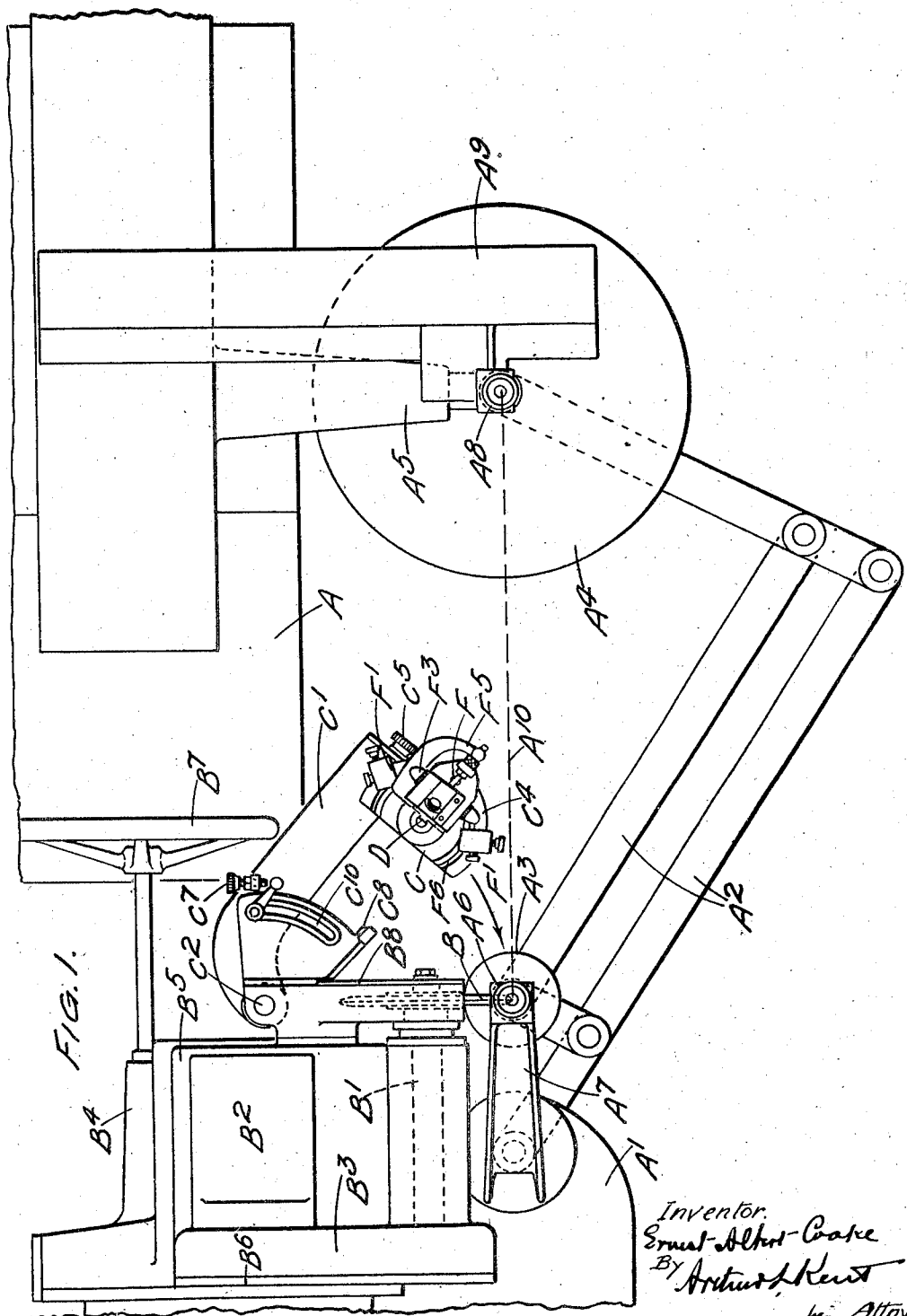
E. A. COOKE

2,234,539

APPARATUS FOR TRUING GRINDING AND ABRASIVE WHEELS

Filed April 10, 1939

7 Sheets-Sheet 1



March 11, 1941.

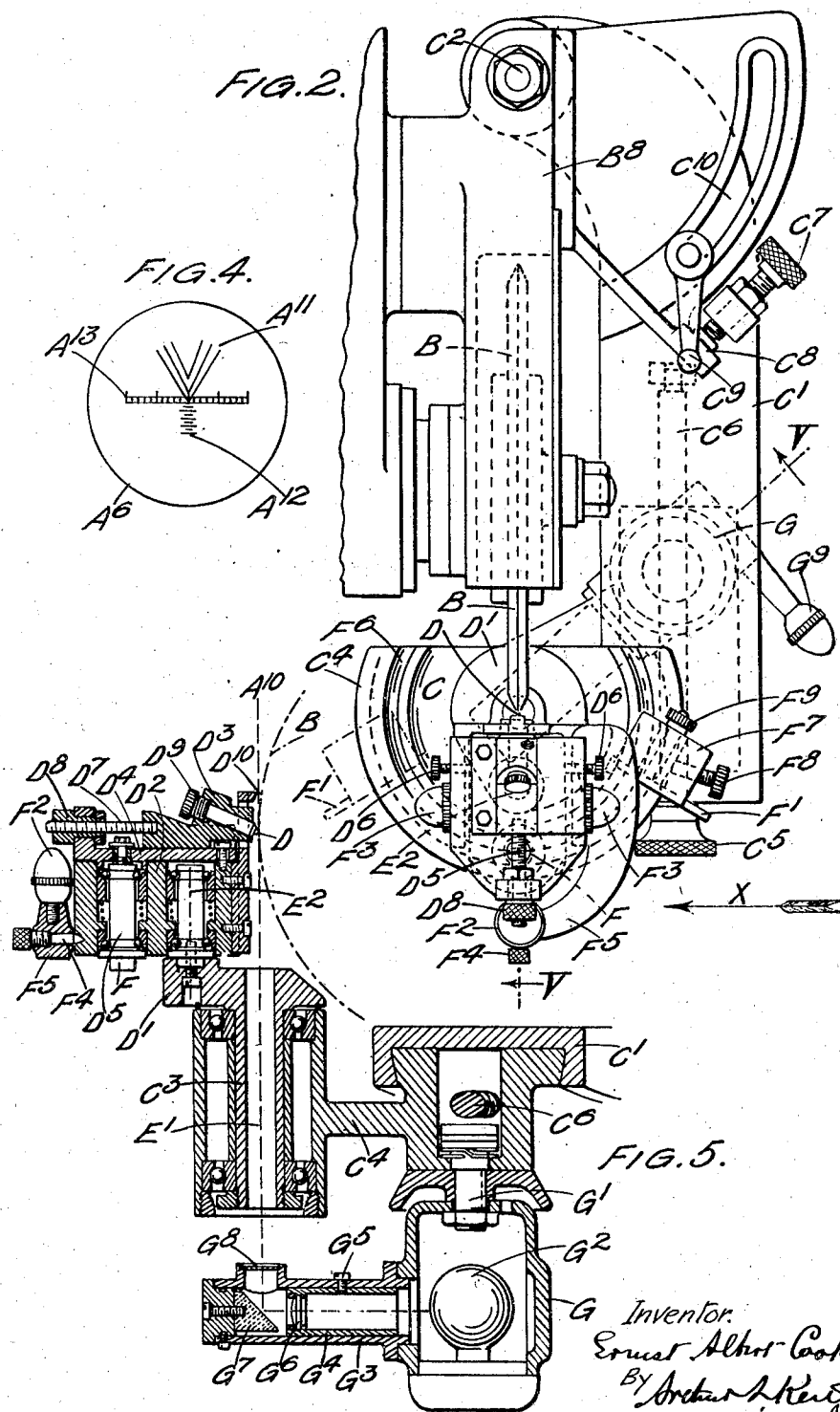
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APPARATUS FOR TRUING GRINDING AND ABRASIVE WHEELS

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7 Sheets-Sheet 2



March 11, 1941.

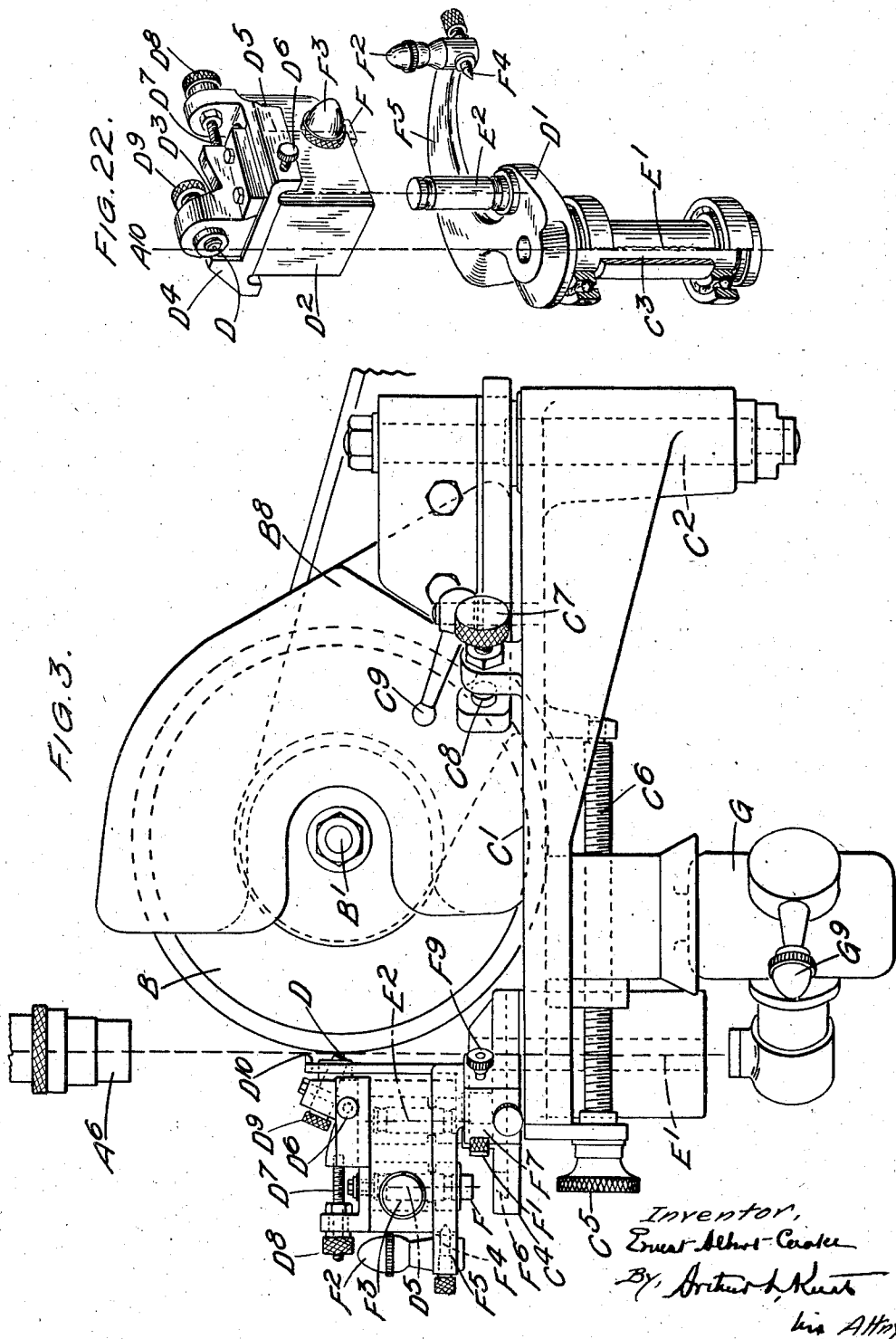
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APPARATUS FOR TRUING GRINDING AND ABRASIVE WHEELS

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7 Sheets-Sheet 3



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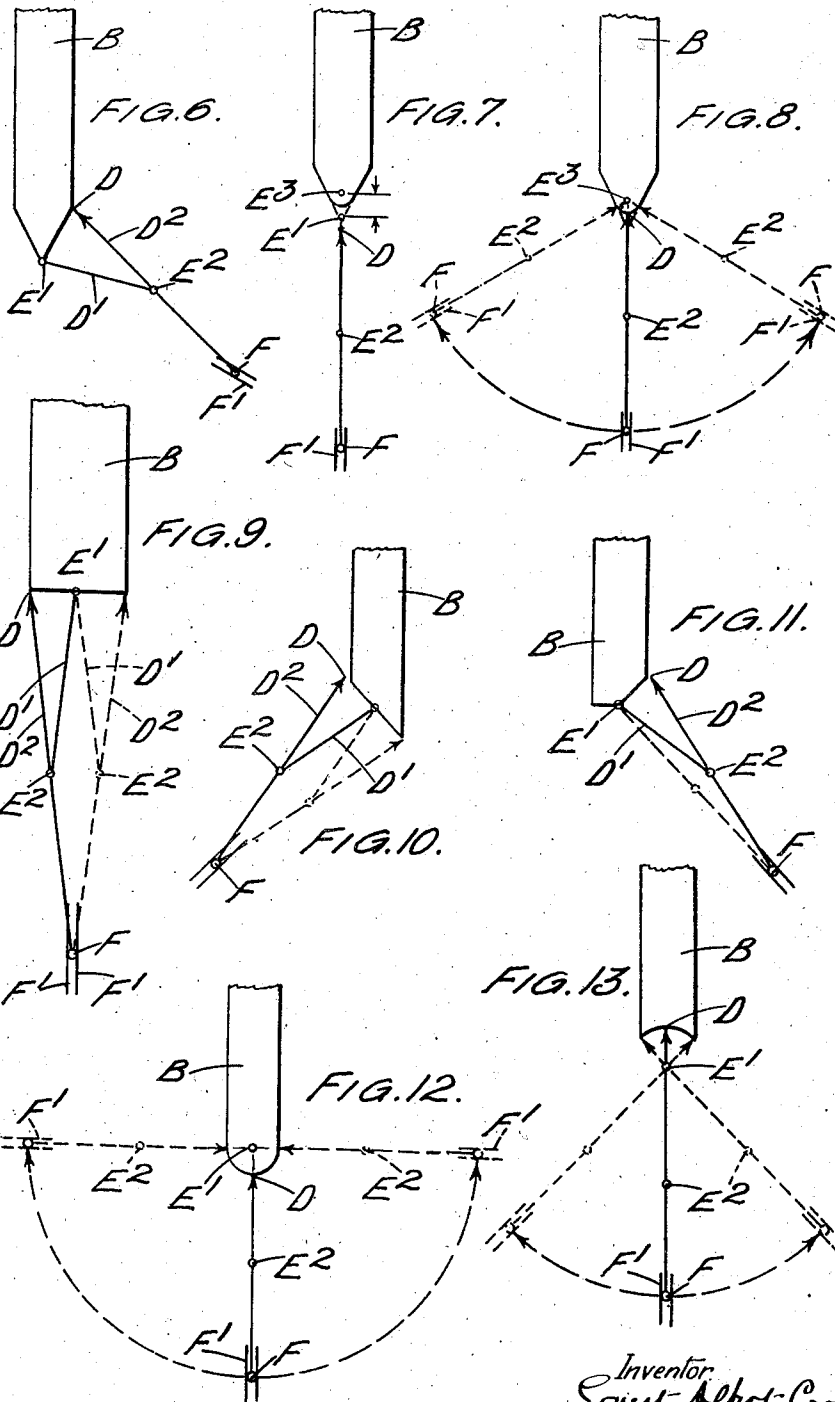
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APPARATUS FOR TRUING GRINDING AND ABRASIVE WHEELS

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7 Sheets-Sheet 4



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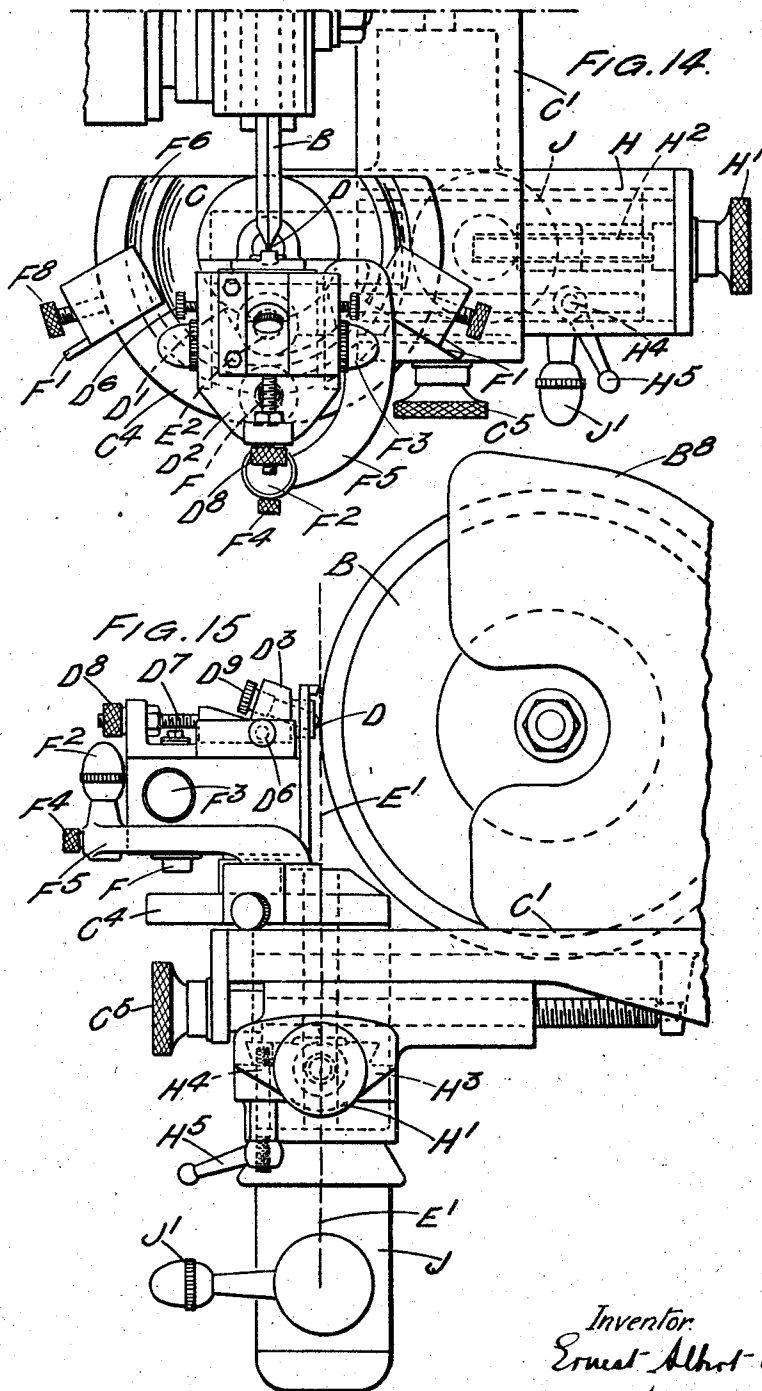
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APPARATUS FOR TRUING GRINDING AND ABRASIVE WHEELS

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7 Sheets-Sheet 5



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APPARATUS FOR TRUING GRINDING AND ABRASIVE WHEELS

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7 Sheets-Sheet 6

FIG. 16.

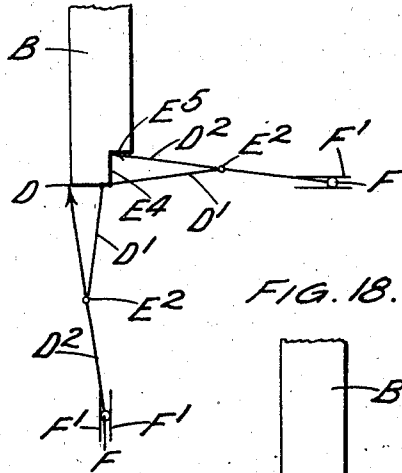


FIG. 17.

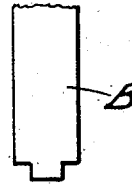


FIG. 18.

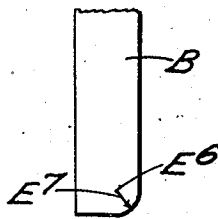


FIG. 19.

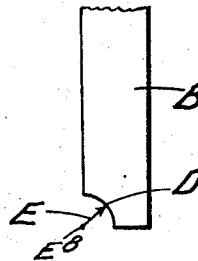
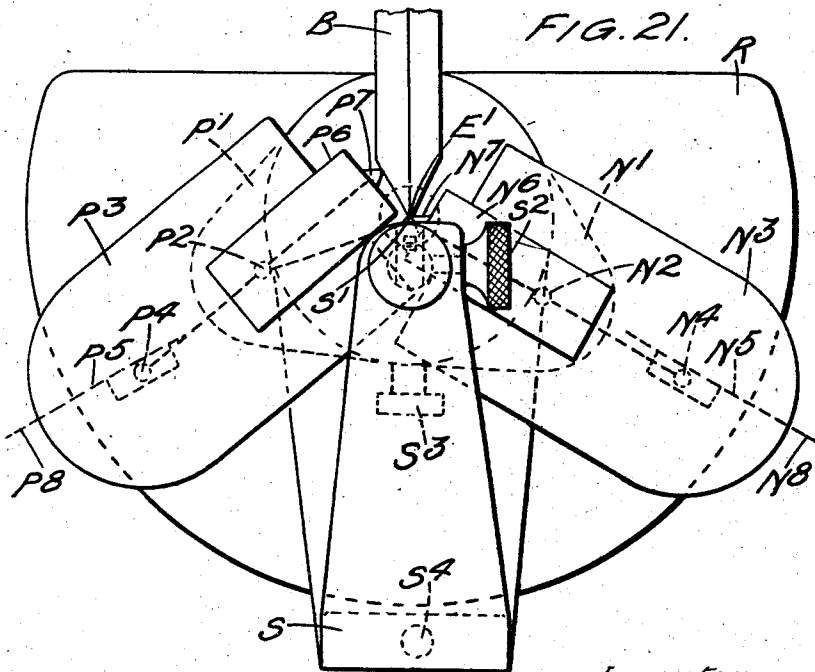


FIG. 21.



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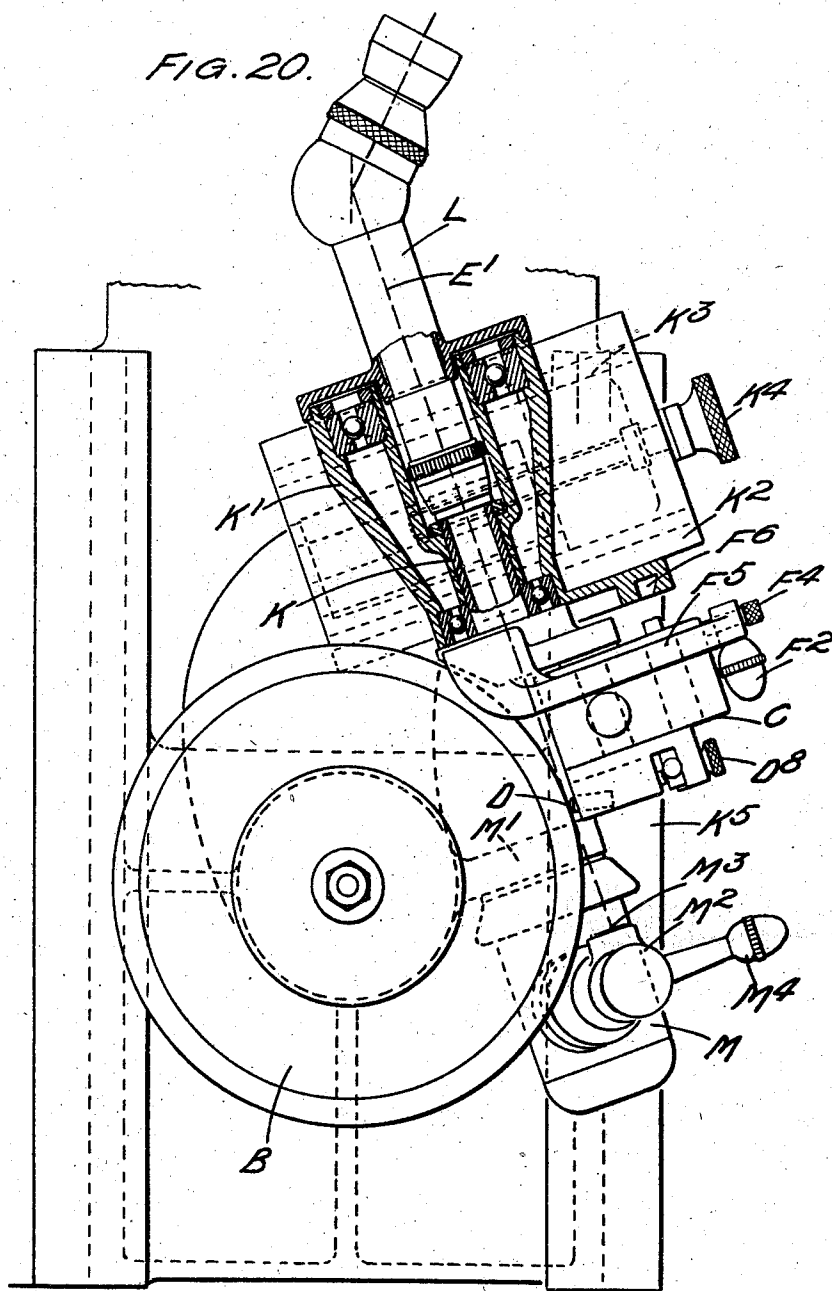
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APPARATUS FOR TRUING GRINDING AND ABRASIVE WHEELS

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7 Sheets-Sheet 7



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UNITED STATES PATENT OFFICE

2,234,539

APPARATUS FOR TRUING GRINDING AND
ABRASIVE WHEELSErnest Albert Cooke, Leicester, England, assignor
to Kapella Limited, Leicester, England, a com-
pany of Great BritainApplication April 10, 1939, Serial No. 266,950
In Great Britain April 11, 1938

16 Claims. (Cl. 125—11)

This invention relates to apparatus for truing grinding and abrasive wheels and the like, for example in grinding and abrading machines.

An object of the invention is to provide a truing unit including a primary link turning about a primary axis and a secondary link turning about a secondary axis on the primary link and carrying a diamond or the like and also a follower which cooperates with a guide or fence arranged in accordance with the form desired for the operative part of the grinding or abrasive wheel.

A further object is to provide straight-line truing by so determining the effective lengths of the links and the arrangement of the guide or fence that when the links are swung about their pivots with the follower in engagement with the guide or fence the diamond or the like is caused to move along a straight-line path. To this end, the distance between the diamond and the secondary axis may normally be equal to the distance between the secondary axis and the follower and also equal to the distance between the primary and secondary axes, the guide or fence being so arranged that the follower in engagement therewith moves radially with respect to the primary axis.

Yet a further object is to provide for adjustment of the diamond or like truing device on the secondary link so as to adjust the distance between the diamond and the primary axis when it is desired to true a curved surface and, for this purpose, means may be provided for locking the primary and secondary links together so that they can turn as a unit about the primary axis.

The frequency with which the grinding wheel of a grinding or abrading machine requires dressing or truing depends upon various factors, for example the coarseness of the abrasive grain, the type of bond employed and the material ground. In most instances the grinding wheel requires truing several times for each article dealt with and it is therefore desirable to avoid the necessity for removing the work from the work support, e. g. a pantograph which serves to locate the work and template or copy, and substituting the truing device on every occasion when truing is necessary. A further object of the invention is to overcome this difficulty by mounting the main supporting arm for the truing unit on the grinding machine in such a manner that the truing unit can be swung at will into or out of its operative position. In this way the work can be removed from the operative position and the truing unit swung into the

operative position on each occasion when truing of the grinding wheel is necessary.

Yet another object of the invention is to obviate the necessity for disturbing the work before truing can be effected by mounting the truing unit directly on a fixed part of the machine, means being provided for adjusting the unit on the said fixed part towards and away from the grinding wheel so that the truing unit lies adjacent to a part of the grinding wheel remote from the work support and truing can be effected without moving the work support or table out of its operative position. Another object of the invention is to provide the truing unit with its own microscope, at least part of the optical system of the microscope being conveniently housed within the pivot of the primary link, the said pivot being hollow for this purpose.

A truing unit according to the invention may be employed in conjunction with engraving machines such as that described in the specification of the United States patent application Serial No. 151,516, and some practical arrangements according to the invention are shown, somewhat diagrammatically and by way of example, in the accompanying drawings, in which—

Figure 1 is a plan showing one form of truing unit mounted on the machine, the truing unit being shown in its inoperative position,

Figure 2 shows the truing unit in plan and on an enlarged scale, the truing unit being in its operative position,

Figure 3 is a side elevation in the direction of the arrow X in Figure 2,

Figure 4 represents the graticule of the microscope included in Figure 3,

Figure 5 is a section on the line V—V of Figure 2,

Figures 6, 7 and 8 illustrate diagrammatically the operation of the truing unit when employed for truing a V-edge of a grinding wheel,

Figures 9, 10, 11, 12 and 13 are similar diagrams illustrating the operation when truing five further forms of grinding wheel,

Figures 14 and 15 show, in plan and side elevation respectively, the mechanism for adjusting the truing unit transversely to the plane of the grinding wheel,

Figures 16, 17, 18 and 19 illustrate, by way of example, five forms of grinding wheel in the truing of which the truing unit is adjusted transversely as described with reference to Figures 14 and 15,

Figure 20 shows, in side elevation, another arrangement according to the invention,

Figure 21 is a plan of yet a further arrangement of the truing unit,

Figure 22 is an exploded view of linkage included in Figs. 1 to 5, 14, 15 and 20.

5 In the arrangement shown in Figure 1 the machine comprises a fixed base A from which projects brackets A¹ to carry pivot bearings for a pantograph A² having an associated work table A³, copy table A⁴ and tracer support A⁵.

10 The tool, in the example illustrated, is shown as a grinding wheel B carried on a horizontal shaft B¹ which is mounted parallel to the primary plane A¹⁰ and is driven by an electric motor (not shown) mounted on a facing B² of a casing B³. The casing B³ is carried on the head of a plunger which can reciprocate up and down in a cylinder forming part of a cross-slide B⁵. The cross-slide B⁵ can be adjusted on a slideway B⁶ in a direction at right angles to the primary plane A¹⁰ by means of a handwheel B⁷. The work table A³ can be moved into and out of the working position shown by swinging the pantograph A² about the brackets A¹. The machine thus far described corresponds to that described in the specification of the said patent application Serial No. 151,516.

A work microscope A⁶ is mounted on a fixed bracket A⁷ and a copy microscope A⁸ is carried on a slide A⁹. A truing unit generally indicated at C is carried by a supporting arm C¹ mounted on a pivot C² carried by the hood B⁸ of the grinding wheel B. The arm C¹ can thus be swung about the pivot C² either to bring the truing unit C into an operative position with respect to the grinding wheel B as shown in Figures 2, 3 and 5, or to swing the truing unit C clear of the grinding wheel B as shown in Figure 1 thus permitting the work table A³ to be moved into the operative position with respect to the grinding wheel B. In this way the truing unit C can be made wholly independent of the work support and truing can be carried out as and when required by merely moving the work out of the operative position and swinging the truing unit C into the operative position.

As shown in Figures 2, 3 and 5 the truing unit comprises a primary link D¹ mounted to pivot on a primary spindle C³ (Figure 5) journaled in a bracket C⁴ carried by the arm C¹, the axis E¹ of the spindle C³ constituting a primary axis which, when the truing unit C is in its operative position, lies in or parallel to the working plane A¹⁰ of the machine. A secondary link D² is mounted to pivot about a secondary axis E² on the primary link D¹. The secondary link D² is furnished with a follower F which will cooperate with either of two fences F¹ shown in Figures 1 and 2, the arrangement being such that when the links D¹, D² are swung about the primary axis E¹ so that the follower F engages one of the fences F¹, and the links are moved so that the follower F moves along the fence F¹, the secondary link D², which carries a holder D³ for a pointed diamond D or the like, moves so that the point of the diamond D moves along a straight-line path as hereinafter described. This movement corresponds to that usually referred to as the "Scott-Russel" straight-line movement.

The secondary link D² carries a guide D⁴ for supporting the diamond holder D³, which guide is mounted to pivot about the axis D⁵ preferably coincident with the follower F, so that the diamond D can be angularly adjusted within narrow limits about the axis D⁵ by means of adjusting screws D⁶. The diamond holder D³ can also

be translationally adjusted on the guide D⁴ by means of a screwthreaded spindle D⁷ secured to the holder D³ and in screwthreaded engagement with a micrometer nut D⁸ journaled in a lug formed integral with the guide D⁴. The micrometer nut D⁸ carries or cooperates with a vernier scale to indicate the position of adjustment of the holder D³ relatively to the primary axis E¹. The diamond D can also be adjusted relatively to the holder D³ by means of a knurled head D⁹ in screwthreaded engagement with the holder. The secondary link D² carries a strip carrying a sighting device D¹⁰ for assisting the operator in positioning the primary axis E¹ so as to lie accurately in the working plane A¹⁰.

Though the use of the micrometer nut D⁸ and micrometer screw, or a graduated wedge, as referred to above are useful means for determining the adjustments of the diamond D, it is preferred to employ the microscope A⁶ for this purpose. To this end the microscope A⁶ has a graticule as shown in Figure 4, comprising three angles A¹¹, say, 47.5°, 50° and 60° respectively for the purpose hereinafter described, and two scales A¹² and A¹³ for measuring the displacement of the diamond D in two directions at right angles to each other, the scale A¹³ being employed for determining the diamond adjustment effected by the nuts D⁸ and D⁹.

The primary link D¹ has an extension F⁶ furnished with a knob F², and the secondary link D² has knobs F³ for facilitating manual operation of the links about their axes. The secondary link D² also has a notch or recess for engagement by a latching stud F⁴ carried by the extension F⁶ of the primary link D¹, the latching stud when engaged, as shown in Figures 3 and 5, locking the primary and secondary links D¹, D² together so that they are constrained to swing as a unit about the primary axis E¹. The bracket C⁴ mounted to slide on the arm C¹ is adjustable along this arm by operation of a knurled head C⁵ which rotates a spindle C⁶ in screwthreaded engagement with the bracket. Positioning of the truing unit C with respect to the microscope A⁶, whose optical axis lies in the working plane A¹⁰, is obtained by means of an adjustment screw C⁷ (Figure 2) carried by the arm C¹ and cooperating with an abutment C⁸ on the fixed frame of the machine, a clamp C⁹, provided on the arm C¹, cooperating with a slot C¹⁰ in a fixed plate for locking the arm C¹ in the position of adjustment, i. e. whether the unit C is in the operative or inoperative position.

The bracket C⁴ is furnished with a dovetailed slot F⁶ accurately machined on a radius struck from the primary axis E¹ and extending through 180° and engaged by two blocks F⁷ each carrying a fence F¹. Each block F⁷ can be adjusted along the slot F⁶ and locked in the position of adjustment by a stud F⁸ which bears against the bracket C⁴. Each fence F¹ is locked in position on the associated block by a stud F⁹ so that when this stud is released the fence F¹ can be adjusted towards or away from the primary axis E¹. The arrangement is such that the follower F, when moved along either fence, will traverse a path radial with respect to the primary axis E¹. The inner end of each fence is provided with a flange or projection which serves to limit the movement of the follower F towards the primary axis E¹. The follower F can be brought into engagement with either of the fences F¹ according to which

side of the edge of the grinding wheel B is to be trued.

Assuming, therefore, that it is desired to true the operative edge of a grinding wheel as shown in Figure 6, the pantograph A² is swung out about the pivots A¹ so that the work table A³ lies clear of the working plane A¹⁰. Having released the clamp C⁹ the arm C¹ is swung from the position shown in Figure 1 to that shown in Figures 2, 3 and 5, the bracket C⁴ being adjusted along the supporting arm C¹ until the sighting piece D¹⁰ is brought into coincidence with the apex of the desired angle A¹¹ on the graticule of the microscope A⁶. The primary axis E¹ is thus set accurately in the working plane A¹⁰. The arm C¹ is now locked in this position of adjustment by tightening the clamp C⁹. In order to bring the most prominent point of the diamond D into coincidence with the primary axis E¹ the studs D⁶ are adjusted so as to swing the diamond holder about the axis D⁵ as may be required. The distance between the diamond D and the secondary axis E² is now equal to the distance between this secondary axis and the axis D⁵ of the follower F, and also equal to the distance between the secondary axis E² and the primary axis E¹. By grasping the handles F³ and swinging the primary and secondary links to one side of the plane of the grinding wheel B, for example to the right as diagrammatically shown in Figure 6, the follower F is brought to bear against the fence F¹ which has previously been adjusted along the slot F⁶ in accordance with the desired angle of the operative edge of the grinding wheel B, e. g. 47.5°, 50° or 60° according to the angle A¹¹ selected. The secondary link D² is now moved so as to cause the follower F to move to and fro along the fence F¹, the path of movement of the diamond D, which is observed through the microscope A⁶, being along a straight line corresponding to one limb of the angle A¹¹ selected on the microscope graticule. Any adjustment necessary to bring the point of the diamond D accurately on to the graticule of the microscope A⁶ is effected by adjusting the fence F¹ along the guide slot F⁶ and then locking the fence in position by means of the stud F⁸.

The diamond D is fed towards the grinding wheel B by adjusting the bracket C⁴ along the arm C¹ by means of the knurled head C⁵, the follower F moving radially with respect to the primary axis E¹ whereas the diamond point moves along a straight line so as to true one face of the V-edge of the grinding wheel as shown in Figure 6. The follower F is now moved from the fence F¹ on one side of the plane of the grinding wheel B and is swung over into engagement with the other fence (which has been omitted from Figure 2 for the sake of clarity but is adjusted in accordance with the angle of the grinding wheel as above described), the process being repeated on this side of the grinding wheel to true the other face of the V-edge thereof.

Having thus trued the angle at the edge of the grinding wheel B the edge is rounded to the required radius as follows. The follower F is brought into the central position shown in Figure 2 and diagrammatically shown in Figure 7 and the latching stud F⁴ is engaged in the recess in the secondary link D². The diamond D is now moved away from the primary axis E¹, as shown in Figure 7, by adjusting the diamond holder D³ on the secondary link by means of the knurled nut D⁸, this movement which is precisely determined

by means of the scale A¹² on the microscope A⁶, being equal to the radius required for the operative edge of the grinding wheel B. With the grinding wheel in rotation the links D¹, D² are oscillated to and fro and the bracket C⁴ carrying the primary and secondary links is fed along the arm C¹ by means of the knurled head C⁵ in a direction towards the grinding wheel B. The diamond D is thus moved to and fro along a circular arc (Figure 8) the two fences limiting the angle of swing, until the primary axis E¹ lies in the position E³ shown in Figure 7 so that the point of the diamond D lies at a distance from the point E³ equal to the radius to be produced on the grinding wheel.

The truing of the grinding wheel B is now complete and the clamp C⁹ is released so as to release the arm C¹ which can be swung away until the truing unit C is removed from the working position, the supporting arm C¹ being then relocked by means of the clamp C⁹. The operative edge of the grinding wheel B is next brought into the working plane A¹⁰, with the assistance of the microscope A⁶, and the work can be restored to the operating position.

It will be understood that the mechanism above described is not limited to the production of one angle and one radius for the edge of the grinding wheel but any combination of angle and radius within a range of nearly 180° is available. For example, by releasing the stud F⁴ from the secondary link D² and setting one or each of the fences F¹ in the central position, as shown diagrammatically in Figure 9, movement of the follower F along the fence or fences will result in the diamond D moving along a straight-line path so as to true a flat end surface on the grinding wheel B. Similarly, a chisel-like edge may be trued as shown in Figure 10 by moving the follower F along one of the fences F¹ adjusted to one side of the plane of the grinding wheel so that the diamond D traverses a straight-line path from one side to the other of the grinding wheel. By successively carrying out the operations described with reference to Figures 9 and 10 two faces may be trued at a large angle to each other as shown in Figure 11. Again by preliminary adjustment somewhat similar to that described with reference to Figures 7 and 8, a grinding wheel having a curved operative edge as shown in Figure 12 may be trued, the primary axis E¹ being displaced towards the axis of rotation of the grinding wheel B by a distance equal to half the thickness of the wheel. It will be understood that in Figure 12, as in Figures 7 and 8, the primary and secondary links are locked together by the spring-loaded stud F⁴.

Figure 13 illustrates diagrammatically the manner in which the apparatus above described may be employed for truing a grinding wheel having a curved reentrant operative edge. For this purpose the primary and secondary links are again locked together by the stud F⁴ but the diamond holder D³ is adjusted, with the assistance of the scale A¹² on the microscope, towards the axis of rotation of the grinding wheel B through a distance equal to the radius of the reentrant grinding surface. The bracket C⁴ is then adjusted away from the grinding wheel through a distance equal to the said radius. By swinging the primary and secondary links to and fro about the primary axis E¹ the diamond D will move along a curved path concentric with the axis E¹ thus truing the reentrant surface of the grinding wheel B.

It is desirable to illuminate the edge of the grinding wheel B and the diamond D for facilitating observation through the microscope A⁶. To this end there is mounted on a pivot G⁴ carried by the bracket C⁴ a housing G containing a lamp G² and carrying a tube G³ containing a sleeve G⁴ longitudinally adjustable within the tube G³ and locked in position therein by a stud G⁵. Arranged within the sleeve G⁴ is a collimating lens G⁶ in alignment with a 45° mirror which may be formed of stainless steel to facilitate tapping of the adjusting stud shown. The mirror G⁷ projects the light emerging from the lens G⁶ as a parallel beam through a window G⁸ and thence through the primary pivot C³ which is hollow for this purpose. The lamp housing G is furnished with a handle G⁹ by which the illuminating unit as a whole can be adjusted about the pivot G⁴ to bring the window G⁸ generally into alignment with the primary axis E¹. The illuminating unit can therefore be adjusted in alignment with the primary axis for setting and finally truing and can then be swung into an inoperative position, thus reducing to a minimum the time during which the window G⁸ is exposed to bombardment of particles of grit which may pass through the hollow primary pivot C³.

As shown in Figures 14 and 15 the truing unit C is adjustable transversely to the arm C¹ along a guide H by means of a knurled head H¹ secured to a threaded spindle H² in threaded engagement with a block H³ secured to the bracket C⁴. The truing unit is locked in the position of transverse adjustment by means of a stud H⁴ and ball handle H⁵. With this arrangement the illuminating system comprises a lamp housing J which can be swung about a vertical pivot by means of a handle J¹, the construction of the illuminating unit being similar to that described with reference to Figure 5, the tubular member G³ extending parallel to the direction of traversing adjustment of the truing unit C by means of the knurled head H¹.

The construction shown in Figures 14 and 15 may be employed for example for truing a stepped disc wheel as shown in Figure 16. To this end the follower F is first caused to cooperate with the fence or fences F¹ in the central position as described with reference to Figure 9 and one of the fences F¹ is then moved over to the right and the truing unit C is traversed by means of the knurled head H¹ to the right through a distance equal to that between the surface E⁴ and the central plane of the grinding wheel B, this adjustment being effected with the assistance of the scale A¹³ of the microscope graticule. Having trued the surface E⁴ the follower F is again restored to the central position and the truing unit C is moved upwards by the knurled head C⁵ whereupon the surface E⁵ can be trued, again in the manner described with reference to Figure 9. Figure 17 shows another form of grinding wheel which can be trued by the apparatus shown in Figures 14 and 15, the central peripheral edge portion being trued as described with reference to Figure 9 whilst the two surfaces forming each of the angles on opposite sides of the central plane of the wheel are trued in the manner described with reference to Figure 16, the truing unit C being traversed by adjustment of the head H¹ first to one side of the central plane of the grinding wheel B and then to the other side thereof.

One corner of the operative edge of the grinding wheel B shown in Figure 18 is rounded on a

radius whose centre E⁶ lies to one side of the central plane of the wheel B. For truing the curved portion of this surface the links D¹, D² are locked together by the stud F⁴ and the truing unit C is traversed to the right as viewed in Figure 18 through a distance equal to that between the centre of curvature E⁶ and the central plane of the wheel B. The diamond D is then adjusted (with the assistance of the graticule scale A¹²) relatively to the secondary link D² in a direction away from the grinding wheel B through a distance equal to the radius E⁷. With the grinding wheel B in rotation and one fence F¹ adjusted centrally in the slot F⁶ and the other fence F¹ to the right of the plane of the grinding wheel, the links D¹, D² are oscillated to and fro between the fences F¹ and the truing unit C is adjusted towards the grinding wheel B whose curved edge is thus trued until the primary axis E¹ coincides with the centre of curvature E⁶, this adjustment being effected with the assistance of the scale A¹² on the microscope graticule.

The reentrant curved surface of the grinding wheel shown in Figure 19 may be trued by the apparatus shown in Figures 14 and 15 in a manner generally similar to that described with reference to Figure 13. For truing this surface, however, the truing unit C will be traversed so as to move the primary axis E¹ to the left through a distance equal to half the thickness of the grinding wheel and, with one fence F¹ arranged centrally and the other to the left, the links D¹, D², locked together by the stud F⁴, will be oscillated between the fences and the unit C fed towards the grinding wheel until the primary axis E¹ coincides with the centre of curvature E⁸ of the curved reentrant surface, the traversing adjustment being effected with the aid of the scale A¹³ on the microscope graticule.

As above described the truing unit, when in its operative position, occupies the position normally occupied by the work table A³, that is to say at the front of the machine. This means that the work table A³ must be removed from its operative position before each truing operation. In order to avoid the necessity for disturbing the work table and pantograph, however, a truing unit according to the invention may be arranged at the back of the machine, for example as shown in Figure 20. In this construction the truing unit C, which comprises primary and secondary links and a diamond D as above described, has its primary pivot K journalled within a housing K¹ supported on a frame K² which can be traversed along guides K³ by means of a knurled head K⁴, the guides K³ being formed in a fixed part of the supporting frame K⁵. The arcuate slot F⁶ along which the fences F¹ above described are adjustable is formed in an integral part of the housing K¹, the object glass of a microscope L being disposed within the primary pivot K thus providing a practical focal length and compactness. It will be noted that with this arrangement the truing unit C is not carried upon a swinging arm as in the constructions above described but can only be moved away from the grinding wheel B by an amount as permitted by the adjustment available along the guides K³. With this arrangement, therefore, the truing unit C is always substantially in its operative position and truing of the grinding wheel B can be effected by merely adjusting the knurled head K⁴ so as to bring the diamond D on to the primary axis E¹. The illuminating unit included in Figure 75

20 comprises a lamp housing M pivoted on a fixed bracket M¹ and furnished with a tubular part M² similar to the tube G³ in Figure 5, the window M³ of the illuminating unit being brought generally into alignment with the primary axis E¹ by turning the lamp housing M about its pivot, a handle M⁴ being provided for this purpose. As in the construction described with reference to Figure 5, the primary pivot K is hollow so that the light beam from the window M³ is directed along the primary axis E¹ towards the microscope objective.

Where intensive production, and consequent rapid wear of the grinding wheel, is liable to take place, the link mechanism and diamond may be duplicated, with the movements of the two diamonds out of phase to avoid fouling each other at the plane of the grinding wheel, a third diamond being employed for producing the radiussed edge on the wheel. One such arrangement is diagrammatically shown by way of example in Figure 21 in which there are two coaxial primary links N¹, P¹ which are preferably relatively adjustable about the common primary axis E¹ and can be locked together by a stud S³. Mounted to turn about secondary axes N², P² on the primary links N¹, P¹ are two secondary links N³, P³ which respectively carry followers N⁴, P⁴. The followers N⁴, P⁴ are arranged to cooperate with fences indicated at N⁵ and P⁵ respectively, these fences being adjustable along an arcuate slot in the bracket R, this slot, which is not shown, being concentric with the primary axis E¹ as above described with reference to the slot F⁶. The secondary links N³, P³ are provided with diamond holders N⁶, P⁶ carrying diamonds N⁷, P⁷ respectively. Mounted to swing about the primary pivot which is coaxial with the primary axis E¹ is an arm S carrying a diamond S¹ which can be drawn out away from the plane of the secondary links N³, P³ and locked in this retracted position by rotation of a knurled stud S².

Having retracted the diamond S¹ the primary links N¹, P¹ are relatively adjusted about the primary axis E¹ to suit the angle of the V-edge of the grinding wheel B, each fence N⁵, P⁵ being so adjusted that when the links N³, P³ are moved so that the followers N⁴, P⁴ move along the fences N⁵, P⁵ the points of the diamonds N⁷, P⁷ will traverse straight lines conforming to the corresponding surfaces of the wheel B to be trued. Since the primary links N¹, P¹ are locked together by the locking stud S³ they move as a unit so that while the diamond N⁷ is moving up along the corresponding face of the grinding wheel the diamond P⁷ is moving down along the corresponding face on the other side of the wheel, risk of the diamonds N⁷, P⁷ fouling each other being thus obviated. Having trued the two V-faces of the grinding wheel B the two followers N⁴, P⁴ are moved down so that the primary and secondary links of each system lie vertical, that is to say so that the diamonds N⁷, P⁷ lie clear of the grinding wheel B on opposite sides thereof. The diamond S¹ is now moved up into its operative position and clamped therein by operation of the knurled head S². Having adjusted the diamond S¹ and the primary axis E¹ in the manner described with reference to Figures 7 and 8, the scale A¹² of the microscope graticule being used for this purpose, the arm S is swung to and fro about the primary axis, a stud S⁴ carried by the arm S cooperating with extensions N⁸, P⁸ of the fences N⁵, P⁵ to limit the swinging movement of

the arm S. In this way the operative edge of the grinding wheel is trued on the required radius.

It will thus be seen that since the dressing or truing unit according to the invention is independent of the work table or support no parts have to be removed from or replaced on the grinding machine when truing is necessary, the work being either moved out of the operating position and the truing unit into the operating position or, when an arrangement such as that shown in Figure 20 is employed, remaining undisturbed. Further, since the truing unit is adapted to be mounted on the grinding machine it is always ready for use and the expenditure of time for mounting the truing mechanism manually in position on the machine before each truing operation can be commenced is obviated. The truing unit is, moreover, self-contained and does not necessitate the use of a different former for each different edge angle. Apparatus embodying the invention will remain accurate over a long period owing to the light pressure, low rubbing velocity and adequate area of contact between the fence or fences and the follower.

Whilst two guides or fences have been described in each of the above constructions, a single fence may be employed by providing a single arcuate slot in the bracket along which the fence can be adjusted from one side to the other of the plane of rotation of the grinding wheel. Further, the truing device may lie below, above or to one side of the grinding wheel during the truing operation, the viewing microscope being horizontal when the truing device lies above or below the wheel, whereas the microscope is vertical when the truing device lies to one side of the wheel.

As will be apparent from the above description the formation of the operative edge of the grinding wheel need not necessarily be of symmetrical V-shape since by suitable modification of the formation and arrangement of the guides or fences, the operative edge of the grinding wheel may be trued to any desired shape, with two straight or curved trued faces on opposite sides of the plane of rotation or with a single trued face of any desired profile. Thus, the invention provides the further advantage that the truing unit can be employed for truing grinding wheels whose operative edges vary widely in profile.

Experience has shown that, especially in the case of fine-grained grinding wheels of fairly hard bond, a diamond making more than point contact will tend to glaze the wheel during the truing operation, thus impairing the cutting qualities of the wheel. A pointed diamond is therefore preferred.

What I claim as my invention and desire to secure by Letters Patent is:

1. In apparatus for truing grinding or abrasive wheels and the like for grinding and abrading machines, in combination, a support for the grinding wheel, a carrier mounted on the support, a truing unit mounted on the carrier and comprising a primary link mounted to swing about a primary axis on the carrier, a secondary link mounted to swing about a secondary axis on the primary link, a truing device carried by the secondary link, a follower carried by the secondary link, and at least one straight guide on the carrier for cooperation with the follower, the distance between the secondary axis and the follower and between the secondary axis and the truing device being normally equal to the distance between the primary and secondary axes,

translational movement of the secondary link about the primary axis accompanied by pivotal movement of the secondary link about the secondary axis, as constrained by the guide engaging the follower, causing the follower to move radially with respect to the primary axis whilst the truing device moves relatively to the grinding wheel along a straight-line path.

2. In apparatus for truing grinding and abrasive wheels and the like for grinding and abrading machines, in combination, a support for the grinding wheel, a carrier mounted on the support, a truing unit mounted on the carrier and comprising a primary link mounted to swing about a primary axis on the carrier, a secondary link mounted to swing about a secondary axis on the primary link, a truing device carried by the secondary link, a follower carried by the secondary link which also pivots about said follower, two guides on the carrier lying respectively on opposite sides of a plane containing the primary axis, and means whereby the follower can be caused to cooperate, at will, with either of the guides, movement of the truing device relatively to the grinding wheel on either side of the plane thereof being effected by moving the secondary link about the primary and secondary axes and follower as constrained by the guide in engagement with the follower on the said side of the plane of the grinding wheel.

3. In apparatus for truing grinding or abrasive wheels and the like for grinding and abrading machines, in combination, a support for the grinding wheel, a carrier mounted on the support, a truing unit mounted on the carrier and comprising a primary link mounted to swing about a primary axis on the carrier, a secondary link mounted to swing about a secondary axis on the primary link, a truing device carried by the secondary link, a follower carried by the secondary link, two straight guides on the carrier lying on opposite sides respectively of a plane containing the primary axis, means for adjusting the guides concentrically with the primary axis, and means whereby the follower can be caused to cooperate, at will, with either of the guides, the distance between the secondary axis and the follower and between the secondary axis and the truing device being normally equal to the distance between the primary and secondary axes, translational movement of the secondary link about the primary axis accompanied by pivotal movement of the secondary link about the secondary axis and radial movement of the follower with respect to the primary axis as constrained by the guide in engagement with the follower on one side of the said plane, causing the truing device to move relatively to the grinding wheel along a straight line path inclined to the said plane in accordance with the position of adjustment of the said guide.

4. In apparatus for truing grinding or abrasive wheels and the like for grinding and abrading machines, in combination, a support for the grinding wheel, a carrier mounted on the support, a truing unit mounted on the carrier and comprising a primary link mounted to swing about a primary axis on the carrier, a secondary link mounted to swing about a secondary axis on the primary link, a truing device carried by the secondary link, a follower carried by the secondary link, at least one guide on the carrier for cooperation with the follower, movement of the secondary link about the primary and secondary

axes, as constrained by the guide engaging the follower, causing movement of the truing device relatively to the grinding wheel along a straight-line path, and means for locking the primary and secondary links together so that the two links can be swung as a unit about the primary axis.

5. In apparatus for truing grinding or abrasive wheels and the like for grinding and abrading machines, in combination, a support for the grinding wheel, a carrier mounted on the support, a truing unit mounted on the carrier and comprising a primary link mounted to swing about a primary axis on the carrier, a secondary link mounted to swing about a secondary axis on the primary link, a truing device carried by the secondary link, means for adjusting the truing device on the secondary link relatively to the primary and secondary axes, a follower carried by the secondary link, two straight guides on the carrier lying on opposite sides respectively of a plane containing the primary axis, means whereby the follower can be caused to cooperate, at will, with either of the guides, the distance between the secondary axis and the follower and between the secondary axis and the truing device being normally equal to the distance between the primary and secondary axes, translational movement of the secondary link about the primary axis accompanied by pivotal movement of the secondary link about the secondary axis, as constrained by that guide in engagement with the follower on either side of the said plane, causing the truing device to move relatively to the grinding wheel along a straight-line path inclined to the said plane, and means for locking the primary and secondary links together so that they can be swung as a unit about the primary axis.

6. In a unit for truing grinding or abrasive wheels and the like for grinding and abrading machines, in combination, a carrier adapted to be mounted on the machine, a primary link mounted to swing about a primary axis on the carrier, a secondary link mounted to swing about a secondary axis on the primary link, a truing device carried by the secondary link, a follower carried by the secondary link, at least one straight fence on the carrier for cooperation with the follower, and a guide on the carrier concentric with the primary axis and along which guide the fence is adjustable, the distance between the secondary axis and the follower and between the secondary axis and the truing device being normally equal to the distance between the primary and secondary axes, translational movement of the secondary link about the primary axis accompanied by pivotal movement of the secondary link about the secondary axis, as constrained by the fence in engagement with the follower, causing the truing device to move relatively to the grinding wheel along a straight-line path.

7. In a unit for truing grinding and abrasive wheels and the like for grinding and abrading machines, in combination, a carrier adapted to be mounted on the machine, a hollow primary pivot on the carrier, a primary link mounted to swing about the axis of the primary pivot, a secondary link mounted to swing about a secondary axis on the primary link, a truing device carried by the secondary link, a follower carried by the secondary link, at least one fence on the carrier for cooperating with the follower, and a device which projects light through the hollow primary pivot and illuminates the working plane

of cooperation between the truing device and the grinding wheel, movement of the follower along the fence radially with respect to the primary axis causing translational movement of the secondary link about the primary axis and pivotal movement about the secondary axis, the truing device thus moving along a predetermined path relatively to the grinding wheel.

8. In a unit for truing grinding and abrasive wheels and the like, for grinding and abrading machines, in combination, a carrier adapted to be mounted on the machine, a hollow primary pivot on the carrier, a primary link mounted to swing about the axis of the primary pivot, a secondary link mounted to swing about a secondary axis on the primary link, a truing device carried by the secondary link, a follower carried by the secondary link, two fences on the carrier lying on opposite sides respectively of a plane containing the primary axis, a guide on the carrier concentric with the primary axis, the fences being adjustable along said concentric guide, means whereby the follower can be caused to cooperate, at will, with either of the fences, and an illuminating device which projects light through the hollow primary pivot and illuminates the working plane of cooperation between the truing device and the grinding wheel, movement of the follower along the fence radially with respect to the primary axis causing translational movement of the secondary link about the primary axis and pivotal movement about the secondary axis, the truing device thus moving along a straight-line path relatively to the grinding wheel.

9. In a unit for truing grinding or abrasive wheels and the like for grinding and abrading machines, in combination, a carrier adapted to be mounted on the machine, a hollow primary pivot on the carrier, a primary link mounted to swing about the axis of the primary pivot, a secondary link mounted to swing about a secondary axis on the primary link, a truing device carried by the secondary link, a follower carried by the secondary link, a microscope at least part of whose optical system is housed within the hollow primary pivot, and at least one fence on the carrier for cooperating with the follower, movement of the follower along the fence causing translational movement of the secondary link about the primary axis and pivotal movement about the secondary axis, the truing device thus moving along a straight-line path.

10. In apparatus for truing grinding or abrasive wheels and the like for grinding and abrading machines, in combination, a support for the grinding wheel, a carrier mounted on the support, means for adjusting the carrier relatively to the support in directions transverse to the plane of the grinding wheel, a bracket mounted on the carrier, means for adjusting the bracket relatively to the carrier in directions generally parallel to the plane of the grinding wheel, a hollow primary pivot on the bracket, a truing unit carried by the bracket and comprising a primary link mounted to swing about the axis of the primary pivot, a secondary link mounted to swing about a secondary axis on the primary link, a truing device carried by the secondary link, a follower carried by the secondary link, at least one guide on the bracket for cooperation with the follower, a microscope mounted on the carrier, at least part of the optical system of the microscope being housed within the hollow primary pivot, and an illuminating device which

projects light in alignment with the hollow primary pivot and illuminates the working plane of cooperation between the truing device and the grinding wheel, movement of the follower along the guide radially with respect to the primary axis causing the truing device to move along a straight-line path relatively to the grinding wheel.

11. In apparatus for truing grinding or abrasive wheels and the like for grinding and abrading machines, in combination, a support for the grinding wheel, a carrier mounted on the support, means for effecting translational adjustment of the carrier in directions generally parallel to the plane of the grinding wheel, a hollow primary pivot on the carrier, a truing unit mounted on the carrier and comprising a primary link mounted to swing about the axis of the primary pivot, a secondary link mounted to swing about a second axis on the primary link, a follower carried by the secondary link, at least one fence mounted on the carrier for cooperation with the follower, a microscope mounted on the carrier and in optical alignment with the primary axis, and an illuminating device which projects light in alignment with the hollow primary pivot and illuminates the working plane of cooperation between the truing device and the grinding wheel, movement of the follower along the guide radially with respect to the primary axis causing the truing device to move along a straight-line path relatively to the grinding wheel.

12. In apparatus for truing grinding or abrasive wheels and the like for grinding and abrading machines, in combination, a support for the grinding wheel, a carrier mounted on the support, means for effecting translational adjustment of the carrier in directions generally parallel to the plane of the grinding wheel, a hollow primary pivot on the carrier, a truing unit mounted on the carrier and comprising a primary link mounted to swing about the axis of the primary pivot, a secondary link mounted to swing about a secondary axis on the primary link, a follower carried by the secondary link, at least one fence mounted on the carrier for cooperation with the follower, a microscope forming an integral unit with the carrier, at least part of the optical system of said microscope being housed within the hollow primary pivot, and an illuminating device which projects light in alignment with the hollow primary pivot and illuminates the working plane of cooperation between the truing device and the grinding wheel, movement of the follower along the guide radially with respect to the primary axis causing the truing device to move along a straight-line path relatively to the grinding wheel.

13. In apparatus for truing grinding or abrasive wheels and the like for grinding and abrading machines, in combination, a support for the grinding wheel, a carrier mounted on the support, a truing unit mounted on the carrier and comprising two primary links mounted to swing about a primary axis on the carrier, two secondary links mounted to swing respectively about two secondary axes on the two primary links, two truing devices carried by the secondary links respectively, two followers carried by the secondary links respectively, the secondary links also swinging about said followers as pivots, the distance between each secondary axis and the corresponding follower and between the secondary axis and the truing device being normally equal

- to the distance between the primary and secondary axes, and two guides mounted on the carrier for cooperation with the followers, movement of the followers along the said guides radially with respect to the primary axis causing simultaneous movement of the truing devices, each truing device moving along a straight-line path corresponding to the surface of the grinding wheel to be trued.
14. In apparatus for truing grinding or abrasive wheels and the like for grinding and abrading machines, in combination, a support for the grinding wheel, a carrier mounted on the support, a truing unit mounted on the carrier and comprising two primary links mounted to swing about a common primary axis on the carrier, two secondary links mounted to swing respectively about two secondary axes on the two primary links, two truing devices carried by the secondary links respectively, two followers carried by the secondary links respectively, two guides mounted on the carrier for cooperation with the followers, movement of the two followers along the said guides causing translational movement of each secondary link about the primary axis and pivotal movement of each secondary link about the corresponding secondary axis, the two truing devices thus moving simultaneously, but out of phase, along straight-line paths corresponding to two faces of the grinding wheel to be trued, an intermediate member mounted to pivot about the said primary axis, a third truing device carried by the intermediate member, and means for adjusting the third truing device on the intermediate member relatively to the primary axis.
15. In apparatus for truing grinding or abrasive wheels and the like for grinding and abrading machines, the combination with the features claimed in claim 14 of means for effecting relative adjustment of the two primary links about the common primary axis, and a device for locking the primary links in such position of adjustment.

16. In apparatus for truing grinding or abrasive wheels and the like for grinding and abrading machines, in combination, a supporting base, a grinding wheel mounted to rotate on said base with its operative edge in a working plane, a carrier mounted on the said base, means for adjusting the carrier on the base towards and away from the plane of the grinding wheel, a device for locking the carrier in the desired position of adjustment, a bracket mounted on the carrier, means for adjusting the bracket on the carrier towards and away from the working plane, a truing unit mounted on the bracket and comprising a primary link mounted to swing about a primary axis on the bracket, a secondary link mounted to swing about a secondary axis on the primary link, a truing diamond carried by the secondary link, a follower carried by the secondary link, two guides on the bracket lying on opposite sides respectively of the plane of the grinding wheel, means for adjusting the guides concentrically with respect to the primary axis, means whereby the follower can be caused to cooperate, at will, with either of the guides, the distance between the secondary axis and the follower and between the secondary axis and the truing device being normally equal to the distance between the primary and the secondary axes, translational movement of the secondary link about the primary axis accompanied by pivotal movement of the secondary link about the secondary axis, as constrained by that guide in engagement with the follower on either side of the said plane, causing the truing device to move relatively to the grinding wheel along a straight-line path, means for locking the primary and secondary links together so that they can be swung as a unit about the primary axis, and means for adjusting the diamond on the secondary link relatively to the primary axis thus determining the radius of the arcuate path of movement of the diamond when the links are swung as a unit about the primary axis.

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