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METHOD AND MEANS FOR GRINDING TAPERED ROLLS

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4 Sheets-Sheet 1

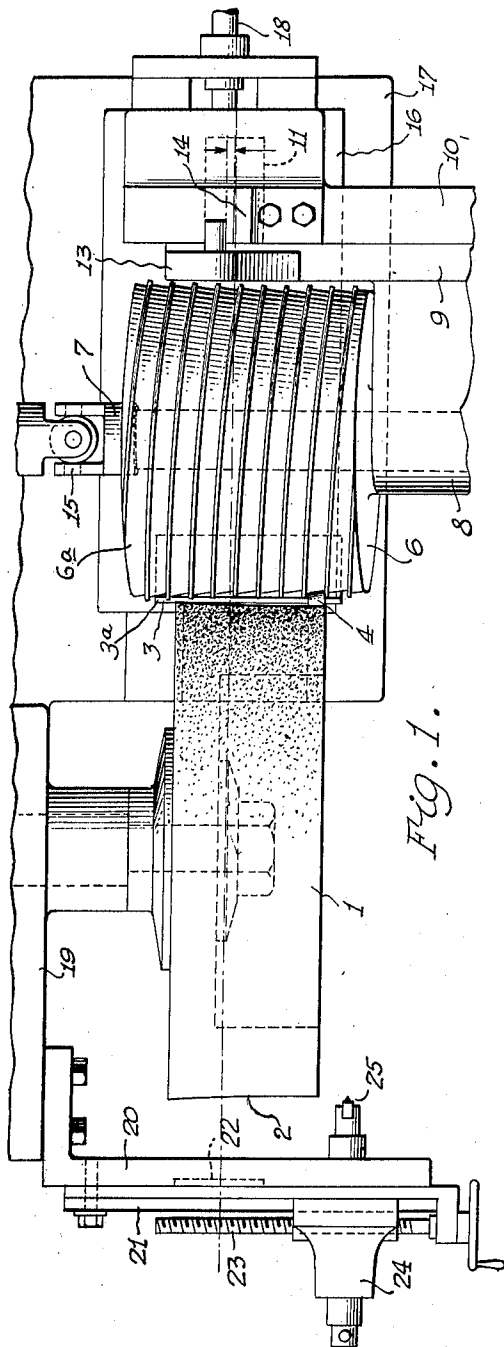


Fig. 1.

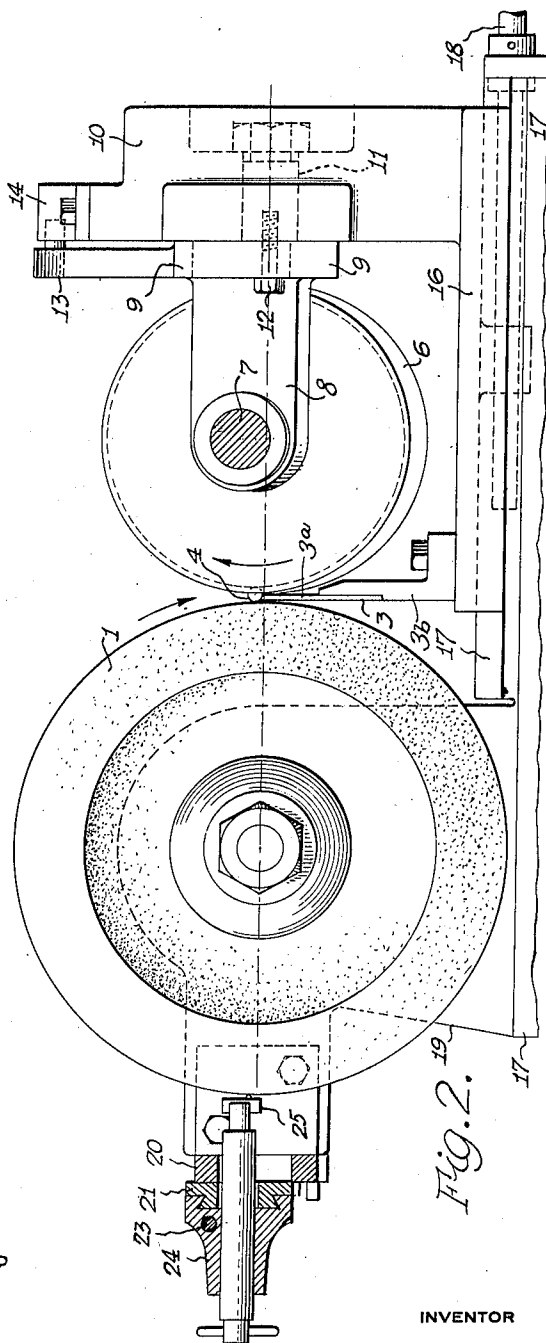


Fig. 2.

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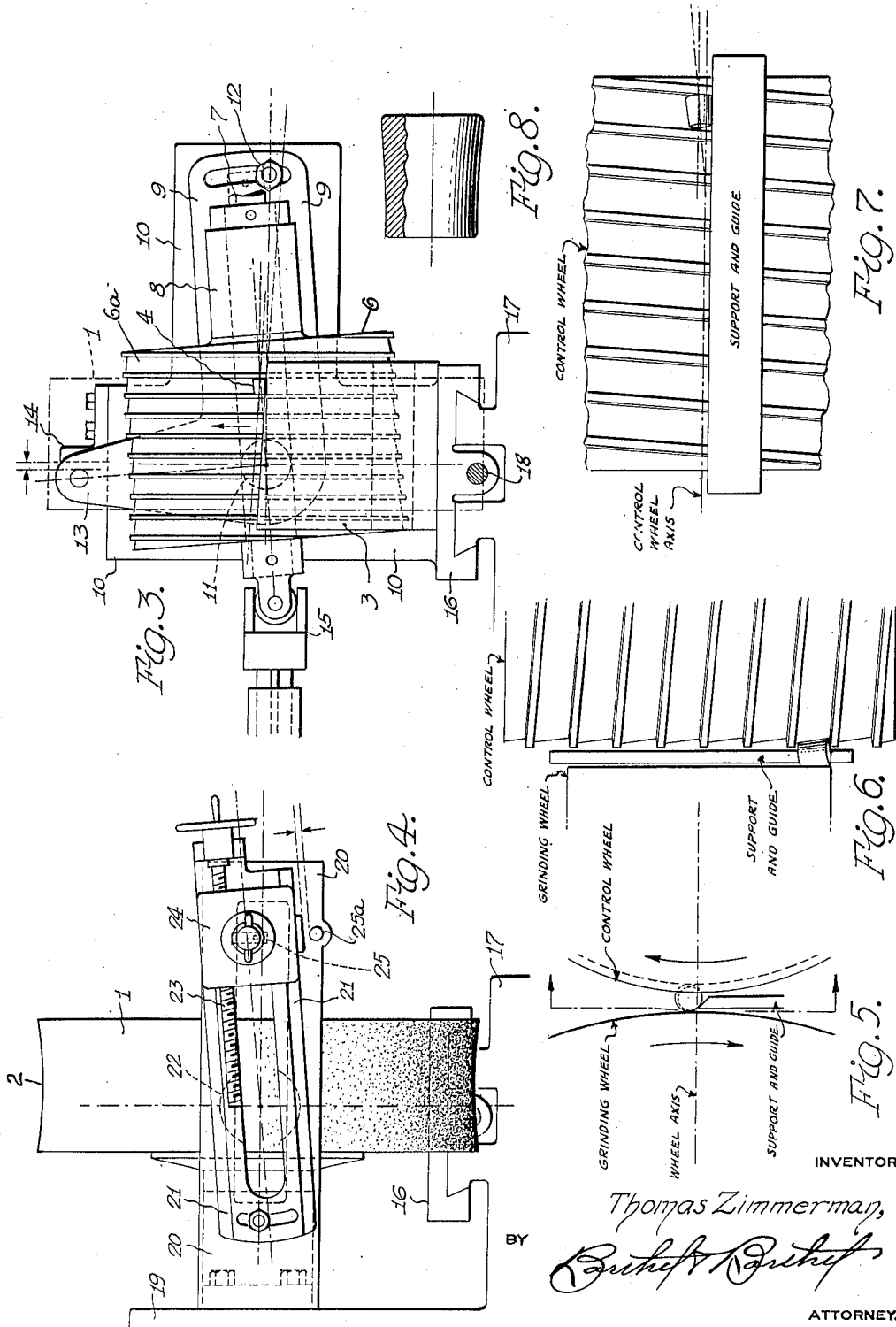
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4 Sheets-Sheet 2



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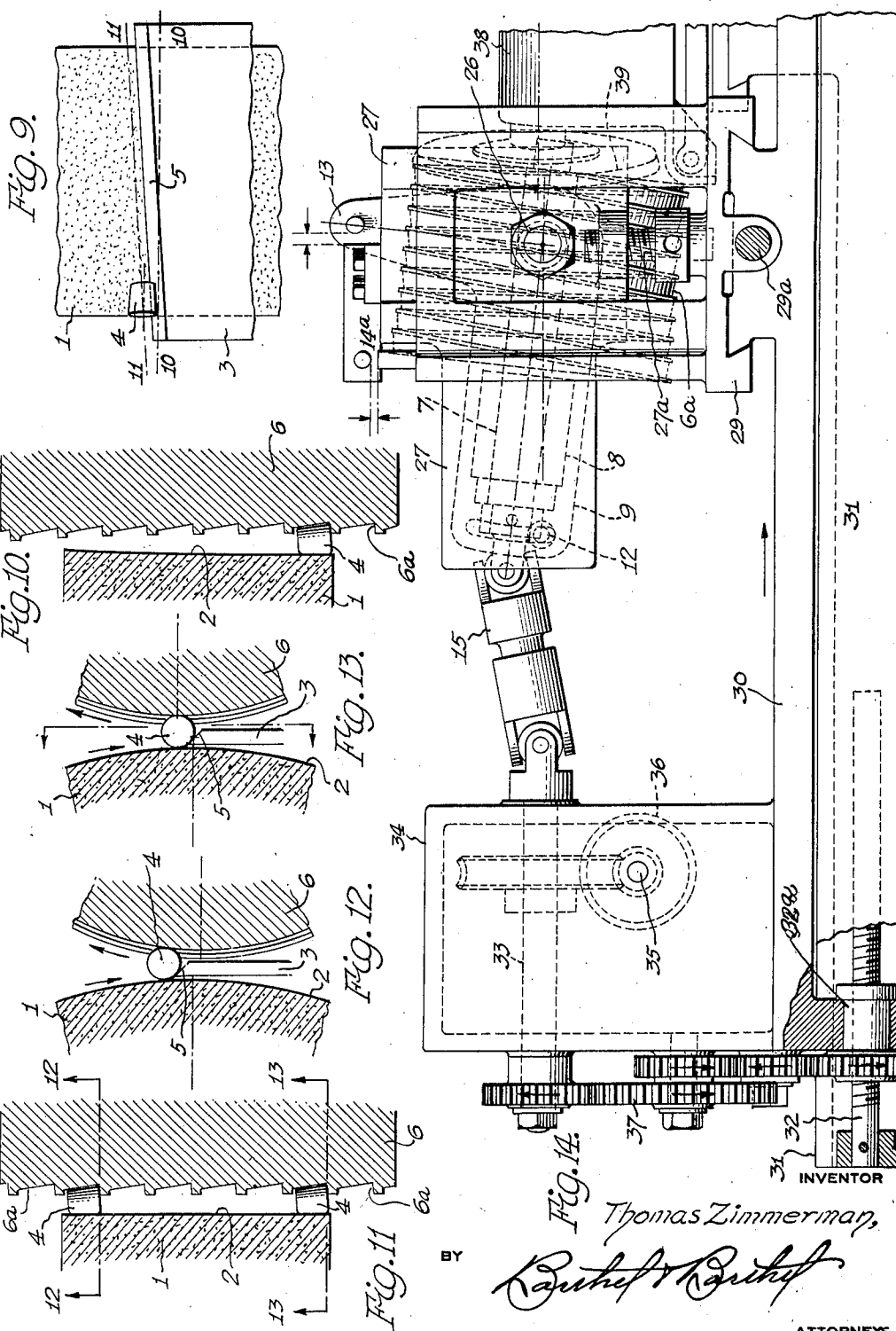
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UNITED STATES PATENT OFFICE

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METHOD AND MEANS FOR GRINDING
TAPERED ROLLS

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32 Claims. (Cl. 51—103)

This invention relates to a method of grinding the conical side surface of tapered rolls and in the means employed in carrying out such method.

The main object of the present invention is to provide a method of centerless grinding of such conical surface of tapered rolls, whereby a substantially true conical surface is secured, eliminating all concavity of such surface. A further object is to provide a method wherein the work is directed along an angular path of travel across the face of the grinding wheel, and wherein the work contacting grinding wheel surface and the grooved work engaging surface of a control wheel, are formed to conform to the line of contact of said wheels with the work throughout such path, thereby producing the desired true taper. It is also an object to provide a method for forming such grinding and control wheel surfaces in accurate conformity with such angular transverse line of contact thereof with the work.

A further object is to provide a construction, arrangement and combination of instrumentalities including a grinding wheel, a control wheel and a work support, whereby these instrumentalities may be very accurately adjusted relatively, to change their relative angular portions according to the work in hand, and to provide means for accurately forming the grinding wheel surface, which means has a definite, fixed relation to the wheel axis and is accurately adjustable to vary the shape of such wheel surface formed thereby.

It is also an object to provide a method which may be carried out by comparatively simple means, and to provide such means which is of such construction as to insure extreme accuracy and a product having the desired qualities.

With the above and other ends in view, the invention consists in the matters hereinafter set forth and more particularly pointed out in the appended claims, reference being had to the accompanying drawings, illustrative of the present method and means embodying the present invention, and wherein

Figure 1 is a plan view of a portion of a machine showing a grinding wheel, a control wheel and adjacent parts, illustrative of an embodiment of the present invention;

Fig. 2 is a side elevation of Fig. 1 with parts shown in section;

Fig. 3 is a view, generally in elevation, of the control wheel assembly viewed from the direction of a vertical plane between the grinding and control wheels in Fig. 2;

Fig. 4 is an elevation of the left hand end of Fig. 1;

Figs. 5, 6 and 7 are diagrammatic views illustrative of a method different from that disclosed by the construction shown in Figs. 1 and 2;

Fig. 8 is a side elevation, partly in section, of a tapered roll produced by the method illustrated in Figs. 5, 6 and 7;

Fig. 9 is a detail view showing a portion of the face of the grinding wheel and work guide or support shown in Figs. 1, 2 and 3;

Fig. 10 is a longitudinal section through adjacent portions of the grinding and control wheels substantially upon the line 10—10 of Fig. 9;

Fig. 11 is a similar section substantially upon the line 11—11 of Fig. 9;

Fig. 12 is a transverse section substantially upon the line 12—12 of Fig. 11;

Fig. 13 is a similar transverse section substantially upon the line 13—13 of Fig. 11;

Fig. 14 is a side elevation of a fixture for holding and driving the control wheel while being ground to the proper form;

Fig. 15 is a plan view of Fig. 14;

Figs. 16 and 17 are details illustrative of the manner of grinding the surfaces of the spiral groove in the control wheel; and

Fig. 18 is a side elevation of a tapered roll produced by the present method.

Taper rolls have been produced by various methods, generally by grinding the tapered peripheries, and the methods used in so doing are varied. Amongst these methods is that which provides for moving the roll blank across the face of the grinding wheel by the use of a control wheel which utilizes a spiral groove within which the roll blank travels during the grinding operation. The present invention pertains to this type of method, and for the purpose of permitting comparison as between the known methods of this type and the present invention, a brief reference is first made to the known standard of this method type, this being shown in Figs. 5 to 7 of the drawings.

As indicated, the roll blank rests upon a support which serves to determine the path of advance of the roll, the support being located between the grinding wheel and the control wheel, the latter having a spiral groove—and consequently a spiral rib—which serves to advance the blank in such advancing path. The upper face of the support is generally arranged so that it is parallel to or in correspondence with a plane connecting the axes of the two wheels, with the result that the periphery of the roll has this relation to such plane while the axis of the roll blank extends angularly to such plane. Since the two wheels have their

active surfaces circular, and the periphery of the roll is circular on any cross-section of the roll, the contact between the three surfaces is necessarily that of opposing arcs, and since the diameter of the roll presents the radius of the roll arc, the fact that the axis of the roll is angular to such plane connecting the axes of the two wheels—and which can be considered as a plane extending horizontally—the actual contact will not conform to the contact which will produce the desired taper, the grinding action tending to produce a periphery such as is indicated in Fig. 8, where the peripheral surface is shown as more or less concave. A roll of this type does not operate correctly with the conical surface of the bearing on which it rests, with the result that the load conditions are not properly distributed, and the roll is subject to improper wear conditions.

One of the features of such arrangement is indicated in Fig. 7, where it will be seen that the angularity of the spiral rib and the axis of the roll is such that the contact of rib and end face of the roll is at the periphery of the end face, thus affecting the advance of the roll by pressure exerted in the direction of the taper face rather than in the direction of the axis of the roll, and permitting rocking of the blank.

The present inventor, in contrast, will provide a substantially true taper, due to certain changes which have been provided in the arrangement of the three members—the grinding wheel, the control wheel and the roll support—so as to cause the roll to traverse the face of the grinding wheel in a somewhat different manner, as will be understood by considering the diagrammatic views, Figs. 9 to 13.

The underlying feature of the present method is that which places the axis of the roll parallel with the axis of the grinding wheel when viewed in the direction of a plane connecting the axes of roll and wheel. This is indicated in Fig. 9, where this relationship is seen, the axis of roll 4 extending in parallelism with the axis of wheel 1. Since the roll rests on the support 3 by contact of the roll periphery with the support, the supporting face of the latter extends angular to such plane, the angularity depending upon the angular relationship between the roll axis and periphery. In other words, the roll, when on the support, will present this parallelism between the roll and wheel axes, and as the roll advances, this parallelism is retained throughout the roll advance. Since the roll is advanced with its large end trailing, the arrangement places the supporting face of support 10 as inclined upwardly in the direction of advance of the roll. Hence, one of the main distinctions as between the known method illustrated and the present method, with respect to the support, is this change in the supporting face of support 10, from the parallel relation with the axis of the grinding wheel to an angular relation to the grinding wheel axis; obviously, this change affects, vitally, the relationship between the roll axis and the axis of the grinding wheel, the roll axis now being brought into the parallelism relationship with the grinding wheel axis, when viewed in the direction of such plane, as compared with the angular relationship previously present. In other words, the path of advance of the roll is now made angular to the axis of the grinding wheel, when viewed in the direction of a radial plane of the grinding wheel, instead of parallel to such axis, as before.

This fundamental change in the relationship

of the axes of roll and grinding wheel sets up a number of conditions which directly affect the method. For instance, since the support face is inclined upwardly, it will be understood that during its progression across the face of the grinding wheel the roll is advancing toward a zone of increasing width between the opposing faces of the grinding and control wheels; since the roll is to retain its grinding relationship with the grinding wheel, compensation for this change must be provided. This is provided, in part, by the arrangement of the control wheel and the manner in which it is dressed and the relationship of its axis with respect to the axis of the grinding wheel. In practice, the axis of the control wheel is angular to the roll axis to an extent equal to that of the support face but with the angularity reverse to that of the support face.

Again, the path of roll advance is such that compensation must be provided with respect to the grinding face as well. In practice, this compensation is provided in the manner in which the grinding wheel is dressed, the surface being more or less concave on a cross-section of the wheel; the particular configuration is made dependent upon the angularity of the support face, and the relation of the latter to the throat of the passage between the wheels, the dressing of the wheel thus being made dependent on the degree of angularity as between the roll axis and its periphery.

In other words, the dressing angles for both wheels are equal to the angularity of the support face with respect to a radial plane of the grinding wheel, and since the support face angle is equal to the angle existing between the axis and the peripheral face of the roll, it can be seen that both wheels, dressed for a particular service, are individual for such particular service. If the roll taper is changed, the change involves a change in the angularity of the support face, in order that the fundamental parallelism between axes be maintained, and hence the change in angularity of the support face brings the requirement of a change in the dressing angles. The feature in this respect lies in the fact that since the taper of the roll is a known value, the various developments can take place on the basis of this known value, and therefore requiring no "cut and try" methods.

As will be understood, the fact that the fundamental parallelism as between the roll axis and grinding wheel axis is present, when viewed in the direction of a plane connecting these axes, such parallelism will be absent when these axes are viewed from a direction normal to such plane. With the large end of the roll as the trailing end during the advance, and with the peripheral face in contact with the grinding face, the roll axis will appear inclined inwardly in the direction of advance when viewed in the direction normal to such plane connecting the axes.

The advantage of the particular method flows from a combination of these activities. The dressing of the grinding face is provided by the movement of the dressing tool across the wheel face at an angle equal to that of the support face when both are viewed in the direction of the plane connecting the roll and grinding wheel axes; when viewed in a direction normal to such plane, the path of the dressing tool will be parallel to the grinding wheel axis—thus reversing the conditions present between the roll and grinding wheel axes. Consequently, the path of travel of the dressing tool across the grinding

face will present a straight line characteristic, although a cross-section of the face will present a more or less concave configuration; this is due to the fact that the dressing is at such angle, so that the line referred to will cross the line of section at the angle of the support face. When, therefore, the roll is positioned on the support face, the relative conditions become such that the portions of the roll periphery which are directly opposite the grinding face at any position of the roll, are portions so located as to correspond with this dressing line of the grinding face, and therefore such contacting portions will be similarly ground, the arrangement providing a line characteristic to both grinding face and roll at the point of tangency of the two faces on any cross-section of the roll and in any of its positions of advance. This insures substantially true taper to the rolls, since grinding activity is concurrently present throughout the length of the active periphery of the roll, with the activity presented on a line which, in practice, is parallel with the support face when viewed in the direction of the plane connecting the roll and grinding wheel axes—and therefore angular to such plane—and which also represents the innumerable points of tangency of the opposing arcs presented by the possible cross-sections of the roll.

In other words, the relationship is such that although the opposing surfaces of roll and grinding wheel are arcs, with respect to the axes, and the grinding face is also curved cross-sectionally, the tangency point of contact of the possible cross-sections of the roll will present the characteristics of a straight line, and the grinding takes place on this line, so that the peripheral face is ground concurrently from end to end of its active length along such line of contact. Obviously, this will be true only when the roll undergoing grinding is of the proper dimensions; the condition would not be present if a roll of different taper formed the work, thus indicating the reason for preparing the apparatus for the individual work to be done.

One other condition is referred to at this point. As indicated, the control wheel is dressed on the basis of the angularity of the support face, with the control wheel axis inclined. This permits of the use of a spiral control wheel rib which extends at such angle that with the roll in position the contact between rib and end face of the roll is within the service-active zone of the end face, so that the pressure of the rib is being exerted in the direction of the roll axis rather than in the direction of the roll periphery as before.

These conditions are shown more or less diagrammatically in Figs. 9 to 13, wherein 1 indicates the grinding wheel with a formed face 2, with 3 indicating the work support having a face 5 on which the work—in the form of a roll blank is supported. The face 5 is inclined upwardly in the direction of roll advance, with the inclination equal to the angularity of the roll taper relative to the roll axis, as indicated in Fig. 9. Hence, in Fig. 9, the line 11—11 (which extends parallel to the direction of length of face 5) would indicate the path of travel of the rear end of the roll axis in traversing the grinding face. If the latter were a straight face, it is apparent that the advancing roll would travel in a direction such as to be moving into a receding zone of the wheel arc; and to overcome this condition, the dressing is arranged in such manner that it gives the effect of building up the grinding face to compensate, thus providing the concave char-

acteristic referred to, and which is indicated in Fig. 10. However, on the line 11—11 of Fig. 9, the grinding face is of straight-line characteristic, as indicated in Fig. 11, this being the result of the dressing operation. Since this line also represents the actual line of contact between roll periphery and grinding face, it will be seen that the periphery is ground into its substantially true taper form.

Figures 12 and 13 present fragmentary sectional views of the relationships between roll and grinding and control wheels at two positions of the roll, Fig. 13, indicating the position at the entrance end, while Fig. 12 shows these at the discharge end of the path. For instance, in Fig. 13, the face 5 has its supporting point of roll 4 as substantially on a horizontal plane through the axis of the grinding wheel, while a similar plane through the axis of the control wheel extends some distance above the plane through the grinding wheel axis. In contrast, the supporting point of the roll in Fig. 12 is some distance above the grinding wheel plane, while the plane of the control wheel is below the grinding wheel plane. The roll 4, in travelling between these positions, has had the line of contact characteristic with the grinding face throughout the travel, since the travel has been along a straight line of the grinding face and contact has been complete on this line, as indicated in Fig. 11.

Feeding of the roll 4 across the face 2 of the grinding wheel along the support 3, is accomplished by means of a feed or control wheel 6 having a spiral groove 6a shaped, in transverse section of the groove length, to substantially conform to the shape of the side of the roll. Since the control wheel is mounted in the assembly in opposed and spaced relation to the grinding face of the wheel—with the work support 3 located within such space—it will be understood that the bottom of the spiral groove not only carries the taper angularity of one side of the roll but must also compensate for the similar angularity of the opposite side of the roll since the latter side is in contact with the face 2 of the grinding wheel; the relation in this respect is illustrated in Fig. 11, from which it is apparent why the roll axis, when viewed from a direction normal to a plane connecting the roll and grinding wheel axes, extends angular to the grinding wheel axis, the bottom of the groove being angular to the control wheel axis to an extent equal to the angularity of one side of a roll relative to the opposite side on a diametrical plane section of the roll.

As pointed out, the axis of the control wheel extends angular to the plane connecting the axes of roll and grinding wheel, as does the supporting surface 5, but the angularity of such surface 5 and the control wheel axis is in opposite directions relative to such plane. Because the control wheel axis is thus inclined to the said plane, it can be understood that the lead of the spiral groove can be so arranged that the pressure-applying side wall of the groove will present its lead as approaching a direction normal to the direction of the axis of the roll, the relatively large diameter of the control wheel as compared with the roll diameter placing the active contact between roll end and rib face—the side of the groove—within a small arc of the rib. Hence, when the roll is in position for grinding, the contact between roll end and rib face will be within the service-active portion of the roll end, a condition which tends to apply the roll-advancing pressure in the general direction of the roll axis.

As indicated in Figs. 1 to 3, the control wheel is secured on a shaft 7 mounted within a bearing 8 formed integrally with a bracket 9 mounted upon a support 10 by means of a center pivoting member 11 and adjustably secured to said support to be rotated about the axis of said pivot, by means of a screw bolt 12 passing through a slot in said bracket 9. On the bracket 9 is an upwardly-extending arm 13 carrying a laterally projecting pin to oppose a lug 14 on the support 10, so that by inserting a suitable gauge block (not shown) as indicated in Figs. 1 and 3, between said lug and pin, the bracket may be very accurately adjusted relatively upon said pivot 11 and thus tilt the control wheel 6 longitudinally, the inclination to the plane connecting the axes of roll and grinding wheel corresponding with the inclination of the edge 5 of the work support relative to such plane but in the opposite direction, as evidenced by the comparison of Figs. 12 and 13 previously referred to.

The control wheel 6 is rotated at the proper speed by means of a shaft driven in any suitable manner and connected to the free end of wheel shaft 7 by a universal joint connection 15, and said control wheel may be accurately adjusted toward and from the grinding wheel 1 to provide for grinding rolls 4 of different diameters, by forming the support 10 integral with a base slide 16 mounted upon ways on the base 17 of the machine, with a screw shaft 18 for moving said slide 16 longitudinally.

While the control wheel groove is shaped with respect to the roll itself, as previously pointed out, the grooved face of the wheel is itself slightly curved to present characteristics of a concave. The reason for this can be understood by considering Fig. 9 in connection with Figs. 12 and 13; the roll 4 in Fig. 13 may be assumed to be the roll 4 of Fig. 9, Fig. 13 indicating the position of the control wheel axis at this particular section of the wheel with respect to a horizontal line which, at this point extends through the roll axis. In Fig. 12, the roll has advanced in the upward direction, but the horizontal line representing the control wheel axis at this point has passed below the horizontal plane passing through the grinding wheel axis. This is due to the opposite inclinations of the support face 5 and the control wheel axis, with the inclinations at equal angles.

The effect of this can be readily understood, both by comparing the position of the roll axis relative to the grinding face in Figs. 12 and 13 and by a similar comparison of the roll axis with the face of the control wheel. For instance, the amount of shift of the roll axis relative to the horizontal plane through the grinding wheel axis represents a comparatively small arc of the grinding face. During the same period, however, the length of the arc between a horizontal plane through the roll axis and the horizontal line through the control wheel axis of Fig. 12 is materially longer, so that the recession represented by the arc of the control wheel is greater than that represented by the arc of the grinding face. Compensation must be provided for this condition and it is done by concaving the face of the control wheel by a dressing operation such as is presently described, and the effect of which is to give the appearance of "building up" the control wheel face, in a manner similar to that indicated with respect to the grinding face in the above description—by concaving the face.

The grinding wheel 1 is mounted in a fixed posi-

tion upon a suitable bearing bracket 19 on the base 17, and this wheel is rotated at the proper speed, in any suitable manner, not shown.

The work support 3 is in the form of a plate or blade 3a adapted to be secured to a supporting member 3b carried by the base slide 16, the plate or blade being secured within a recess of the support. Since the taper angle may differ with respect to rolls of different dimensions, the plate is individual to a particular angle, to provide the relationship between the axes of roll and grinding wheel previously referred to. By substituting one plate or blade for another, the various conditions to be met can be readily taken care of, as well as the desired height of the face 5 with respect to the throat within which the roll advances.

As heretofore pointed out, the face 2 of the grinding wheel is dressed to present the face in such manner that the advancing roll will contact with the grinding face throughout the active length of the peripheral face considered in the direction of the roll axis. This result is obtained by means of the grinding wheel dressing assembly shown more particularly in Figs. 1, 2 and 4, being permanently carried by the grinding assembly. As pointed out, there is a definite relationship existing between the taper angle of the roll, the roll support, the dressed face of the grinding wheel and the similar face of the control wheel, and this relationship can be seen by a comparison of Figs. 3 and 4.

The dressing means or assembly includes a bracket 20 rigidly secured to the bearing bracket 19 and extending laterally therefrom past the periphery of the grinding wheel and in spaced relation thereto. Mounted upon the outer face of this bracket 20 is a way member 21 which is connected to said bracket to swing about a centering pivot member 22 which is located in exact axial alignment with the axis of the centering pivot 11; movable longitudinally of said way member, by means of an adjusting screw 23, is a slide 24 carrying a dressing tool 25.

As will be understood, the way member 21 will provide a fixed path of travel for the dressing tool with the tool movable along such path by operation of the screw 23. If the way member be positioned in such manner that such path of travel is in parallelism with the grinding wheel axis, the face will be dressed as a straight face. However, if the way member be shifted so as to locate the path of travel as angular to such parallelism, the face will be given a concave curvature in cross-section, with the curvature and form dependent upon the relationship of such path of travel relative to the parallelism condition. This will be readily understood from the following:

Assume the angularity to be as in Fig. 4, in which the axis of the tool travel path intersects a plane through the axis of the grinding wheel, with the point of intersection at the axis of centering pivot 22. Obviously, the tool will contact the grinding face periphery initially at the point of intersection referred to—this point being located on a diameter of the grinding wheel in the position shown; the path of the tool to the left of such point of intersection in Fig. 4 will be below the diameter, and therefore on a receding portion of the arc of the grinding face, while the portion of the travel path to the right of the point of intersection will be above such diameter and therefore on a receding portion of the arc. Hence, as the tool traverses the face of the grinding wheel, it initially contacts with the face at such point of intersection, and as the tool is advanced

toward the face, it gradually develops the point into a line effect along the axis of the travel path, this being continued until the tool has become active throughout the entire width of the face.

5 The resultant effect will cause the face, in cross-section, to be curved to present it as concave. But although the face, in cross section, presents the concave characteristic, it will be readily understood that if a straight edge be placed on said
10 face in exact correspondence with the axis of the path of travel of the tool, such straight edge will contact the grinding face at all points throughout the width of the face.

In other words, by dressing the grinding face
15 in this manner, the face of the wheel, although of cylindrical peripheral form, will present a straight-line characteristic along a line corresponding to the axis of the travel path of the dressing tool. If, then, a roll be brought into
20 contact with such face so as to permit the active peripheral face of the roll to contact with the face on such line, the roll periphery will be concurrently ground throughout the length of the active peripheral face considered lengthwise of
25 the roll; this is due to the fact that at such time the taper face of the roll—a straight face—will be in contact with the grinding face on a line which is also of straight line effect. Hence, if the angularity of the axis of the path of travel
30 of the tool be properly selected with relation to the roll being ground, this line of contact characteristic can be set up and thereby secure the substantially true taper form of the roll.

As pointed out heretofore, this latter action is
35 secured by considering the angularity of the supporting face 5, the angularity of the latter being determined by the fact that the fundamental of the development is found in the fact that the axes of roll and grinding wheel extend in parallelism
40 when viewed in the direction of a plane connecting these axes. By considering the latter as a standard the variations as to angularity of the taper of the roll can be considered on a common basis, due to the fact that when such an arrangement of the axes is had, it is possible to set up the line of contact characteristic between roll and
45 grinding face in presence of changes in the dimensions of the roll itself. Such changes, when they involve a different taper angle, necessarily vary
50 the angular relation of the support face 5 to such plane connecting the roll and grinding wheel axes, while the roll diameter changes can be taken care of by the position of such support face within the throat set up by the opposing faces of
55 the grinding and control wheels, the angularity not being affected by the size of the roll.

The axis of the travel path of the dressing tool is therefore placed at the same angle to such plane connecting the roll and grinding wheel axes as is the support face 5; this can be readily understood from Fig. 4, since it is obvious that if
60 bracket 20 were carried around the periphery of the grinding wheel to the position of face 5, the axis of the tool travel path would correspond to the position of the face and the angular relation of such face to this plane. Since the bracket is located on the opposite side of the grinding wheel, the angularity of the axis of the travel path has the direction shown. The latter condition, how-
65 ever, can also be used as a test for considering the angularity of the axis of the control wheel, as indicated in Fig. 3, by simply comparing the similarity in angular relationship between the axis of the travel path in Fig. 4 and the axis of
70 the control wheel in Fig. 3 relative to the plane

connecting the axes of roll and grinding wheel—since both views are based on a common point of observation. Hence, the axis of the tool travel path is not only based on the angularity of the support face 5 but also on the angularity of the control wheel axis—with each of them based
5 fundamentally on the parallelism relationship of the axes of the roll and grinding wheel.

In practice, the angularity of the way member, when determined, can be readily obtained by
10 loosening the member sufficiently to permit its being swung about the axis of pivot 22, and locating it relative to a pin 25a carried by the bracket 20 (Fig. 4), a gauge block (not shown) being positioned between pin and member; after positioning,
15 the member is again properly secured by tightening the connections, the swinging of the member being permitted by the pin and slot connection between bracket 20 and the way member, this adjustment possibility being similar to that provided
20 by the connection between support 10 and bracket 9, through screw bolt 12 in Fig. 3.

As heretofore pointed out, the control wheel 6 is provided with its grooved face of concave characteristic, although the individual groove is
25 shaped relative to the roll in such manner that the roll periphery will properly contact with the bottom of the groove as the roll advances, the concavity being arranged along definite lines so as to set up the seeming "building up" of the
30 wheel to compensate for the conditions set up by the inclined path of travel of the roll during its advance. Since the curvature of the wheel, like that of the grinding face, will depend upon the angularity of such travel path of the roll, the dressing of the control wheel, as with the grinding face, is individual to the particular roll being operated upon. In practice, therefore, the actual
35 dressing of the control wheel is preferably provided by a separate apparatus, a single machine for this purpose being adapted to provide the wheel dressing operations on wheels of different types, and thus meet the conditions of a dressing station for a multiplicity of roll grinding units such as are shown in Fig. 1, for instance. A dressing machine of this type is illustrated in Figs. 14
40 and 15.

This machine is designed to dress the control wheel by producing thereon the proper spiral groove effect with the groove having the proper
50 cross-sectional shape, and to also provide the compensating concave characteristic to the control wheel face as previously pointed out. The control wheel is itself a unit, made up of the shaft 1, to which the control wheel 6 is secured,
55 as by a key or spline connection, the bearing 8, bracket 9, and arm 13 and its pin; the free ends of the shaft are arranged to permit ready securing of one of the coupling members 15, the shaft end being reduced and provided with an opening
60 for the passage of a pin to lock the coupling member to the shaft. The control wheel units are removable and positionable bodily, and since each wheel is capable of being dressed, and they are of a generally similar type, these units can be kept
65 in stock and used wherever required, a single dressing machine being able to take care of the dressing operations required in preparing control wheels for the various grinding machines that may be in operation.

The dressing machine itself is arranged to support the control wheel unit in proper relation to the dressing wheel and to feed the wheel relative to the dressing wheel in such timed relation as to cause the groove to be properly formed with the
70 75

general arrangement such as to provide the concavity characteristic referred to. To provide this result there must be a relative traversal of the control wheel face by the dressing wheel, and for this purpose, the machine is designed on the basis of a permanently-located dressing wheel and an advancing and retreating movement of the unit in the longitudinal direction of the unit to develop the spiral traversal, together with a movement of the unit at right angles thereto—toward and from the dressing wheel—to provide the depth to the groove. To provide the support for the unit and the several movements, the dressing machine is arranged substantially as follows:

31 indicates the machine base carrying ways on which is mounted a base slide 30 adapted to traverse the base ways. Base slide 30 carries ways extending transversely of the slide, these ways being adapted to carry a horizontal slide 29 carrying a vertically extending bracket 28, which, in turn, carries ways to receive a vertical slide 27, the latter being designed to carry the control wheel unit, and therefore being shaped to accommodate the latter and permit its attachment thereto in general simulation of the mounting of the unit in its normal working relation. To provide the latter, slide 27 carries the equivalent of the pivot pin 11 heretofore referred to, this equivalent being in the form of a pivotal axis 26 about which the unit is adjusted similarly to its adjustment about pivot 11, the latter preferably forming part of the unit. With the pivot 11 mounted in slide 27, and with bolt 12 securing bracket 9 to such slide 27, the unit will be mounted in general similarity to its mounting on the support 10, slide 27 having a lug 14a which serves the same purpose as lug 14 on support 10.

Since the axis of pivot 11 is designed to lie in a horizontal plane through the axis of the dressing wheel, provision is made to adjust the position of slide 27 vertically in its ways, this being provided by an adjusting screw 27a carried by the slide 29 and connected with slide 27. The movements of the unit toward and from the dressing wheel are provided by moving slide 29 along its ways by means of a suitable adjusting screw 29a.

Shaft 7 of the unit is rotated and the base slide 30 is moved along its ways from a suitable power source, not shown, but which is indicated by the worm and gear 35 mounted in the gear box 34, the worm gear being mounted on shaft 33 which carries one of a train of gears, indicated generally at 37, adapted to rotate a threaded sleeve 32a mounted on slide 30 and which co-operates with a threaded rod 32 carried by the base 31. Obviously, the speed reduction form of the drive connections will cause the slide 30 to advance at a slow speed, and during this period the shaft 7 is being rotated by shaft 33 through a suitable coupling structure analogous to coupling 15, previously described. Hence, the speed of rotation of shaft 7—with the control wheel thereon—and the advance of base slide 30 are in positive timed relation, and since the advance is relative to the fixedly-located dressing wheel, the resultant groove will be in the form of a true spiral.

As heretofore pointed out, the dressing of the control wheel is designed in such a way as to provide a concave characteristic to its face as an entirety—the specific shape of the bottom of the groove is individual, but the helix as an entirety has this characteristic—this being provided to set up efficient operation. This characteristic is due to the desire to provide a straight-line effect to the face of the control wheel complementary to

this effect produced in dressing the grinding wheel, as previously explained. For instance, in Fig. 3 the roll is shown as in the position of the roll in Figs. 1 and 9; in Fig. 9 the axis of the roll travel path is indicated by the line 11—11, and this also indicates the straight-line dressing of the grinding wheel. Considering this in connection with Fig. 3 it will be understood that such roll travel path axis would extend upwardly toward the left of the control wheel shown when considered with respect to a horizontal plane, the amount of inclination corresponding to the line 11—11 of Fig. 9; in other words, line 11—11 in Fig. 9, would be reversed in direction of inclination when applied to the control wheel in Fig. 3. In dressing the control wheel, therefore, the design is to produce the straight-line effect on this line 11—11 as applied to the wheel in Fig. 3. As a result, the throat between the two wheels will present the characteristic of a straight-line characteristic—inclined to the horizontal—on the supporting face 5, the face of the control wheel and the face of the grinding wheel, with the straight-line condition at the same angle to the plane connecting the axes of roll and grinding wheel when viewed in the direction of such plane. The faces of the control wheel and grinding wheels are in the form of opposing arcs, but, through the dressing operations, these faces are each given the characteristic of this straight-line effect; and since these faces are located on opposite sides of the supporting face 5, there is set up the condition that the roll periphery can lie in contact with these three elements—the grinding wheel, supporting face and control wheel—with the contact on three distinct straight lines lengthwise of the roll periphery, the lines of contact at the sides being parallel with that provided by the supporting face.

In dressing the control wheel, therefore, the unit is positioned on slide 27 in such way that in traversing the face of the control wheel the relative advance is such that the axis of the dressing wheel will traverse the face of the control wheel along a line which corresponds to the axis of the roll travel path, thus setting up this complementary straight-line effect on the control wheel. Since, in contrast with the dressing of the grinding face, the dressing wheel for the control wheel remains stationary, this traversal characteristic is provided by advancing the control wheel unit relative to the fixedly-located dressing wheel as previously described.

However, due to the fact that the axis of the dressing wheel extends on a horizontal plane instead of a plane corresponding to the axis of the roll travel path, the unit angularity on slide 27 must be shifted as compared with the position of Fig. 3, by rotating the unit on its pivot 11 through an angle which corresponds to the angle between the dressing wheel axis considered as extending in the plane of the roll travel path axis and the horizontal plane in which the dressing wheel axis is actually located. And since the axis of the roll travel path in Fig. 3 is at an angle equal to that which is presented by the angle between the roll axis and a side of the roll, when the latter is considered on the basis of a central longitudinal section of the roll, the rotation of the unit on slide 27 will be such that the angularity of the axis of shaft 7 to the horizontal will equal twice the angle of the roll referred to, or be equal to the angle between the two sides of the roll section referred to. It is because of this condition that the distance showing of the pin 75

carried by arm 13 is greater in Fig. 14 than in Fig. 3—the difference in this distance represents the amount of rotation of the unit on its pivot to compensate for the shift in the axis of the dressing wheel to the horizontal from a plane which would correspond to the axis of the roll travel path.

This method of providing the required adjustments is preferred since the adjustment of the unit about its pivot is a requisite to meet the conditions of rolls having different tapered angles, and the unit therefore offers greater facility of adjustment than the dressing wheel axis. Since the traversing path of the dressing wheel is designed to correspond with the angle of the axis of the roll travel path—and in parallelism with the supporting face 5—the dressing wheel axis would require changing whenever a change was made to meet the conditions of a roll of different taper. By locating the dress-wheel axis on a horizontal plane, it becomes possible to provide the adjustments entirely by the unit. And since all adjustments of the unit are based on the angle between the roll axis and one of its tapered sides, all adjustments can be readily made regardless of the particular roll that is being made the basis of the preparation of the grinding apparatus through adjustment of the angle of the supporting face, the dressing of the grinding wheel and the dressing of the control wheel. And, as previously pointed out, the foundation of such preparation is the maintenance of the roll axis as parallel with the axis of the grinding wheel when viewed in the direction of a plane connecting such axes. The reverse inclination of the control wheel axis, previously discussed, permits the production of a spiral groove on the face of the control wheel with the lead of the groove substantially normal to the axis of the roll, the advantage of which is pointed out above. In other words, the inclination of the control wheel axis to the horizontal can determine the lead angle of the spiral helix. And the fact that the control wheel axis is inclined to the axis of the roll travel path to a greater extent than is the axis of the grinding wheel to such path axis is immaterial, since the difference in concavity conditions in the two opposing faces provides the necessary compensation, due to the presence of the complementary straight-line characteristics referred to.

The dressing wheel is indicated at 39 and carried by a fixed bearing 38, the axis of which is preferably inclined to the path of advance of the slide 30, to enable the use of a dressing wheel of proper shape to produce the groove, it being possible to utilize edge and side grinding faces of the wheel for groove production, as well as developing the helix characteristic more efficiently. The dressing wheel 39 may be varied in form, diameter and width to accord with the cross-sectional shape of the groove, the latter being preferably formed with the pressure-applying side face of the rib and the bottom face of the groove conforming generally to the included angle of the tapered side and large end of the roll. For instance, Fig. 18 discloses a roll in which the included angle is indicated at $87^{\circ} 22'$, the taper relation between the roll axis and one of the taper sides being $2^{\circ} 38'$, with the angle between the opposite side faces as $5^{\circ} 16'$. As indicated in Fig. 16, the bottom and pressure-applying faces of the groove have the same included angle as that indicated in the roll. However, the angularity indicated in Fig. 16 does not represent the angularity of the bottom of the groove relative to a

vertical plane taken longitudinally of the control wheel along its axis; this is due to the fact that, as indicated in Figs. 10 and 11, the roll axis does not extend in parallelism with the grinding wheel axis when viewed in a direction normal to a plane connecting the roll and grinding wheel axes, so that the bottom of the groove must compensate for this variation. Hence, the bottom of the groove in Fig. 16 would be angular to a vertical plane through the control wheel of that figure in an amount equal to twice the taper angle, or an actual angle of $5^{\circ} 16'$, this being indicated in this figure by the fact that the pressure-applying face is inclined to a true vertical taken through the view, the inclination amounting to $2^{\circ} 38'$, thus setting up the conditions presented in Figs. 10 and 11.

The angular dimensions indicated in Fig. 18 can illustrate the angles employed in a machine designed to grind the rolls to the dimensions indicated, and can be indicated by use of the several angles deduced from those indicated. For instance, the angle of the supporting face would be $2^{\circ} 38'$ relative to a horizontal plane; the dressing structure of Fig. 4 would be set to cause the dressing tool to advance at this same angle; the axis of shaft 7 in Fig. 3 would be set at this same angle but inclined in the opposite direction. When, however, the control wheel unit is positioned on slide 27, the angularity of shaft 7 to the horizontal would be increased to $5^{\circ} 16'$ —twice the foregoing angularity—due to the rotation of the unit on its pivot to compensate for the fixed location of the dressing wheel 39. When the grinding wheel and control wheel are dressed under these conditions, and the supporting face 5 and control wheel are arranged at the angles indicated, the assembled elements will receive the roll of Fig. 18 with its axis extending horizontally, and will advance the roll across the face of the grinding wheel along the axis of the roll travel path with the roll axis remaining horizontal throughout the travel, and with the active periphery of the roll having a line contact with both grinding wheel and control wheel during such advance.

It will be understood, of course, that tapered rolls having other forms or proportions and dimensions may be ground by changing the groove form and the re-dressing of the grinding wheel and control wheel and inclination of the supporting face 5 to suit the changed conditions. And, as illustrated in Fig. 17, a separate grinding wheel 40 may be employed to properly shape the groove side, by simply substituting this wheel for the wheel 39 after the bottom of the groove has been formed.

As will be seen by a comparison of Fig. 3 with Figs. 14 and 15, the direction of grinding advance of the dressing wheel over the face of the control wheel is from the discharge end of the helix toward the entrance end, this being the arrangement of the dressing machine. This places the pressure-applying face of the rib as in advance of the bottom of the groove and enables it to be accurately ground at the time the bottom of the groove is being formed, it being possible to do this through the use of a dressing wheel of the type shown and which has its axis inclined as indicated. Such arrangement permits the groove to be ground with accuracy to conform to the shape of the roll being ground, and, due to such accurate grinding and to the concavity characteristic of the wheel face as an entirety, the rolls to be ground will accurately seat in said

groove, and shattering or skewing of these rolls during the grinding operation will be prevented.

As pointed out in connection with the adjustment of the control wheel unit in Fig. 3 by the use of a suitable gauge block between the pin of arm 13 and the lug 14, the unit, in the position of Fig. 14 will be held in its adjusted position by a suitable gauge block positioned between such pin and lug 14a. In both positions, the unit will be held firmly in position by the presence of the pivot 11, the bolt 12 and the gauge block, these providing assurance against change of position of the unit after adjustment.

As indicated in Figs. 10 and 11, the axial length of the control wheel is preferably greater than the similar length of the grinding wheel face. Hence, the actual travel path of the roll is provided by an intermediate zone of the length of the control wheel. This permits the control wheel to be employed with grinding wheel faces of different widths.

As will be understood from the above, the arrangement of the several members of the grinding instrumentality for the rolls is centered about the relationship as to angularity between the roll axis and the roll periphery. The angularity varies in practice as between different bearing structures, and the apparatus is designed to meet this condition, the concavity characteristics of the grinding wheel and the control wheel being individual to this angularity relationship, so that both faces are varied when a new job is undertaken, the dimensions and angularity relationship of the roll of the new job being made the basis for the changes.

To permit this result it is obvious that some basic condition must be common throughout the range of operations, and applicant has selected the roll axis and the grinding wheel axis as this basis, with these axes in parallelism when viewed in the direction of a plane connecting these axes. This being standard in all operations, the remaining features are varied to meet the individual conditions. This parallelism is maintained throughout the travel of the roll across the grinding face, although the plane necessarily shifts as the roll moves up the inclined face of the roll support, such plane corresponding to a radius of the grinding wheel in any position of the roll in the width of the grinding wheel. Hence, the standard is always present throughout the grinding operations on a roll.

Having thus fully described my invention what I claim is:

1. In the grinding of tapered rolls, wherein the face of the grinding wheel is concaved, and the roll is fed across such concave face of the wheel during grinding of the roll, the method of feeding the roll which consists in supporting the roll to locate its periphery in contact with the wheel face with the roll axis extending in parallelism with the wheel axis when the supported roll is viewed in a direction corresponding with a plane connecting the roll and wheel axes, and feeding the roll in its advancing direction by pressure applied within the service-active zone of the end face of the roll and exerted in a direction substantially parallel with the wheel axis when the roll advancing path is viewed in a direction at right angles to such plane, the path of advance of the roll being angular to the wheel axis when viewed in the direction of the plane connecting the roll and wheel axes.

2. A method as in claim 1 characterized in that the angularity of the path of roll advance being such as to cause the roll axis to move upwardly

progressively during its feeding movement while maintaining the constancy of parallelism of roll and wheel axes when viewed in the direction of the plane connecting the roll and wheel axes.

3. A method as in claim 1 characterized in that the angularity of the path of roll advance being such as to cause the roll axis to move upwardly progressively through a definite distance range during its feeding movement while maintaining the constancy of parallelism of roll and wheel axes when viewed in the direction of the plane connecting the roll and wheel axes.

4. A method as in claim 1 characterized in that the angularity of the path of roll advance being such as to cause the roll axis to move upwardly progressively through a definite distance range during its feeding movement while maintaining the constancy of parallelism of roll and wheel axes when viewed in the direction of the plane connecting the roll and wheel axes, the length of the distance range being determined by the width of the wheel and the angularity of the travel path.

5. In the grinding of tapered rolls, wherein the face of the grinding wheel is concaved, and the roll is fed across such concave face of the wheel during grinding of the roll, the method of feeding the roll which consists in supporting the roll to locate its periphery in contact with the wheel face with the roll axis extending in parallelism with the wheel axis when the supported roll is viewed in a direction corresponding with a plane connecting the roll and wheel axes, and feeding the roll in its advancing direction by pressure applied within the service-active zone of the end face of the roll and exerted in a direction parallel with the wheel axis when the roll-advancing path is viewed in a direction at right angles to such plane, the axis of the roll, when viewed in the latter direction, being angular to the wheel axis, the path of advance of the roll being angular to the wheel axis when viewed in the direction of the plane connecting the roll and wheel axes.

6. In the grinding of tapered rolls, wherein the face of the grinding wheel is concaved, and the roll is fed across such concave face of the wheel during grinding of the roll, the method of feeding the roll which consists in supporting the roll to locate its periphery in contact with the wheel face with the roll axis extending in parallelism with the wheel axis when the supported roll is viewed in a direction corresponding with a plane connecting the roll and wheel axes, and feeding the roll in its advancing direction by pressure applied within the service-active zone of the end face of the roll and exerted in a direction parallel with the wheel axis when the roll-advancing path is viewed in a direction at right angles to such plane, the axis of the roll, when viewed in the latter direction, being angular to the wheel axis, the concavity of the wheel face being such as to present the line of contact of roll periphery and wheel face as co-extensive with the length of the active zone of the roll periphery, considered in the direction of the roll axis, within the roll travel path, the path of advance of the roll being angular to the wheel axis when viewed in the direction of the plane connecting the roll and wheel axes.

7. In the grinding of tapered rolls, wherein the face of the grinding wheel is concaved, and the roll is fed across such concave face of the wheel during grinding of the roll, the method of feeding the roll which consists in supporting the roll to locate its periphery in contact with the wheel face with the roll axis extending in parallelism with the wheel axis when the supported roll is viewed in a

direction corresponding with a plane connecting the roll and wheel axes, and feeding the roll in its advancing direction by pressure applied within the service-active zone of the end face of the roll and exerted in a direction parallel with the wheel axis when the roll-advancing path is viewed in a direction at right angles to such plane, the axis of the roll, when viewed in the latter direction, being angular to the wheel axis, the concavity of the wheel face being such as to present the line of contact of roll periphery and wheel face as coextensive with the length of the active zone of the roll periphery, considered in the direction of the roll axis, within the roll travel path, with the line of contact angular to the plane connecting the roll and wheel axes.

8. A method as in claim 7 characterized in that the angularity of the line of contact is in correspondence with the angular relation between the path of roll advance and such plane connecting the roll and wheel axes.

9. A method as in claim 1 characterized in that the concavity of the wheel face, on a section of said face corresponding to the angularity of the roll travel path relative to the wheel axis, presenting the line of the face in such section as a straight line.

10. A method as in claim 1 characterized in that the concavity of the wheel face, on a section of said face corresponding to the angularity of the roll travel path relative to the wheel axis, presents the line of the face in such section of straight line characteristic, a radial section of the wheel face presenting the line of the face in such latter section as having a concave characteristic co-operative with the roll face to cause the line of contact of roll and wheel face within the travel path to be co-extensive with the active peripheral length of the roll.

11. A method as in claim 1 characterized in that the angularity of such path of roll advance to the plane connecting the roll and wheel axes corresponding in value to the angularity of the roll periphery relative to the roll axis on a plane extending through the roll axis in the direction of length of such axis.

12. A method as in claim 1 characterized in that the angularity of such path of roll advance to the plane connecting such axes corresponding in value to the angularity of the roll periphery relative to the roll axis on a plane extending through the roll axis in the direction of length of the roll axis, the roll being advanced with the larger end trailing.

13. In the grinding of tapered rolls, grinding apparatus for supporting, feeding and grinding the roll periphery by endwise feed advance of the roll, said apparatus including a rotatable grinding wheel having a peripheral grinding face of concave characteristic on a radial section of the wheel corresponding to the direction of length of the wheel axis, a roll support adjacent the wheel face and having the direction of length of its supporting face extending angular to the line of such section with the angularity equal to the angularity between the roll axis and roll periphery to cause the roll to be supported relative to the grinding face with the roll axis extending in parallelism with the wheel axis when the roll is viewed in a direction corresponding to a plane connecting such axes but with the roll axis angular to the wheel axis when viewed in a direction normal to such plane and with the latter angularity such as to place the roll periphery in linear contact with the grinding face throughout the length

of the active peripheral face of the roll, and means for feeding the roll along such supporting face by pressure applied to the end face of the roll and exerted in the direction of the roll axis, whereby the parallelism of roll and wheel axes as viewed in the direction of such plane will be maintained during travel of the roll across the face of the grinding wheel.

14. Apparatus as in claim 13 characterized in that the means is operative to apply its roll-advancing pressure by contact with the roll end within the service-active zone of the latter.

15. Apparatus as in claim 13 characterized in that the means includes a rotatable control wheel carrying a spirally-arranged peripheral rib with the space between the rib convolutions forming a spiral channel, the bottom of which has a cross-sectional configuration such as to provide linear contact with the roll periphery and with a rib face active in the advance of the roll, the channel bottom and the grinding face being located on opposite sides of the roll supporting face and active with the supporting face to provide a throat within which the roll travels during its advancing movement.

16. Apparatus as in claim 13 characterized in that the means includes a rotatable control wheel having its periphery of rib and channel configuration in longitudinal section of the control wheel, with the configuration extending spirally of the periphery, the axis of rotation of the control wheel extending angularly to the plane connecting the roll and grinding wheel axes and with the angularity equal to but of opposite direction from that of the angularity of the roll supporting face relative to such plane, and with the channeled face of concave characteristic.

17. In apparatus for grinding tapered rolls, a rotatable grinding wheel having a peripheral grinding face, a rotatable control wheel having a peripheral face of rib-and-channel characteristic with the rib and channel extending spirally of such face to form a continuous roll-advancing means during rotation of the wheel, and a roll support having a supporting face between opposing faces of said wheels, to thereby complete a throat within which the roll is advanced across the grinding face by the spiral rib of the control wheel, said wheel faces being of concave characteristic, said roll-supporting face and the control wheel axis being inclined relative to the grinding wheel axis and to each other with the angularity of the supporting face and control wheel axis opposite with respect to each other and of equal value with respect to the wheel axis.

18. Apparatus as in claim 17 characterized in that the angularity between such grinding wheel axis and the roll-supporting face is equal to the angularity between the roll axis and roll periphery.

19. Apparatus as in claim 17 characterized in that the angularity between such grinding wheel axis and the control wheel axis is equal to the angularity between the roll axis and roll periphery.

20. Apparatus as in claim 17 characterized in that the assembly carries means permitting individual adjustment of the roll-supporting face and the control wheel axis to permit variation in angularity relative to the wheel axis to permit grinding operations on rolls differing as to taper value.

21. Apparatus as in claim 17 characterized in that the angularity between the grinding wheel axis and the roll supporting face is equal to the

angularity between the roll axis and the roll periphery, the direction of inclination of the supporting face being such that a roll positioned with its large end trailing will present the roll axis as extending in parallelism with the grinding wheel axis when viewed in the direction of a plane connecting such axes, with the roll advance maintaining such parallelism relationship.

22. Apparatus as in claim 17 characterized in that the lead of the rib formation of the control wheel and the angularity of the control wheel axis relative to the roll supporting face are co-related to present the rib lead to extend substantially normal to the axis of a roll positioned on the supporting face.

23. Apparatus as in claim 17 characterized in that the lead of the rib formation of the control wheel and the angularity of the control wheel axis are co-related relative to the grinding wheel axis in a manner to present the lead of the rib as extending substantially normal to such grinding wheel axis.

24. Apparatus as in claim 17 characterized in that the concavity of the grinding wheel face is complementary to the degree of angularity of the roll supporting face relative to the grinding wheel axis in that the wheel face presents a linear characteristic transversely on a line corresponding to the angularity of such roll supporting face relative to the grinding wheel axis, with the line related angularly to the grinding wheel axis as to degree of angularity equal to the angularity between the roll axis and roll periphery.

25. Apparatus as in claim 17 characterized in that the concavity of the control wheel face is complementary to the degree of angularity of the roll supporting face relative to the grinding wheel axis but with the line of angularity extending in a direction opposite that of the line of angularity of the supporting face relative to the grinding wheel axis, the concavity presenting a linear characteristic transversely of the face relative to the control wheel axis with the line angular to the axis to an angularity value equal to that of the angularity between the roll axis and roll periphery.

26. Apparatus as in claim 17 characterized in that the transverse concavity of the face respectively of the grinding and control wheels presents a linear characteristic on a line angular to the axis of the wheel carrying the face with the angularity equal to the angularity between the roll supporting face and the grinding wheel axis when viewed in the direction of a plane connecting the grinding wheel axis with the axis of a roll seated on such supporting face, such angularity being equal to the angularity between the roll axis and roll periphery, the control wheel axis being inclined relative to the grinding wheel axis and angular to the inclination of the roll supporting face, the inclination of the control wheel axis relative to the supporting face being such as to present an angularity equal in value

to that presented by the opposite tapering sides found on a longitudinal and axial section of a roll.

27. Apparatus as in claim 17 characterized in that the grinding wheel is supported by a frame, said control wheel being supported by a frame carried by and movable adjustably relative to the grinding wheel frame in directions normal to the axis of the grinding wheel, whereby the throat between the wheels is variable to accommodate rolls differing in dimetrical dimensions.

28. Apparatus as in claim 17 characterized in that the grinding and control wheels are supported by individual frames, the frame of the control wheel including means for controllably varying the angularity of the control wheel axis relative to the grinding wheel axis.

29. Apparatus as in claim 17 characterized in that the control wheel is supported by a frame movable bodily in directions normal to the grinding wheel axis, and means carried by the frame for adjusting the angularity of the control wheel axis relative to the grinding wheel axis.

30. Apparatus as in claim 17 characterized in that the control wheel is supported by a frame, and means carried by the frame for adjusting the angularity of the control wheel axis relative to the grinding wheel axis, with the adjustability centered relative to a point intermediate the ends of the control wheel.

31. In a device of the character described, a grinding wheel, a control wheel formed with a spiral groove throughout the length thereof providing a roll engaging peripheral surface curved in the direction of the length of said wheel, and means for supporting said wheel including a bearing bracket, a support, and a centering pivot member about which said bracket is adapted to be turned relative to said support to adjust said wheel to a longitudinally inclined position.

32. A device for the purpose described comprising a grinding wheel supported to rotate upon a horizontal axis and formed with a peripheral grinding face curved transversely thereof, a control wheel formed with a spiral feed groove with the exterior of said control wheel curved longitudinally thereof, a roll supporting plate interposed between said grinding and control wheels with its upper edge longitudinally inclined to the horizontal plane of the axis of said grinding wheel to form an inclined path of travel for the roll across the face of the grinding wheel, and means for adjustably supporting said control wheel including a fixed support, a bracket mounted upon said support by a centering pivot and having a bearing for the shaft of said wheel, said bracket having an upwardly extending arm provided with a laterally extending pin to oppose limiting means on said support, and means for holding said bracket in the position to which it is adjusted upon said centering pivot.

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