Aug. 29, 1944. W. HORBERG 2,356,850

FORMING CONICAL FRUSTUMS BY PROGRESSIVE CHAMFERING

Filed Jan. 28, 1943 2 Sheets-Sheet 1

Fig. 1

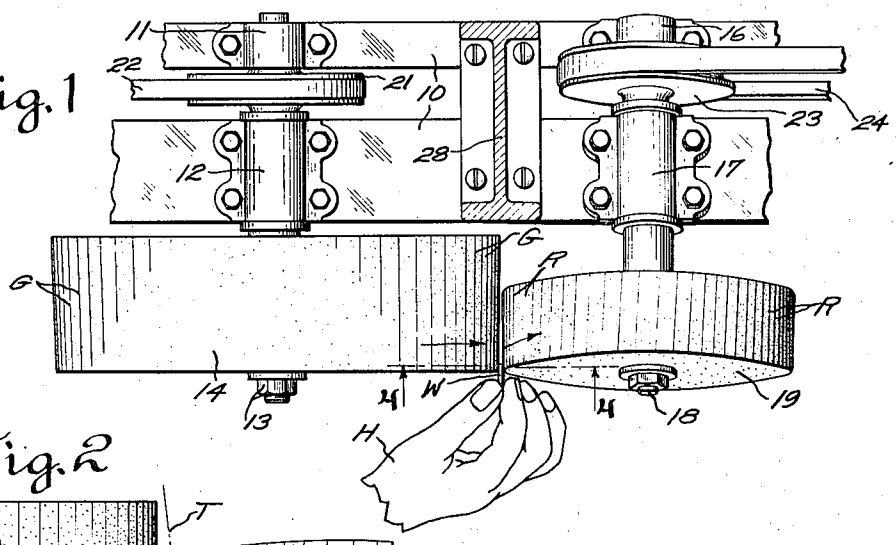


Fig. 2

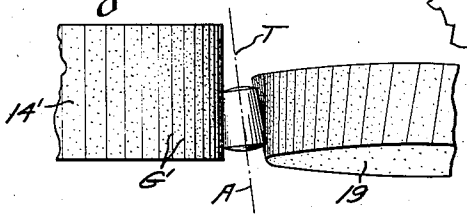


Fig. 3

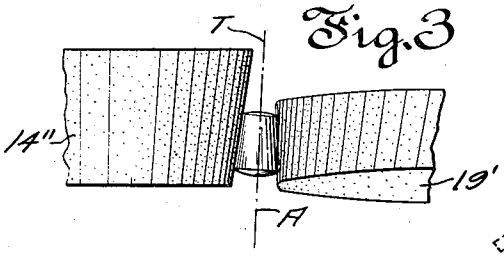


Fig. 16

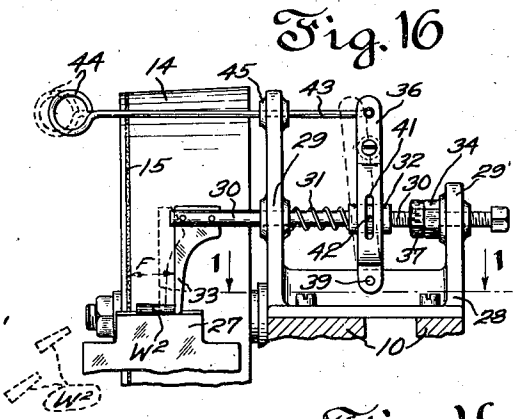


Fig. 5

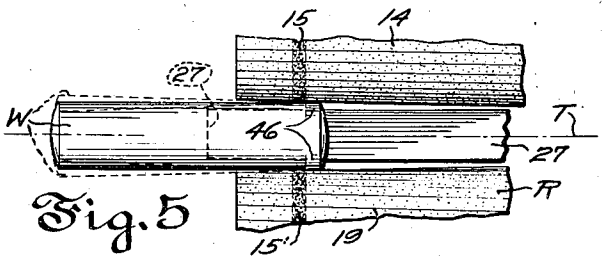


Fig. 4

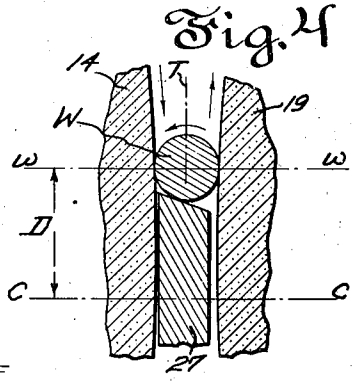
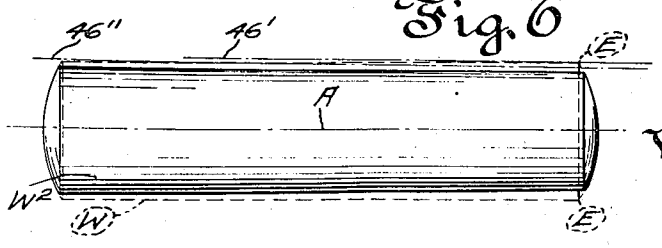


Fig. 6



INVENTOR
William Horberg
BY
ATTORNEY

Aug. 29, 1944. W. HORBERG 2,356,850

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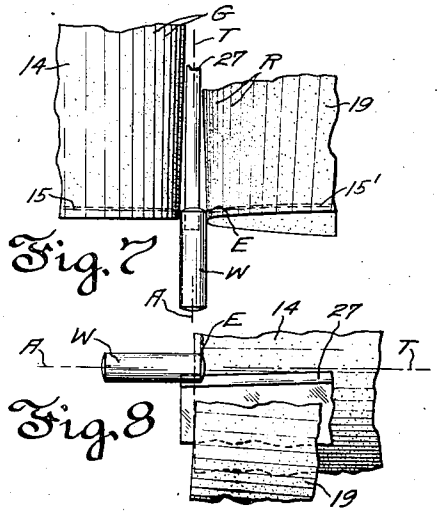


Fig. 7

Fig. 8

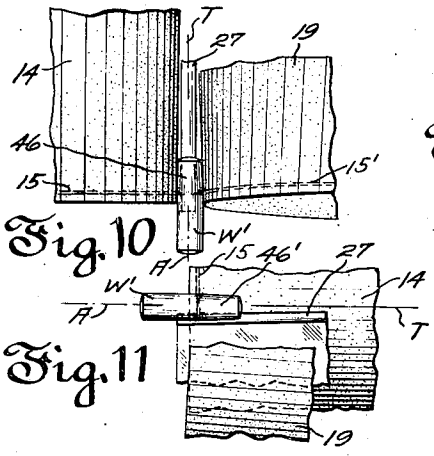


Fig. 10

Fig. 11

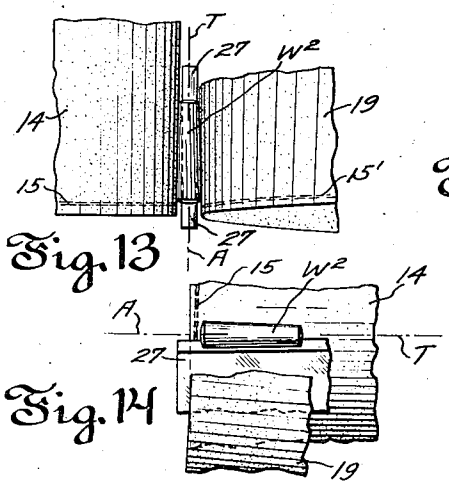


Fig. 13

Fig. 14

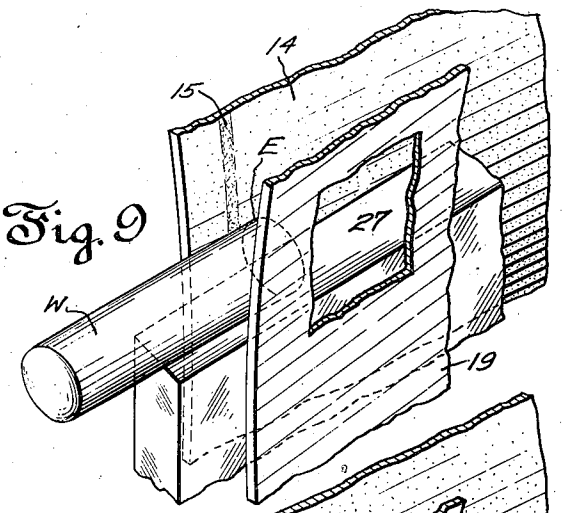


Fig. 9

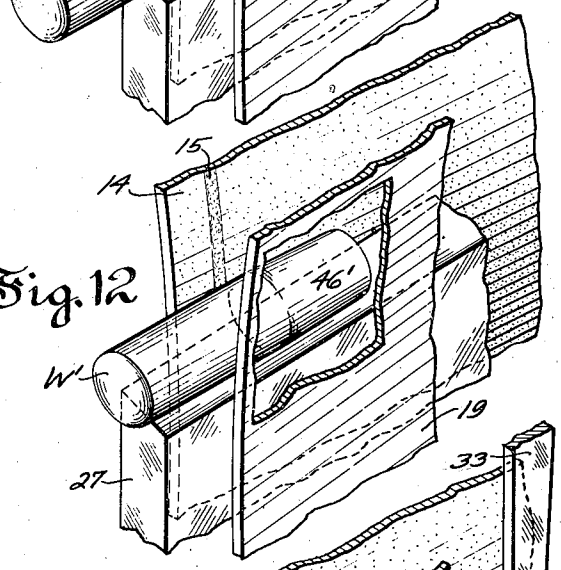


Fig. 12

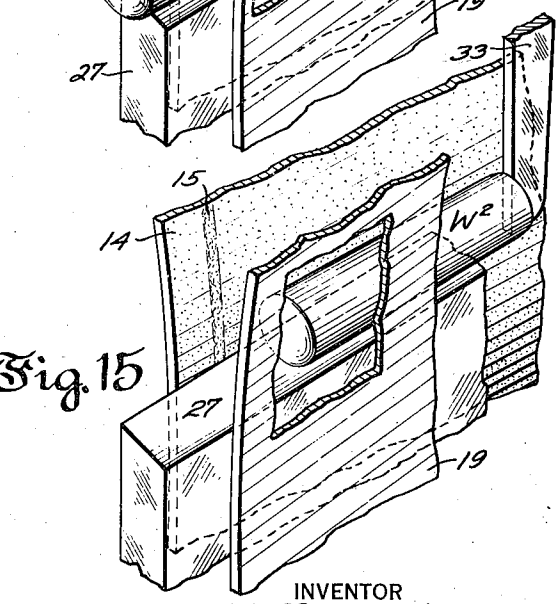


Fig. 15

INVENTOR
William Horberg
BY
ATTORNEY

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UNITED STATES PATENT OFFICE

2,356,850

FORMING CONICAL FRUSTUMS BY PROGRESSIVE CHAMFERING

William Horberg, Bridgeport, Conn.

Application January 28, 1943, Serial No. 473,820

6 Claims. (Cl. 51—289)

This invention relates to improved methods of generating frusto-conical forms by means of a single continuous shape changing process performed on a short section of rod, or any work blank of similar nature, which need not taper originally in conformity with the conical shape required of the finished product. The process involves rotating or rolling the blank in contact with a shape generating surface or surfaces, one of which in certain species of the improved process may be of abrasive nature, and any of which surfaces may travel either in a straight or curved path tangent to the surface of the blank being processed. My improved method may be employed in converting cut-off lengths of metallic wire or rod stock into so-called taper pins of the standard variety commonly used as dowel pins or for fastening hubs of wheels to shafts.

In the art of generating frusto-conical bodies requiring an accurately dimensioned finely ground surface finish, it has heretofore been the practice to perform extra operations on a rod-like work blank preliminary to the abrading or other rolling operation which produces the finished taper. The object of such preliminary operations has been first to convert the work blank, if for example mainly cylindrical in shape, coarsely to an oversize conical shape that possesses taper of approximately the same degree as that required in the finished product.

It is an object of the present invention to reduce the number of such extra or preliminary taper-producing operations, and preferably to eliminate all extra taper-producing operations, preliminary to the above mentioned final abrading or rolling process and thereby reduce the amount of handling and the number of processing steps required to convert cut-off pieces of rod stock into accurately dimensioned frusto-conical articles, such as standard taper pins.

Another object is to accomplish accurate dimensioning and smooth surface finishing of a frusto-conical body by the grinding down action of a traveling abrasive surface while permitting a narrow region of such abrasive surface extending along its direction of travel to remain severely worn as occasioned by its extra severe duty of initially attacking the more or less sharp peripheral edge of the leading end of a cylindrical work blank thrust thereagainst obliquely at the beginning of each grinding operation. The abrasive surface may travel in a straight or curved path tangent to the circular curvature of the work-blank or resulting frusto-conical body.

A related object is to grind down a very large number of cylindrical work blanks to frusto-conical form in a manner to leave them free from surface defects and by a process which involves entering the leading end of each successive blank obliquely into contact with the before mentioned localized region of extra wearing attack on the traveling abrasive surface without frequently having to interrupt continuous production for dressing down the abrasive surface to rid it of this impaired region of extra wear.

Another object is to convert a mainly cylindrical blank into a frusto conical body by gradually imparting conical taper to the blank progressively along its length starting at a leading end of the blank which possesses a more or less sharp peripheral edge. This may be termed progressive chamfering.

I have found, for instance, that if a work blank of cylindrical shape having the usual shoulder-like edge at each of its ends is introduced endwise into a tapered work-receiving trough that is bordered and defined at its sides by the peripheral abrasive surface of a rotary grinding wheel and by the opposed relatively inclined peripheral surface of a work rotating and feeding wheel, and bordered and defined at the bottom by the inclined top edge of a fixedly stationed work supporting blade, that the more or less sharp peripheral edge of the entering end of the cylindrical work blank severely attacks and produces extra rapid wear in an axially narrow, band-like region of the abrasive surface all around the periphery of the grinding wheel where the successive cylindrical work blanks first enter into contact therewith. In processes of so-called centerless grinding for producing frusto conical bodies such as taper pins, it is important that a fine and smooth surface finish be produced, unmarred by defects due to this region of extra wearing attack on the abrasive surface. It has been recognized that such extra wear of the abrasive wheel surface can be more or less avoided by pre-forming to conical shape a cylindrical work blank, such as results from cutting off pieces of long rod or wire stock. This pre-forming is commonly done by first machining or stamping the blank to oversive dimensions in a manner to impart to it coarsely, at least, a taper corresponding to that required in the finished product. An alternative has been to frequently and wastefully stop production for the period required to redress the above mentioned worn region of the abrasive surface and thereafter readjust the work sizing feed screw so as to resume production of parts having the same size as before the grinding wheel

was redressed. Another alternative has been to resort to plunge grinding wherein one or both of the processing wheels is moved bodily toward and away from the other wheel. Such former practices have objectionably increased the cost of manufacture and reduced the speed of production of taper pins and like products and have resulted in the output of more and more imperfect work as the defects occasioned by a regionally worn abrasive wheel creep in progressively and impair the product.

My present improvements makes possible not only much faster and uninterrupted production of more perfectly surfaced and more accurately dimensioned taper pins or the like, without resorting to the above described less efficient alternative methods, but accomplish this with substantial reduction in cost of manufacture.

In the appended drawings:

Fig. 1 is a plan view of cooperative parts of apparatus illustrating some of various means which may be employed to assist in practicing my improved process.

Figs. 2 and 3 represent modified shapes and dispositions of two wheels which may be employed to roll in contact with the work as shown in Fig. 1.

Fig. 4 is a fragmentary view on an enlarged scale taken in section on the plane 4—4 in Fig. 1 looking in the direction of the arrows.

Fig. 5 is a fragmentary plan view looking downward on Fig. 4 showing the work piece rollingly gripped and steadied at only its leading end by the processing wheels.

Fig. 6 is a still further enlarged view of a typical work piece indicated in its original form and in its actual finished form.

Figs. 7, 8 and 9 are plan, side and perspective views of the work receiving throat or trough, bordered and defined by traveling processing surfaces together with an intermediate rest or support that underlies the work.

Figs. 10, 11 and 12 are views like 7, 8 and 9, respectively, showing the work advanced further endwise into the processing throat or trough.

Figs. 13, 14 and 15 are views like 7, 8 and 9, respectively, showing the finished work advanced to final position in the throat or trough.

Fig. 16 shows, on the same scale as Fig. 1, a suggestive feed stop and work ejecting instrumentality.

It is understood in the art of so-called centerless grinding that a work blank which is to be ground to cylindrical or conical shape need not be supported for rotation by means of centers engaging its ends but may be ground to such shapes while merely resting or floating broadside and rotatably upon the top edge of an underlying upright blade-like support interposed between the closely neighboring peripheral surfaces of a grinding wheel and a work retaining wheel. The retaining wheel serves to maintain the work piece in grinding contact with the abrasive surface of the grinding wheel and also may exert control of the speed of rotation of the work piece about the latter's own axis by means of the tractive clinging of the relatively slow traveling surface of the control wheel to the surface of the work piece while rolling in contact therewith. Such retaining wheel may appropriately be termed a regulating wheel or control wheel.

It is further understood in the art of centerless grinding that if the control wheel has its axis disposed in a vertical plane parallel with a vertical plane containing the axis of the grinding wheel, but nevertheless has its axis inclined in relation to a horizontal plane containing the axis of the grinding wheel, then this skewed relationship of the control wheel enables the revolving of its peripheral surface to set up a component tractional force on the work piece in a direction urging, or feeding in, the latter in an axial direction across the traveling abrasive surface of the grinding wheel while the work piece simultaneously rotates on its own axis. In such cases the peripheral surface of the control wheel is given such geometrical contour as enables it to contain rectilinear generant elements capable of coinciding with the straight line elements in the conical surface of a work piece at every point of tangency of the wheel surface to the work surface. These geometrical generant elements are infinite in number because comprising the generatrix of the wheel surfaces or other processing surfaces involved.

Referring to Fig. 1, as illustrative of various apparatuses capable of assisting in my improved process, the numeral 10 denotes a section of any apparatus framework on which may be stationed bearing boxes 11 and 12 rotatably supporting the shaft 13 of a grinding wheel 14 having a conically tapered peripheral face which, being conically contoured, may be said geometrically to consist of or contain an infinite number of rectilinear generant elements G, while 16 and 17 represent similarly stationed or adjustable bearing boxes rotatably supporting the inclined shaft 18 of a control wheel 19 which is skewed in relation to the grinding wheel 14 and whose peripheral face is trued to such contour that it also contains geometrically an infinite number of rectilinear generant elements R.

The closest together groups of rectilinear generant elements in both wheels mutually converge as they extend rearward toward the apparatus frame 10. The wheel faces containing these groups border on and define opposite sides of a work receiving throat or trough which tapers to a narrowest end or extremity nearest said frame. A floor for this trough is formed by the top slanting edge of a blade-like work support 27 which edge is also inclined up-hill as it extends rearward toward the apparatus frame 10. At 21 and 22 are represented a pulley and belt, respectively illustrative of any means for rotating the grinding wheel. At 23 and 24 are correspondingly represented a pulley and belt, respectively, for rotating the control wheel independently of the speed of the grinding wheel. Hand cranks or other forms of manual or power drive may serve to rotate the grinding and control wheels independently of each other at different relative speeds. The axes of these two wheels may remain fixedly stationed in my improved process. The arrows in Fig. 1 indicate that both wheels may be rotated in the same clockwise direction which will result in the neighboring peripheries of the wheels traveling in relatively opposite directions and in direction crosswise of their generant elements, the face of the grinding wheel traveling downward in Fig. 4 and that of the control wheel traveling upward in Fig. 4. Both wheels thus tend to impart to the work piece 26 a counterclockwise rotation about its own axis in Fig. 4. Figs. 8, 11 and 14 show that portions of the length of the work piece which have been shaped to frusto-conical form may rest broadside and rotatably upon the top edge of the before mentioned support blade 27 between the grinding wheel and the control wheel. Also the lead-

ing end of a non-conical blank may or need not at first rest on and slide along such support blade in approaching its first contact with the processing wheels.

In the illustration here given, the horizontal axis of the work piece W in Fig. 4, which may be mainly or completely cylindrical, is assumed to be on a level designated *w—w* at a distance D above the horizontal plane C—C containing the axis of shaft **13**. The opposed peripheries of the grinding wheel and control wheel are nearest to each other in the neighborhood of this plane C—C. Figs. 4, 8, 11 and 14 show that the top edge of support plate **27** slants off at an angle of, say, 20 degrees relative to the horizontal while the same blade edge is inclined lengthwise with respect to the horizontal at the same angle that each of the generant elements of the peripheral wheel faces, which are in contact with the work piece, is inclined from front to back with respect to a line or vertical plane T longitudinal and central of the aforesaid throat or trough between these wheel faces. Thus the tapered work receiving throat or trough, as jointly defined by the upwardly out-flaring peripheries of wheels **14** and **19** and by the work supporting blade edge, is bordered by mutually converging surfaces of said wheels and blade edge, causing said throat or trough to narrow evenly from its front or work entering end to its rear end.

In Fig. 2 the same arrangement of grinding and control wheel **19** is shown except that the grinding wheel is dressed down to have a cylindrically curved peripheral surface instead of a conically curved peripheral surface, wherefore all of the rectilinear generant elements of its periphery are represented by parallel lines G', instead of by converging lines G as in Fig. 1.

Fig. 3 shows wheels arranged as in Fig. 1 except that the grinding wheel **14** is dressed to a conical taper twice as steep as is the conical taper of grinding wheel **14** in Fig. 1, and control wheel **19'** in Fig. 3 is contoured accordingly to permit the angular inclination of the straight line elements in the peripheral surface of grinding wheel **14''** in relation to the axis of shaft **13** to equal the total angle of taper included between one side of the frusto-conical body and its diametrically opposite side. Thus in Fig. 1, the axis A of the work piece will be parallel to the axis of shaft **13** throughout the grinding process, whereas in Fig. 3 the axis A of a similar work piece would be inclined in one direction with respect to the axis of shaft **13** to the extent of half the said total angular taper of the frusto-conical body, while in Fig. 4, the axis A of a similar work piece would be inclined in the opposite direction with respect to the axis of shaft **13** to the extent of half the said total angular taper of the frusto-conical body.

Fig. 16 shows one of many devices that may be provided to assist in limiting the feeding-in travel of the work piece axially inward toward the smaller end of the work receiving trough by blocking the path of the leading end of the work piece. The same, or some additional device if desired, may be employed to eject the finished work piece from the trough. At **28** is represented a bracket structure mounted on apparatus frame **10** thus to afford slide bearings **29** and **29'** for a plunger rod **30** that may be urged constantly toward the right in Fig. 16 by the action of a spring **31** interposed between bearing **29** and a collar **32** fixed on the rod. Finger **33** fixed on rod **30** occupies the path of feeding-in advance of the frusto-conical body or finished taper pin W2 between the grinding wheels **14**, **14'** or **14''** and control wheel **19**. Stop **33** is normally stationed in a limit position shown in Fig. 16 against the urge of spring **31** by means of the check nut **34** which has threaded engagement with rod **30** and is prevented from loosening by lock nut **37** at selected variable points along the length of the rod for determining the normal position of stop **33** along the work receiving trough. Adjustable stop or finger **33** thus limits the resistible lengthwise feeding-in movement of the work piece, whether caused manually or under the urge of the skewed control wheel **19** or **19'**, by obstructing the path of travel of the smaller or leading end of the finished taper pin. An upright swinging lever **36** is pivotally mounted on bracket **28** at **39** and has a vertically elongated slot **41** occupied by an operating stud **42** projecting laterally from collar **32**. The top end of lever **36** may be pulled forward by means of a horizontal operating wire **43** having the front looped end **44** and slidably supported in any stationary frame guide **45**. This causes the work contacting lower end of finger **33** to dislodge the frusto-conical body W2 from its wedged relationship to the grinding and control wheels and to back said body out of the grinding throat by impelling or throwing it toward the left in Fig. 16 thereby to discharge it from the grinding throat without further grinding. The rear end of wire **43** impellingly connects to the top end of lever **36**.

With this understanding of illustrative kinds of apparatus which may take sundry other forms unimportant in detail to the improved methods here concerned, the steps of my improved process will be described with particular reference to Figs. 4, 5 and 6 to 15, inclusive. Fig. 6 shows in full lines at W2 a taper pin to be produced by a single continuous grinding operation starting with an oversize cylindrical work blank represented by the broken lines W, which may be rod-like and of other than cylindrical shape. It will be observed that the cylindrical blank W is a trifle larger in diameter than is the largest diameter of the finished frusto-conical product, or taper pin W2 at its left end in Fig. 3. The circular peripheral shoulder-like edge E of the leading end of the blank W at the right of Fig. 6, which becomes the smaller end of the finished taper pin W2, is more or less sharp as results from usual methods of obtaining the blank by cutting it off from a continuous length of rod or wire stock.

As shown in Fig. 1, the operator picks up a work blank grasping either of its ends by the thumb and finger of his hand H and rests the opposite or leading end of the blank between the grinding and control wheels and ultimately on the top edge of support blade **27**. Or he can slide the blank ahead endwise along this blade edge until the shoulder-like edge of the leading end wedges or is lodged simultaneously between the high speed downward traveling peripheral surface of grinding wheel **14**, **14'** or **14''**, and the relatively inclined slow speed upward traveling tractive surface of control wheel **19**.

At this point the blank begins to be rotated counterclockwise in Fig. 4 upon its own axis through the rolling impulse imparted to the blank by its rolling contact with the peripheral surface of the control wheel. In this rolling contact the control wheel exerts sufficient tractive control of the speed of rotation of the blank to maintain a lower linear speed of travel of the

blank's periphery than is performed by the surface of grinding wheel 14 that contact therewith. Hence the abrasive surface of the grinding wheel begins to grind a chamfer on the shoulder-like edge of the leading end of the blank and in doing this becomes subjected to extra severe wearing attack which gives rise to an impaired region in the form of a narrow peripheral groove 15, or band of extra wear, extending all the way around the periphery of the grinding wheel. At first this worn band or groove may be no wider than, say, a sixteenth of an inch but as more and more work blanks have their leading end successively presented to this same impaired region of initial wearing attack, the worn or impaired region may increase in width steadily in the course of producing quantities of the same size taper pin. Although the degree of wear in this impaired region may almost be imperceptible to begin with, work pieces if depending for final surface finish on the abrading action of that portion of the grinding wheel surface containing the impaired region, would become more and more seriously imperfect as production proceeds. This is avoided in the following manner.

The rolling contact between control wheel 19 or 19' and work blank W serves from the very beginning to urge the work blank rearward, or toward the right in Figs. 5, 8 and 9, owing to the skewed relation of the control wheel 19 or 19' to the grinding wheel 14, 14' or 14'' as hereinbefore described. This feeds the work blank progressively inward between the wheels so that the grinding wheel progressively wears down a chamfer 46 on the cylindrical work piece W. This chamfer increases in extent lengthwise of the work blank through the stages 46' and 46'' in Fig. 6 as the work blank feeds farther and farther in between the wheels until finally the chamfer 46 comes to constitute the whole peripheral surface of the finished article or taper pin W2, and thereby converts the cylindrical blank into a frusto conical body. This progressive abrading of the original chamfer is illustrated in Figs. 10 to 15, inclusive. Figs. 10, 11 and 12 show the work about half finished and Figs. 13, 14 and 15 show the work completely finished. In the latter three figures it is to be especially noted that the entire length of the work piece capable of contacting with the traveling abrasive surface of the grinding wheel has passed rearward or to the right in Figs. 13, 14 and 15 sufficiently for to occupy a position entirely beyond and clear of the impaired region 15 of wearing attack.

In its progress from entering position in Figs. 7, 8 and 9 to advanced positions in Figs. 10 to 15, inclusive, the work blank is manually first wedged or lodged between the converging peripheral surfaces of control wheel and grinding wheel before or while only the leading end of the blank is slidably supported on the top edge of blade 27. The traveling processing surfaces of the wheels thereupon rollingly seize or grip opposite sides of the shoulder-like edge of the work blank end in such equalized manner that the axis A of the work piece is immediately and thereafter maintained in alignment with the center-line T of the tapering throat or trough bordered jointly by the upward inclined support blade edge and the rearwardly converging wheel surfaces. In keeping the axis of the work blank so aligned with trough center T the hand of the operator may be employed to steady and prevent wobbling of the trailing end of the work piece to such irregular positions as is indicated by broken lines in Fig. 5. I have discovered however, that almost at the instant the chamfer 46 begins to be generated, the rolling effect of the wheels upon the entering end of the work blank produces a strong steadying and centering effect on the axis of the work blank causing the latter quickly to assume and maintain true coincidence with horizontal line T of the work receiving throat or trough. The resulting frusto-conical body possesses the same longitudinal axis as did the original work blank. This discovery has made it possible for the workman merely to pick up a cylindrical work blank and wedge or lodge its sharp edged leading end between the processing wheels and then release the blank or deliver it to the feeding-in urge of the control wheel whereupon the traveling processing surfaces of these wheels are capable of assuming control of the work blank and of maintaining such control from the time the work blank begins to be rotated until it is dragged all the way inward from its position in Fig. 9 to its position in Fig. 15. Axis A of the work blank need not deviate from coincidence with the center line T of the processing throat or trough during the entire process.

Figs. 15 and 16 show that the lengthwise processing travel of successive work pieces may be arrested at a constant definite point by some stop instrumentality such as the bottom end of finger 33 carried by rod 30 and which occupies the path of feeding advance of the leading end of the frusto-conical body W2 which is a residuum of the original leading end of the original work blank W. In this lengthwise position of W2 no portion of its conical surface can be contacted or marred by the impaired region 15 of wearing attack on the processing surface of grinding wheel 14 or 14'. The finished work piece is then ousted by finger 33 in a direction diverse from its feeding in travel by pulling smartly on wire handle 44 as hereinbefore described. This exerts sufficient impelling force on the finished work piece to dislodge it from the processing and traction surfaces of wheels 14 and 19 and discharge or cast it out from the grinding throat.

It will be observed that the differential in diameter between the cylindrical work blank W and the larger end of the frusto-conical product W2 determines how far the trailing end of the work piece must be fed in beyond the point of the initial contact of the leading end of the work blank with the processing wheels before striking stop 33. Hence if a wider impaired region of wearing attack is to be allowed to accumulate on the grinding wheel and/or on the control wheel, this differential in diameter between blank and finished product must be stepped up accordingly in order to provide for more grinding down longitudinal travel of the work piece over the distance marked F in Fig. 16.

As a mere example of one kind of work piece, and of instrumentalities convenient of use in processing it according to the present invention, the work blank W, indicated by broken lines in Fig. 6, may comprise a cylindrical piece cut off from rod stock to be .067'' in diameter by .270'' long having ends spherically curved to .0625'' radius. Or, of course, the ends may be flat. The frusto-conical body or taper pin resulting from my improved process shown in full lines in Fig. 6 may measure .0625'' diameter at its larger left end and have a total inclusive conical taper of .02083'' per inch of length. Such a work piece may be processed successfully by keeping its axis

horizontal at level *w—w* about ⅛" above the horizontal plane C—C containing the axis of rotation of grinding wheel 14, 14' or 14". The mean point of the used width of face on the periphery of control wheel 19, or 19' which is in contact with the work may also be in horizontal plane C—C. Curvature of the processing surfaces may accord with a diameter of 20" for the grinding wheel and 12" for the control wheel. The relative speeds of the wheels may be as desired it being found satisfactory for the surface of the grinding wheel to travel ten times as fast as the surface of the control wheel.

The foregoing dimensions and suggested relation of sizes will be understood in no sense to imply any restriction on the scope of coverage of the appended claims since very wide variation in size and taper of work piece and of processing throat or trough have been found satisfactory in practicing the present improved methods. Also the traveling processing surfaces may be flat instead of curved as would be the case with a traveling endless belt having an abrasive surface. In broader aspects of the improvements the work blank, if composed of deformable material, may be converted into a frusto-conical body by non abrasive rolling pressure concentrated at a chamfering angle progressively along its length which, starting with the leading end of a cylindrical blank, would produce a conical frustum therefrom by progressively chamfering the blank through the exertion of such rolling pressure upon it.

The following claims are therefore directed to and intended to cover the method steps which they define irrespective of what instrumentalities may be employed in performing such steps and irrespective of the size and shape of the blank worked upon or of the conical frustum produced.

I claim:

1. The method of reducing a mainly cylindrical work blank to a frusto-conical body by centerless processing which includes the steps of, placing the leading end of said blank in the receiving entrance of a tapered processing throat having a relatively narrow opposite extremity and bordered by a traveling processing surface and a feeding-in traction surface traveling in skewed relation to said processing surface, delivering said blank to the feeding-in urge of said traction surface so that said blank is drawn progressively farther and farther into the processing throat toward said narrow extremity thereof until said blank is reduced by said processing surface to a frusto-conical body whose leading end is the residuum of said leading end of said blank, blocking said frusto-conical body before said leading end thereof passes said narrow throat extremity in a manner to resist the feeding-in urge of said traction surface thereon, and then ousting said body in a direction diverse from the feeding-in travel thereof with sufficient impelling force to dislodge said body from said surfaces and discharge said body from the processing throat.

2. The method of reducing a mainly cylindrical work blank to a frusto-conical body by centerless processing which includes the steps of, placing in the receiving entrance of a tapered processing throat having a relatively narrow opposite extremity the leading end of a mainly cylindrical work blank, lodging said leading end of the blank in rolling engagement with a traveling processing surface and an infeeding traction surface traveling in skewed relation to said processing surface, delivering said blank to the feeding-in urge of said traction surface so that said blank is drawn progressively farther and farther into the processing throat toward said narrow extremity thereof until said blank is reduced by said processing surface to a frusto-conical body whose leading end is the residuum of said leading end of said blank, blocking said frusto-conical body before said leading end thereof passes said narrow throat extremity in a manner to resist the feeding-in urge of said traction surface thereon, and then ousting said body in a direction diverse from the feeding-in travel thereof with sufficient impelling force to dislodge said body from said surfaces and discharge said body from the processing throat.

3. The method of reducing a mainly cylindrical work blank to a frusto-conical body by centerless grinding which includes the steps of, advancing into the relatively large receiving entrance of a tapered grinding throat having a relatively narrow opposite extremity the leading end of a mainly cylindrical work blank axially shorter than the length of said throat between said entrance and said extremity and of small enough diameter in proportion to the width of said throat entrance to freely enter said throat for an initial distance, wedging said leading end of the blank at an initial point within said throat spaced said initial distance inward from said throat entrance between a throat defining traveling abrasive surface and a throat defining infeeding traction surface traveling in skewed relation to said abrasive surface, delivering said blank to the feeding-in urge of said traction surface at said initial point within said throat so that said blank is drawn from said point progressively farther and farther into the grinding throat toward said narrow extremity thereof a greater distance than the axial length of said blank whereby said blank is ground down by said abrasive surface to a frusto-conical body whose leading end is the residuum of said leading end of said blank and whereby said body is advanced deep enough into said throat to be beyond and clear of said initial point of wedging contact of said blank with said surfaces, and blocking said frusto-conical body before said leading end thereof passes said narrow throat extremity in a manner to resist feeding-in of said body by said traction surface.

4. The method of reducing a mainly cylindrical work blank to a frusto-conical body by centerless grinding which includes the steps of, picking up and holding by manual finger grasp and thereby maneuvering one end of a mainly cylindrical work blank in a manner to place the opposite or leading end thereof in the relatively large receiving entrance of a tapered grinding throat having a relatively narrow opposite extremity, lodging said leading end of the blank at a point inward of said throat entrance between a throat defining traveling abrasive surface and a throat defining infeeding traction surface traveling in skewed relation to said abrasive surface while continuing to hold and steady the opposite end of said blank by manual finger grasp, delivering said blank from manual finger grasp to the feeding-in urge of said traction surface so that said blank is drawn progressively farther and farther into the grinding throat toward said narrow extremity thereof until said blank is ground down by said abrasive surface to a frusto-conical body whose leading end is the residuum of said leading end of said blank,

blocking said frusto-conical body before said leading end thereof passes said narrow throat extremity and then ousting said body in a direction diverse from the feeding-in travel thereof with sufficient impelling force to dislodge said body from said surfaces and discharge the same from the grinding throat.

5. The method of reducing a mainly cylindrical work blank to a frusto-conical body by centerless grinding which includes the steps of, placing in the relatively large receiving entrance of a tapered grinding trough having a relatively narrow opposite extremity and upwardly outflaring sides the leading end of a mainly cylindrical work blank smaller in diameter than the width of said trough entrance, lodging said leading end of the blank at a point inward of said trough entrance in rolling engagement with the abrasive periphery of a rotating grinding wheel forming one side of said trough and a feeding-in tractional periphery of a rotating control wheel skewed in relation to said grinding wheel and forming the opposite side of said trough, delivering said blank to the feeding-in urge of said control wheel periphery so that said blank is drawn progressively farther and farther into the grinding trough toward said narrow extremity thereof until said cylindrical blank is ground down by said abrasive periphery to a frusto-conical body whose leading end is the residuum of said leading end of said blank, blocking said frusto-conical body before said leading end thereof passes said narrow trough extremity in a manner to resist the feeding-in of said body by said tractional periphery, and then ousting said body in a direction diverse from the feeding-in travel thereof with sufficient force to dislodge said body from said surfaces and discharge said body from the grinding trough.

6. The method of reducing a mainly cylindrical work blank to a frusto-conical body by centerless grinding which includes the steps of, placing in the receiving entrance of a tapered grinding throat having a relatively narrow opposite extremity the leading end of a mainly cylindrical work blank smaller in diameter than the width of said throat entrance, lodging said leading end of the blank at a point inward of said throat entrance in rolling engagement with a throat defining traveling abrasive surface and a throat defining feeding-in traction surface traveling in skewed relation to said abrasive surface, delivering said blank to the feeding-in urge of said traction surface so that said blank is drawn progressively farther and farther into the grinding throat toward said narrow extremity thereof until said blank is ground down by said abrasive surface to a frusto-conical body whose leading end is the residuum of the leading end of said blank, blocking said frusto-conical body before said leading end thereof passes said narrow throat extremity in a manner to resist the feeding-in of said body by said traction surface, and then ousting said body in a direction diverse from the feeding-in travel thereof with sufficient impelling force to dislodge said body from said surfaces and discharge said body from the grinding throat.

WILLIAM HORBERG.