

June 9, 1942.

A. C. WICKMAN

2,286,046

MEANS FOR TRIMMING SHAPED GRINDING WHEELS

Filed Oct. 15, 1940

4 Sheets-Sheet 1

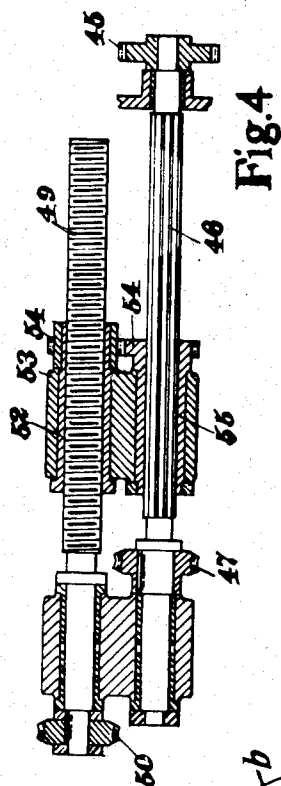


Fig. 4

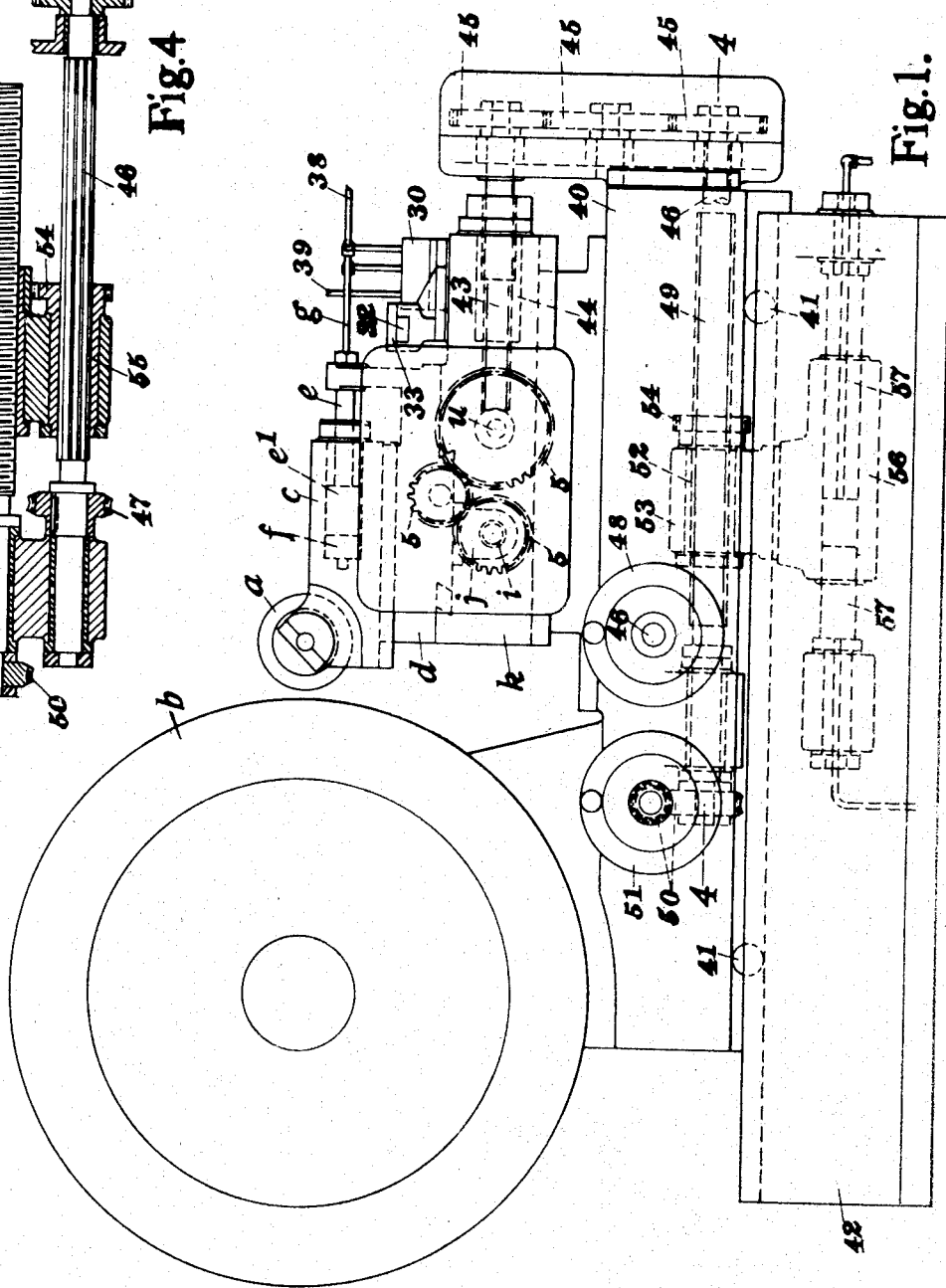


Fig. 1.

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4 Sheets-Sheet 2

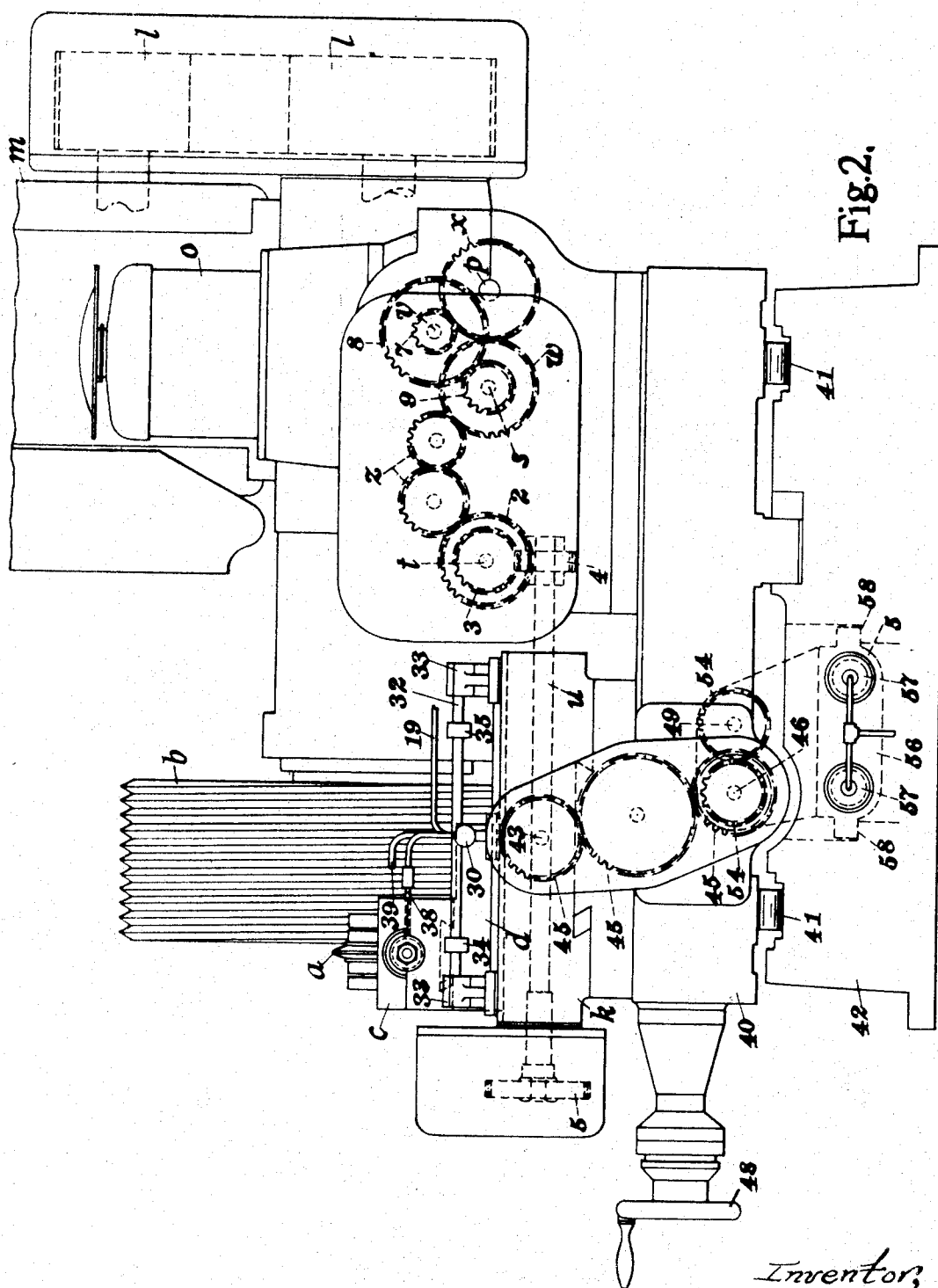


Fig. 2.

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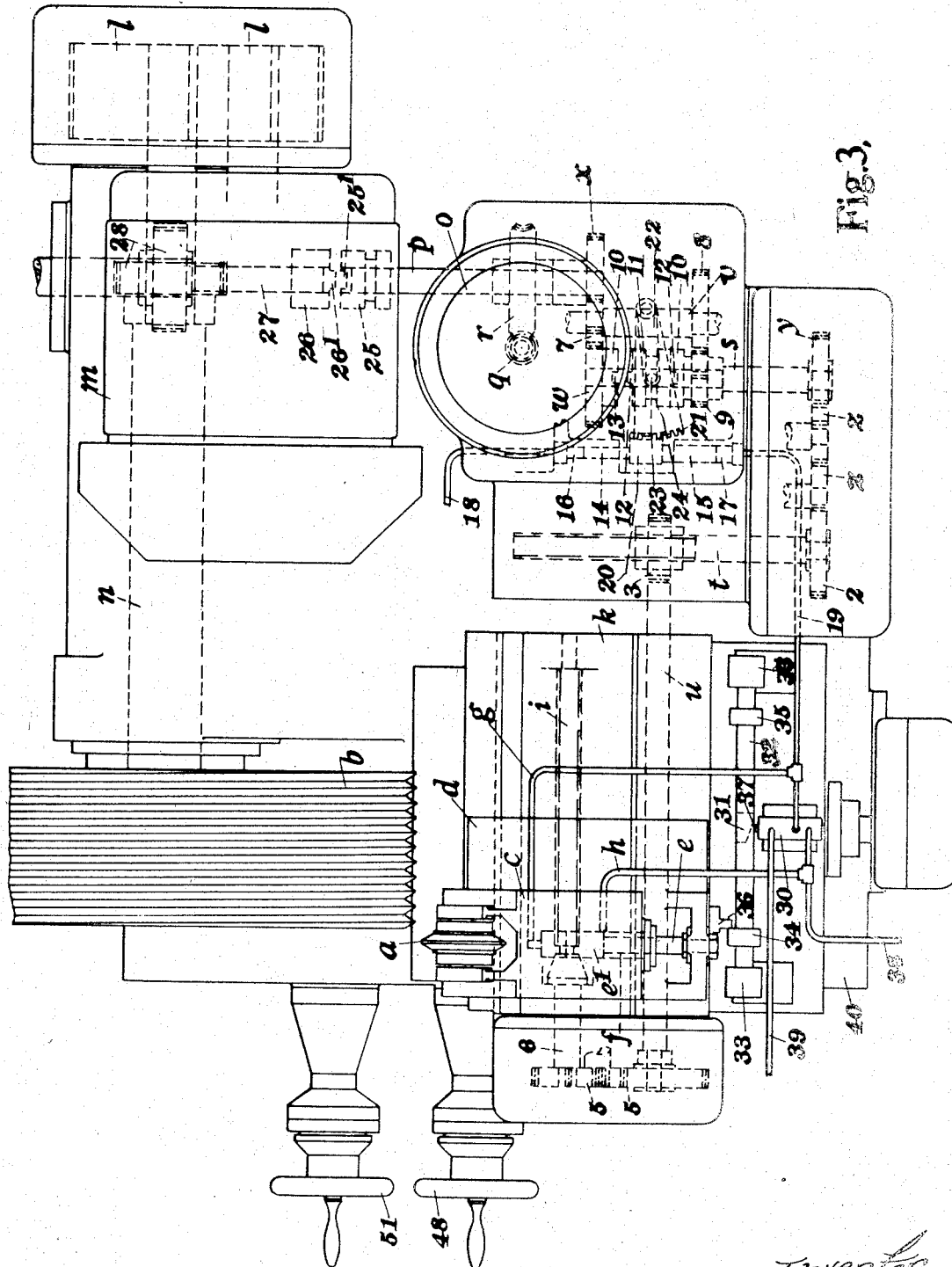
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MEANS FOR TRIMMING SHAPED GRINDING WHEELS

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4 Sheets-Sheet 3



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MEANS FOR TRIMMING SHAPED GRINDING WHEELS

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4 Sheets-Sheet 4

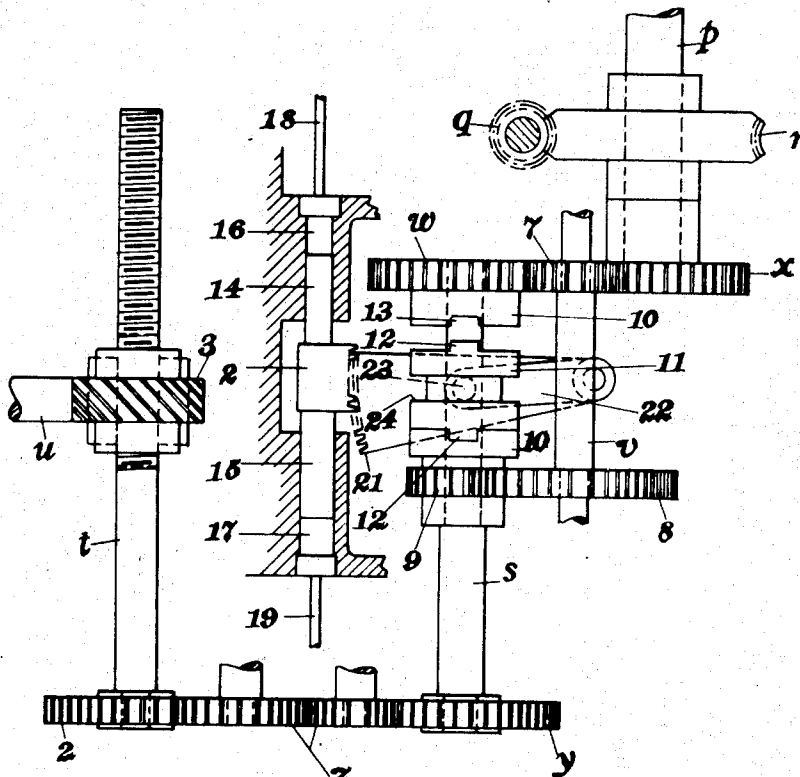


Fig. 5.

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UNITED STATES PATENT OFFICE

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MEANS FOR TRIMMING SHAPED GRINDING
WHEELSAxel Charles Wickman, Tile Hill, Coventry,
EnglandApplication October 15, 1940, Serial No. 361,325
In Great Britain October 9, 1939

3 Claims. (Cl. 125—11)

This invention has for its object to provide improved means for trimming a grinding wheel having a helically shaped peripheral abrasive surface adapted for use in the grinding to a desired form the teeth of gear wheels, spline shafts and other like bodies.

The invention also comprises the combination of a rotary trimming roller adapted to effect the required trimming by a crushing action on the grinding wheel, a slide on which the rotary trimming roller is mounted, and which is movable towards and away from the periphery of the grinding wheel, another slide which carries the first slide and is movable in a direction along the periphery of the grinding wheel, means for actuating the first slide, a reversible mechanism for actuating the second slide, means for rotating the grinding wheel and the reversible mechanism, a clutch for controlling the action of the reversible mechanism, and means associated with the second slide for controlling the movements of both slides and thereby causing the trimming roller to pass through successive operation-cycles automatically.

In the accompanying sheets of explanatory drawings—

Figure 1 is a front elevation, Figure 2 a side elevation, and Figure 3 a plan, of means constructed in accordance with the invention for trimming the helically shaped periphery of a grinding wheel used for grinding the teeth of gear wheels.

Figure 4 is a section on the line 4—4 of Figure 1.

Figure 5 is a fragmentary plan view illustrating to a larger scale than the other figures, a part of the mechanism employed for moving the trimming roller.

In carrying the invention into effect as shown, I employ a hard steel trimming roller *a* having its periphery shaped to a V-form corresponding with the cross section of the helix-groove of the grinding wheel *b* to be trimmed. Or the trimming roller may have formed around its periphery two or more similarly shaped circumferential grooves so that it can engage the grinding wheel groove at several adjacent positions. This roller *a* is freely rotatable and can not only be pressed against the peripheral surface of the grinding wheel but can also travel along that surface so as to cause the whole length of the helical groove of the grinding wheel to be subjected to the action of the roller, rotation of the roller being obtained from its engagement with the rotating grinding wheel. The required trim-

ming of the grinding wheel *b* is obtained by the crushing action of the trimming roller *a* on the wheel, causing the helical groove in the latter to receive the form imparted to it by the roller.

For enabling the trimming operation to be effected automatically, I employ a slide *c* on which the roller *a* is so mounted that it can rotate freely. This slide *c* is movable at right angles to the axis of the grinding wheel *b*, and is mounted on another slide *d* which is movable parallel with that axis. Movement of the first slide *c* in each direction is effected by fluid operated means which may conveniently consist of a plunger *e* carried on the second slide *d* and co-operating with a cylinder *f* mounted on or formed in the first slide, a pair of pipes *g*, *h*, being provided for conducting fluid to and from opposite ends of the cylinder. The plunger *e* is formed with an enlarged head *e'* which is situated in the cylinder *f* so that when pressure fluid is supplied by the pipes *g*, *h*, to both ends of the cylinder, the first slide *c* will move the trimming roller *a* towards the grinding wheel *b*, but when pressure fluid is supplied to one end only of the cylinder by the pipe *h*, the first slide will retract the trimming roller from the grinding wheel. Movement of the second slide *d* in each direction is effected by a screw *i* engaging a nut *j* on this slide and rotatably mounted on a part *k* which carries the second slide.

Rotation of the screw *i* is effected from any convenient source of motion which also serves to rotate the grinding wheel *b*. This source of motion may be an electric motor as *m* from which a shaft *n* carrying the grinding wheel *b* is ordinarily driven in the work-grinding operation through belt gearing indicated as a whole by *l*, the rotation of the screw *i* being then effected through reduction gearing at an appropriate slow rate. But preferably and as shown the said source consists of a separate small electric motor *o* which is brought into action only in the wheel trimming operation, this motor serving to rotate both the grinding wheel *b* and the screw *i* of the second slide *d* through a rotary shaft *p* to which the motor is connected by a worm *q* and worm wheel *r*, the motor *m* being then used for driving the wheel *b* at an appropriate higher speed only when it is required to operate on the work piece.

The screw is driven from the shaft *p* through a variable speed reversible mechanism adapted to give a quick reverse or return movement to the second slide *d*, and to impart a forward and active movement to the second slide at a rate appropri-

ate to the helix of the grinding wheel *b*. This mechanism comprises three interconnected shafts *s*, *t*, *u*, through which the forward movement is imparted to the second slide *d*, and which serve together with a fourth shaft *v* to transmit the required quick reverse or return movement to the second slide. On one end of the first shaft *s* is freely mounted a gear wheel *w* which engages another gear wheel *x* secured on the adjacent end of the motor-driven shaft *p*. The other end of the shaft *s* has secured to it a gear wheel *y* which is connected by a pair of interengaging gear wheels *z* to another gear wheel *2* on the adjacent end of the second shaft *t*, the latter shaft and the shafts *p*, *s*, being arranged parallel with each other at right angles to the axis of the grinding wheel *b*. Splined on the second shaft *t* is a slidable helical gear wheel *3* which engages another helical gear wheel *4* on the adjacent end of the third shaft *u*, the latter shaft being situated parallel with the axis of the grinding wheel *b* and having its other end connected by interengaging gear wheels *5* with an extension *6* on the adjacent end of the screw *i* above mentioned. The fourth shaft *v* has secured to it a small gear wheel *7* which engages the gear wheel *x* on the motor-driven shaft *p*. Also secured on the fourth shaft *v* is another gear wheel *8* which is of considerably larger diameter than the gear wheel *7* and which engages a further gear wheel *9* freely mounted on the first shaft *s*, the latter gear wheel being of smaller diameter than and situated at a suitable distance from the other freely rotatable gear wheel *w* on the first shaft. For alternatively connecting the two gear wheels *w*, *9*, to the shaft *s*, and thereby controlling the forward and reverse movements of the second slide *d* there is employed a fluid-operated clutch comprising a pair of outer parts *10* respectively formed on or secured to the gear wheels *w*, *9*, and an intermediate part *11* slidably keyed to the shaft *s*, the intermediate part being formed at each end with a single tooth or projection *12* for engaging a single complementary notch or recess *13* in the adjacent outer part of the clutch, so that the component parts of the clutch can be interengaged only when in predetermined relative positions. Alternatively a single tooth or projection as above described may be formed only on that end of the intermediate clutch part which is adapted to engage the outer clutch part on the gear wheel *w*, the other end of the intermediate part being adapted in any convenient and ordinary manner to engage the other outer clutch part.

When the intermediate clutch part *11* is in one of its extreme positions it engages the outer clutch part *10* on the gear wheel *w* and the motor *o* can serve to rotate the screw *i* (in the direction for imparting forward movement to the second slide *d*) through the parts *q*, *r*, *p*, *x*, *w*, *s*, *y*, *z*, *2*, *t*, *3*, *4*, *u*, *5* and *6*. In its other extreme position the intermediate clutch part *11* engages the outer clutch part *10* on the gear wheel *9* and the motor can serve to rotate the screw *i* (in the direction for imparting quick return movement to the slide *d*) through the parts *q*, *r*, *p*, *x*, *7*, *v*, *8*, *9*, *s*, *y*, *z*, *2*, *t*, *3*, *4*, *u*, *5* and *6*.

The fluid-operated means for actuating the slidable part *11* of the clutch consist of a pair of coaxial plungers *14*, *15* which are slidable in a pair of corresponding cylinders *16*, *17*, a pair of pipes *18*, *19* being provided for conducting fluid to and from the cylinders. The plungers *14*, *15*, are formed on or secured to opposite ends of a short toothed rack *20* which engages a pivoted

toothed sector *21*, the latter having secured to it a lever *22* through which movement can be imparted to the slidable clutch part *11* by the interaction of a projection *23* on the lever and a peripheral groove *24* in the said clutch part. The plunger *15* and its cylinder *17* are of greater diameter than the plunger *14* and its cylinder *16* so that when pressure fluid is supplied by the pipes *18*, *19*, to both of these cylinders, the slidable part *11* of the clutch will engage the clutch part *10* on the gear wheel *w* for causing forward movement of the second slide *d*, but when pressure fluid is supplied to the cylinder *16* only by the pipe *18* the slidable clutch part will engage the clutch part *10* on the gear wheel *9* for causing quick return movement of the second slide.

Another clutch consisting of a pair of interengageable parts *25*, *26*, is provided between the motor-driven shaft *p* and another coaxial shaft *27* which is connected to the grinding wheel shaft *n* through helical gearing *28*, the clutch part *25* being slidably mounted on the end of the shaft *p* remote from the gear wheel *x*, and the clutch part *26* being secured on the adjacent end of the shaft *27*. Moreover the clutch part *26* is formed with a single tooth or projection *26¹* for engagement by a single complementary notch or recess *25¹* in the other clutch part *25* so that the two clutch parts are interengageable only when in a predetermined relationship, and thus ensure that in successive cycles the trimming roller *a* shall engage the grinding wheel *b* at the proper position. The slidable clutch part *25* may be actuated by hand or by fluid operated means similar to those previously described for actuating the slidable part *11* of the other clutch.

In association with the second slide is mounted an appropriate valve and tappet mechanism adapted to cause the trimming roller *a* to move automatically through the trimming cycle. This mechanism comprises a valve *30* of any convenient form, and a tappet *31* adapted to actuate the valve. The tappet *31* is carried by or forms part of a slidable member *32* mounted in end bearings *33*. The slidable member *32* is provided with a pair of abutments *34*, *35* through which the said member can be moved in opposite directions by another abutment *36* on the second slide *d* for controlling the action of the valve *30*, the latter being provided with a spring-loaded operating member *37* adapted to be actuated by an adjacent inclined surface of the tappet. To the body part of the valve *30* are connected the adjacent ends of a pressure-fluid supply pipe *38*, a fluid exhaust pipe *39*, and the pipe *19* leading to the cylinder *17* of the operating means for the gear-controlling clutch, the latter pipe having connected to it the pipe *g* of the fluid operated means for actuating the first slide *c*. The other pipe *h* of the fluid operated means for actuating the first slide *c* is connected to the pressure fluid supply pipe *38*, the latter and the other pipe *18* of the operating means for the gear-controlling clutch being in communication with any convenient pressure fluid supply pump (not shown).

During the trimming cycle the trimming roller *a* is pressed against the grinding wheel *b* and is rotated by the latter which is driven at a suitably slow rate from the motor *o*. At the same time the roller *a* is caused to travel along the helix of the wheel *b* by the motion of the slide *d* under the action of the screw *i*. In this condition the pipes *g*, *19* are connected by the valve *30* to the pressure-fluid supply pipe *38*, and the

motor *o* drives the screw at a relatively slow rate through the parts, *q, r, p, x, w, s, y, z, 2, t, 3, 4, u, 5* and *6*. On the slide *d* reaching the end of its travel the slidable member *32* of the tappet mechanism is moved by contact of the abutment *36* on this slide with the abutment *34* on the said member, and the tappet *31* actuates the operating member *37* of the valve *30* to connect the pipes *g, 19* to the exhaust pipe *39*. This causes the first slide *c* to retract the trimming roller *a* from the grinding wheel *b*, and the fluid pressure conveyed by the pipe *18* causes the rack *20* to actuate the lever *22* and engage the slidable clutch part *11* with the gear wheel *9* to cause the screw *i* to return the second slide *d* quickly to its initial position, the screw *i* being driven by the motor *o* through the parts *q, r, p, x, 1, v, 8, 9, s, y, z, 2, t, 3, 4, u, 5* and *6*. At the end of the return movement of the second slide *d* the slidable member *32* of the tappet mechanism is returned to its initial position by contact of the abutment *36* with the other abutment *35* on the said member, and the tappet *31* releases the operating member *37* of the valve *30*, the latter being thus caused to connect the pipes *g, 19*, to the pressure fluid supply pipe *38*, whereupon the first slide *c* is caused to advance the trimming roller *a* into contact with the grinding wheel *b*. The cycle above described is then repeated, the trimming action being continued in successive cycles until the wheel has been properly trimmed.

In the example shown the mechanism above described is built into a grinding machine, and is mounted at the side of the grinding wheel *b* remote from that which operates on the work piece (not shown). For enabling this to be effected the part *k* which carries the second slide *d* consists of a third slide movable at right angles to the axis of the grinding wheel, this third slide serving also to carry the above described valve and tappet mechanism and screw together with the shaft *u* and associated parts of the mechanism for transmitting motion to the screw. The other parts of the latter mechanism together with the third slide *k* and the grinding wheel *b* are mounted on a fourth slide *40* movable in the same direction as the third slide, the fourth slide being carried by rollers *41* on the bed *42* of the machine. The third slide *k* is movable by a hand-operable screw *43* engaging a nut *44* on this slide, and this screw is connected by gearing *45* with a rotatable shaft *46* on the fourth slide *40*, this shaft being operable through worm gearing *47* by a hand wheel *48*. Also mounted on the fourth slide *40* is another screw *49* which is arranged parallel with the shaft *46* and is operable through worm gearing *50* by another hand wheel *51*. In engagement with the screw *49* is a nut *52* carried by a bearing *53* through which pass both this screw and the shaft *46*. The nut *52* is connected by a pair of inter-engaging gear wheels *54* to a bush *55* mounted in the bearing *53* and slidably splined on the shaft *46*. The bearing *53* is carried by a pair of parallel cylinders *56* formed integrally with or connected to each other and slidably mounted on a pair of fixed plungers *57* and supports *58* in the bed *42* of the machine. Pressure fluid acting in one of the cylinders *56* causes the fourth slide *40* and all the other slides *c, d*, and *k* mounted on it to be moved simultaneously in the direction for carrying the grinding wheel *b* away from the work piece, and fluid pressure acting in the other cylinder *56* has the reverse

effect. Rotation of the shaft *46* by its hand wheel *48* causes the nut *52* and the screw *43* associated with the third slide *k* to be rotated, so causing the third slide to move on the fourth slide *40* and the latter to move to an equal extent on the bed *42*. Rotation of the screw *49* by its hand wheel *51* causes the fourth slide *40* to move carrying the third slide *k* with it. The movements of the hand wheels *48, 51* serve to effect adjustments of the positions of the trimming roller *a* and grinding wheel *b* relatively to each other and to the work piece.

The invention is not limited to the example above described as subordinate mechanical details may be varied to suit different conditions, and the application of the invention to the grinding of splined shafts, worms and the other like bodies is essentially similar, the shape of the trimming roller being in all cases made to correspond with the cross sectional configuration of the helix of the grinding wheel. Moreover, whilst it is usually preferable to employ a freely rotatable trimming roller, this roller may sometimes be positively rotated.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. Means for trimming a helically shaped periphery of a grinding wheel, comprising the combination of a rotary trimming roller adapted to effect the required trimming by a crushing action on the grinding wheel, a slide on which the trimming roller is mounted, and which is movable towards and away from the periphery of the grinding wheel, a second slide which carries the first slide and is movable in a direction along the periphery of the grinding wheel, fluid operable means for actuating the first slide, a variable speed reversible screw mechanism for actuating the second slide, means for rotating the grinding wheel and the reversible screw mechanism, a fluid operable clutch for controlling the action of the reversible screw mechanism, the clutch having component parts which so far at least as the movement of the second slide in the operative direction is concerned, are inter-engageable only when in predetermined relative positions, valve and tappet mechanism operable by the second slide for controlling the said fluid operable means and the clutch, a third slide carrying the second slide and movable in the same direction as the first slide, a fourth slide carrying and movable in the same direction as the third slide, a bed carrying the fourth slide, hand operable means for moving the third and fourth slides together and relatively to each other, and fluid operable means for moving the fourth slide together with the third slide.

2. Means for trimming a helically shaped periphery of a grinding wheel, comprising the combination of a rotary trimming roller adapted to effect the required trimming by a crushing action on the grinding wheel, a slide on which the trimming roller is mounted, and which is movable towards and away from the periphery of the grinding wheel, another slide which carries the first slide and is movable in a direction along the periphery of the grinding wheel, means for actuating the first slide, a reversible mechanism for actuating the second slide, means for rotating the grinding wheel and the reversible mechanism, a clutch for controlling the action of the reversible mechanism, means associated with the second slide for controlling the movements of both slides and thereby causing the trimming

roller to pass through successive operation-cycles automatically, a third slide carrying the second slide and movable in a direction towards and away from the periphery of the grinding wheel, a fourth slide carrying and movable in the same direction as the third slide, a bed carrying the fourth slide, and means for moving the third and fourth slides either jointly or independently.

3. Means for trimming a helically shaped periphery of a grinding wheel, comprising the combination of a rotary trimming roller adapted to effect the required trimming by a crushing action on the grinding wheel, a slide on which the trimming roller is mounted, and which is movable towards and away from the periphery of the grinding wheel, another slide which carries the first slide and is movable in a direction along the periphery of the grinding wheel, means for actuating the first slide, a reversible mechanism for actuating the second slide, means for rotating the grinding wheel and the reversible mechanism, a clutch for controlling the action

of the reversible mechanism, means associated with the second slide for controlling the movements of both slides and thereby causing the trimming roller to pass through successive operation-cycles automatically, a third slide carrying the second slide and movable in a direction towards and away from the periphery of the grinding wheel, a fourth slide carrying and movable in the same direction as the third slide, a bed carrying the fourth slide, a nut on the third slide, a screw engaging the nut, a rotatable hand operable shaft mounted on the fourth slide, gearing connecting the shaft to the screw, a second and hand operable screw mounted on the fourth slide and arranged parallel with the shaft, a nut on the second screw, a bush slidable on the shaft, gearing interconnecting the bush and the nut on the second screw, and fluid operable means carrying the bush and the nut on the second screw.

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