Dec. 17, 1935. G. DAVIDSON 2,024,433

APPARATUS FOR THE MANUFACTURE OF THE GROOVED ROLLS AS USED IN PILGER ROLLING MILLS

Filed Dec. 22, 1934 4 Sheets-Sheet 1

Fig. 1.

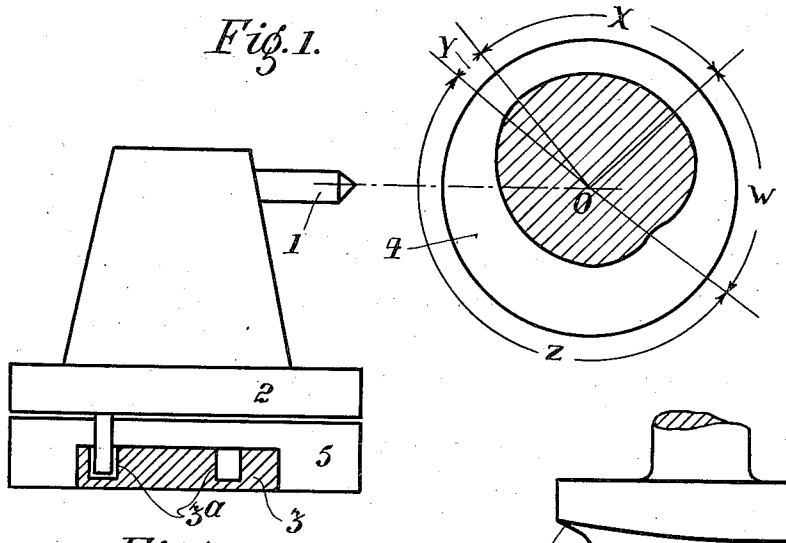


Fig. 2.

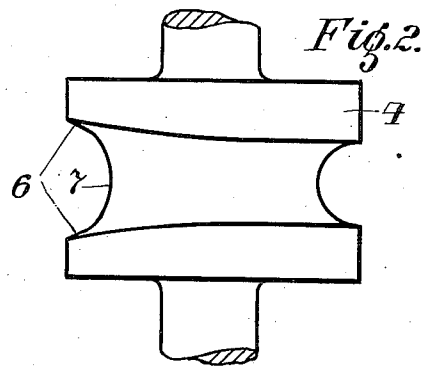


Fig. 3.

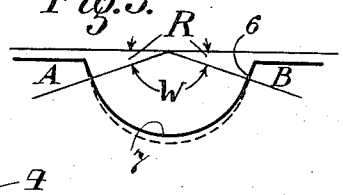
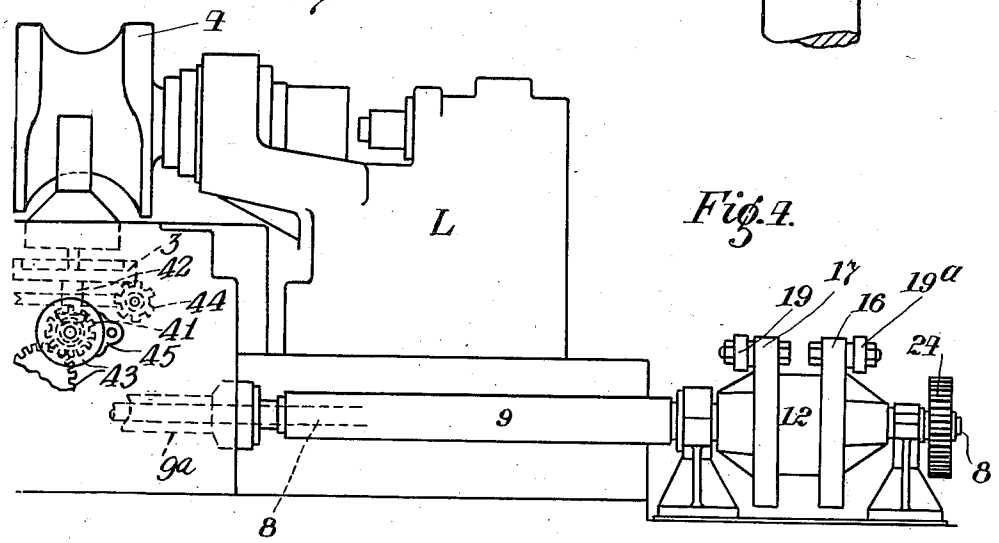


Fig. 4.



Inventor:
Graham Davidson
By J. C. Jochum & Fitty.

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Fig. 5.

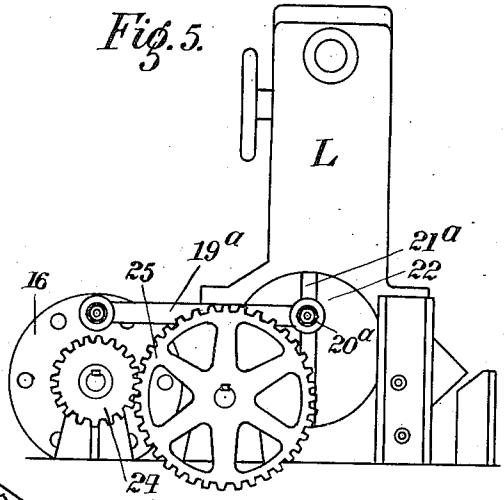


Fig. 8.

Inventor:
Graham Davidson
By Jochum & Atty

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APPARATUS FOR THE MANUFACTURE OF THE GROOVED ROLLS AS USED IN PILGER ROLLING MILLS

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Fig. 6.

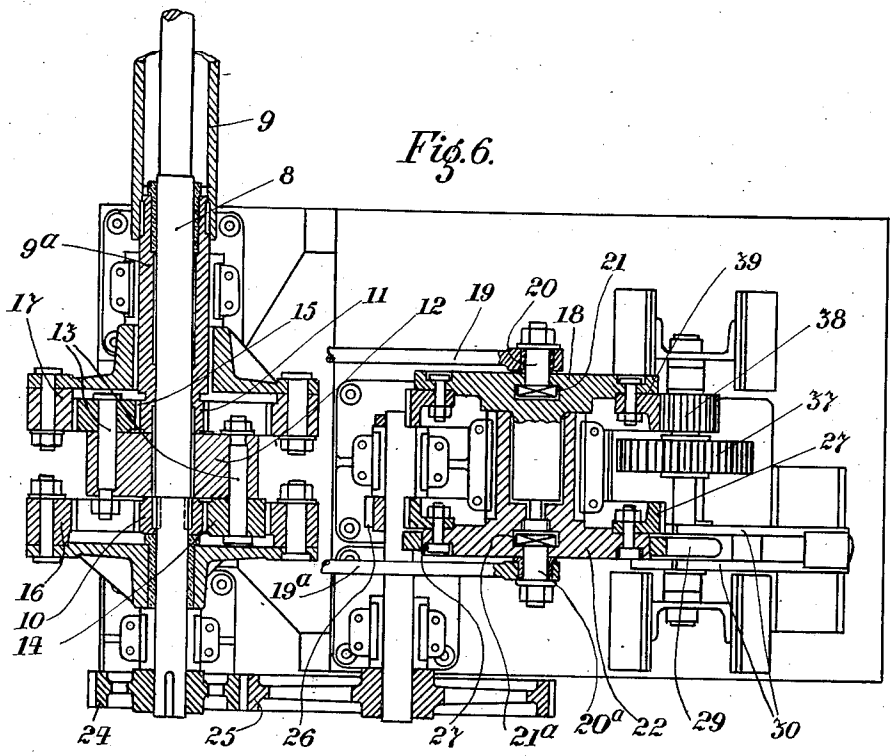
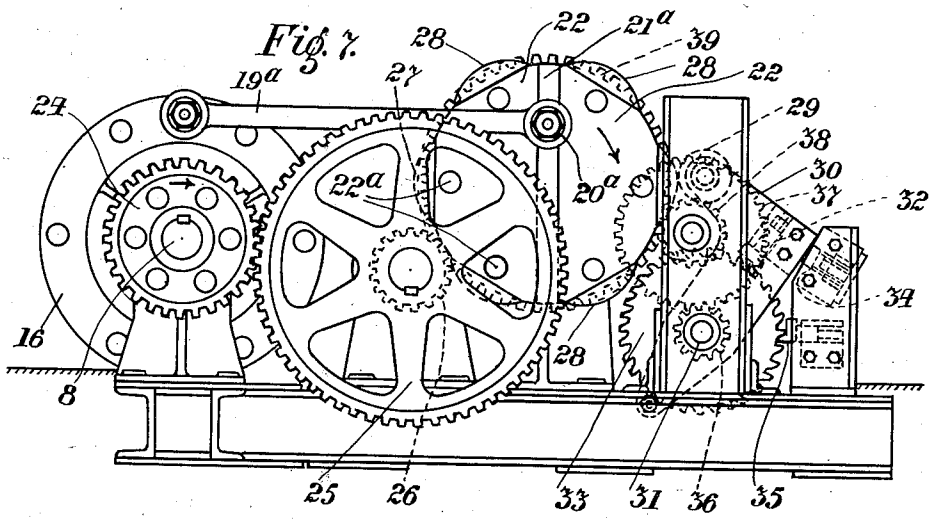


Fig. 7.



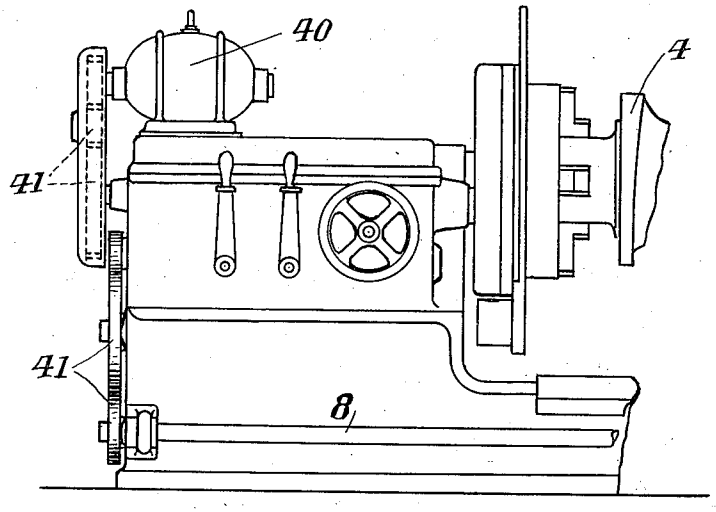
Inventor:
Graham Davidson
By Cushman Darby & Cushman

Dec. 17, 1935. G. DAVIDSON 2,024,433

APPARATUS FOR THE MANUFACTURE OF THE GROOVED ROLLS AS USED IN PILGER ROLLING MILLS

Filed Dec. 22, 1934 4 Sheets-Sheet 4

Fig. 9.



Inventor
Graham Davidson
By
Attorney

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UNITED STATES PATENT OFFICE

2,024,433

APPARATUS FOR THE MANUFACTURE OF THE GROOVED ROLLS AS USED IN PILGER ROLLING MILLS

Graham Davidson, Wishaw, Scotland, assignor to Stewarts and Lloyds Limited, Glasgow, Scotland

Application December 22, 1934, Serial No. 758,740
In Great Britain August 22, 1934

20 Claims. (Cl. 82—19)

This invention relates to apparatus, such, for instance, as set forth in the specification of Becker's Patent No. 1,499,633, used in the cutting of the grooves of the rolls of pilger rolling mills for the manufacture of weldless tubes from hollow blooms.

In the well known Becker apparatus the cutting tool of a lathe machine is actuated by mechanism in such manner that a compound motion is given to it, this motion combining two rectilinear motions at an angle to each other, one being of a uniform speed and the other of variable speed, together with a swinging motion, the composite motion imparted to the tool producing on the roll the inclined flanks having a variable angle to the axis of rotation of the roll while a circularly curved profile between the flanks and having eccentrically ascending and descending portions, as regards rotation of the roll about its axis, is produced by the combination of a swinging motion with a rectilinear motion at a variable speed. The last mentioned rectilinear motion of the tool is effected by means of a control cam driven at constant speed. The groove as made by the Becker lathe is found to be somewhat disadvantageous in practice as rolls of the Becker profile do not give the most uniform stressing of the material of the hollow bloom being acted on due to the fact that the accumulation of material at the sides or "fins", effected during the rolling process, are not drawn out equally to the adjacent parts having less material, the consequence being that the tubes produced are not as perfect as they might be, being liable to variations in the wall thickness and to small undulations in the material.

In the rolls as made in a Becker machine the "bellmouth", "rolling or finishing pass", "relief" and "gap" parts of the groove are all bound by definite angles bearing a definite relationship irrespective of the diameter of the roll and, as the production of the mill is proportional to the lengths of the "bellmouth" and "rolling pass" which together with the "relief" make up the "working portion" or "working pass" it means that in the case of small diameter rolls there is the further disadvantage that the mill production is not so large as it might be.

The object of this invention is to operate the tool of the lathe in such a manner that a pilger roll can be cut on a Becker, or like, lathe of a profile which will allow for the accumulated material as aforesaid being so allowed for that during the pilgering in the rolling mill of the hollow bloom into the finished tube, the tube material will be much more uniformly stressed and better drawn out than heretofore, and therefore better tubes produced.

According to our invention, we provide mechanism whereby the control cam can be driven at a variable speed, that is to say, can be accelerated and decelerated during its motion, and this is done in such a manner as to cause the tool to cut the roll groove of a profile which renders the roll capable of stressing the material of the bloom during the rolling operation more uniformly and drawing it out better than heretofore, thereby giving better results than formerly. The amount of acceleration and deceleration can be varied to suit requirements by an adjustable part of the mechanism.

The effect of accelerating the control cam is that the tool, when cutting the roll, is moved into the "bellmouth" of the roll groove earlier than if the cam had been rotating, as usual, at constant speed, the acceleration and consequently the advancement of the tool preferably increasing, as the tool swings across the section, from zero at the inner edge of a flat to maximum at the root of the groove and then correspondingly decreasing from the "root" to the inner edge of the other flat.

The cycle of acceleration and deceleration is timed to correspond with the time taken by the tool to move round the groove from one "flat" edge to the other.

The acceleration and deceleration has no effect during the action of the concentric part of the control cam so that no deepening occurs in the "finishing pass" of the roll, and the action throughout the "relief" angle is negligible as the gradient there is very gradual.

In accordance with a further feature of the invention, the second mentioned disadvantage is avoided by injecting a further alternate acceleration and deceleration into the cam motion, said acceleration and deceleration being timed so that a complete cycle thereof occurs during each revolution of the roll. Thus the working portion of the roll can be made a maximum length irrespective of the roll diameter and full production can therefore be obtained through the life of a roll.

The mechanism is characterized by the combination of two different so-called "correcting" motions for the drive of the control cam, the motion for "correcting" it during the cross sectional shaping of the "bell mouth" of the groove comprising a cycle of alternate acceleration and deceleration imparted to the cam drive during each swing of the tool from the inner edge of one

"flat" to the inner edge of the other, and the motion for "correcting" it to vary the length of "working" portion of the groove comprising a cycle of alternate acceleration and deceleration imparted to the control cam drive during each revolution of the roll.

The two correcting motions may be imparted by means of a double epicyclic gear in the cam drive, comprising two elements controlled respectively with reference to the rotational speed of the roll and the traversing speed of the tool from one inner "flat" edge to the other.

The said elements may be controlled by variable-throw cranks driven from the control cam drive.

In order that the nature of the invention may be clearly understood, one embodiment of how the invention may be put into practice in connection with a standard Becker lathe will now be described, but merely by way of example, and with reference to the accompanying drawings, wherein:—

Fig. 1 shows diagrammatically the tool and associated mechanism of the Becker lathe and the roll in position therein.

Fig. 2 is a plan of a pilger roll as obviously produced by this lathe.

Fig. 3 shows the groove profile as corrected by the mechanism in accordance with the invention.

Fig. 4 is a front view showing diagrammatically part of a Becker lathe with an attachment in accordance with the invention.

Fig. 5 is an end view corresponding to Fig. 4.

Fig. 6 is a sectional plan view of the attachment to a larger scale.

Fig. 7 is a corresponding elevation.

Fig. 8 is a part elevation to a larger scale of the ratchet mechanism in Fig. 7.

Fig. 9 shows diagrammatically the driving motor end of the Becker lathe.

Referring to the drawings wherein the same numerals or letters denote the same parts throughout, in Fig. 9, **40** denotes the driving motor driving through gearing **41** the roll **4** shown mounted in the lathe and also driving the spindle **8**. As shown diagrammatically in Fig. 4 the cam **3** is driven by the bevel gearing **41** on shaft **42** which is driven from the extended sleeve **9a** through the intermediary of gearing **43** and a differential gear inside a casing **45**, the latter being controlled to compensate for the effect of the swinging movement of the tool with reference to the cam **3**. The swinging movement of the tool, which is a slow movement, is obtained by means of a worm wheel **44** connected to the cross slide and driven by a worm which is driven through gearing from the gear box of the slide rest. In Fig. 1, **1** denotes the cutting tool mounted on slide **2** which as the pilger roll rotates, is moved out and in in known manner by the rotatable cam **3** and the cam slot **3a** to give to the pilger roll **4** the cross sectional profile as shown. The slide **2** and cam **3** are mounted on a swivelling base **5** by means of which the swinging motion is imparted to the tool.

The "finishing pass", the "bellmouth", the "gap" and the "relief" of the pass of the roll are indicated by the angles X, W, Z, and Y which they respectively subtend at the centre O of the roll (Fig. 1).

In Fig. 2, the lateral "flats" are denoted by **6** and the arcuate groove by **7**.

Referring to Fig. 6, the known control cam **3** (Fig. 1)—of the Becker lathe—is normally driven from a spindle running at constant speed. An extension **8** (Fig. 6) is made to this spindle and a sleeve **9** fitted on the outside thereof is connected to bevel gears (not shown) driving the control cam. The bevel gears previously were keyed direct to the spindle, but when the spindle was extended and the sleeve **9** put on, the key was removed so that the gears might rotate freely with the sleeve independently of the extended spindle, hereinafter called "spindle **8**". The sleeve **9** is rigidly keyed to a sleeve **9a** movable freely on the spindle **8** (Fig. 6) and terminating in a pinion **11**. Keyed on the shaft **8** is a pinion **10**. The pinions **10** and **11** are the same size. On the spindle **8** runs a loose disc **12** with stub-axles **13** carrying planet wheels **14**, **15** which engage respectively with the above-mentioned two pinions **10**, **11**. On the outside of the planet wheels **14**, **15** are two internally toothed rings **16**, **17** gearing respectively with said wheels and loosely mounted respectively on the spindle **8** and the sleeve **9a** of the pinion **11**.

The above forms a double epicyclic unit and its action is as follows:—

For one clockwise revolution of the pinion **10** (holding the rings **16**, **17** stationary), the planet wheel **14** is turned in an anti-clockwise direction, and since it revolves itself on the teeth of its outer ring **16** it will drag the disc **12** round in a clockwise direction. This disc will then drag the axle of the second planet wheel **15** round in a clockwise direction, and this planet wheel will rotate itself in an anti-clockwise direction against the teeth of its outer ring **17** and will therefore force the pinion **11** round in a clockwise direction. If (as shown) the two pinions **10**, **11** are of the same size, the planet wheels **14**, **15** of the same size, and the rings **16**, **17** of the same size, then, for one clockwise revolution of the pinion **10**, there is one clockwise revolution of the pinion **11** provided the rings **16**, **17** are held stationary. If the ring **16** is allowed to move freely, then the planet wheel **14** will merely rotate on its axle without moving the disc **12** and consequently no motion will be imparted to the pinion **11** and the cam **3** will remain stationary.

Thus it will be seen that, while the pinion is rotating uniformly with the driving spindle **8** of the control cam **3**, it is possible to alter the motion of the second or driven pinion **11** by controlling the motion of the said ring **16**, the other ring **17** meanwhile being held stationary.

Similarly, if the ring **16** is held stationary the motion of the driven pinion **11** can still be altered by controlling the movement of the ring **17** so that there are two independent sources of control over the motion of the driven pinion **11** which, as aforesaid, is connected with the control cam **3** of the lathe.

By moving the rings **16**, **17** simultaneously any motions imparted to the rings will be combined into a resultant motion which will be imparted to the driving sleeve of the control cam through the driven pinion **11**.

The motion imparted to the ring **17** is given by rotation of a disc **18** through a connecting rod **19** connected, at one end, to the ring **17** and, at the other, to a square-headed crank-pin **20** adjustable in the diametral slot **21**. By putting the crank pin **20** at the centre of the disc **18** no motion is imparted to the ring **17**, but by placing the crank pin at the extreme end of the slot **21** the maximum oscillatory movement is imparted to the ring **17**. As the ring **17** acts on the tool to cause deepening of the "bellmouth" W of the roll groove as the roll rotates the disc **18** is timed

to give one complete revolution as the tool 1 cuts across the roll section from the inner edge of one flat to the inner edge of the other (from A to B, Fig. 3). The effect of this, at a section across the "bellmouth" W, is to deepen the groove by varying the curve gradually from the usual almost semi-circular arcuate shape as shown in full lines, Fig. 3, to the shape part oval shape, which is not now per se, indicated in dotted lines, by relatively displacing the jaw curves through certain angles against the direction of rotation of the rolls. The "finishing pass" X, which is concentric with the axis of the roll, is not deepened owing to the fact that the angular motion of the cam 3 has been retarded in the concentric portion, and so does not impart any transverse radial motion to the tool during the machining of the "finishing pass". This is a very slow motion, and is accomplished through reduction gearing, the action of which will be explained later.

The motion of the ring 16 is obtained in exactly the same way from another slotted disc 22, connected to the said ring through connecting rod 19*a*, by locating the crank pin 20*a* in the slot 21*a* at predetermined positions between the centre of the disc and the periphery. The essential difference is that the disc 22 makes one revolution for each turn of the roll in the lathe. The connections to the rings 16 and 17 are made in the same way. In Fig. 6 the connecting rods are broken off.

Thus, it will be seen that there is a constant oscillatory motion imparted to the ring 16 of a frequency equal to the number of revolutions per minute of the roll being machined, which motion causes alternate accelerations and decelerations of the same frequency in the control cam, and, superimposed on this is a slow oscillatory motion injected by means of the ring 17 which is oscillated by means of the connecting rod 19 and associated mechanism timed over the complete radial traverse of the tool round the curved portion of the cross section of the roll.

The result is the production of a roll with a groove of improved shape giving a constant working length with a "bellmouth" corrected as indicated by the dotted line in Fig. 3 to accommodate the accumulation of material which is unavoidable in any Pilger process due to the necessary lateral relief of the rolls.

The improved rolls materially increase the rate of tube production and definitely eliminate most of the non-uniformity in the tube walls. Further, the rolls enable thin gauge tubes to be rolled without the well-known crescent shaped marking and splitting of the material because they allow of a much more uniform flow of material through the "working" pass of the rolls.

It must be noted that the attachment apparatus in accordance with the invention does not interfere in any way with the gradual lessening of the relief angle R (Fig. 3) from the beginning of the "bellmouth" W to the beginning of the "rolling or finishing pass" which is accomplished by a special mechanism already in the standard Becker lathe.

The motion of the disc 18 controlling the deepening effect is accomplished by gearing down from the driving spindle 8 which runs at constant speed, through the gear wheels 24, 25, 26 on to an externally toothed ring 27 bolted to the disc 22. Round the circumference of the disc 22 are bolted six cams 28 which actuate the roller follower 29 mounted in a forked member 30 of bell crank shape which is pivoted about the axis 31 and carries the spring-urged pawl 32 engaging the ratchet wheel 33. The follower 29 is urged into engagement with the cams by means of the spring-urged abutment 34 and the ratchet wheel is locked against retrograde movement by means of the spring-urged detent 35.

As a guard against an over-swing on the forward movement of the ratchet a small brake pad is allowed to rub on the side surface of the said ratchet wheel 33.

Further, as it may be necessary sometimes to adjust the angular position of the disc 18 with relation to the rest of the mechanism, a clutch is embodied which disengages wheel 36 from 37 by sliding the former along a feather key on its shaft.

The ratchet wheel 33 drives the disc 18 through gear wheels 36, 37, 38 and toothed ring 39 which is bolted to said disc 18. The reason for the mechanism being constructed in this way is because the travel of the Becker lathe tool across the roll is controlled by a ratchet capable of altering the cross feed according to whether 1, 2, 3 or more teeth are taken in one sweep of the pawl. To correspond with this it is necessary to put on 1, 2, 3 or more cams on the disc 22.

This portion of the attachment is capable of adjustment so that further variations which may be desired can be made in the shape of the cross section of the roll by the following method:—

Suppose the number of teeth for the cross feed on the Becker lathe is three, then normally three cams 28 would be put on the disc 22, but it is also possible for the first sixth part of the cross travel to put on two cams, for the second sixth part three cams, and for the third sixth part four cams, for the fourth sixth part four cams, for the fifth sixth part three cams, and for the last sixth part two cams. It is to be noted that this refers to the circular part of the travel between the inner edges of the flats, thus giving a groove with a smaller root curve than if three cams had been used for the entire travel.

It will be seen from the foregoing that a number of roll cross sections can be effected with this mechanism.

In Fig. 7 six cams are shown on the disc 22 being removably secured by set pins.

With a Becker lathe provided with our invention it is not only possible to lengthen the "working portion or pass" of the rolls, but, also, when using extra large diameter rolls, to shorten the pass to suit the maximum stroke of the air cylinder of the Pilger mill for returning the mandrel bar and bloom between the rolls at each revolution thereof.

The mechanism hereinbefore described, while specially applicable to lathe machines of the "Becker" type, is also applicable to other lathe machines working on the same or similar principle.

I claim:—

1. In a lathe for shaping the grooves of pilger rolls, including means for rotating a roll, a cutting tool and a cam for moving said tool out and in with reference to the roll; mechanism for imparting timed acceleration and deceleration to said cam.

2. In a lathe for shaping the grooves of pilger rolls, including means for rotating a roll, a cutting tool, a rotating control cam for moving said tool out and in with reference to the roll, driving means for the cam and means for imparting

an arcuate swinging motion to the tool; correcting mechanism in said driving means for imparting timed acceleration and deceleration to said cam so that the ordinary arcuate cross section of the curved part of the groove can be varied by deepening it at the part known as the "bellmouth".

3. In a lathe for shaping the grooves of pilger rolls, including means for rotating a roll, a cutting tool, a rotating control cam for moving said tool out and in with reference to the roll, driving means for the cam and means for imparting an arcuate swinging motion to the tool; correcting mechanism in said driving means for imparting a cycle of acceleration and deceleration to said cam during each swing of the tool.

4. In a lathe for shaping the grooves of pilger rolls, including means for rotating a roll, a cutting tool, a rotating control cam for moving said tool out and in with reference to the roll, driving means for the cam and means for imparting an arcuate swinging motion to the tool; correcting mechanism in said driving means for imparting a cycle of acceleration and deceleration to said cam during each revolution of the roll.

5. In a lathe for shaping the grooves of pilger rolls, including means for rotating a roll, a cuting tool, a rotating control cam for moving said tool out and in with reference to the roll, driving means for the cam and means for imparting an arcuate swinging motion to the tool; a correcting mechanism in said driving means for imparting a cycle of acceleration and deceleration to said cam during each swing of the tool and a further correcting mechanism in said driving means for imparting a cycle of acceleration and deceleration to said cam during each revolution of the roll.

6. In a lathe for shaping the grooves of pilger rolls, including means for rotating a roll, a cutting tool, a rotating control cam for moving said tool out and in with reference to the roll, driving means for the cam and means for imparting an arcuate swinging motion to the tool; a correcting mechanism in said driving means for imparting a cycle of acceleration and deceleration to said cam during each swing of the tool, a further correcting mechanism in said driving means for imparting a cycle of acceleration and deceleration to said cam during each revolution of the roll and means interconnecting said correcting mechanisms whereby the former is controlled from the latter.

7. In a lathe for shaping the grooves of pilger rolls, including means for rotating a roll, a cutting tool, a rotating control cam for moving said tool out and in with reference to the roll, driving means for the cam and means for imparting an arcuate swinging motion to the tool; an epicyclic gear in said driving means and means for controlling said gear so as to impart a cycle of acceleration and deceleration to said cam during each swing of the tool.

8. In a lathe for shaping the grooves of pilger rolls, including means for rotating a roll, a cutting tool, a rotating control cam for moving said tool out and in with reference to the roll, driving means for the cam and means for imparting an arcuate swinging motion to the tool; an epicyclic gear in said driving means and means for controlling said gear so as to impart a cycle of acceleration and deceleration to said cam during each rotation of the roll.

9. In a lathe for shaping the grooves of pilger rolls, including means for rotating a roll, a cutting tool, a rotating control cam for moving said tool out and in with reference to the roll, driving means for the cam and means for imparting an arcuate swinging motion to the tool; an epicyclic gear in said driving means and means for controlling said gear so as to impart a cycle of acceleration and deceleration to said cam during each swing of the tool, a further epicyclic gear in said driving means and means for controlling said gear so as to impart a cycle of acceleration and deceleration to said cam during each rotation of the roll, and means interconnecting said control means.

10. In a lathe for shaping the grooves of pilger rolls, including means for rotating a roll, a cutting tool, a rotating control cam for moving said tool out and in with reference to the roll, a power drive for the cam and means for imparting an arcuate swinging motion to the tool; an epicyclic gear in said drive, a variable throw-crank connected at its reciprocating end to an element of said gear and means for rotating said crank once for every revolution of the roll.

11. In a lathe for shaping the grooves of pilger rolls, including means for rotating a roll, a cutting tool, a rotating control cam for moving said tool out and in with reference to the roll, a power drive for the cam and means for imparting an arcuate swinging motion to the tool; an epicyclic gear in said drive, a variable-throw crank connected at its reciprocating end to an element of said gear and means for rotating said crank once during each swing of the tool.

12. In a lathe for shaping the grooves of pilger rolls, including means for rotating a roll, a cutting tool, a rotating control cam for moving said tool out and in with reference to the roll, a power drive for the cam and means for imparting an arcuate swinging motion to the tool; an epicyclic gear comprising a sun wheel, a planet wheel and a rotatable ring member engaging said planet wheel; a rotating member, means for driving said member from said drive, so that the member rotates once for each rotation of the roll, a connecting rod attached to said ring member and a radially adjustable connection on said rotating member for said rod.

13. In a lathe for shaping the grooves of pilger rolls, including means for rotating a roll, a cutting tool, a rotating control cam for moving said tool out and in with reference to the roll, a power drive for the cam and means for imparting an arcuate swinging motion to the tool; an epicyclic gear comprising a sun wheel, a planet wheel and a ring member engaging said planet wheel; a rotating member, means for driving said member from said drive so that it rotates once during each swing of the tool, a connecting rod attached to said ring member and a radially adjustable connection on said rotating member for said rod.

14. In a lathe for shaping the grooves of pilger rolls, including means for rotating a roll, a cutting tool, a rotating control cam for moving said tool out and in with reference to the roll, a drive for the cam and means for imparting an arcuate swinging motion to the tool; an epicyclic gear in said drive comprising a sun pinion, a planet wheel and a toothed ring member engaging the same; and means for imparting a complete oscillation to said ring member during each rotation of the roll.

15. In a lathe for shaping the grooves of pilger rolls, including means for rotating a roll, a cutting tool, a rotating control cam for moving said tool out and in with reference to the roll, a drive

for the cam and means for imparting an arcuate swinging motion to the tool; an epicyclic gear in said drive comprising a sun pinion, a planet wheel and a toothed ring member engaging the same; and means for imparting a complete oscillation to said ring member during each swing of the tool.

16. In a lathe for shaping the grooves of pilger rolls, including means for rotating a roll, a rotating cam for moving said tool in and out with reference to the roll during each revolution of the roll, a drive for the cam and means for imparting a slow, arcuate swinging motion to the tool; a double epicyclic gear in said drive, each gear comprising a sun wheel, a planet wheel and a rotatable ring member; means for imparting a complete oscillation to one ring member during each rotation of the roll and means for imparting a complete oscillation to the other ring member during each swing of the tool.

17. In a lathe for shaping the grooves of pilger rolls, including means for rotating a roll, a rotating cam for moving said tool in and out with reference to the roll during each revolution of the roll, a drive for the cam and means for imparting a slow, arcuate swinging motion to the tool; a double epicyclic gear in said drive each comprising a toothed sun wheel, a planet wheel and a rotatable toothed ring engaging said planet wheel; a control element for each ring comprising a rotating slotted disc, a connecting rod, an adjustable connection for an end of said rod in said slot and a connection for the other end to the respective ring; gearing between said drive and one of said discs which is rotated once for each rotation of the roll, and reduction gearing between said disc and the other disc for rotating the latter once during each swing of the tool.

18. In a lathe for shaping the grooves of pilger rolls, including means for rotating a roll, a rotating cam for moving said tool in and out with reference to the roll during each revolution of the roll, a drive for the cam and means for imparting a slow arcuate, swinging motion to the tool; a double epicyclic gear in said drive each comprising a toothed sun wheel, a planet wheel and a rotatable toothed ring engaging said planet wheel; a control element for each ring comprising a rotating slotted drive, a connecting rod, an adjustable connection for an end of said rod in said slot and a connection for the other end to the respective ring; gearing between said drive and one of said discs which is rotated once for each rotation of the roll, reduction gearing between said first disc and the other disc, spaced removable cams on said first disc and pawl and ratchet means operated by said cams for driving said reduction gearing so that said second disc is rotated once during each swing of the tool.

19. Correcting mechanism for the cam drive of a Becker lathe, comprising epicyclic gear means and cyclic control means operated by the drive itself for imparting a cycle of acceleration and deceleration timed over each revolution of the roll and a cycle of acceleration and deceleration timed over each swing of the tool.

20. Correcting mechanism for the control cam drive of a Becker lathe, comprising a double epicyclic gear, each including a toothed sun wheel, a toothed planet wheel, and a toothed rotatable ring; a control element for each ring including a rotatable and diametrally slotted disc, a connecting rod connected to the respective ring and an adjustable connection in the slot for said rod, gearing for driving one of said disc members from the control cam drive, spaced cams on said disc, a removable mounting for said cams, a pawl and ratchet mechanism driven by said cams and gearing between said mechanism and the other disc, said gearing being driven by said pawl and ratchet mechanism.

GRAHAM DAVIDSON.