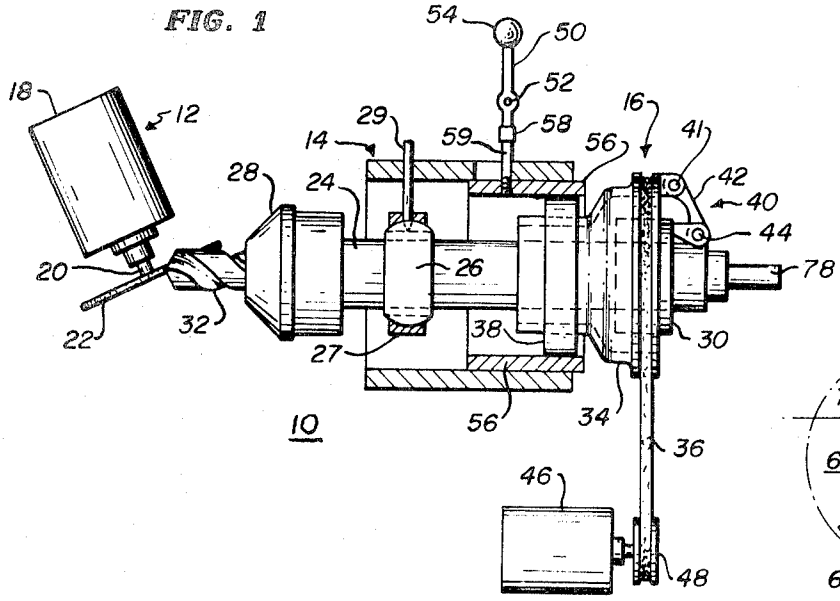
Nov. 23, 1971 T. GROB ET AL 3,621,613

METHOD AND APPARATUS FOR THINNING THE WEB OF A DRILL

Filed May 15, 1969 3 Sheets-Sheet 1

FIG. 1



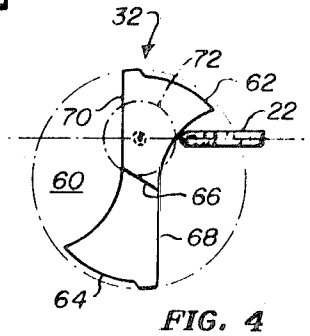
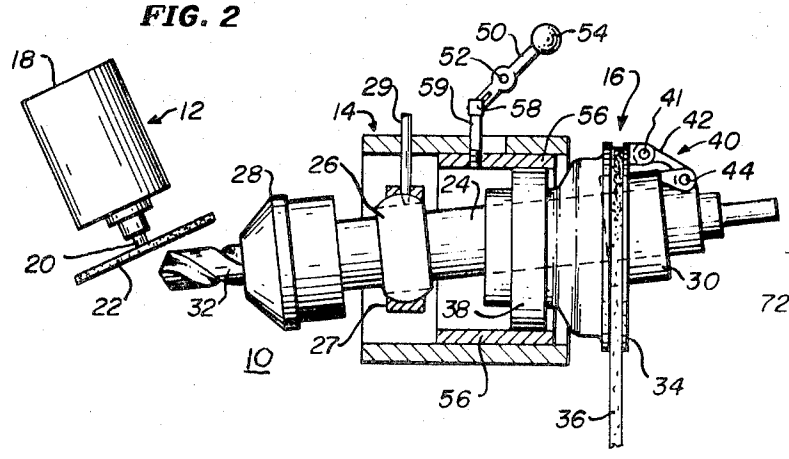


FIG. 4

FIG. 2



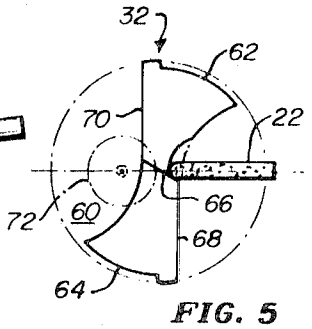
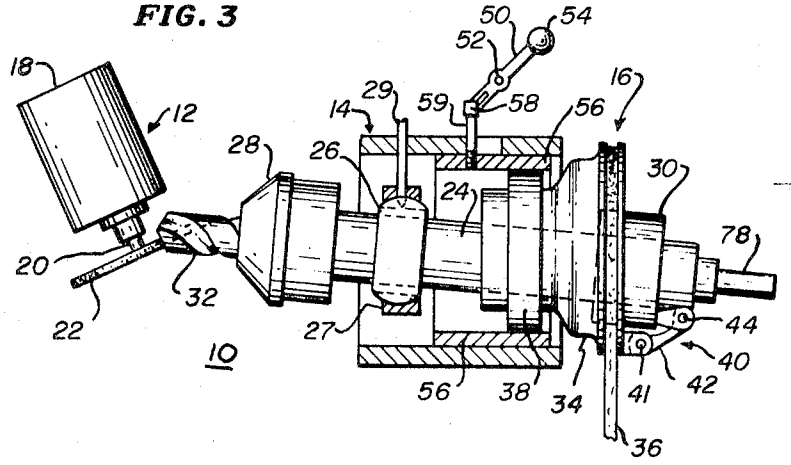


FIG. 5

FIG. 3



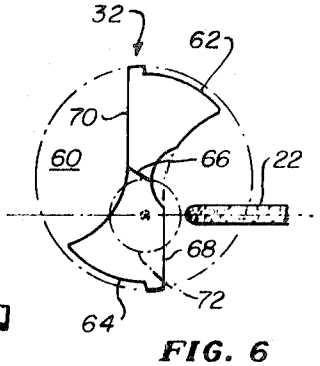


FIG. 6

INVENTORS
Theodore Grob
Donald H. Tesker

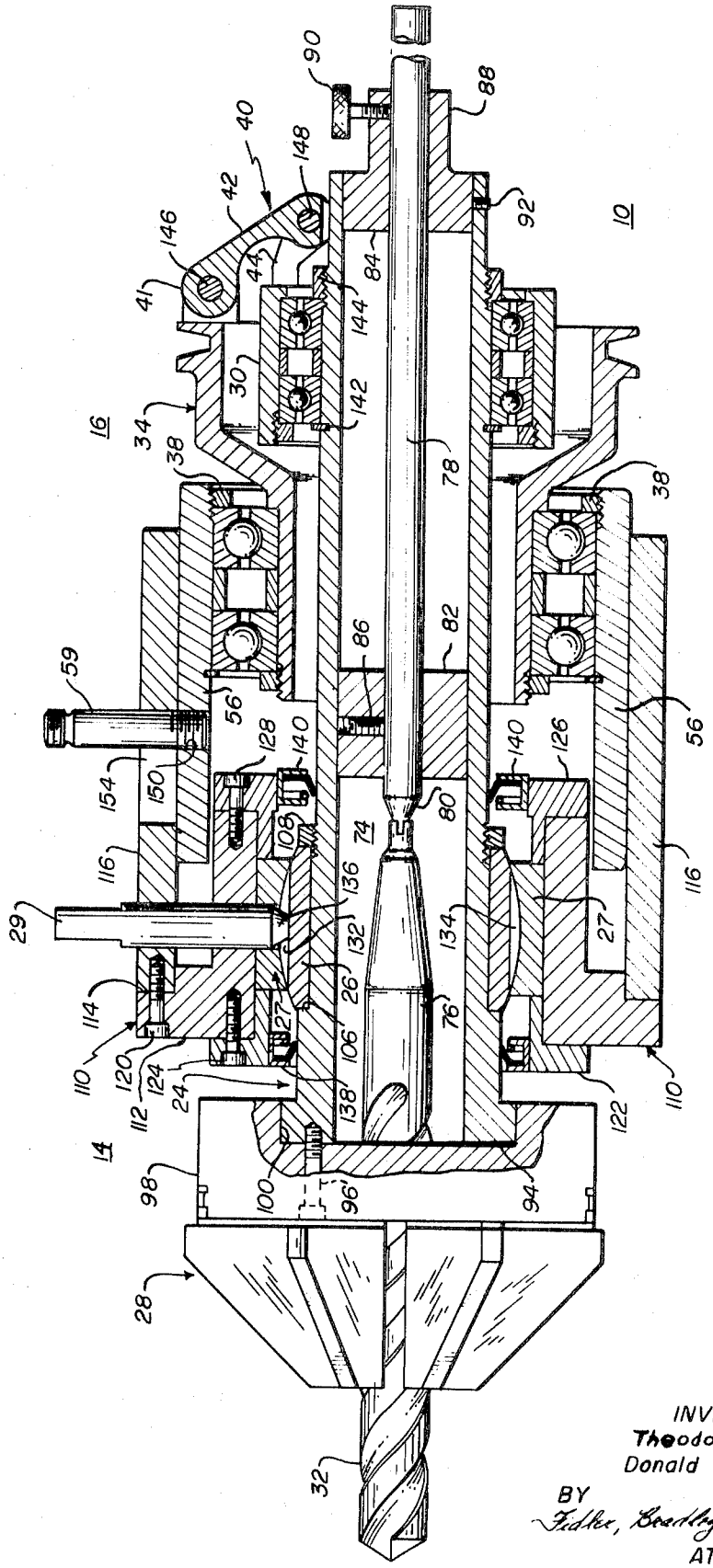
BY
Fidler, Bradley & Strawbridge
ATTYS.

Nov. 23, 1971 T. GROB ET AL 3,621,613

METHOD AND APPARATUS FOR THINNING THE WEB OF A DRILL

Filed May 15, 1969 3 Sheets-Sheet 2

FIG. 7



INVENTORS
Theodore Grob
Donald H. Tesker

BY
Fidler, Bradley & Gutenacker
ATTYS.

Nov. 23, 1971 T. GROB ET AL 3,621,613

METHOD AND APPARATUS FOR THINNING THE WEB OF A DRILL

Filed May 15, 1969 3 Sheets-Sheet 3

FIG. 9

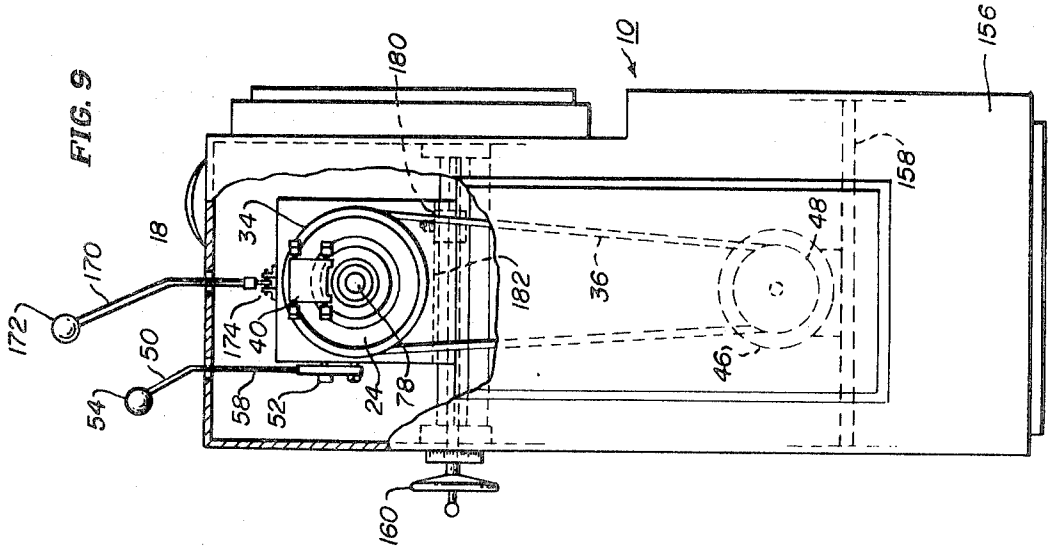
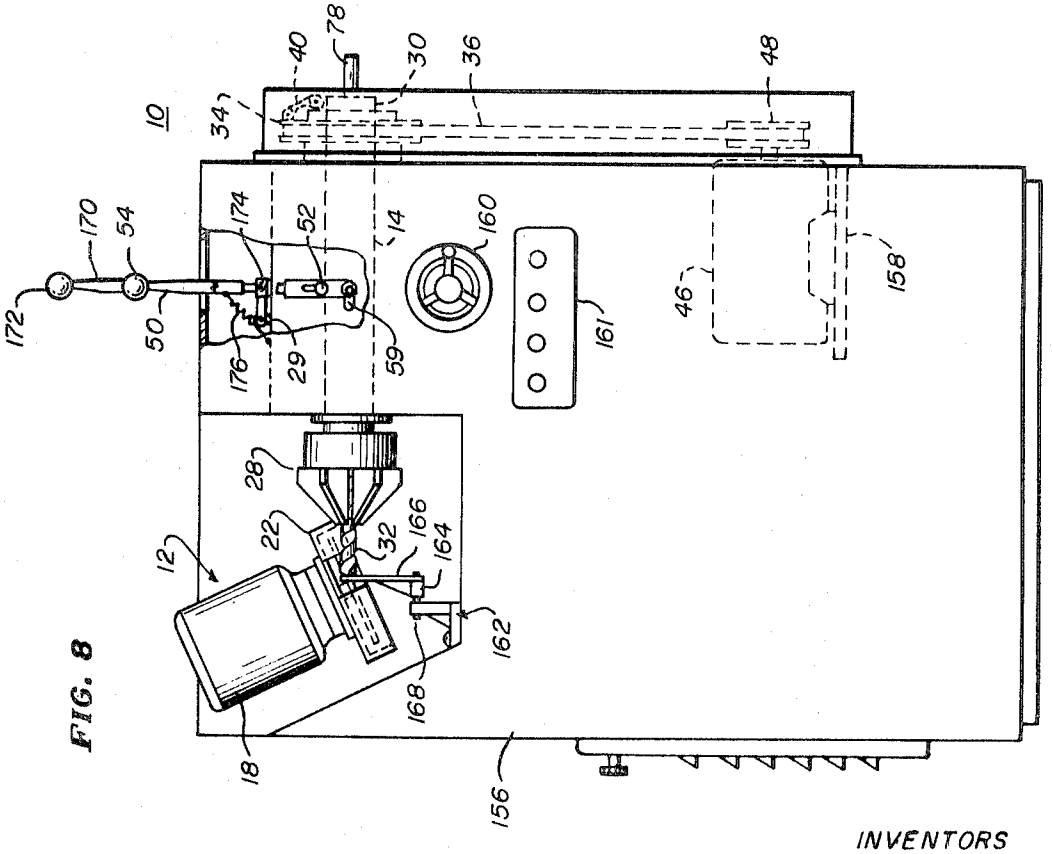


FIG. 8



INVENTORS
Theodore Grob
Donald H. Tesker
BY
Fidler, Bradley & Talmadge
ATTYS.

United States Patent Office 3,621,613 Patented Nov. 23, 1971

3,621,613

METHOD AND APPARATUS FOR THINNING THE WEB OF A DRILL

Theodore Grob, Grafton, and Donald H. Tesker, Saukville, Wis., assignors to Grob & Tesker Corporation, Grafton, Wis.

Filed May 15, 1969, Ser. No. 824,758
Int. Cl. B24b 3/28, 19/02
U.S. Cl. 51—90 8 Claims

ABSTRACT OF THE DISCLOSURE

To thin the web of a drill, the drill is orbited so that, once during each orbit, its web contacts a rotating grinding wheel that is positioned approximately at a 25-degree angle from the horizontal. The grinding wheel abrades the web to form a recess having a radius determined by the radius of the orbit. The raduis of the orbit may be adjusted while the drill is orbiting.

This invention relates to methods and apparatuses for thinning the webs of drills.

The webs of drills are thinned to enable the drill to proceed through a workpiece with less force during a drilling operation. They are thinned in web thinning machines which bring the web of a drill against a rotating grinding wheel to abrade a portion of the web and to shorten the chisel edge.

In one type of prior art web thinning machine, one side of the web of the drill and the rotating grinding wheel are moved in a straight line back and forth against each other with the plane of rotation of the grinding wheel and the direction of motion between the drill and the grinding wheel being substantially aligned. After the web has been thinned from one side of the web, the drill is rotated 180 degrees and the opposite side of the web is moved back and forth against the rotating grinding wheel to thin the web from this side.

The prior art web thinning machines and the methods used by these machines have several disadvantages.

One disadvantage of these machines and the method used by them is that the same portions of the working surface of the grinding wheel contact the web repeatedly during the grinding operation. This causes the surface of the grinding wheel to become excessively hot because of the repeated friction against the same portion of the grinding wheel. Because of the heat generated, the prior art machines require relatively large volumes of coolants to prevent overheating of the grinding wheel.

Another disadvantage of the prior art web thinning machines and methods used by the machines is that the grinding wheel becomes excessively worn at some locations on the grinding wheel because these same locations on the wheel are repeatedly brought into contact with the drill. Because of this uneven wear on the grinding wheel, the grinding wheel must be dressed periodically.

A still further disadvantage of the prior art web thinning machines is that they require an excessively long set-up time by a skilled operator to correctly align the drill with the grinding wheel before the web thinning operation begins.

Accordingly, it is an object of this invention to provide a novel method and apparatus for thinning the web of a twist drill.

It is a further object of this invention to provide a method of thinning the web of a twist drill that does not cause the grinding wheel or drill to become excessively hot when fluid coolants are not used or when only small volumes of fluid coolants are used.

A further object is the provision of a method and apparatus for thinning the web of a drill in which the set-up time is reduced and the grinding wheel is dressed by the web thining operation. Another object is to provide a machine and method for thinning webs in which the radius of the recess ground into the web can be easily controlled and the same size grinding wheels can be used to thin different sized drills.

Broadly, the present invention provides a method for thinning the web of a drill point which comprises moving the point of the drill and a rotating grinding wheel with respect to one another in a direction oblique to the plane of rotation of the grinding wheel so that the grinding wheel contacts the drill point and is repeatedly swept across a controlled portion of the web. A web thinning machine in accordance with this invention comprises a first means for mounting a drill, a second means for removing material from the drill upon contact therewith and a third means for moving said first and second means with respect to one another in an orbital motion whereby said second means removes a portion of the material from a drill point by repeatedly sweeping across a portion of its web.

In one embodiment of the invention, a method and apparatus for thinning the web of a drill are provided in which the point of the drill is orbited about a center so that one side of the web of the drill is brought into contact with a rotating grinding wheel at some location of its orbit. The radius of the orbit controls the radius of the recess ground into the web. The location of the point and the alignment of the flute of the drill with respect to the grinding wheel are set before the orbiting begins and determine the location of the recess ground into the web. The radius of the orbit may be changed without stopping the orbiting to permit a recess having a longer radius to be ground into the web. Alternatively, the grinding wheel can be orbited. In both embodiments, contact between the grinding wheel and the drill point can be achieved by advancing the wheel toward the drill or vice versa or by moving both the wheel and the drill simultaneously.

To support the drill during a web thinning operation, the web thinning machine includes a pivotally-mounted tubular spindle having a first end and a second end, with a drill chuck fastened to the first end to hold the drill. To orbit the drill, a spherical sleeve bearing is attached between the first and second ends of the spindle and a ball bearing assembly is attached near the second end of the spindle and concentric with it. The ball bearing assembly is orbited and, as the ball bearing assembly orbits, it carries the second end of the spindle causing the first end of the spindle to orbit with the drill about the spherical sleeve bearing without rotating.

To orbit the ball bearing assembly, a bell housing is rotatably mounted around the ball bearing assembly with its longitudinal axis aligned with the longitudinal axes of the spindle and concentric ball bearing assembly. It is attached to the housing of the ball bearing assembly by a radially extending lever. The bell housing is rotated by a V-belt that passes around its outer periphery and is movable in a longitudinal direction by a sleeve journalled to it for non-rotating longitudinal movement with respect to the spindle. The bell housing rotates the radially extending lever and the ball bearing assembly.

If the ball bearing asembly is in the center of the bell housing, it rotates about the spindle to which it is journalled while the spindle remains stationary. However, if the bell housing is moved longitudinally, the lever connecting the bell housing to the ball bearing assembly pulls the ball bearing assembly away from the longitudinal axis of the bell housing causing both the ball bearing assembly and the second end of the spindle to be moved in an orbi-

tal path within the bell housing as the bell housing rotates.

The radius of the orbit is controlled by the amount of longitudinal displacement of the bell housing because this controls the angle of the lever and the amount the second end of the spindle and the ball bearing assembly are displaced from the longitudinal axis of the bell housing. During the orbiting motion, the spindle is held from rotating but its first and second ends are permitted to orbit about the spherical sleeve bearing.

From the above description, it can be understood that the web thinning machine of this invention has several advantages over the prior art web thinning machines. One of these advantages is that the machine is simple to operate and may be set up in a short time. Another of the advantages is that the grinding wheel and drill remain sufficiently cool without the application of large amounts of fluid coolants. They remain cool because the grinding wheel sweeps across the web of the drill in a transverse direction so that different portions of the grinding wheel contact the drill at different times. Still another advantage of the invention is that the grinding wheel is dressed during the grinding of the web because it sweeps evenly across the web so that each portion of the working surface of the grinding wheel is subject to wear. A still further advantage is that the same thickness of grinding wheel can be used to thin the webs of different size drills because the grinding wheel sweeps across the entire portion of the web that is to be thinned.

The above noted and other features of the invention will be better understood from the following detailed description when considered with reference to the accompanying drawings, in which:

FIG. 1 is a schematic drawing, in elevation, of a machine for thinning the webs of drills according to an embodiment of the invention;

FIG. 2 is a view similar to FIG. 1 but shows the web thinning machine in operation moving the drill in an orbit;

FIG. 3 is a view similar to FIG. 2 but shows the drill held in a position in orbit 180 degrees from that shown in FIG. 2;

FIG. 4 is a schematic side view showing the point of a drill orbiting toward a grinding wheel for thinning of the web of the drill in accordance with an embodiment of the invention;

FIG. 5 is a view similar to FIG. 4 but shows the grinding wheel and the point of the drill at a position 90 degrees removed in the orbit from that shown in FIG. 4;

FIG. 6 is a view similar to FIG. 5 but showing the point of the drill and the grinding wheel at a point 90 degrees removed in the orbit from that shown in FIG. 5;

FIG. 7 is an enlarged fragmentary view, partially broken away and in section, of the web thinning machine;

FIG. 8 is an elevational view, partially broken away, of the web thinning machine in accordance with an embodiment of the invention; and

FIG. 9 is a side view, partially broken away, of the web thinning machine of FIG. 8.

GENERAL STRUCTURE

In FIGS. 1–3, a drill web thinning machine **10** having a drill grinder assembly **12**, a movable drill holding assembly **14**, and a drill orbiting assembly **16** is shown in a simplified schematic elevational view.

The drill grinder assembly **12** includes an electric motor **18** rigidly connected to the web thinning machine and having a shaft **20** for driving a rotatable about ⅛ inch wide grinding wheel **22**. The position of the motor **18** and the grinding wheel **22** is adjusted so that the grinding wheel **22** rotates in a plane that forms an angle with the horizontal plane, which angle is selected in accordance with the angle of the flutes of the drill that is to have its web thinned. The angle is generally slightly less than the angle of the flutes of the drill, which for ordinary fluted drills, is approximately 30 degrees but may be larger, such as 45 degrees, for high spiral type twist drills. If the angle at the end of the flute is approximately 30 degrees, the grinding wheel **22** is positioned at an angle of 25 degrees with respect to the horizontal plane.

For the purposes of explanation, the drill being thinned will hereinafter be considered to be a double-fluted twist drill in which the flutes are at a 30-degree angle, although it is to be understood that the webs of other types of drills may be thinned in the web thinning machine **10**.

The movable drill holding assembly **14** includes a spindle **24** with a chuck **28** mounted rigidly to one end and a concentric ball bearing assembly **30** mounted to the opposite end. The chuck **28** holds a drill **32** so that the point of the drill **32** extends adjacent to the grinding wheel **22** of the drill grinder assembly **12**. The spindle **24** is pivotally mounted to the web thinning machine. For this purpose a spherical sleeve bearing **26** is attached to the spindle **24** and movably rests against a ball bushing **27** attached to the web thinning machine to permit pivoting of the spindle in any direction. The spherical sleeve bearing **26** and the spindle **24** are held from rotating by an index pin **29** so that the drill **32** and the chuck **28** can move in an orbital non-rotating path. The movable drill holding assembly **14** and the drill orbiting assembly **16** are movable horizontally by a drill feed mechanism (FIGS. 8 and 9) to bring the orbiting drill **32** into contact with the grinding wheel **22** at the closest point of its orbit.

The drill orbiting assembly **16** includes a movable, tubular housing **34** having a narrow diameter end and a larger diameter end with a pulley groove adapted to receive a V-belt **36** around the outer wall of its larger diameter end and with a ball bearing assembly **38** mounted to its inner wall around its narrow diameter end. It is located around and coaxial with the ball bearing assembly **30** so that its longitudinal axis lies along the longitudinal axes of the spindle **24** and the ball bearing assembly **30**. To connect the bell housing **34** to the housing of the ball bearing assembly **30**, an orbit connector lever **40** includes an arm **42** pivotally mounted at its first end to a yoke **41** that is welded to the edge of the large diameter end of the bell housing **34** and pivotally mounted at its second end to a yoke **44** that is welded to the housing of the ball bearing assembly **30**.

The bell housing **34** is rotated by the V-belt **36** that connects the bell housing **34** and the pulley **48**. The pulley **48** is driven by an electric motor **46**. The bell housing **34** is connected to the spindle **24** only through the ball bearing assembly **30** circumscribing the spindle **24** and the orbit connector linkage **40** extending radially between the ball bearing assembly **30** and the bell housing **34**. With this connection, it is free to rotate with respect to the spindle **24** without imparting any rotary motion to the spindle **24**.

To move the bell housing **34** laterally with respect to the spindle **24**, an orbit adjusting lever **50** is pivotally mounted to the frame of the web thinning machine by a pivot pin **52**. It has a handle **54** at one end and is pivotally connected to an orbit pin **59** at the other end by a pivot pin **58**. A sleeve **56** is connected to the orbit pin **59** and to the housing of a ball bearing assembly **38** so that the lever **50** moves the bell housing **34** laterally when the handle **54** is moved while permitting the movable bell housing **34** to rotate within the ball bearing assembly **38**.

By moving the bell housing **34** laterally to the left, the connector lever **40** is moved to a more horizontal position as shown in FIG. 2 to displace the distal end of the spindle **24** upwardly from the longitudinal axis of the bell housing **34** causing it to pivot on the spherical bearing **26**. With this mechanization, the amount of offset of the drill **32** during orbiting is controlled by the lateral displacement of the bell housing **34**.

Since the ball bearing assembly **30** carries the spindle **24** as the bell housing **34** rotates, the drill **32** moves in an orbit, the radius of which is controlled by the lateral

displacement of the bell housing 34. The radius of the orbit of the drill 32 is adjusted from the orbit adjusting handle 54 which controls the lateral displacement of the bell housing 34.

GENERAL OPERATION

To thin the web of a drill 32, the drill 32 is inserted within the chuck 28 with its chisel edge horizontal and the chuck is tightened around it. The distance that the drill 32 extends from the chuck 28 is one factor that determines the location of the recess ground into the web of the drill 32 by the rotating grinding wheel 22 during the thinning operation. By increasing the distance of the point of the drill 32 from the chuck 28, the recess is ground into the web at a lower location on the point of the drill 32. The 25 degree angle between the grinding wheel 22 and a horizontal plane that passes through the longitudinal axis of the bell housing 34 causes the grinding wheel 22 to asume an angle slightly less than the flute of the drill 32. Best results have been obtained with this angle.

With the spindle 24 in the position shown in FIG. 1, the drill 32 is spaced from the grinding wheel 22. While the spindle is in this position, the motor 18 of the grinder assembly 12 is started and the grinding wheel 22 is rotated. The orbit motor 46 is started to drive the V-belt 36 and the movable bell housing 34.

While the spindle 24 has its longitudinal axis overlying the longitudinal axis of the bell housing 34, the spindle 24 remains stationary and the bell housing 34 rotates, causing the ball bearing assembly 30, to which the bell housing 34 is connected by the orbit connector lever 40, to rotate about the spindle 24. The bell housing 34 also rotates on the ball bearing assembly 38 with respect to the sleeve 56 and the orbit adjusting lever 50.

To cause the drill 32 to begin orbiting, the handle 54 of the orbit lever 50 is moved to the right as shown in FIGS. 2 and 3. When the handle 54 is moved to the right, the orbit adjusting lever 50 pivots about the pin 52, pulling the sleeve 56 to the left as shown in FIGS. 2 and 3. The sleeve 56 pulls the ball bearing assembly 38 and the bell housing 34 to the left causing the orbit connector lever 40 to pivot in a counterclockwise direction as shown in FIG. 2.

As the orbit connector lever 40 pivots, its arm 42 is pulled to a more horizontal position causing the ball bearing assembly 30 to move from the longitudinal axis of the bell housing 34. After the ball bearing assembly 30 has been displaced from the longitudinal axis of the bell housing 34, it continues to rotate about the spindle 24 but also pulls the spindle 24 in an orbital path within the bell housing 34 which orbital path is centered about the longitudinal axis of the bell housing 34.

While the ball bearing assembly 30 is displaced from the center of the bell housing 34 the spindle 24 pivots, with the spherical sleeve bearing 26 sliding within the ball bushing 27 so that the drill 32 is moved from the center of the extended longitudinal axis of the movable bell housing 34. The orbit connector lever 40 now causes the drill 32 and the ball bearing assembly 30 to orbit about the longitiudinal axis of the bell housing 34 at the same rate that the bell housing 34 is rotating.

During the orbiting, the drill 32 is pivoted downwardly as the ball bearing assembly 30 is pivoted upwardly about the spherical bearing 26 as shown in FIG. 2 and the drill 32 is pivoted upwardly as the ball bearing assembly 30 is pivoted downwardly as shown in FIG. 3, which illustrates the bell housing 34 at a position 180 degrees from that shown in FIG. 2. The radius of the orbit can be adjusted during the orbiting motion by moving the handle 54 to the right to increase the radius of the orbit or to the left to decrease the radius of the orbit.

To move the orbiting drill 32 against the rotating grinding wheel 22 for the purpose of thinning its web, a feed mechanism moves the movable drill holding assembly 14 and the bell housing 34 in a horizontal direction towards

the grinding wheel 22. As the point of the drill 32 approaches the rotating grinding wheel 22, the point of the drill 32 is caused to sweep across the rotating grinding wheel as best shown in FIGS. 4, 5 and 6.

In FIGS. 4 5 and 6, the point 60 of the drill 32 is shown with the top portions of the lands 62 and 64 meeting to form the chisel edge 66 and having cutting lips 68 and 70. The point 60 orbits along the path shown in dotted lines at 72 to bring the top portion of the land 62 near the rotating grinding wheel 22 as shown in FIG. 4. As shown in FIG. 5, the point 60 continues to orbit as the grinding wheel 22, while rotating, sweeps into the web of the top portion of the land 62 abrading a portion of the web and passing through the chisel edge 66 to thin the web and shorten the chisel edge 66. As the point 60 continues to orbit, it separates from the grinding wheel 22 as shown in FIG. 6 and continues to move until it completes the orbit and returns for further grinding.

The radius of the recess abraded into the web is increased by increasing the size of the orbit. This is accomplished by moving the handle 54 further to the right as shown in FIGS. 1, 2 and 3. The size of the orbit may be changed while the drill 32 is orbiting, if desired.

After the web of the drill 32 has been thinned from one side, the drill 32 is rotated 180 degrees by an indexing mechanism, hereinafter described so that the web can be thinned by the grinding wheel 22 from the opposite side of the point 60. By using another embodiment of web thinning machine, not shown, it is possible to eliminate the step of indexing the drill 32. Instead of indexing the drill, it is possible to use two grinding wheels, one positioned on each side of the drill 32 and attached to the frame of the web thinning machine so that the point 60 contacts a different grinding wheel on each of its two sides at diametrically opposite positions in its orbit. This enables both sides of the point to be thinned at the same time during the same orbits.

Since the grinding wheel 22 sweeps across the point 60 in a direction that forms an angle with the plane in which the grinding wheel 22 rotates during the grinding operation, a different portion of the edge of the grinding wheel 22 is brought into contact with the point 60 of the drill 32 at each different location during the sweeping of the drill 32 across the web. This enables the web thinning machine to have several advantages.

Firstly, this sweeping action reduces the heating of the grinding wheel 22 because different portions of the grinding wheel are abrading the drill at each different location of the sweeping action. Secondly, the even sweep of the wheel across the point 60 of the drill 32 causes the grinding wheel 22 to abrade evenly. Because it is abraded evenly across its surface, it dresses itself during the grinding operation so that no further dressing operation is necessary. Indeed, even if a wheel in need of dressing were to be used in this operation, the wheel would become dressed during the web thinning process. Thirdly, the same grinding wheel 22 can be used for different size drills because the grinding is done with a sweeping action rather than with the reciprocating action employed in the prior art web thinning machines. Fourthly, the web thinning machine is easily set-up and operated.

SPECIFIC STRUCTURE

In FIG. 7, a more detailed illustration of the web thinning machine 10 is shown in an enlarged fragmentary elevational view, partially broken away and in section.

As best shown by this figure, the spindle 24 is tubular, having a smooth cylindrical central passage 74 adapted to receive the shank 76 of the drill 32 in its first end and adapted to receive a cylindrical aligning rod 78 in its second end. A centering bore in the end of the shank 76 of the drill 32 receives a pointed end 80 of the aligning rod 78 to hold the shank along the longitudinal axis of the spindle 24.

To hold the aligning rod **78** along the longitudinal axis of the spindle **24**, there is provided, near the end **80** of the aligning rod **78** within the passage **74**, a first cylindrical spacer **82** having a central passage through which the aligning rod **78** extends and, near the other end of the aligning rod **78**, a second cylindrical spacer **84** having a central passage through which the aligning rod **78** extends. The cylindrical spacer **82** includes an outer surface conforming to the inner walls of the passageway **74** of the spindle **24** and a radially extending tapped hole that receives a set screw **86**, which set screw is tightened against the aligning rod **78** to hold it in place. The second cylindrical spaced **84** includes a central boss **88** extending longitudinally outside of the passage **74** of the spindle **24**. The central boss **88** includes an extension of the central passage through which the aligning rod **78** passes and a tapped radially extending hole through which a thumb screw **90** passes to hold the aligning rod **78** within the cylindrical spacer **84**. The cylindrical spacer **84** is held in place at the end of the tubular spindle **24** by a set screw **92** which passes through a tapped hole in the wall of the tubular spindle **24** near its end portion and presses against the spacer **84**.

To position the drill **32** with the proper length extending from the chuck **28**, the thumb screw **90** is loosened and the aligning rod **78** and the cylindrical plug **82** are pushed forward by grasping the end of the aligning rod **78** that extends from the spindle **24** and pushing it into the spindle so that it pushes the drill **32** further out of the chuck **28**. Then, the thumb screw **90** is tightened to hold the aligning rod in place along the longitudinal axis of the tubular spindle **24**.

To hold the drill **32** in place, the chuck **28** includes a body **98** that receives a flange **94** on the first end of the spindle **24** in a counterbore **100**. The flange is fastened to the body by a plurality of socket head cap screws **96** that pass through the body **98** of the chuck into the flange **94**.

To permit the spindle **24** to pivot, a ball bushing **27** is movably positioned against the outer curved surfaces of the spherical sleeve bearing **26**, which is mounted around the outer circumference of the spindle **24** at a point intermediate its ends. The spherical bearing **26** is held on one side by the shoulder **106** of the spindle **24** and at its other side by the lock nut **108**. The ball bushing **27** is held in place by the cylindrical ball bushing holder **110** which has a cylindrical inner surface abutting the outer surface of the ball bushing **27** and has a radially extending cylindrical flange **112** with a shoulder **114** into which the cylindrical outer housing **116** of the spindle **24** fits to mount the spindle **24** to the web thinning machine **10**. A plurality of cap screws **120** are threaded through a corresponding plurality of cylindrically spaced aligned bores in the flange **112** of the bushing holder **110** and tapped holes in the edge of the cylindrical outer housing **116** to hold the ball bushing holder **110** to the outer housing **116**.

To seal the spherical bearing **26**, a first flanged cylindrical outer bearing and seal retainer **122** has its cylindrical outer surface positioned against the bottom of the ball bushing holder **110** and has the inner surface of its outwardly extending flange positioned against the side of the ball bushing holder **110**. Each of a plurality of socket head cap screws **124**, spaced circumferentially along the flange of the outer bearing and seal retainer **122**, threadedly engages a different one of the aligned tapped holes in the ball bushing holder **110** and first outer bearing and seal retainer **112**. A second flanged cylindrical outer bearing and seal retainer **126** is similarly positioned with its cylindrical outer surface against the opposite end of the ball bushing holder **110** and with its radially extending flange having its inner surface positioned against the side of the ball bushing holder **110**. The second outer bearing and seal retainer **126** is fastened to the ball bushing holder **110** by a plurality of spaced-apart cap screws **128** that pass through the flange of the second outer bearing and seal retainer **126** and into aligned tapped holes in the ball bushing holder **110**. Two circular oil seals **138** and **140** are positioned between the spindle **24** and the two cylindrical outer bearings and seal retainers **122** and **126**, respectively, to seal the spherical bearing **26**.

The ball bearing assembly **30** is held to the spindle **24** by the snap ring **142** which fits into a circumferential groove in the outer wall of the tubular spindle **24** and abuts one end of the ball bearing assembly **30** and by the lock nut **144** around the outer circumference of the spindle **24** on the opposite end of the ball bearing assembly **30**. The arm **42** of the connector lever **40** is pivoted to the yoke **41** on the end of the movable bell housing **34** by the pivot pin **146** and is pivoted to the yoke **44** on the ball bearing assembly **30** by the pivot pin **148**.

In the drill orbiting assembly **16**, the ball bearing assembly **38** is mounted to the sleeve **56**, which includes a tapped hole **150** that receives the threaded orbit pin **59**. The pin **59** extends radially outwardly from the sleeve **56**. An elongated slot **154** in the outer spindle housing **116** permits the orbit pin **59** to slide longitudinally with respect to the spindle, carrying the sleeve **56**, the ball bearing assembly **38**, and the bell housing **34** in a longitudinal direction to tilt the end of the spindle **24** upwardly bringing the pivot pin **146** closer to the ball bearing assembly **30** as the pivot pin **146** is moved longitudinally. With this mechanism, orbiting of the drill **32** is provided as shown best in FIGS. 1–6.

In FIG. 7 the tapped hole **150**, the threaded pin **59** and the slot **154** are shown to be longitudinally aligned with the index pin **29** for the purpose of providing a clear illustration of each of these elements of the machine in one figure, but are in practice, located 90 degrees around the sleeve **56** from the index pin **29** as shown in FIGS. 8 and 9.

To prevent the spindle **24** from rotating while the web of a drill is being ground on one side, the ball bushing **27**, the ball bushing holder **110**, and the cylindrical outer spindle housing **116** each have aligned apertures at one location to receive an index pin **29**. The spherical bearing **26** has two longitudinally slots **132** and **134** cut into its outer surface at diametrically opposite locations and adapted to receive the tapered end **136** of the index pin **29**. With this mechanization, the pin **29** is inserted into a first of the slots **132** to prevent the spindle **24** from rotating and yet to permit it to pivot about the spherical bearing **26** while the drill **32** is orbited against a grinding wheel to thin one side of the web.

Because there are two diametrically opposite slots **132** and **134** in the spherical bearing **26**, the drill **32** may be rotated 180 degrees so that the web can be thinned from its opposite side. To permit the drill to be rotated 180 degrees, the index pin **29** is pulled from the slot **132** and the spindle **24** is rotated 180 degrees within the ball bushing holder **27**. The index pin **29** is then inserted in the second slot **134** to hold the spindle **24** with the opposite side of the web of the drill **32** facing the grinding wheel **22** (FIGS. 1–3) to permit thinning of this side of the web.

In FIG. 8, the web thinning machine **10** is shown in an elevational view with a cabinet **156** having a support plate **158** mounted at its lower end to support the orbit motor **46**. The orbit motor **46** is positioned beneath the bell housing **34** and the V-belt **36** extends upwardly between the pulley **48** driven by the motor **46** and the bell housing **34** to rotate the housing **34**. A plurality of control buttons are shown at **161** for starting and stopping the orbit motor **46** to begin the rotation of the housing **34** and the grinder motor **18** to rotate the grinding wheel **22**.

The orbit adjusting lever **50** is pivotally connected to the side of the housing **156** by pivot pin **52** so that the operator has ready access to the orbit adjusting handle **54** as best shown in FIG. 9. When this handle is pulled, the orbit adjusting lever **50** pivots about the pivot pin **52** to

move the orbit adjusting pin 59 (FIG. 7) which changes the radius of the orbit of the drill 32. To move the drill holding assembly 14 toward the grinding wheel 22, a feed wheel 160 extends outwardly from the cabinet 156 so that the operator may turn it while watching the position of the drill 32 as it orbits close to the grinding wheel 22.

A drill extension adjuster 162 is mounted to the cabinet and includes an upstanding stanchion 164 to which a length gauge 166 is pivotally mounted by means of a pivot pin 168. The gauge 166 is moved outward to contact the tip of the drill 32 after the drill is inserted into the chuck 28. This enables the drill 32 to be positioned the desired length from the chuck 28.

The gauge 166 is pivoted away from the point of the drill during grinding to permit the grinding operation. The gauge 116 is adjustable by a screw thread to control its distance from the chuck 28 for the purpose of adjusting the location of the recess ground into the web by varying the distance of the point of the drill 32 from the chuck 28.

To index the drill 32, an indexing lever 170 is provided having an index handle 172. The index lever 170 extends downwardly to the support member 174 shown best in FIG. 8 and pivots thereabout to lift the end of the pivot arm 176 and the index pin 29 permitting the drill 32 to be rotated 180 degrees before the index pin 29 is again inserted into a selected one of the slots 132 and 134 in the spherical bearing 26 (FIG. 7).

In FIG. 9 a side view of the drill web thinning machine 10 is shown having a broken away portion exposing the end of the housing 34 and the spindle 24. As best shown in this figure, the orbit connector lever 40 is connected at one end to the housing 34 and at the other end to the ball bearing assembly 30 on the spindle 24 to control the amount of orbit of the drill 32 (FIG. 8). Once the orbiting is started the feed wheel 160 is rotated to turn a lead screw 178 which moves the threaded lead nut 180 and the slide 182 to carry the movable drill holding assembly 14 and the bell housing 34 either to or away from the grinding wheel 22 as best shown in FIG. 8.

SPECIFIC OPERATION

To thin the webs of a drill 32 in the drill web thinning machine 10, the shank 76 of a drill 32 is inserted in the open multiple jaw chuck 28 and the aligning rod 78 (FIG. 7) is moved inwardly into the tubular spindle 24 until the point 80 of the aligning rod contacts the centering aperature in the shank 76 of the drill 32. The aligning gauge 166 (FIG. 8) is pivoted in line with the point of the drill 32 and adjusted for the desired length of the drill 32 from the chuck 28. Next the aligning rod 76 is pushed until the point of the drill 32 contacts the gauge 166 and then the thumb screw 90 is tightened to hold the aligning rod in place. The chisel edge 66 is aligned horizontally and the chuck 28 is tightened about the flutes of the drill 32 to hold the drill firmly to the tubular spindle 24. The index pin 59 is normally in either of the slots 132 or 134.

Once the drill 32 is properly in position, the grinder motor 18 is started to rotate the grinding wheel 22 and the orbit motor 46 is started, which drives the belt 36 extending around the pulley 48 of the orbit motor 46 and around the movable bell housing 34, to rotate the bell housing 34.

As the bell housing 34 rotates, it causes the orbit connector lever 40 to rotate and drive the ball bearing assembly 30 around the centrally located tubular spindle 24. The bell housing 34 rotates on the ball bearing assembly 38 which separates it from the sleeve 56 that is connected to the orbit adjusting pin 59 within the outer spindle housing 116 so that the sleeve 56 and the orbit adjusting pin 59 remain stationary.

To cause the drill 32 to orbit with a desired radius the orbit adjusting handle 54 is pulled to the right as shown in FIG. 8 causing the orbit adjusting lever 50 to pivot about the pivot pin 52 and to move the orbit adjusting pin 59 to the left as shown in FIG. 7. The orbit adjusting pin 59 moves the sleeve 56 to the left with it, which in turn moves the movable bell housing 34 to the left through the interconnecting ball bearing asesmbly 38.

As the movable bell housing 34 moves longitudinally to the left with respect to the spindle 24, the connector lever 40 pivots about the pivot pins 148 and 146 to raise the pivot pin 148 toward the same level as the pivot pin 146 pulling the ball bearing assembly 30 and the end of the spindle 24 upward from the longitudinal axis of the bell housing 34. As the ball bearing assembly 30 is pulled from the longitudinal axis of the bell housing 34, the tubular spindle 24 pivots on the vertical bearing 26 within the bearing bushing 27 to cause the drill 32 to move in the opposite direction from the ball bearing assembly 30. The connector lever 40, as it rotates around with the bell housing 34, causes the ball bearing assembly 30 to orbit within the bell housing 34, which in turn causes the drill 32 on the opposite end of the spindle 24 to orbit. The radius of the orbit is controlled by the longitudinal displacement of the bell housing 34 caused by moving the orbit adjusting handle 54 to the right or to the left. With this mechanization, the operator may adjust the radius of the orbit of the drill 32.

After the orbit of the drill as been adjusted, the operator feeds the drill 32 towards the grinding wheel 22 by turning the feed wheel 160. The turning of the feed wheel 160 moves the lead nut 180 along the lead screw 178 to carry the movable drill holding assembly 14 along the slide 182 towards the rotating grinding wheel 22. The operator moves the drill point 60 into contact with the rotating grinding wheel 22 so that the web of the drill point 69 is abraded each time the point 60 of the drill 32 reaches the grinding wheel 22 in its orbit 72 (FIGS. 3–5). If desired, the radius of the orbit may be changed at this time, or a deeper cut may be made by turning the feed wheel 160 further to feed the point 60 of the drill 32 closer to the grinding wheel 22.

After the web has been abraded from one side, the operator retracts the drill 32 by turning the feed wheel 160. The operator then operates the index pin handle 172 to cause the index lever 170 to pivot and raise the lever 172 which retracts the index pin 29 from one of the two slots 134 and 136 in the spherical sleeve bearing 26. The spindle 24 is then rotated 180 degrees and the index pin 29 is inserted into the other of the two slots 134 and 136. With the spindle 24 in this position, the drill 32 has been rotated 180 degrees so that the opposite side of the web now faces the grinding wheel 22. The opposite side of the web of the drill is next moved towards the rotating grinding wheel 22 by rotating the feed wheel 160 to thin this side of the web.

It can be understood from the above description, that the web thinning machine has several advantages. Firstly, it is simple in operation and economical in construction. Secondly, the set up time is short for the machine. Thirdly, the same size grinding wheel 22 may be used to thin the webs of any size drill. Fourthly, the grinding wheel 22 is dressed as it sweeps across the drill point so that a dressing operation is not needed. Fifthly, the drill point and the grinding wheel remain cool without the use of fluid coolants because different portions of the wheel are performing the abrading at different times in the sweep of the grinding wheel 22 across the web of the drill 32 so that the grinding wheel 22 does not become overheated.

Although an embodiment of the invention has been described with particularity, many modifications and variations are possible in the embodiment in the light of the above teachings. It is therefore to be understood that,

within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

We claim:

1. Web thinning apparatus, comprising:
first means for mounting a drill and securing it against rotation on its own axis;
second means for removing material from said drill upon contact therewith; and
third means for moving said first and second means with respect to each other in an orbital motion,
whereby said second means removes a portion of the material from a drill by sweeping across a portion of its web.

2. Web thinning apparatus according to claim 1 in which said second means comprises a grinding wheel.

3. Web thinning apparatus according to claim 1 in which said first means comprises:
an elongated holder adapted to hold a twist drill so that its point projects therefrom;
said elongated holder being pivotable at a fulcrum intermediate its first and second ends; and
driven means for driving the second end of said elongated holder in a rotary path about said fulcrum.

4. Web thinning apparatus according to claim 3 in which said driven means includes:
a rotatable tubular member circumscribing said second end of said elongated holder;
said elongated holder including a bearing assembly rotatably connected to said second end; and
adjusting means for adjusting the distance between said bearing and a point along said periphery of said rotatable tubular member,
whereby said second end may be held away from the central axis of said tubular member to cause said second end to orbit without rotating as said tubular member rotates;
said adjusting means including a lever pivotally connecting said point on the periphery of said rotatable tubular member and said bearing assembly.

5. Web thinning apparatus according to claim 4 in which said adjusting means further includes:
a second lever;
a movable member movable longitudinally with respect to said elongated holder;
said second lever being connected to said movable member to move said member when said second lever is is moved,
whereby the first mentioned lever moves the bearing assembly toward or away from the central axis of said tubular member;
a second bearing connected to said movable member;
said second bearing being rotatably connected to said rotatable tubular member whereby movement of said lever moves said rotatable tubular member longitudinally with respect to its central axis while permitting said rotatable tubular member to rotate with respect to said lever.

6. Web thinning apparatus according to claim 5 further including:

a spherical sleeve bearing mounted to said elongated holder;
a bearing bushing positioned radially outward from said spherical sleeve bearing to provide said fulcrum for said elongated holder;
said cylindrical sleeve bearing including diametrically opposed openings on its outer surface and said bushing including at least one aperture alignable with said openings;
an index pin insertable through said aperture and said bushings and into said either one of said diametrically spaced openings to hold said elongated holder from rotating while permitting it to pivot in any direction,
whereby said elongated holder may be indexed to either of two points of rotating 180 degrees apart and held there by said index pin against further rotation while permitting pivoting in any direction.

7. Web thinning apparatus according to claim 5 further including a pivotal gauge swingable in line with a longitudinal axis of said elongated holder and being positionable a predetermined distance from the first end thereof,
whereby the length of said drill extending from said elongated holder may be adjusted with reference to said pivotable gauge.

8. Web thinning apparatus according to claim 5 in which said elongated holder includes:
a drill chuck mounted to the first end of said elongated holder to hold a drill;
an elongated passage through said elongated holder and along the central axis thereof;
a collar at the second end of said elongated holder having a central aperture;
an aligning rod passing through said central aperture and extending along the central axis of said elongated holder;
the end of said aligning rod being alignable with the end of the shank of a drill to hold the drill centered along said central axis of said elongated holder;
said collar including a holding means for holding said rod in place; and
spacer means within said elongated passage for holding said aligning rod in line with said central axis of said elongated holder.

References Cited

UNITED STATES PATENTS

3,040,480	6/1962	Winslow et al.	51—219 X
3,056,237	10/1962	Comiskey	51—219 X

THERON E. CONDON, Primary Examiner

E. F. DESMOND, Assistant Examiner

U.S. Cl. X.R.

51—219 R, 288