June 5, 1934. R. V. MILLER 1,961,891

ABRADING DEVICE

Filed Feb. 3, 1928 5 Sheets-Sheet 1

Fig. 1

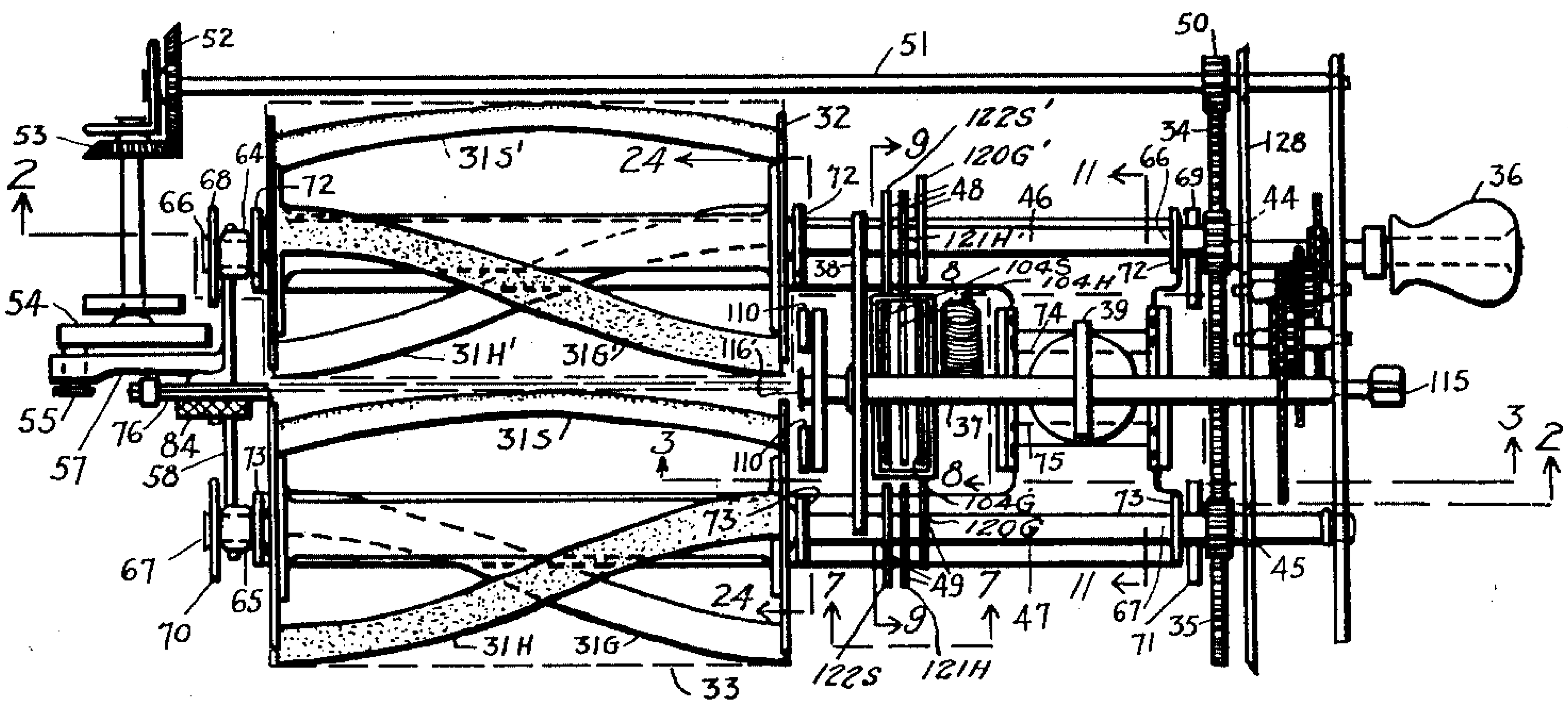
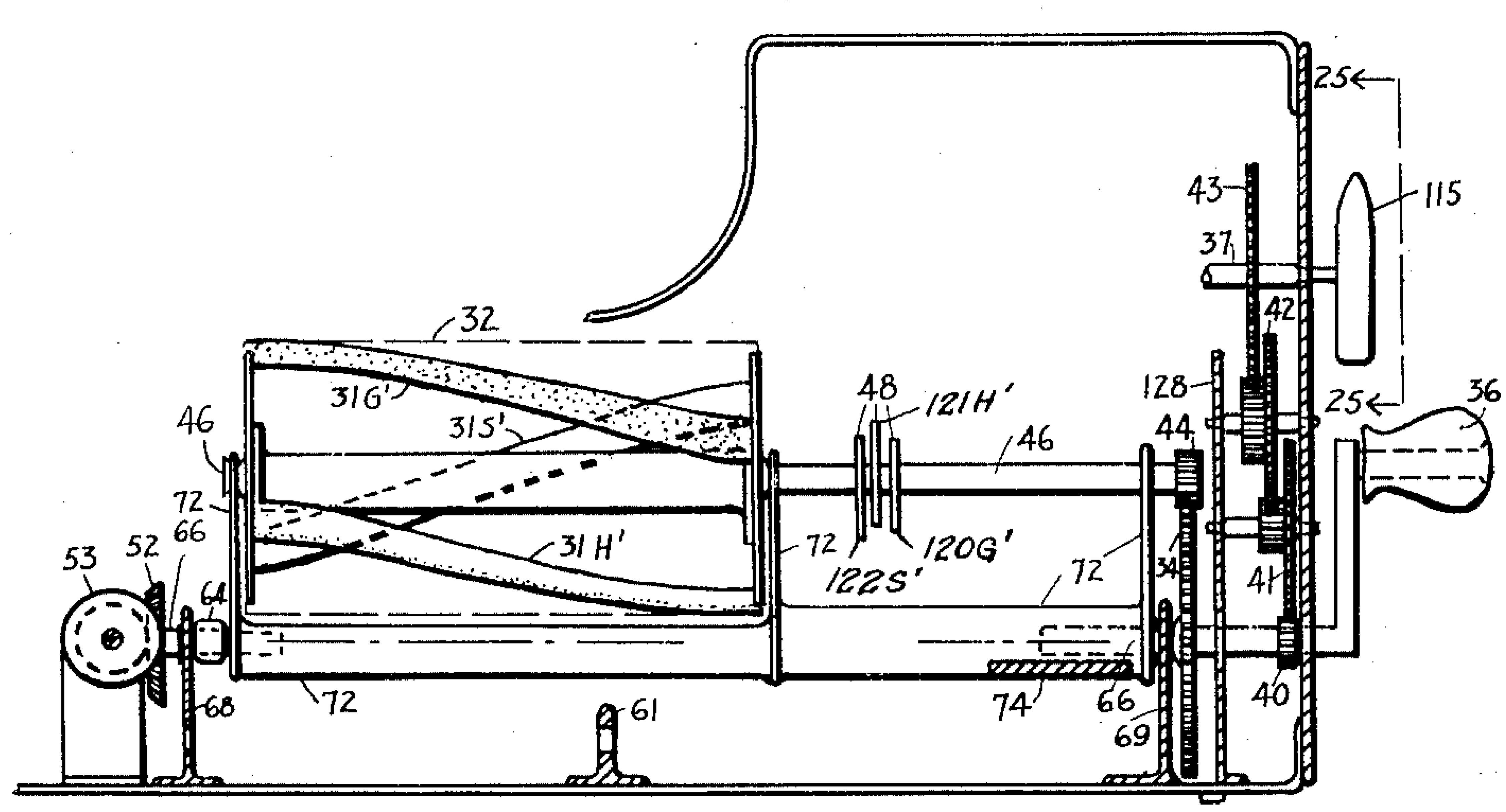


Fig. 2



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ABRADING DEVICE

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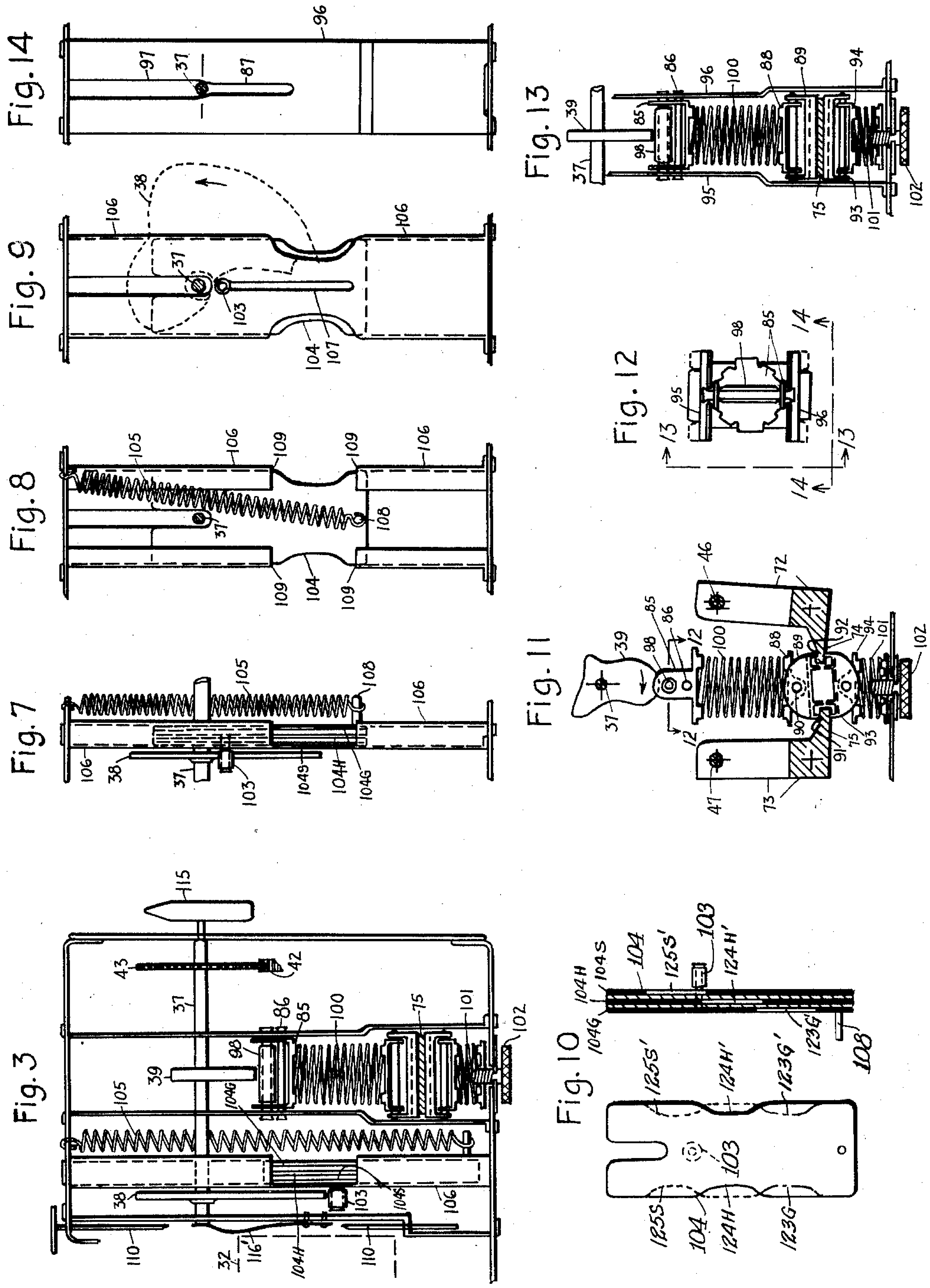

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ABRADING DEVICE

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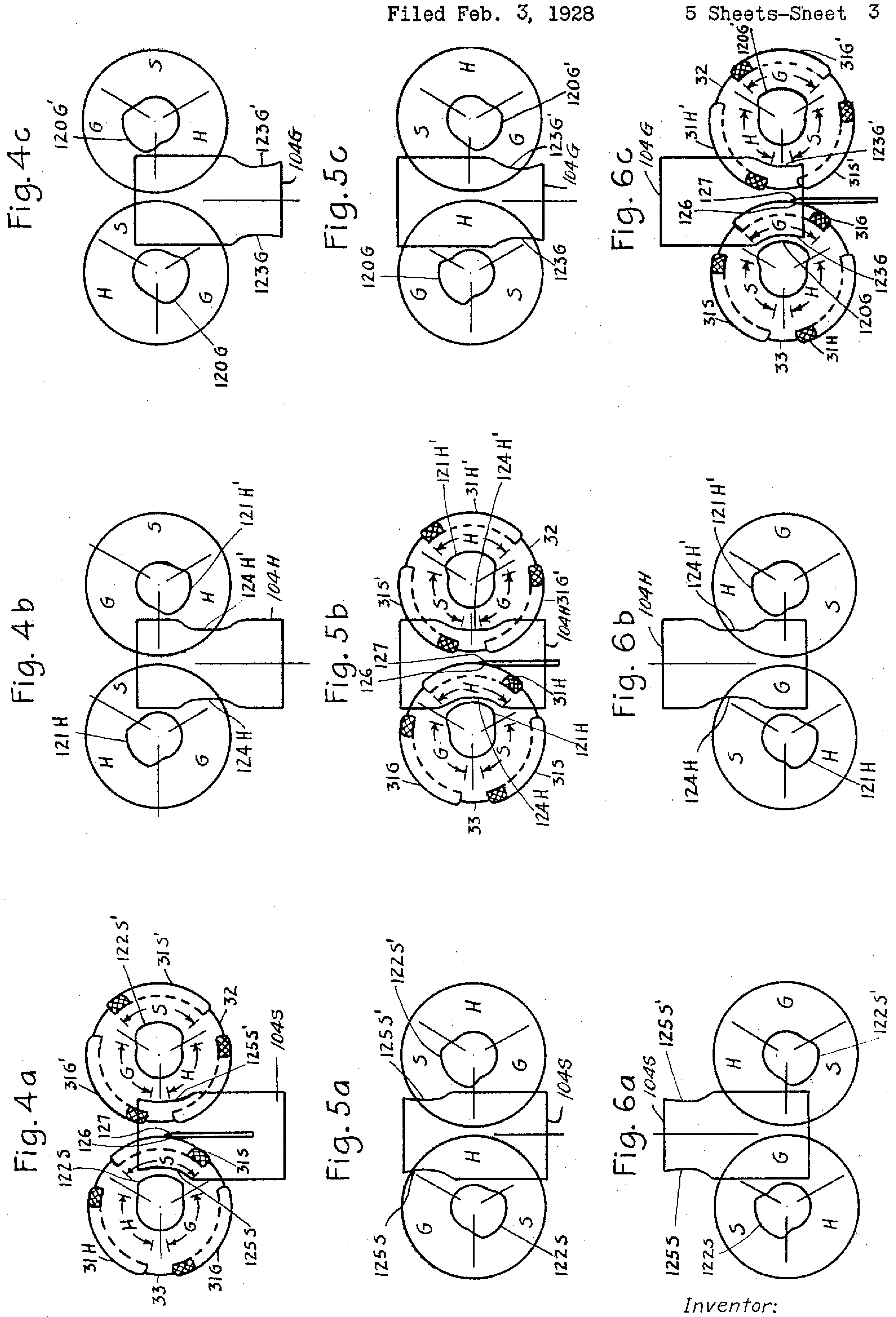

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ABRADING DEVICE

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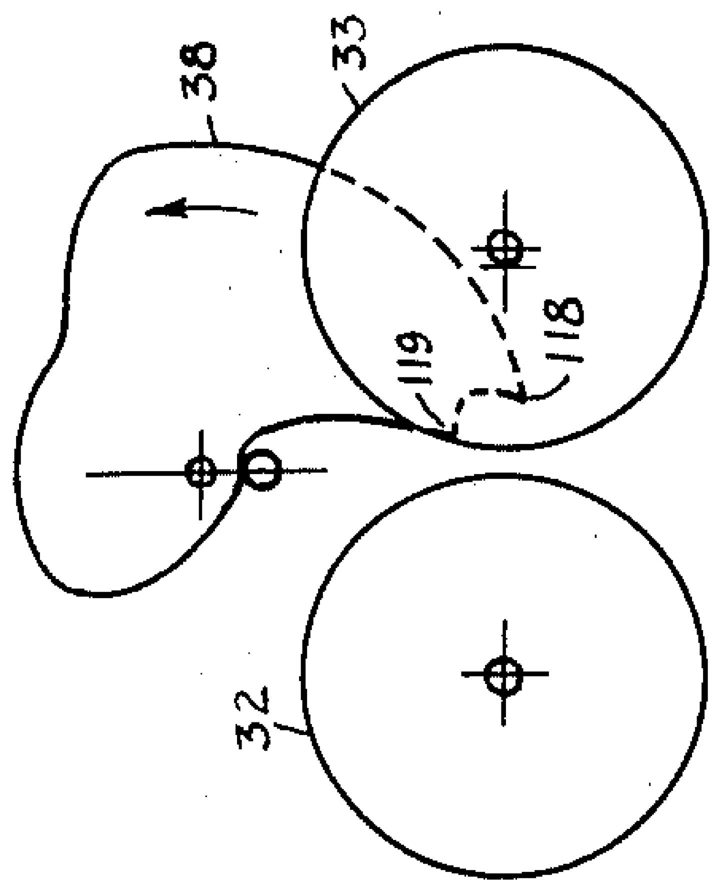

Fig. 17

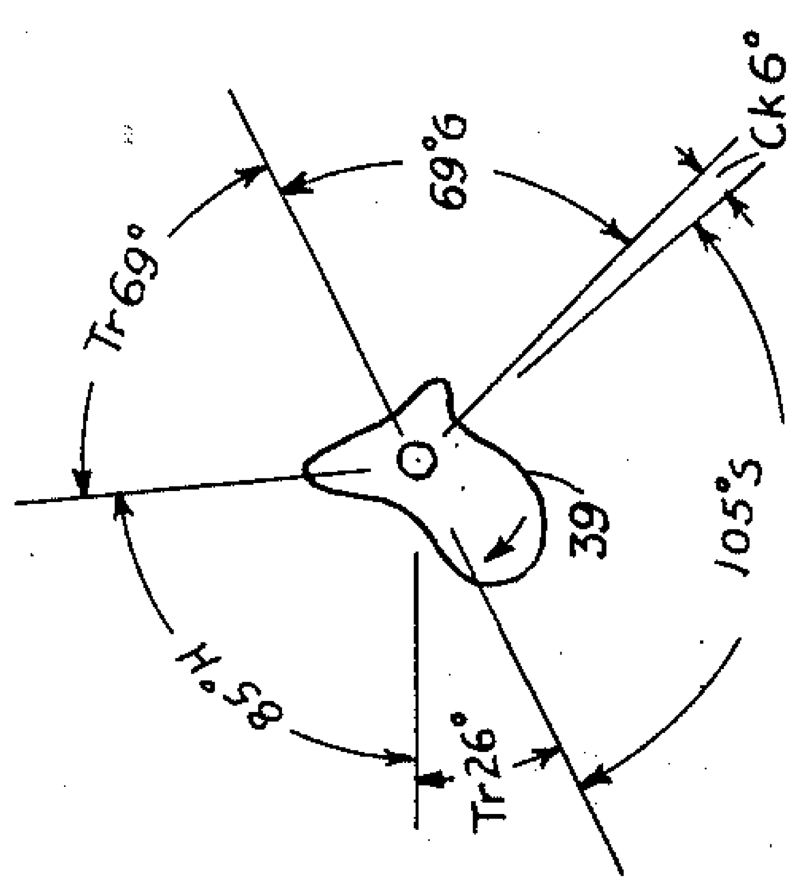

Fig. 16

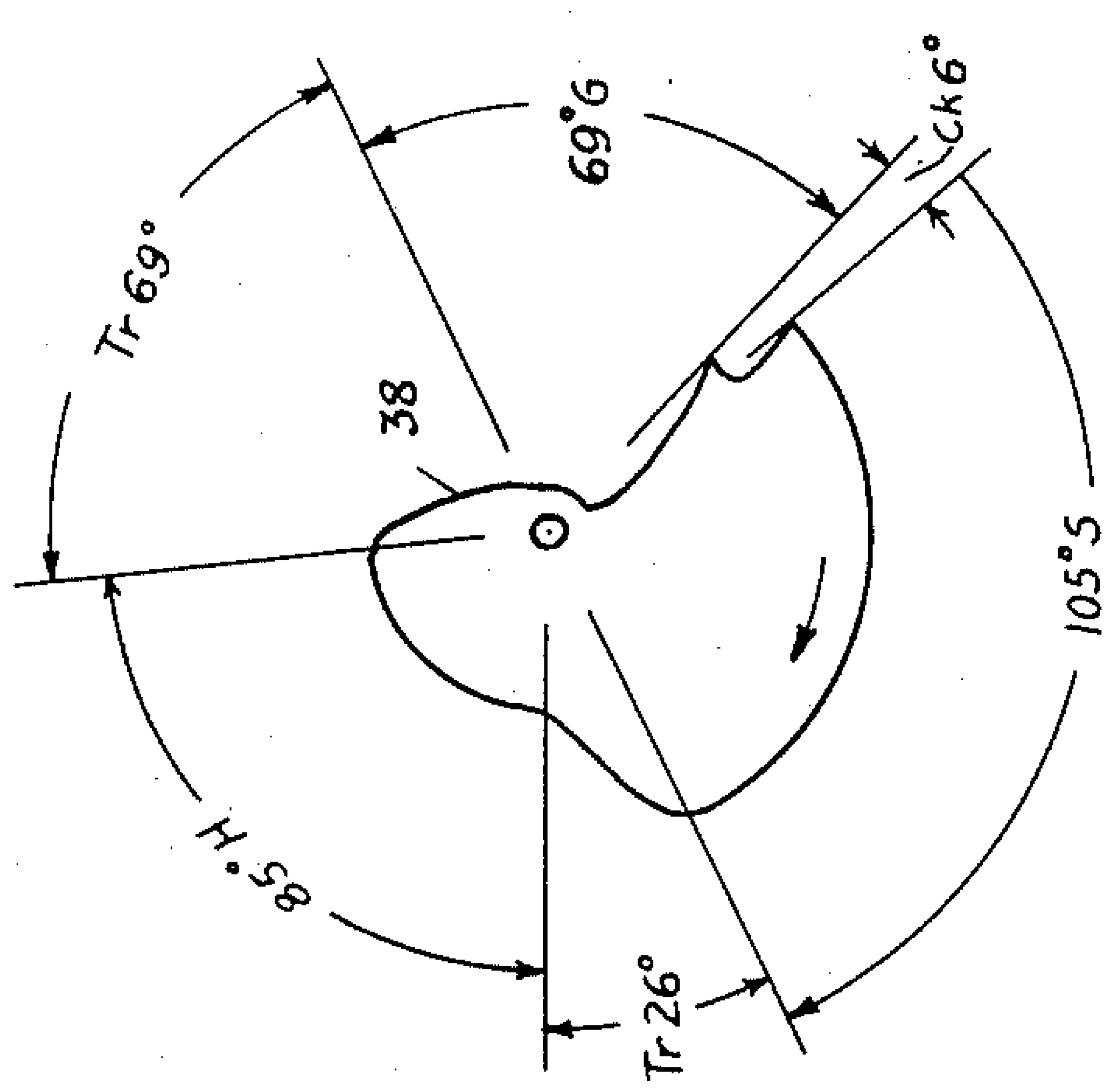

Fig. 15

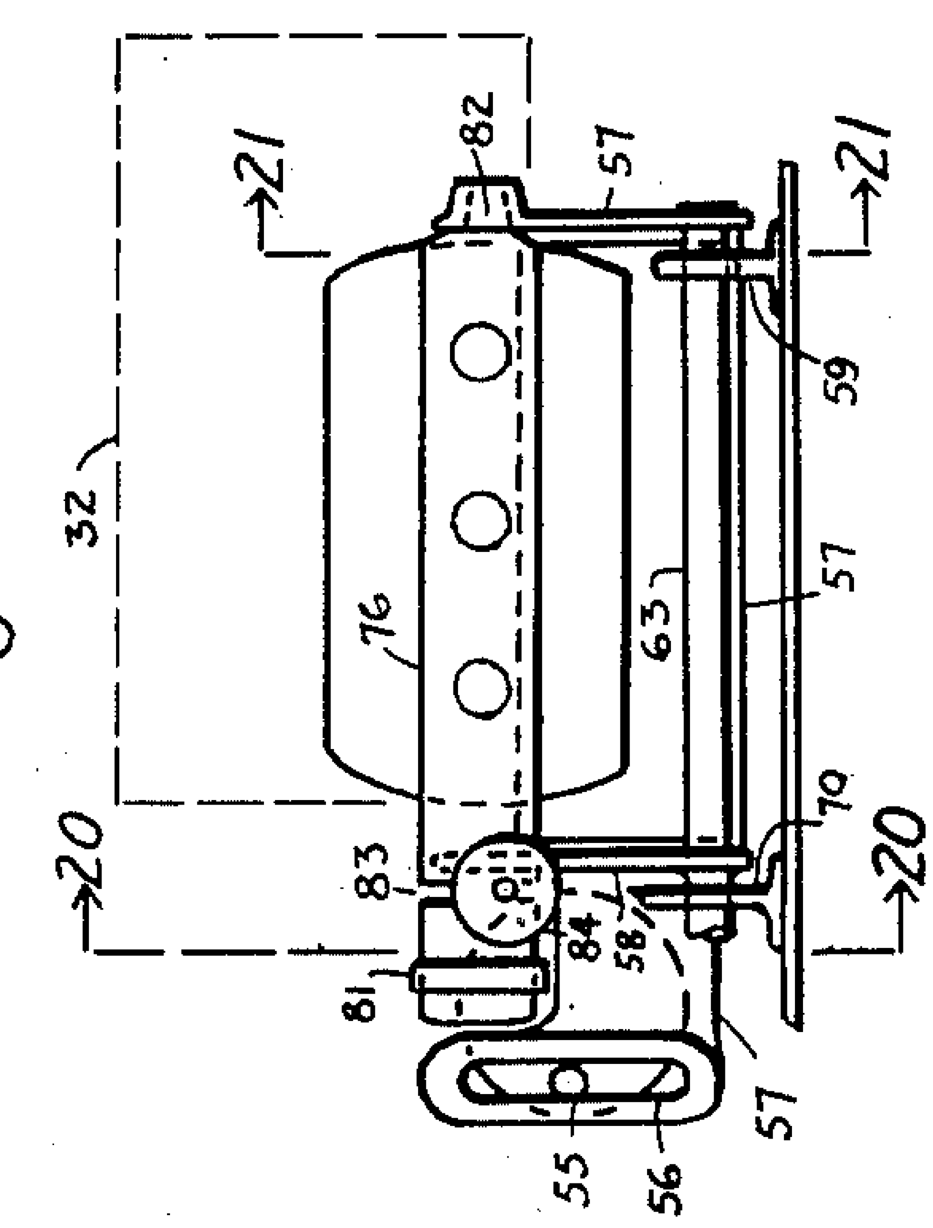

Fig. 19

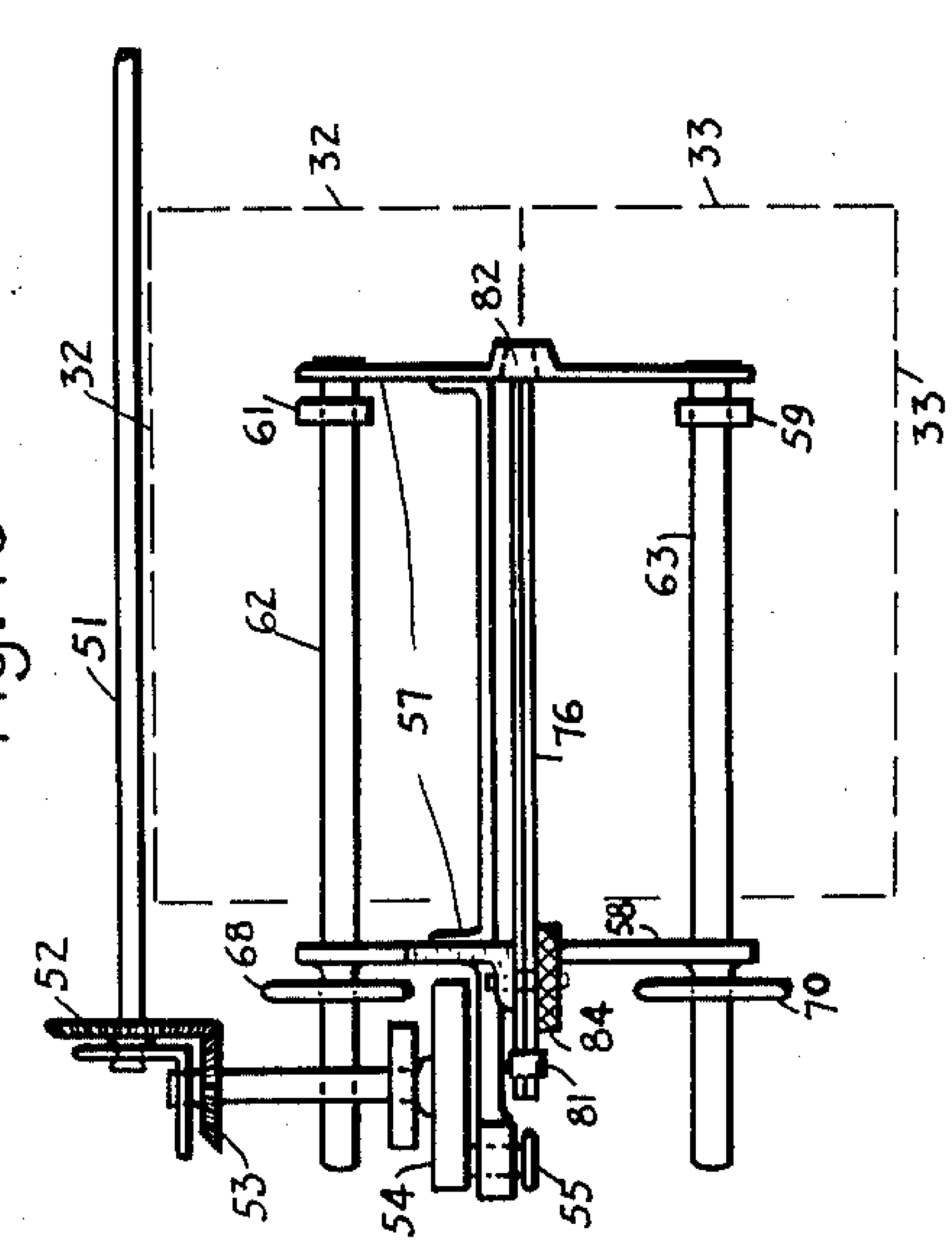

Fig. 18

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Fig. 20

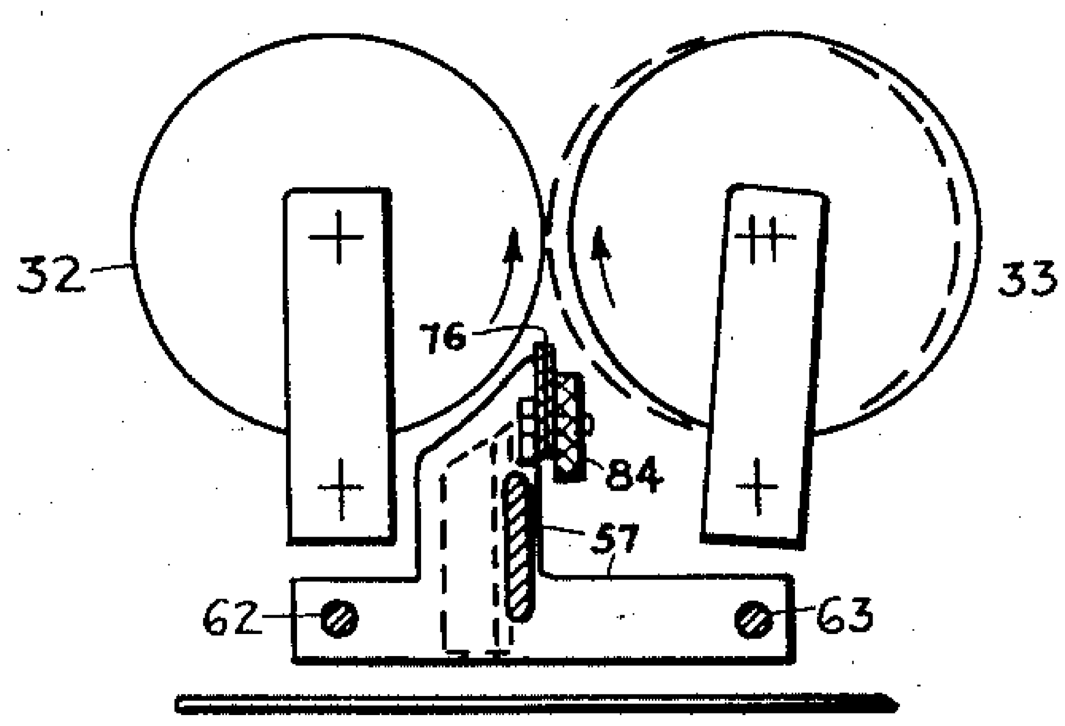


Fig. 21

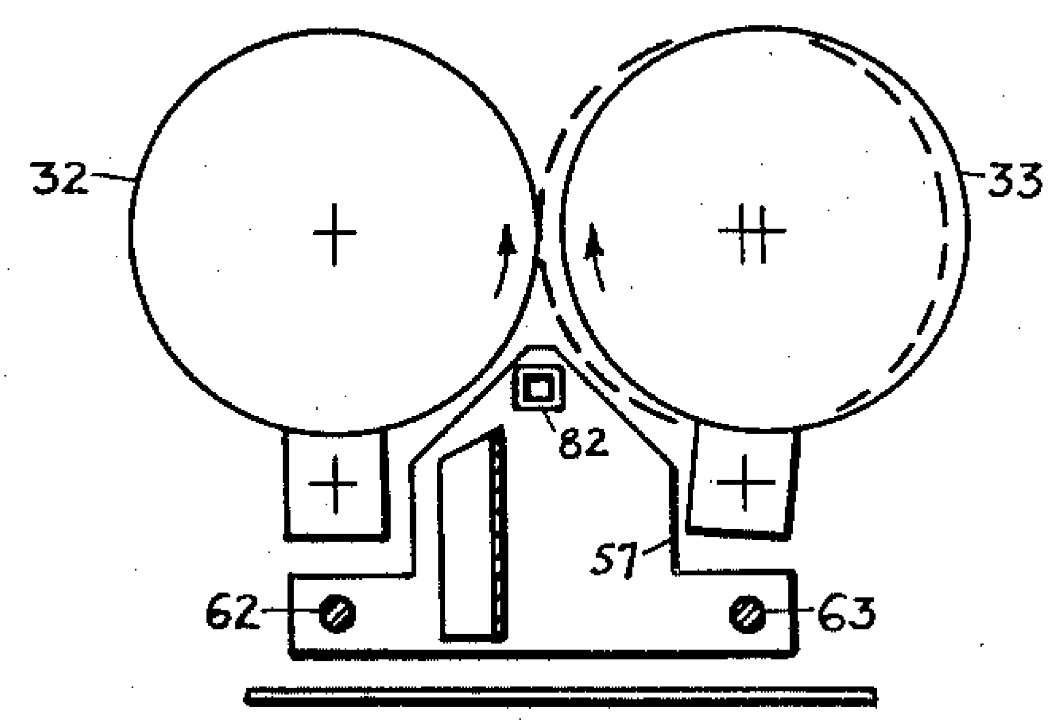


Fig. 22

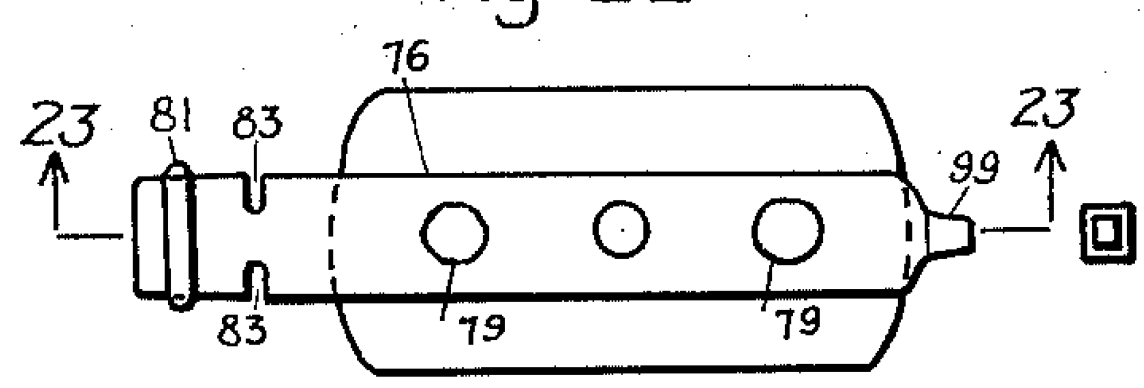


Fig. 23

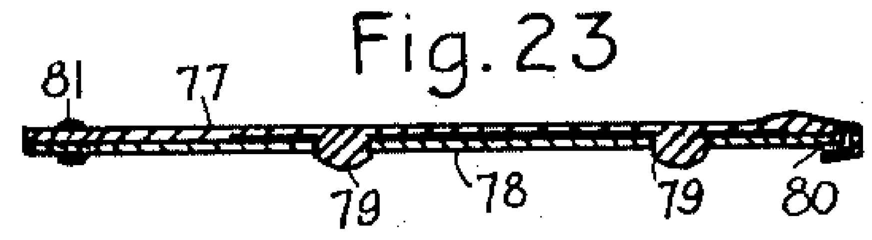


Fig. 24

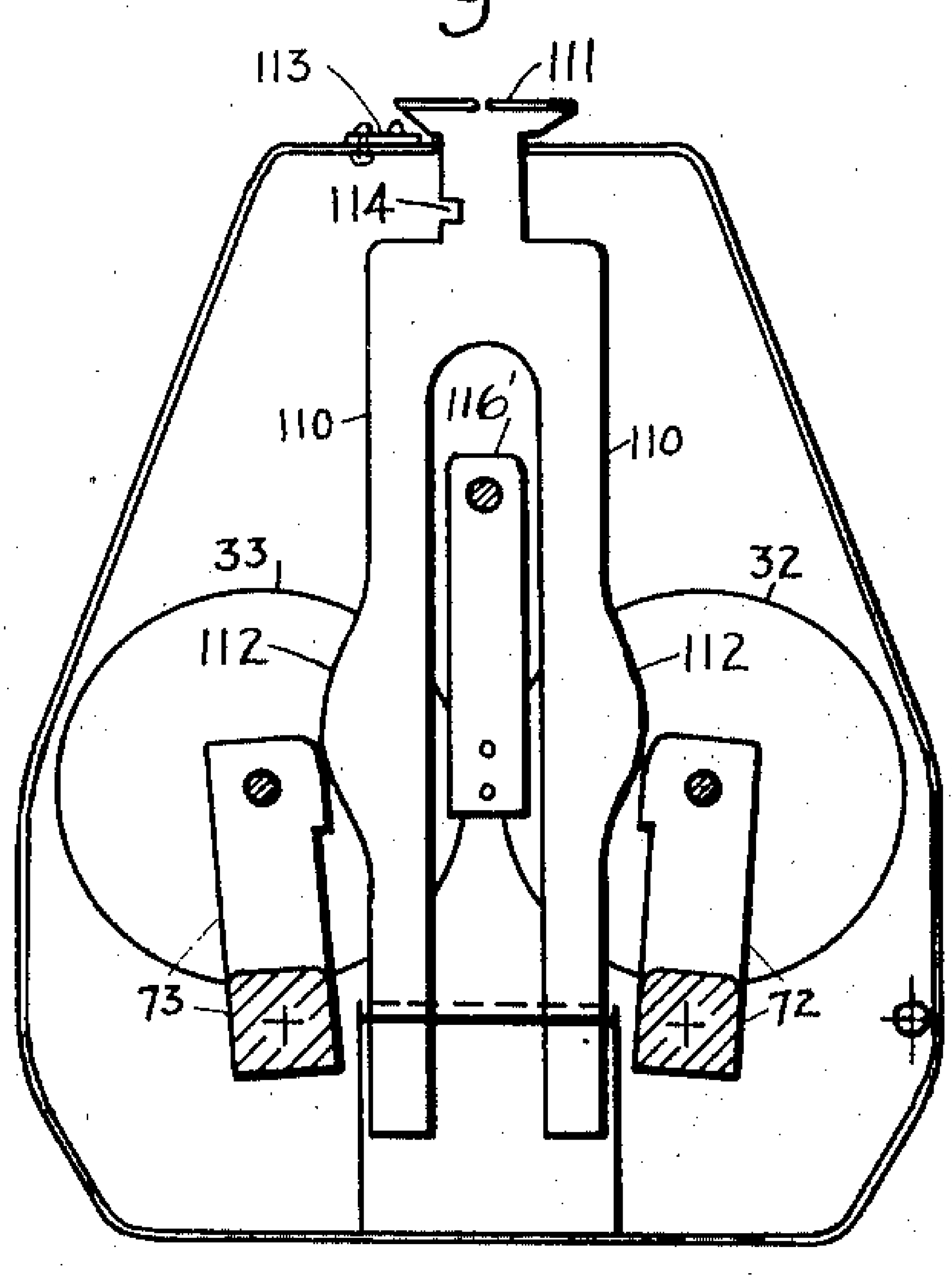
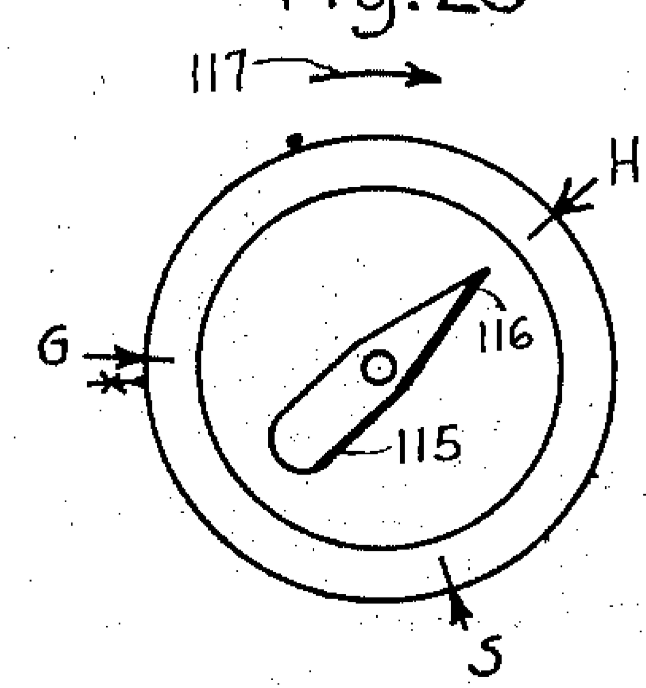


Fig. 25



Inventor:
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Patented June 5, 1934 1,961,891

UNITED STATES PATENT OFFICE

1,961,891

ABRADING DEVICE

Raymond V. Miller, Washington, D. C.

Application February 3, 1928, Serial No. 251,715

46 Claims. (Cl. 51—84)

These improvements relate to abrading devices, such as blade sharpeners and the like. The object of this invention is to provide a simple device by means of which a complete cycle of different abrading operations, as, for instance, coarse grinding, honing and stropping, may be performed, one after the other, upon a blade or other work, without the necessity of stopping the machine or changing the position of the blade in the machine. A further object is to avoid the complicated mechanism heretofore required to make the blade travel from one kind of sharpening roll to another of different abrasive quality.

A further object is to cause these operations to follow each other automatically, without stopping the machine or adjusting it in any way.

A further object is to provide simple means whereby the operator may select, from the cycle of operations of which the device is capable, any desired operation, and cause the device to perform either that particular operation alone, or to begin with that particular operation and to continue automatically with the other abrading operations following it in the cycle.

A further object is to provide means whereby the number of strokes made on the work during the various abrading operations may be made to vary widely, instead of being approximately equal.

A further object is to provide automatic variation of the pressure by which each quality of abrasive is pressed against the edge to be sharpened.

A further object is to provide means for changing this pressure through any desired range or cycle while each operation is being performed.

A further object is to provide means for applying an entirely different cycle of pressures during the action of each different quality of abrasive on the blade or work, in order to obtain the best results from each quality of abrasive.

A further object is to provide means whereby the adjustment of the position of the abrasive elements with respect to the edge being sharpened is made automatically, regardless of any reasonable amount of wear of the abrasive elements.

A further object is to provide means whereby the predetermined cycle of pressures between abradants and work will be maintained regardless of any reasonable amount of wear of the abradants.

Figure 1 is a plan view of one embodiment of my shapening device.

Figure 2 is a vertical section on line 2—2 of Figure 1.

Figure 3 is a partial section on line 3—3 of Figure 1.

Figures 4—*a*, 4—*b*, 4—*c*, 5—*a*, 5—*b*, 5—*c*, 6—*a*, 6—*b* and 6—*c* illustrate the mechanism for selecting the operations in their proper order, showing the diagrammatical relation between the cams and cam actuators.

Figure 7 is a section on line 7—7 of Figure 1.

Figure 8 is a section on line 8—8 of Figure 1.

Figure 9 is a section on line 9—9 of Figure 1.

Figure 10 is a view of the cam actuators.

Figure 11 is a section on line 11—11 of Figure 1.

Figure 12 is a section on line 12—12 of Figure 11.

Figure 13 is a section on line 13—13 of Figure 12.

Figure 14 is a section along line 14—14 of Figure 12.

Figures 15 and 16 are diagrams showing a method of laying out the operation selector cam and pressure cams, respectively.

Figure 17 is a diagram showing the relation between the operation selector cam and the axes of the abrading cylinders.

Figure 18 is a plan of the reciprocating carriage.

Figure 19 is a side elevation of the reciprocating carriage.

Figures 20 and 21 are sections along lines 20—20 and 21—21, respectively, of Figure 19.

Figure 22 is an elevation of the blade holder.

Figure 23 is a section along line 23—23 of Figure 22.

Figure 24 is a section on line 24—24 of Figure 1.

Figure 25 is a section along line 25—25 of Figure 2.

Referring now to the drawings accompanying and forming part of this specification, it should be noted that in the embodiment of the invention shown on the drawings there are three abrasive blocks, each of different abrasive quality, mounted on the periphery of each abrading cylinder. These three abrasives are referred to in this specification as coarse grinding, honing (or fine grinding) and stropping elements, respectively. It will be noted that the letters G, H and S (or G′, H′ and S′) are appended to certain reference numbers of parts or are used alone. These letters are used as a legend to identify the particular abrading element or operation which that portion of the drawings in question is intended to illustrate. The letter G invariably indicates coarse grinding; the letter H honing (or fine grinding); and the letter S stropping; whether applied to abrading elements, cams, cam actuators, grooves in cam actuators, sectors of rotatable cylinders, or other parts. The letters without the prime symbol (′)

indicate parts relating to one abrading cylinder, while the letters with the prime symbol indicate similar parts on the opposite (alternating) abrading cylinder. These letters are also referred to repeatedly in this specification so that the numbered parts may readily be associated with the respective abrading elements to which they relate.

The above objects are accomplished by using the construction and arrangement described below. Suitable abrading materials are formed into spiral shaped blocks 31G, 31H, 31S, 31G', 31H', and 31S' clamped on the periphery of two revolving cylinders 32 and 33 (see Figures 1 and 2). These two cylinders are identical and are made to revolve in synchronism with each other by the gears 34 and 35 when the crank 36 is turned. The axles 66—66 and 67—67 are fixed in position by the pieces 68 and 69, and 70 and 71, respectively. The axle or shaft 46 of the cylinder 32 is supported in the piece 72—72 which is a rigid casting pivoted at its lower ends on axle 66—66 (see Figure 2). The upper portion of 72 can therefore move back and forth, thus moving the circumference described by the abrasive blocks, toward or away from the blade edge. Piece 73 is similar. The projections 74 and 75 (Figures 11, 2 and 1) are part of the rigid castings 73 and 72, and serve as lever arms for the spring pressure that holds the cylinders against the blade edge. These lever arms, formed by the knife edges 91 and 92 (Figure 11) are equal, thereby providing assurance of equal pressure of the abradant on both faces of the blade edge from the pressure spring 100. The counter shaft 37 carrying cams 38 and 39 (see Figure 3) is given slow motion through gear wheels 41, 42 and 43. Part 128 (Figure 2) is a plate extending across the frame from side to side. It forms a bearing for the inner ends of axles of gears 41, 42 and 43. Gears 34 and 35 are in mesh with each other and with pinions 44 and 45, respectively. These two pinions drive shafts 46 and 47 to which are fastened the abrading cylinders 32 and 33 and the two groups of selector cams 48 and 49. Group 48 comprises cams 122s' (nearest the cylinders), 121H' and 120G' (farthest from the cylinders); group 49 comprises cams 122S (nearest the cylinders), 121H and 120G (farthest from the cylinders); front elevations of these cams are shown in Figures 4, 5 and 6. Gear 34 drives pinion 50 and shaft 51 at cylinder speed. Bevel gear 52 on shaft 51 has a diameter equal to one and a half times the diameter of bevel gear 53 which it drives. Bevel gear 53 is on the same shaft as the crank disc 54. Therefore, the crank pin 55 by working in the slot 56 causes the carriage 57 to move twice in one direction and once in the opposite direction to each revolution of an abrading cylinder. This gives the double diagonal motion to the abrasives working on each side of the blade edge. The carriage 57 travels back and forth on the supporting pieces 70, 59, 68 and 61, through which the two rods 62 and 63 slide. Pieces 64 and 65 are spacers to permit clearance for piece 58 of the carriage.

Each block of abrasive material, whether of carborundum, emery, leather or other substance, is, in the embodiment shown, shaped like a section of spiral wrapping on the periphery of the cylinder, substantially as shown in Figures 1, 2, 4—*a*, 5—*b* and 6—*c*. As the machine shown in the drawings is a very simple application of this invention each group of abrasive material will consist, in this case, of but one block of material. Each block will therefore occupy approximately one-third of the circumference of each cylinder, or slightly less. Figures 4—*a*, 5—*b* and 6—*c* show how the edges of the abrasive blocks should be rounded so as to make a smooth contact with the blade edge. The blade, which is held in one plane by a holder, is clamped in its holder in any suitable manner, of which one is as shown in Figures 22 and 23. The blade holder 76 can be fixed in position on the frame of the reciprocating carriage 57 in any suitable manner, for example, as shown in Figures 18, 19, 20 and 21. The holder shown consists of two halves, one of which, 77, is rigid while the other half, 78, is of spring steel. The blade fits in a recess in the rigid half, being centered on suitable lugs 79 corresponding to the shape of the blade. The small end of the spring steel half fits into a socket 80 in the end of the rigid half. The convex side of the spring steel half is toward the blade, so that when the sliding collar 81 is slipped over both halves of the blade holder the blade is held rigidly in the holder. The holder, in turn, is secured to the carriage 57 by sliding the small end 99 of the holder into the tapered square socket 82 and engaging the slot 83 of the holder under the clamp nut 84, on the other end of the carriage. Tightening this nut part of a turn secures the holder in the carriage. If the holder is for double edged blades the center line of the blade and the holder will be made coincident with the center of the tapered square socket 82, so the blade can be quickly reversed. The blade holder can be turned through a hundred and eighty degrees (for double edged blades) by merely loosening the clamp nut 84 and reinserting the square end 99 of the blade holder in its socket 82 on the frame of the carriage, after which the clamp nut 84 is again tightened, thus locking the blade holder to the frame of the reciprocating carriage. This permits double edged blades as well as single edged blades to be sharpened in the same machine. A separate blade holder may of course be required for each type of blade to be sharpened. It is understood, obviously, that the axis of the blade holder will be placed at a proper distance below the plane containing the cylinder axles 46—46 and 47—47 so as to secure a proper grinding angle with the face of the blade, and also so that when a double-edged blade is rotated through a hundred and eighty degrees in its holder the second edge will be the same distance below this plane as was the first edge.

The spring 100 pressing down on the projecting lugs 74 and 75 of the supporting pieces 72 and 73 (Figures 2 and 3) through the knife edges 91 and 92 (Figure 11), causes the two cylinders 32 and 33 to approach the blade edge with the same degree of pressure. The position of the cams and the composite cam actuator of course permits the periphery of but one cylinder at a time to actually touch the blade edge. The cylinder not permitted (at any given instant) to touch the blade edge is stopped by one of the cams just before it would otherwise touch the blade edge.

Figures 3 and 11 show how the cam 39 depresses the pressure spring and transmits the pressure variation to the two cylinder supporting pieces 72 and 73. A roller 98 is fitted to the top of part 85 (Figure 11). Part 86 is merely a guide pin to slide in the slot 87 to hold the spring in position (Figures 13 and 14). The axis of roller 98 also acts as a guide in this slot. Parts 88 and 89 transmit the spring pressure through pivot 90 to the two knife edges 91 and 92 on the bottom of part 89 (see Figure 11). These knife edges form the ends of two equal lever arms which insure that the pressure of the abrading cylinders will always be the same on both faces of the blade edge. Parts 93 and 94 are similar to parts 89 and 88, respectively. Figure 14 is an elevation of parts 95 and 96 which are shown in a transverse direction in Figure 13. These parts can be clamped to the base of the machine in the manner shown in Figure 14, thereby acting as stiffeners for the machine. These parts have suitable slots 87 and 97 for guide pins 98 and 86 and for the countershaft 37.

The crank pin 55 and disc 54 revolve at one and one half times the speed of the cylinders 32 and 33, with the result that when a given abrasive block on cylinder 32, as 31S' (Figure 6—*c*), touches the blade edge the first time the reciprocating carriage (with the blade) is travelling from right to left, and when this block touches the blade edge the next time the reciprocating carriage is travelling in the opposite direction, from left to right. This reversal occurs with each contact between any given block on this cylinder 32 and the blade edge.

The pressure by which the peripheries of the two cylinders are forced to approach the blade edge by means of the spring 100 is governed by the cam 39 which bears down on the top of the spring 100 with a varying pressure depending on how far the cam 39 has rotated in its cycle. The counter spring 101, (Figure 11) provided with an adjusting screw 102, acts with a light pressure against the main pressure spring 100. Its purpose is to permit the net spring pressure to be adjusted to zero when the pressure cam 39 is in the zero position, and also to eliminate any lost motion when near zero pressure. One revolution of the cam 39 covers one complete cycle of pressures for the three abrading operations. This cam 39 is geared in a suitable manner, as through the gears 40, 41, 42 and 43, with the crank 36 so that the cam will make but one revolution to a number of revolutions of the crank (possibly to twenty-five or thirty revolutions of the crank). The best speed ratios between the crank, the cylinders 32 and 33, and the pressure cam 39, can be readily determined and adjusted by those skilled in the art.

The cam 38 attached to the same shaft 37, as the pressure cam 39, presses against the roller 103 (Figure 3) of the composite cam actuator 104, sliding it, against the pressure of the comeback spring 105, from one end of its travel to the other end. As the composite cam actuator 104 slides from one setting to another the machine first does coarse grinding, then fine grinding (honing), and lastly, stropping (polishing). The distribution of the number of strokes given in each of these operations is determined by the shape of the cam 38. The best shape for this cam can be readily determined by those skilled in the art.

Figures 3, 7, 8 and 9 show how the composite cam actuator 104 is supported in a guide 106. This guide is cut away sufficiently near its center so as not to interfere with the contacts between cams and cam actuator. Part 103 is a roller which bears against the cam 38 and which causes the composite cam actuator to rise or fall as the radius of cam 38 varies. The guide 106 has suitable slots for the roller 103, the lug 108 (for the end of the comeback spring 105) and for the countershaft 37. Slot 107 (Figure 9) accommodates the supporting pin of roller 103. The composite cam actuator must be made long enough so that it will always have its upper and lower ends in the slides 109 of the guide 106. The guide 106 can be clamped to the top and bottom of the case in the manner shown, thereby keeping the composite cam actuator always properly centered, and also acting as a stiffener for the machine.

The manner of working out the shapes for the pressure cam and the selector cam is illustrated in Figures 15 and 16 which show selector and pressure cams respectively, looking toward the end of the machine containing the cylinders. In the selector cam shown in Figure 15 the coarse grinding arc is approximately 69° (indicated by letter G). This is the arc of shortest radius, because (see Figures 4, 5 and 6) the machine does coarse grinding when the composite cam actuator is in its highest position. In order to reach the fine grinding (honing) position the composite cam actuator must be depressed to the position shown in Figure 5—*b*. The radius of the cam cannot be abruptly increased, so an arc is allowed for the transition to the larger radius. In Figure 15 approximately 69° is allowed, on account of the relatively short circumference of the cam at this part. This arc is marked "Tr 69°". The fine grinding (honing) arc in Figure 15 (marked "85° H") is approximately 85°. This arc keeps the composite cam actuator depressed to the middle point of its vertical travel, in which position the machine does fine grinding (honing). To reach the stropping position, the composite cam actuator is depressed to the lowest point in its vertical travel. As the circumference of the cam is relatively longer where the radius is larger, an arc of only about 26° has been allowed in Figure 15 for the transition from the fine grinding arc to the stropping arc. This arc is marked "Tr. 26°". In Figure 15 approximately 105° has been allowed for stropping. This arc is marked "105° S". The abrupt lessening of the radius at the end of the stropping arc to a point midway between the stropping and fine grinding radii (for an arc of about 6° in Figure 15 marked "Ck6°") is for the purpose of causing a click when the roller 103 drops to the lesser radius, thereby indicating to the operator that the cycle of operations is completed. The cam shown in Figure 15 was worked out on a basis of giving more strokes by the finer abrasives and less strokes by the coarser ones. The number of degrees in each arc might vary considerably from the number shown in Figure 15. The shape of the selector cam must be worked out in each case to best suit the particular abrasives used, and can readily be formed by those skilled in the art.

Figure 16 shows a typical pressure cam wherein the arcs for coarse grinding, fine grinding and stropping comprise the same number of degrees as the corresponding arcs on the selector cam described above. The shape of this cam within each arc is such as to have its largest radius at the beginning of the arc, and to taper down to the minimum radius as the end of the arc is reached. The larger radius gives the heaviest spring pressure at the beginning of each abrading operation, and as this radius decreases, the spring pressure approaches zero at the end of each operation. The proper variation of pressure can be built into this cam by those skilled in the art, so as to best suit the abrasives used.

In Figures 15 and 16 the letters G, H, and S indicate the coarse grinding, honing and stropping arcs, respectively.

When the sliding piece 110 is pressed down by button 111 to the position shown in Figure 24 both cylinders are pushed back from possible contact with the blade edge by the shoulders 112 (piece 110 being symmetrical). This position is provided for use when inserting the blade holder in the carriage 57. This prevents injury to the blade edge and avoids accidental cutting of a finishing strop while inserting the blade holder in the carriage. The friction lug 113 when placed in groove 114 (the operating position) holds the sliding piece 110 in the operating position.

Means for manually setting the machine to perform any particular abrading operation of which it is capable, are provided as follows. By pressing in on the indicator pointer 115 and causing the shaft 37 carrying cams 38 and 39 to slide longitudinally against the pressure of the flat spring 116' (Figure 3) until gear 43 is no longer in mesh with the pinion on gear 42, the indicator pointer can be rotated (turning shaft 37 and cams 38 and 39) until the indicator points to the operation desired. (See Figure 25). When the pressure on this indicator pointer is released the gear 43 is brought into mesh again with the pinion on gear 42, causing the machine to proceed with its operations beginning with the one selected. The flat spring 116' (Figure 3) keeps gear 43 and pinion on 42 in mesh at all times except when the indicator pointer 115 is pushed in against the pressure of the spring. The cam rollers 98 and 103 are made sufficiently wide so that they will not lose contact with the pressure cam and the selector cam, respectively, when the shaft 37 is moved longitudinally in order to select a given operation or series of operations. The position of the indicator pointer 115 on the shaft 37 is such as to prevent the shaft from being pushed in so far as to cause the cams to lose this contact.

The outside of the case in the vicinity of the indicator pointer 115 can be marked in the manner shown in Figure 25 to indicate where the pointer 116 should be set in order to begin with any particular operation. The arrow 117 indicates the order in which the operations will follow one another.

Having described in general the construction of the device shown on the drawings, a specific description will now be given of the means provided to obtain the operative position and relation of the cams and cam actuators for moving the abrasive cylinders into and out of operative position while the cylinders are rotating. The cylinders 32 and 33 are provided with separate and differently arranged cams for this purpose. On the axle of cylinder 33 are three such cams, 122S, 121H, and 120G (Figures 1, 4, 5 and 6) spaced along the axle so that each cam will rub against its corresponding individual cam actuator. These actuators are, respectively, 104S, 104H, and 104G (see Figures 1, 3, 4, 5, 6, 7 and 10). On the axle of cylinder 32 are also three such cams, 120*s*', 121H', and 120G' (Figures 1, 2, 4, 5, 6 and 10) spaced along the axle so that each cam will rub against its corresponding individual cam actuator. These actuators are, respectively, 104S, 104H and 104G (see Figures 1, 2, 4, 5, 6 and 10). It will be noted, in the embodiment shown, that the cam actuators for the cams on the axle of cylinder 32 are formed by one side of parts 104S, 104H and 104G, while the cam actuators for the cams on the axle of cylinder 33 are formed by the other side of these same parts. It is obvious that in other embodiments of the device the respective cam actuators for the cams on the two axles would not necessarily have to be formed on the same piece of material. Neither would it be necessary to fasten the parts 104S, 104H and 104G together to form a so-called "composite" cam actuator. These details can be altered as may best suit the various uses to which the invention may be applied, without departing from the spirit of the invention.

In the side elevation of the composite cam actuator 104 shown in Figure 10 the dark portions represent the straight sides of the various cam actuators, the unshaded portions represent the grooves in the various cam actuators, and the cross-hatched portions represent spacers between the individual cam actuators. In Figure 10 the cam actuator marked 104G contains grooves 123G and 123G', and co-acts with cams 120G and 120G'; the cam actuator marked 104H contains grooves 124H and 124H', and co-acts with cams 121H and 121H'; the cam actuator marked 104S contains grooves 125S and 125S', and co-acts with cams 122S and 122*s*'.

It will be observed that actuator 104S controls cam 122S on one axle and cam 122S' on the other axle. Similarly, actuator 104H controls cam 121H on one axle and cam 121H' on the other axle; and actuator 104G controls cam 120G on one axle and cam 120G' on the other axle. The cylinders and the cams are all secured to their respective axles so as to maintain their positions with respect to each other.

It will be noted that although only three different qualities of abrasive elements are shown on the drawings, requiring three cams on the axle of each cylinder, the construction is such that this number could be changed to any desired number of different abrading elements, without departing from the principle of selective operation of any desired element upon the work while the cylinders are rotating, while also preventing the other elements from operating upon the work.

Consider first the relations existing between the selecting elements when the device is set for the coarse grinding operation. The composite cam actuator 104 is placed in the highest of its three possible vertical positions. The relations then existing between the three individual cam actuators and their corresponding cams are shown in Figures 6*a*, 6*b* and 6*c*.

At this point attention is invited to the fact that Figures 4, 5 and 6 (*a*, *b* and *c* in each) are diagrammatic, and show only the minimum theoretical length of cam actuators required. Actually the cam actuators are made longer than this theoretical minimum. The relative actual lengths are shown in the details in Figures 3, 7, 8, 9 and 10. These actual lengths are required in order that neither end of the composite cam actuator may slip out of the slots 109 of guide 106, for any position of the composite cam actuator.

The two cylinders revolve in opposite directions, always in synchronism because they are connected through gears 34, 35, 44 and 45, gears 34 and 35 being always in mesh with each other. It will be noted from Figure 6*a* that the cams 122S and 122S' prevent the "S" arcs of the cylinder peripheries from approaching the blade edge, because the high portions of these cams will rub against straight portions of the actuator 104S, forcing the axles 46 and 47 of the cylinders away from the blade edge as the cams rotate through the arc embraced by the high portions of these cams. The pivotal support of frames 72 and 73 provides for this lateral movement of the axles 46 and 47. Similarly, it will be noted from Figure 6b that the cams 121H and 121H' prevent the "H" arcs of the cylinder peripheries from approaching the blade edge, because the high portions of these cams will rub against the straight portions of the actuator 104H, forcing the axles of the cylinders away from the blade edge as the cams rotate through the arc embraced by the high portions of these cams. It will be noted from Figure 6c, however, that the "G" arcs of the cylinder peripheries are not prevented from approaching the blade edge, because in this case the grooves 123G and 123G' in the actuator 104G are adjacent to the cams 120G and 120G'; with the result that the pressure from spring 100, acting through the pivoted frames 72 and 73, (Figure 11) forces the "G" arcs of the cylinder peripheries to abrade the blade edge as these arcs pass the edge. It will be noted also that the cams 120G and 120G' are so arranged that the "G" arcs of the two cylinder peripheries will alternate in abrading the blade edge.

Consider next the relations existing between the selecting elements when the device is set for the fine grinding (honing) operation. The composite cam actuator 104 is placed in the middle position of its three possible vertical positions. The relations then existing between the three individual cam actuators and their corresponding cams are shown in Figures 5a, 5b and 5c. It will be noted from Figure 5a that the cams 122S and 122S' prevent the "S" arcs of the cylinder peripheries from approaching the blade edge, because the high portions of these cams will rub against the straight portions of the actuator 104S, forcing the axles 46 and 47 of the cylinders away from the blade edge as the cams rotate through the arc embraced by the high portions of these cams. Similarly, it will be noted from Figure 5c that the cams 120G and 120G' prevent the "G" arcs of the cylinder peripheries from approaching the blade edge, because the high portions of these cams will rub against the straight portions of the actuator 104G, forcing the axles of the cylinders away from the blade edge as the cams rotate through the arc embraced by the high portions of these cams. It will be noted from Figure 5b, however, that the "H" arcs of the cylinder peripheries are not prevented from approaching the blade edge, because in this case the grooves 124H and 124H' in the actuator 104H are adjacent to the cams 121H and 121H'; with the result that the pressure from spring 100, acting through the pivoted frames 72 and 73, forces the "H" arcs of the cylinder peripheries to abrade the blade edge as these arcs pass the edge. It will also be noted that the cams 121H and 121H' are so arranged that the "H" arcs of the cylinder peripheries will alternate in abrading the blade edge.

Consider now the relations existing between the selecting elements when the device is set for the stropping operation. The composite cam actuator 104 is placed in the lowest of its three possible vertical positions. The relations then existing between the three cam actuators and their corresponding cams are shown in Figures 4a, 4b and 4c. It will be noted from Figure 4b that the cams 121H and 121H' prevent the "H" arcs of the cylinder peripheries from approaching the blade edge, because the high portions of these cams will rub against the straight portions of the actuator 104H, forcing the axles 46 and 47 of the cylinders away from the blade edge as these cams rotate through the arc embraced by the high portions of these cams. Similarly, it will be noted from Figure 4c that the cams 120G and 120G' prevent the "G" arcs of the cylinder peripheries from approaching the blade edge, because the high portions of these cams will rub against the straight portions of the actuator 104G, forcing the axles 46 and 47 of the cylinders away from the blade edge as the cams rotate through the arc embraced by the high portions of the cams. It will be noted from Figure 4a, however, that the "S" arcs of the cylinder peripheries are not prevented from approaching the blade edge, because in this case the grooves 125S and 125S' in the actuator 104S are adjacent to the cams 122S and 122S'; with the result that the pressure from spring 100, acting through the pivoted frames 72 and 73, forces the "S" arcs of the cylinder peripheries to abrade the blade edge as these arcs pass the edge. It will be noted also that the cams 122S and 122S' are so arranged that the "S" arcs of the cylinder peripheries will alternate in abrading the blade edge.

If the individual cam actuators are made to slide separately instead of simultaneously as one unit, the same operative position and relation of individual cams and their corresponding cam actuators as described above and shown in Figures 4a, 4b, 4c, 5a, 5b, 5c, 6a, 6b and 6c are maintained. As each individual actuator has merely a straight portion and a grooved portion (wide portion and narrow portion), as shown in Figures 4a, 4b, 4c, 5a, 5b, 5c, 6a, 6b and 6c, it is obvious that in this case each individual actuator need slide to but two vertical positions; one in which the straight (wide) portion of the actuator will rub against the high portion of its corresponding cam, and the other in which the grooved (narrow) portion of the actuator will be adjacent to the cam so that no rubbing between the cam and its actuator will take place.

In Figures 4, 5 and 6 (a, b and c in each) it will be noted that clearance is allowed between cams and cam actuators for all positions except where they are intended to be in actual contact, as when pushing a cylinder away from the blade edge. A study of these figures shows how the necessary amount of vertical movement of the composite cam actuator is governed by the size of the cams. These figures also illustrate how the shape, length and position of the grooves 125S, 125S', 124H, 124H', 123G and 123G' in the several cam actuators are determined; how the several cam actuators are assembled into one composite cam actuator which will function as intended; and also how the shoulders of the cams are the critical points in their design, and must be worked out to correlate with all the assumed clearances and with the arc subtended by each abrasive block. In the particular embodiment of the invention shown in the drawings the arc subtended by each abrading element is taken as ninety degrees, thus allowing ample arcs between blocks to compensate for any reasonable amount of flexure of the blade, lack of precise correlation between cams and cam actuators, and reasonable variation from the assumed clearances.

It will be noted from examination of Figures 4 5 and 6 (a, b and c in each) that the arc of actual contact between each abrading element and the work is only about sixty degrees. This is for the purpose of preventing the ends of the abrading elements from making contact with the blade edge, which contact would obviously damage the delicate edge. Such contact is prevented because the shoulder of the cam immediately in advance of the shoulder on any given cam (as they rotate) is still pressing against the straight portion of its actuator and thereby is delaying the making of contact until after the foremost end of the abrasive block has rotated beyond the blade edge; and, similarly, because the shoulder immediately following the shoulder on any given cam (as they rotate) begins to press against the straight portion of its actuator before the hindmost end of the contacting abrasive block has reached the blade edge as it rotates, thereby moving the abrasive block clear of the blade edge. This feature is more clearly described by referring to a particular abrading operation, as for instance, honing (see Figures 5*a*, 5*b* and 5*c*). In these figures the left hand cylinder is shown abrading the blade edge with the honing element. Before the honing element 31H approaches the blade edge (as it rotates) the shoulder of cam 120G (Figure 5*c*) presses against the straight portion of its actuator 104G, thereby preventing contact; and as this shoulder completes its contact with its actuator, which occurs after the upper or foremost end of the honing element 31H has rotated about fifteen degrees beyond the blade edge, the honing element 31H is eased into contact with the blade edge. Similarly, when the lower or hindmost end of the contacting honing element 31H has rotated to within about fifteen degrees of the blade edge the shoulder of cam 122S (Figure 5*a*) presses against the straight portion of its actuator 104S, thereby moving the honing element clear of the blade edge. It will be obvious to those expert in the art that this gradual making and breaking of contact at a point a short distance from the respective ends of the abrading element is essential if satisfactory results are to be obtained.

It will of course be understood that I do not desire to be limited to the precise construction or arrangement herein described and shown, as it is obvious that the details of the construction and arrangement may be varied considerably without departing from the spirit of the invention.

With this in mind I desire to point out particularly that although in the embodiment described the cams 120G, 121H and 122S have their high (long radius) portions in the same arc as the "G" abrasive, "H" abrasive and the "S" abrasive occupy, respectively, on the cylinder periphery, and that their respective cam actuators (104G, 104H and 104S) contain grooves (123G, 124H and 125S) for controlling the relative oscillating movement between the abrasive cylinder and the work, nevertheless each of these cams could also be constructed with a short radius portion in the same arc as its corresponding abrasive material occupies on the cylinder periphery (the remainder of the arc on the cam being of longer radius), in which case the actuator for each cam would have, instead of a groove, a raised portion; and the co-action between the various cams and their actuators would give the same control of the relative oscillating movement as in the embodiment shown, without departing from the spirit of the invention.

With this same idea in mind I desire to point out further that although in the embodiment shown and described each cam actuator works in the same plane as its respective cam occupies, nevertheless the cam actuators could be arranged to work in a horizontal plane (approximating the plane occupied by the blade edge), in which case the several actuators would comprise grooves (or raised portions, according to the type of cam used) in one piece of metal movable horizontally, parallel with the axles 46 and 47, without departing from the spirit of the invention, inasmuch as the essential requirement is that each actuator shall selectively co-act with its corresponding cam to produce the relative movement described.

Furthermore, with this same idea still in mind, I desire particularly to point out that although in the embodiment shown and described the various graded abrading elements are blocks of material fixed on the periphery of the rotatable cylinder, nevertheless the construction could comprise, in lieu of such blocks, rotating abrasive rolls with their axes mounted on the periphery of the cylinders 32 and 33, or, in lieu of such blocks, could comprise rotating spider frames with their axes mounted on the periphery of the cylinders 32 and 33, these frames to carry the axes of rotating abrasive rolls at their individual peripheries, without departing from the spirit of the invention.

With the same idea still in mind I desire also to point out particularly that although in the embodiment shown and described the various graded abrasive elements are made to selectively contact with the work by moving the frame 72 carrying cylinder 32 toward and away from the work, nevertheless, without departing from the spirit of the invention, the frame 72 carrying cylinder 32 could be constructed so as to be not movable but, instead, the work holder could be arranged to be movable so as to selectively bring the work toward and away from the rotatable cylinder 32.

Operation

The blade to be sharpened is clamped in holder 76 which is in turn secured in reciprocating carriage 57, button 111 having first been pushed down as far as it will go, thereby placing the abrasive cylinders in inoperative position. After the holder is in the carriage button 111 is pulled up again to its top position and secured by catch 113, thereby putting the abrasive cylinders back into operative position. The particular abrading operation which it is desired to perform first is then selected by pressing indicator 115 toward the cylinders as far as it will go (thus throwing the gear connection out of mesh) and turning the indicator until pointer 116 is opposite the name or distinguishing letter of the desired operation; indicator 115 is then released, whereupon the pressure from spring 116′ forces gear 43 back in mesh with pinion 42.

Turning crank 36 counterclockwise (in the embodiment shown) causes the abrading cylinders to rotate and the blade to reciprocate back and forth. The peripheries of both abrading cylinders are continually urged toward the blade edge by the pressure from spring 100 acting on the pivotally supported frames carrying axles 46 and 47 of the cylinders. On account of the co-action between cams and cam actuators, however, (as shown in Figures 4, 5, and 6) the periphery of neither cylinder can touch the blade edge until one of the cams on the axle of that cylinder comes into position such that its high portion enters the groove in its corresponding cam actuator. The cam actuator for that cam must of course be in such vertical position that its groove is opposite the cam. When this condition obtains, the blade edge will be worked on by that kind or grade of abrading material which is in the same arc as the high portion of said cam; there being, in this arc, no rubbing of cams against cam actuators to prevent the cylinder periphery from touching the blade edge. The high portions of the cams on the two cylinder axles are so arranged with respect to the grooves in their corresponding actuators that only one particular kind or grade of abrading material makes contact with the blade edge during any one cycle of operations; furthermore, such contact is made alternately, first by one cylinder and then by the other cylinder.

The vertical position of the composite cam actuator determines which particular kind or grade of abrading material will act on the work. In the device described, the upper position of the composite cam actuator produces the coarse grinding operation, the middle position produces the honing operation, and the lower position produces the stropping operation. The rotation of cam 38 by the gear train causes the composite cam actuator to remain in the upper position for a time, then to shift to the middle position for a time, then to shift to the lower position for a time, and finally to shift back to the upper position again.

For each position of the composite cam actuator the pressure cam 39 compresses spring 100 through a different range, thereby causing a varying pressure during each separate abrading operation, which pressure is adjusted to be most suitable to each of the three different kinds or grades of abrasives used.

The last operation will always be stropping, regardless of whether coarse grinding has been omitted, or whether both coarse grinding and honing have been omitted. When the stropping operation is finished, roller 103 is released as it reaches arc Ck6°, and a click is produced by the contact of this roller against cam 38 at the point where the radius is suddenly decreased, thereby announcing to the operator that the blade is ready for removal from the machine.

I claim:

1. In an abrading device, the combination of a work holder, a rotatable abradant-carrying member having on its periphery a plurality of abrading elements, each of which performs a separate and distinct operation upon the work different from that performed by the other elements, a frame in which said member is mounted, said frame being movable to and from the work and means for selectively moving the frame to cause contact of a desired abrading element only with the work, said means comprising cams mounted upon the shaft of said member, there being one cam for each abrading element, and a composite cam actuator movable to different positions to select the abrading element to be caused to contact with the work.

2. The combination of claim 1 in combination with means for moving the composite cam actuator comprising a cam actuated from an element driving the shaft of the rotatable abradant-carrying member through speed-reducing gearing.

3. In an abrading device the combination of a work holder, a rotatable abradant-carrying member having on its periphery a plurality of abrading elements, each of which performs a separate and distinct abrading operation upon the work different from that performed by the other elements, a frame in which said member is mounted, said frame being movable to and from the work, means for selectively moving the frame to cause contact of a desired abrading element with the work while preventing contact of the remaining abrading elements with the work and means for adjusting the pressure with which said frame is urged towards the work, to correspondingly vary the pressure of the abrading element upon the work.

4. In an abrading device the combination of a work holder, a rotatable abradant-carrying member having on its periphery a plurality of abrading elements, each of which performs a separate and distinct abrading operation upon the work different from that performed by the other elements, a frame in which said member is mounted, said frame being movable to and from the work, means for selectively moving the frame to cause contact of a desired abrading element with the work while preventing contact of the remaining abrading elements with the work, a spring for urging said frame toward the work and means comprising a cam for controlling the pressure with which said frame is urged toward the work.

5. In an abrading device the combination of a work holder, a rotating abradant-carrying member having on its periphery a plurality of abrading elements, each of which performs a separate and distinct operation upon the work different from that performed by the other elements, a frame in which said member is mounted, said frame being movable to and from the work means for selectively moving said frame to cause contact of a desired abrading element only with the work, said means comprising cams mounted upon the shaft of said member, there being one cam for each separate and distinct abrading operation that can be performed by the device, a composite cam actuator movable to different positions to select the abrading element to be caused to contact with the work, a cam on an axle for moving said composite cam actuator, a spring for urging said frame toward the work, a second cam upon said axle for controlling the pressure with which said frame is urged toward the work, means for driving said rotatable abradant-carrying member and means controlled from said means for driving through reducing gearing for rotating said axle.

6. The combination of claim 5 in which said frame is pivotally mounted on an axis parallel to the axis of said member, in combination with a second similar rotatable abradant-carrying member placed on the side of said work holder opposite to the first said member and means for causing said second member and the first said member to alternately become operative with respect to the work.

7. In an abrading device the combination of a work holder, a rotatable abradant-carrying member having on its periphery a plurality of abrading elements each of which performs a separate and distinct operation upon the work, different from that performed by the other elements, a frame in which said member is mounted, said frame being movable to and from the work while said member is rotating and means for selectively moving the frame while said abradant-carrying member is rotating to cause contact of a desired abrading element with the work while preventing contact of the remaining abrading elements with the work.

8. The combination of claim 7 with means for changing such contact during the rotation of

said abradant-carrying member from an element of one abrasive quality to an element or elements of other abrasive quality and causing contact of the desired abrading element only with the work, while preventing contact of the remaining abrading elements with the work.

9. The combination of claim 7 with means for causing reciprocating motion of the work with respect to the abrading elements, in a direction parallel with the axis of the rotatable abradant-carrying member.

10. The combination of claim 7 in which said means comprises cams mounted upon the shaft of the rotatable abradant-carrying member.

11. The combination of claim 7 in which said means comprises a number of cams equal to the number of abrading elements, said cams being mounted upon the shaft of the rotatable abradant-carrying member.

12. The combination of claim 7 in which said means comprises a composite cam actuator movable to different positions to select the abrading element to be caused to contact with the work.

13. The combination of claim 7 in which said means comprises a number of individual cam actuators movable to different positions to select the abrading element which it is desired to put into operative action upon the work.

14. The combination of claim 7 with a second similar rotatable abradant-carrying member placed on the side of said work holder opposite to the first said member to alternately become operative with respect to the work, said second member and said first member being both urged toward the work by pressure from the same spring through equal lever arms, thus providing that equal pressure shall be exerted upon the work by both said members.

15. In an abrading device the combination of a work holder, a rotatable abradant-carrying member having on its periphery a plurality of abrading elements which are maintained at a fixed radial distance from the axis of the abradant carrying-member, each of which elements performs a separate and distinct operation upon the work different from that performed by the other elements, a frame in which said member is mounted, said frame being movable to and from the work and means for selectively moving the frame to cause contact of a desired abrading element with the work while preventing contact of the remaining abrading elements with the work.

16. The combination of claim 15 with means for changing such contact during the rotation of said abradant-carrying member from an element of one abrasive quality to an element or elements of other abrasive quality and causing contact of the desired abrading element only with the work, while preventing contact of the remaining abrading elements with the work.

17. The combination of claim 15 with means for causing reciprocating motion of the work with respect to the abrading elements, in a direction parallel with the axis of the rotatable abradant-carrying member.

18. The combination of claim 15 in which said means comprises cams mounted upon the shaft of the rotatable abradant-carrying member.

19. The combination of claim 15 in which said means comprises a number of cams equal to the number of abrading elements, said cams being mounted upon the shaft of the rotatable abradant-carrying member.

20. The combination of claim 15 in which said means comprises a composite cam actuator movable to different positions to select the abrading element to be caused to contact with the work.

21. The combination of claim 15 in which said means comprises a number of individual cam actuators movable to different positions to select the abrading element which it is desired to put into operative action upon the work.

22. The combination of claim 15 with a second similar rotatable abradant-carrying member placed on the side of said work holder opposite to the first said member to alternately become operative with respect to the work, said second member and said first member being both urged toward the work by pressure from the same spring through equal lever arms, thus providing that equal pressure shall be exerted upon the work by both said members.

23. In an abrading device the combination of a work holder, a rotatable abradant-carrying member having on its periphery a plurality of abrading elements each of which performs a separate and distinct operation upon the work different from that performed by the other elements, a frame in which said member is mounted, and means for selectively providing relative movement between the frame and said work to cause contact of a desired abrading element with the work while preventing contact of the remaining abrading elements with the work.

24. The combination of claim 23 with means for changing such contact during the rotation of said abradant-carrying member from an element of one abrasive quality to an element or elements of other abrasive quality and causing contact of the desired abrading element only with the work, while preventing contact of the remaining abrading elements with the work.

25. The combination of claim 23 with means for causing reciprocating motion of the work with respect to the abrading elements, in a direction parallel with the axis of the rotatable abradant-carrying member.

26. The combination of claim 23 in which said means comprises cams mounted upon the shaft of the rotatable abradant-carrying member.

27. The combination of claim 23 in which said means comprises a number of cams equal to the number of abrading elements, said cams being mounted upon the shaft of the rotatable abradant-carrying member.

28. The combination of claim 23 in which said means comprises a composite cam actuator movable to different positions to select the abrading element to be caused to contact with the work.

29. The combination of claim 23 in which said means comprises a number of individual cam actuators movable to different positions to select the abrading element which it is desired to put into operative action upon the work.

30. The combination of claim 23 with a second similar rotatable abradant-carrying member placed on the side of said work holder opposite to the first said member to alternately become operative with respect to the work, said second member and said first member being both urged toward the work by pressure from the same spring through equal lever arms, thus providing that equal pressure shall be exerted upon the work by both said members.

31. The combination of claim 23 in which said means have means to prevent the ends of the abrading elements from making contact with the work.

32. In an abrading device the combination of

a work holder and a rotatable abradant-carrying member for abrading work placed in said holder, said member being provided with a plurality of abrading elements having means which maintain said abrading elements at all times in positions at a fixed radial distance from the axis of said member, said member being provided with means to cause the abrading elements to intermittently contact with the work, said elements differing from each other so they will perform different abrading operations upon the work.

33. The combination of claim 32 and means for selectively causing contact of a desired abrading element with the work while preventing contact of the remaining abrading elements with the work.

34. The combination of claim 32 with means for varying the pressure with which the abrading elements are caused to contact with the work, in which said means for varying the pressure have means to provide a predetermined range of pressures for each abrading operation.

35. In an abrading device, the combination of a work holder, a rotatable abradant-carrying member having on its periphery a plurality of abrading elements, each of which performs a separate and distinct operation upon the work different from that performed by the other elements, a frame in which said member is mounted, said frame being movable to and from the work and means for selectively moving the frame to cause contact of a desired abrading element only with the work, said means comprising cams mounted upon the shaft of said member, there being one cam for each abrading element, and a composite cam actuator movable to different positions to select the abrading element to be allowed to contact with the work, in combination with means for moving the composite cam actuator comprising a cam actuated from an element driving the shaft of the rotatable abradant-carrying member through speed-reducing gearing, together with means for selectively setting the position of the composite cam actuator independently of such gearing so that any one of the several possible abrading operations may be selected to be performed, to the exclusion of having to go through the entire cycle of operations of which the device is capable.

36. In an abrading device the combination of a work holder, an abradant-carrying member containing a plurality of abrading elements for abrading work placed in said holder, said elements being of different abrasive qualities such that each will perform a distinctive operation upon the work, means for selectively providing relative movement between said work holder and said abradant-carrying member to cause contact of a desired abrading element with the work while preventing contact of the remaining abrading elements with the work, and means for changing such contact from an element of one abrasive quality to an element of a different abrasive quality while maintaining unchanged the relative positions of said work holder and said abradant-carrying member.

37. The combination of claim 36 with means for varying the pressure with which the abrading elements are caused to contact with the work, in which said means for varying the pressure have means to provide a predetermined range of pressures for each abrading operation.

38. The combination of claim 36 with a second similar abradant carrying member placed on the side of said work holder opposite to the first said member to alternately become operative with respect to the work.

39. The combination of claim 36 with a second similar abradant carrying member placed on the side of said work holder opposite to the first said member to alternately become operative with respect to the work, said second member and said first member being both urged toward the work by pressure from the same spring through equal lever arms, thus providing means for exerting equal pressures upon the work by both said members.

40. The combination of claim 36 in which said means have means to prevent the ends of the abrading elements from making contact with the work.

41. In an abrading device the combination of a work holder, an abradant carrying member containing a plurality of abrading elements for abrading work placed in said holder, said elements being of different abrasive qualities such that each will perform a distinctive operation upon the work, means for selectively causing contact of a desired abrading element with the work while preventing contact of the remaining abrading elements with the work, means for changing such contact from an element of one abrasive quality to an element of a different abrasive quality while maintaining unchanged the relative positions of said work holder and said abradant carrying member and also while maintaining the relative motion between said work holder and said abradant carrying member, together with means for varying the pressure with which the abrading elements are caused to contact with the work, in which said means for varying the pressure have means to provide a predetermined range of pressures for each abrading operation.

42. In an abrading device the combination of a work holder, a rotatable abradant-carrying member having on its periphery a plurality of abrading elements, each of which performs a separate and distinct operation upon the work different from that performed by the other elements, a frame in which said member is mounted, said frame being movable to and from the work and means for selectively moving the frame to cause contact of a desired abrading element only with the work, said means comprising cams mounted upon the shaft of said member, and cam actuators movable to different positions to select the abrading element to be caused to contact with the work.

43. The combination of claim 42 in combination with means for moving the separate cam actuators comprising cams actuated from an element driving the shaft of the rotatable abradant-carrying member through speed-reducing gearing.

44. The combination of claim 42 in combination with means for preventing all abrading elements on the rotatable member from making contact with the work while the work is being secured in work holder or being removed therefrom.

45. In an abrading device, the combination of a work holder, a rotatable abradant-carrying member having on its periphery a plurality of abrading elements of different abrasive qualities, each of which performs a separate and distinct operation upon the work different from that performed by the other elements, a frame in which said member is mounted, means for providing relative movement between the frame and said work and to cause contact of a desired abrading element only with the work, said means com-

prising cams mounted upon the shaft of said member, and cam actuators movable to different positions to select the abrading element to be caused to contact with the work, in combination with means for moving the cam actuators comprising cams actuated from an element driving the shaft of the rotatable abradant-carrying member through speed-reducing gearing, together with means for selectively setting the position of the cam actuators independently of such gearing so that any one of the several abrading operations may be selected to be performed, to the exclusion of having to go through the entire cycle of operations of which the device is capable.

46. In an abrading device the combination of a work holder, an abradant-carrying member containing a plurality of abrading elements for abrading work placed in said holder, said elements being of different abrasive qualities such that each will perform a distinctive operation upon the work, means for selectively providing relative movement between the work and said abrading elements to cause contact of a desired abrading element with the work while preventing contact of the remaining abrading elements with the work, and means for changing such contact from an element of one abrasive quality to an element of a different abrasive quality while maintaining unchanged the relative positions of the work and said abradant-carrying member.

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