April 14, 1942. A. SIMONS 2,279,347

METHOD AND APPARATUS FOR DRAWING METAL

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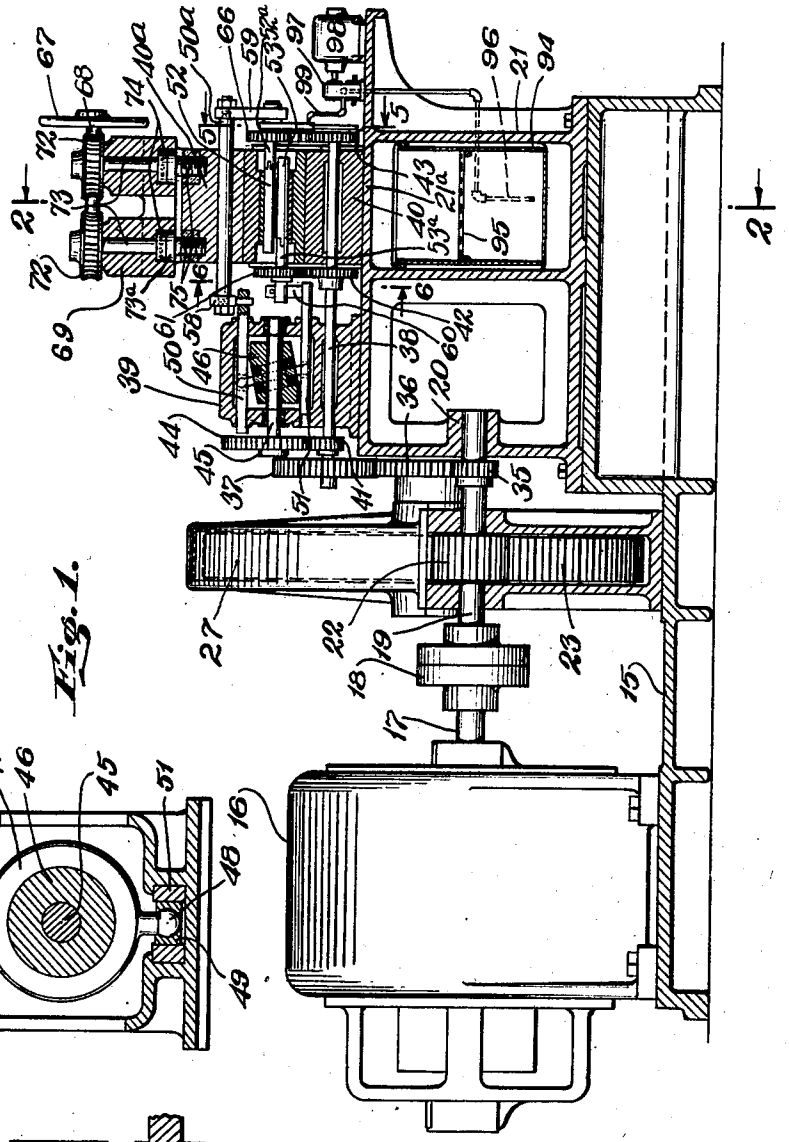


Fig. 1.



Fig. 9.

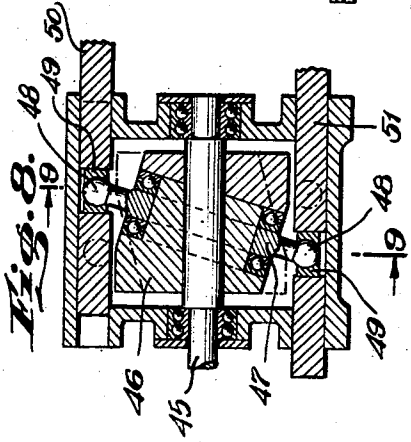


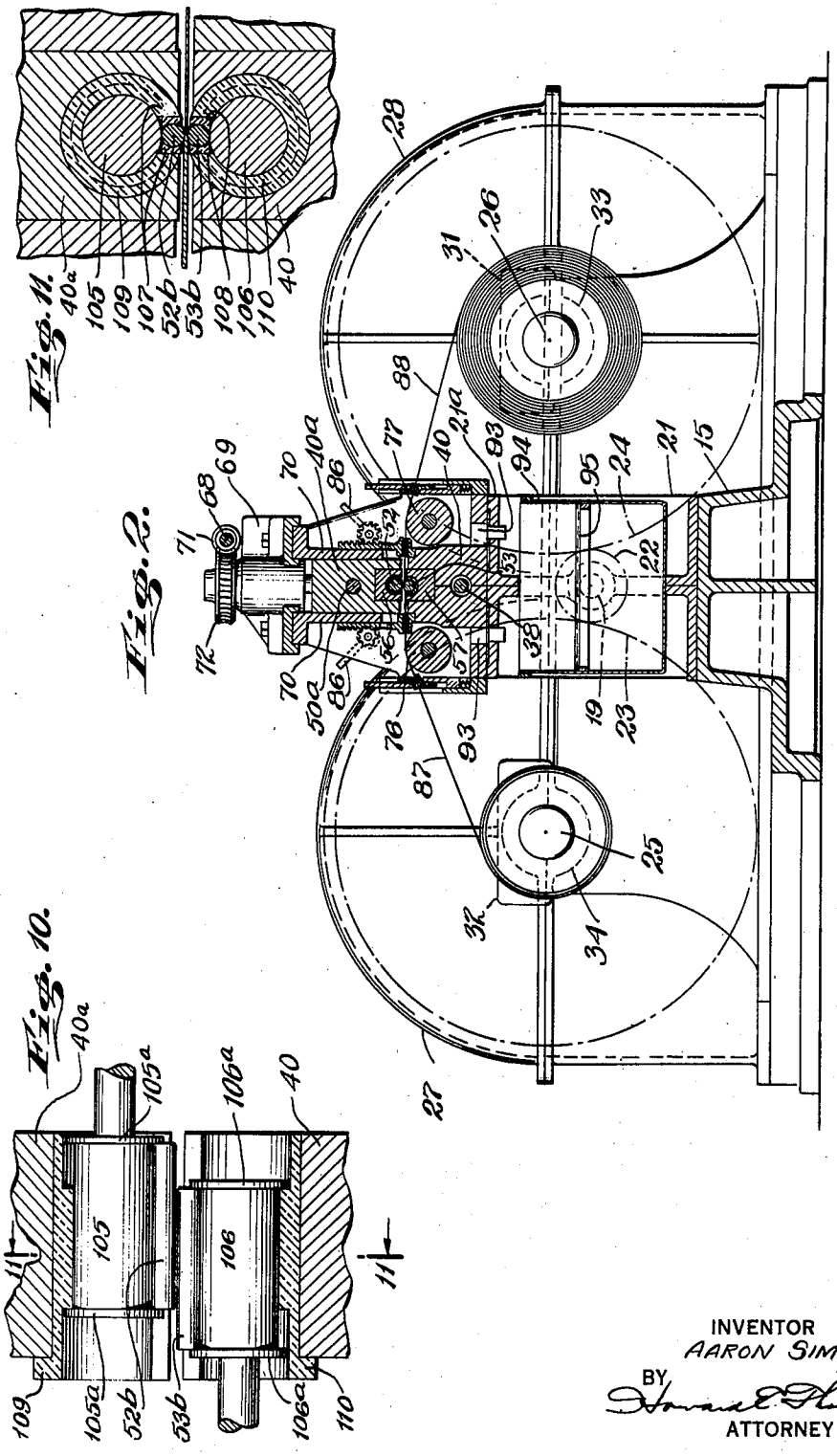
Fig. 8.

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Fig. 2.

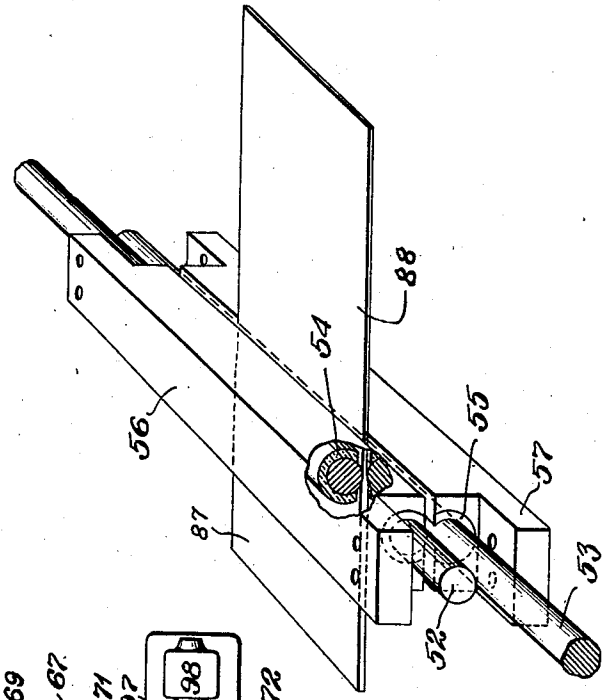
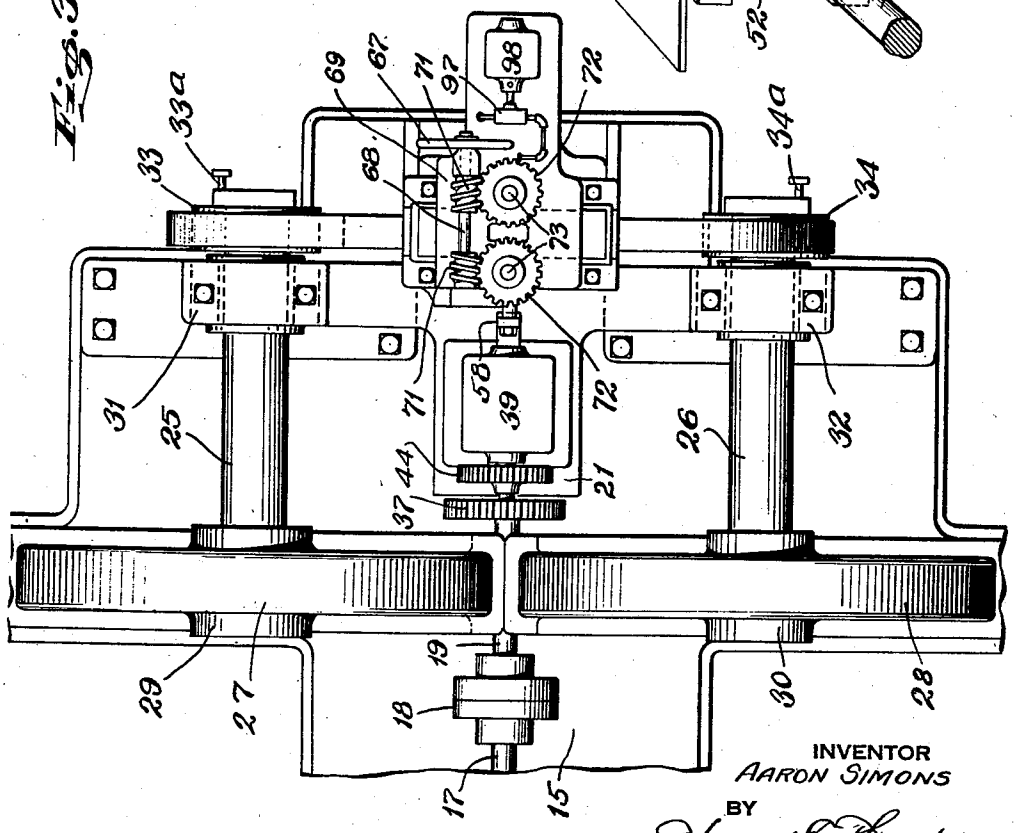



Fig. 3.




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METHOD AND APPARATUS FOR DRAWING METAL

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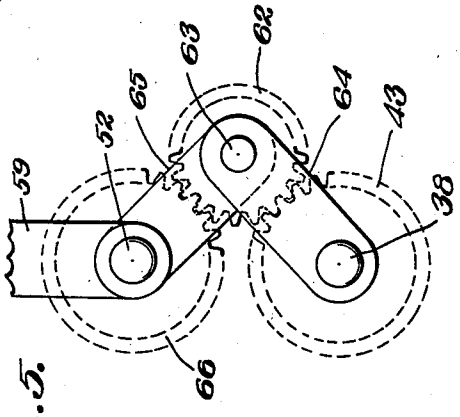



Fig. 5.

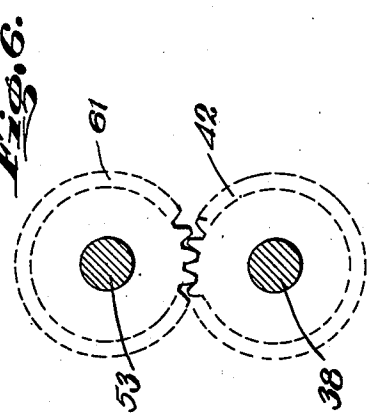



Fig. 6.

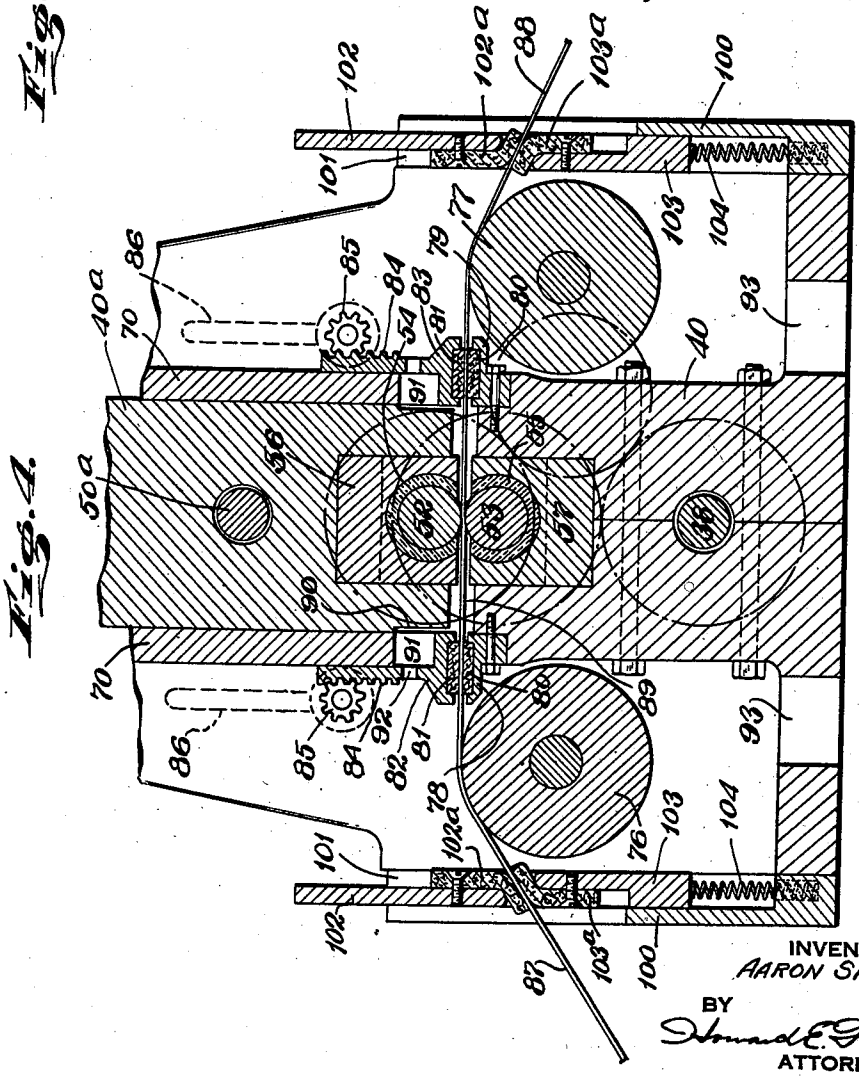



Fig. 4.

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Patented Apr. 14, 1942 2,279,347

# UNITED STATES PATENT OFFICE

2,279,347

## METHOD AND APPARATUS FOR DRAWING METAL

Aaron Simons, Bronx, N. Y.

Application April 22, 1939, Serial No. 269,373

20 Claims. (Cl. 205—1)

This invention relates to a method and apparatus for drawing cold metal strip or sheet to reduce the thickness thereof while substantially maintaining or slightly reducing the width thereof, as distinguished from the methods and machines for cold rolling of metal strip and sheet. It constitutes a continuation in part of the structure disclosed in my prior application Serial No. 132,497, filed March 23, 1937, and involves certain improvements over the apparatus illustrated in my prior Patent #2,092,188 issued September 7, 1937.

The object of the invention is to provide a machine or apparatus of the character described, employing a pair of cylindrical dies or die members of small and equal diameter, in parallel relationship to each other, supported along substantially their full length by friction bearings, between which die elements a workpiece, such as a strip or sheet, is mechanically drawn to reduce the thickness thereof, and substantially to maintain or slightly to reduce the width thereof; and further to provide for a reciprocating sliding motion of said die elements at equal speeds and in parallel planes and in opposite directions to each other transversely of the direction of travel of the workpiece, to reduce the frictional surface resistance between said die elements and the workpiece so as to permit the workpiece to be drawn between said die elements; and further to provide for the rotation of the die elements on their own axes at a surface speed slower than the speed of travel of the drawn product so as constantly to change the point of contact of said die elements with the workpiece, thereby reducing the heating of the die elements and the wear thereof; and further to provide a lubricating chamber around the workpiece and the die elements to supply the desired lubrication, and means for circulating lubricant through said chamber and maintaining a constant level of lubricant therein and means for removing surplus lubricant from the drawn product; and still further to provide means for adjusting one of said die members toward and from the other in controlling the desired operating spacing between the die elements so as to predetermine the thickness of the drawn product, and with these and other objects in view, the invention consists of a machine or apparatus of the character described and of a method of drawing metal strip and sheet, as more fully hereinafter described and claimed.

The invention is fully disclosed in the following specification, of which the accompanying drawings form a part, in which the separate parts of my improvement are designated by suitable reference characters in each of the views, and in which:

Fig. 1 is a side and sectional view of the machine made according to my invention.

Fig. 2 is a transverse sectional view substantially on the line 2—2 of Fig. 1.

Fig. 3 is a plan view of the machine as seen in Fig. 1 with part of the construction broken away.

Fig. 4 is a view similar to Fig. 2 showing only a part of the construction and on an enlarged scale.

Fig. 5 is a detail view of the gear construction shown in Fig. 1 taken along the line 5—5 of Fig. 1.

Fig. 6 is a detail view of the gear construction shown in Fig. 1 taken along the line 6—6 of Fig. 1.

Fig. 7 is a diagrammatic perspective view showing the die elements and supports therefore indicating the passage of a workpiece between said elements.

Fig. 8 is a view similar to Fig. 1 showing a part of the construction and on an enlarged scale.

Fig. 9 is a section on the broken line 9—9 of Fig. 8.

Fig. 10 is a view similar to Fig. 1 showing only a part of the construction and illustrating a modification; and

Fig. 11 is a section on the line 11—11 of Fig. 10.

Wire, rods and other thick pieces of metal which have relatively small peripheral dimensions in comparison to their cross-sectional areas, may be drawn through fixed dies. Thin flat shapes, such as strip and sheet have large peripheral dimensions in comparison to their cross-sectional areas and therefore present too large a frictional surface resistance for drawing through a fixed die, and are therefore cutomarily reduced in thickness by rolling.

My process and apparatus permits the drawing of thin strip and sheet. Although I use rotating cylindrical die members, these members perform the same passive function as is performed by a wire drawing die, and serve as a portal through which the strip is drawn and do not operate in the manner of the rolls of a rolling mill. The differences in the principles involved, the operation performed and the results obtained, between my strip drawing mill and the usual cold rolling mill are as follows:

In cold rolling the rolls must bite or grip the

strip, compress it and push it forward. It has been found that the surfaces of the rolls must present a small angle to the incoming strip, and a comparatively long portion of the strip must be in contact with the rolls, otherwise the rolls will not bite or grip and push the strip. In drawing, the reverse is true. The angle presented to the incoming strip must be large and the length of strip in contact with the die must be comparatively small, so that the strip shall not be gripped by the die, but shall be free to be drawn or pulled between the die members.

In wire drawing, it has been learned, that the results depend to a great measure on the entrance angle of the die, or the angle formed by the opposite sides of the inner contour of the die in a cross-sectional view. In comparing a pair of cylinders to a die, the entrance angle must be considered the angle formed by the tangents drawn to the surfaces of the cylinders at the median points of contact between the die cylinders and the strip. In wire drawing dies the entrance angle ranges approximately from about eight degrees to about eighteen degrees. In my apparatus the entrance angle between the cylindrical die members is of the same order as the entrance angle of wire drawing dies. In cold rolling the entrance angle must be less than five degrees, otherwise the rolls will not grip and push the strip.

To secure the small entrance angle and the large gripping area necessary for cold rolling, the diameters of the rolls must be relatively large. To secure the large entrance angle and small contact necessary for drawing, the diameters of the cylindrical die members must be relatively small.

In cold rolling, in view of the fact that the rolls must grip and push the strip, the surface speed of the rolls is approximately equal to the speed of travel of the outcoming strip, and the maximum amount of surface friction is present at the points at which the incoming strip meets the rolls. In my apparatus, it is not desirable to have the die members push the strip, but on the contrary, the strip is pulled between the die members, hence the surface speed of my die members is materially less than the speed of travel of the outcoming reduced strip. Preferably I provide a speed of rotation of my die members which is such that their surface speed shall be greater than the speed of travel of the incoming strip and materially less than the speed of travel of the outcoming reduced strip, thereby decreasing the surface friction at the points at which the incoming strip meets the die members.

In reducing thickness by cold rolling, a great pressure must be exerted. The rolls cannot be supported by longitudinal bearings along their full length, because the frictional surface resistance between the rolls and the bearings, under the operating pressure, would make it difficult, if not impossible, to rotate the rolls. Hence the rolls are equipped with reduced diameter necks at each end and are supported by bearings at these necks only. In my apparatus the cylindrical die members are longitudinally supported by friction bearings along substantially their full length, but the sliding motion of the dies in these bearings, sufficiently reduces the frictional surface resistance between the die members and the bearings to enable the die members to rotate freely.

In spite of their large diameter, the rolls in cold rolling mills, tend to bend because of the heavy pressure under which they operate. This results in a strip of convex cross-section, having a crown or thicker portion in the center and thinner edges. In my apparatus the die members are longitudinally supported in bearings, and their ends are not mounted but are substantially free, hence they do not bend, and the drawn strip is of uniform thickness. The sliding motion of the dies transversely of the strip assists in effecting this uniform thickness.

In cold rolling, the strip is compressed in all directions, and is not only elongated but is also widened, resulting in a thin, rough, jagged edge. In drawing, the strip is not crushed between heavy rolls, but is pulled or drawn, which tends to lengthen it, and at the same time to reduce it in all other dimensions, so that the strip is not widened, but its width is slightly reduced or substantially maintained, and the edges are of uniform thickness with the rest of the strip, and are not rough and jagged.

It has been learned in wire drawing that a small entrance angle tends to harden the wire more than a large entrance angle. It is also known that cold rolling hardens metal, so that intermediate annealings are generally necessary if a large total reduction of thickness is to be effected. In my method of drawing the strip between small diameter cylindrical dies with a resulting large entrance angle, the strip is not hardened as much as in cold rolling, permitting larger individual reductions in thickness, and a greater total amount of reduction without intermediate annealings.

Furthermore, the forward motion of the strip between the dies, and the simultaneous transverse sliding motion of the die members, combine to give the strip a smoother and more polished surface than can be obtained by cold rolling.

In a cold rolling mill, the strip cuts a groove or track in the rolls, necessitating their regrinding. In my apparatus the cylindrical die members, because of their sliding motion, have their wear better distributed and are less subject to tracking. Furthermore these die members, not being subject to bending, can be constructed of very hard material such as high speed tool steel or tungsten carbide, or other materials of this type and kind, so as still further to reduce their wear, and enable them to operate with strips and sheets of hard material.

In the accompanying drawings, I have shown for illustrative purposes one form of apparatus for carrying the invention into effect. In Figs. 1, 2, and 3, a base or frame of the machine 15, is provided, which will be of a contour in various cross-sections to adapt the mounting thereon of the several mechanisms later described. An electric motor 16, is arranged at one end of the frame, the shaft 17 of the motor having a coupling as at 18 with a drive shaft 19. One end of the drive shaft 19 has a bearing as at 20 in a supplemental frame 21 arranged upon the upper end of the main frame 15. The upper surface of the frame 21 forms a table 21*a*. On the shaft 19 is a drive pinion 22 which meshes with two large gears 23 and 24 arranged upon drum operating shafts 25 and 26. The gears 23 and 24 are disposed in suitable housings 27, 28 arranged upon the frame 15 and having suitable bearings 29 and 30 for the shafts 25 and 26. Other bearings 31 and 32 support the other ends of said shafts adjacent the drums 33 and 34. In the structure shown the drum 34 is the let-off drum and the drum 33 is the driving or pulling drum for pulling

the workpiece between the dies as later described. A clutch pin or the like **33***a*, **34***a*, is employed for keying the respective drums **33**, **34** to the shafts **25**, **26**; that is to say, when the drum **34** is keyed to the shaft **26**, the drum **33** is free to rotate on the shaft **25**, and vice versa, in order to make the machine reversible and to provide positive drawings of the workpiece through the machine by either of said drums. It will of course be understood that a reversible motor can be employed to reverse the direction of operation of the machine. Suitable means will be provided to detachably secure the end of the workpiece to the driving drum, but as this means is no direct part of the invention, no illustration thereof is given.

Arranged upon the shaft **19** is a gear **35** meshing with a gear **36** which in turn meshes with a gear **37** on a driven shaft **38** supported in a housing **39** arranged upon the supplemental frame **21** and extending through a fixed die supporting block **40** which is integral with the frame of the machine and is supported on the supplemental frame **21** adjacent and in close proximity to the housing **39**.

On the shaft **38** are three gears or pinions **41**, **42** and **43**. The gear **41** meshes with a gear **44** on a shaft **45** supported in the housing **39** and to which is coupled a die operating member **46** in the form of an oblique cylinder. This cylinder supports, by ball thrust bearings, a collar **47**, the collar having projecting ball end pins **48** arranged in suitable bearings **49** in upper and lower die operating rods **50** and **51** which are slidably mounted in the housing **39**.

At **52** and **53** are shown upper and lower die rods or elements arranged in open tubular bearings **54** and **55** in supporting bars **56** and **57** respectively. The bar **57** is supported in the stationary block **40** whereas the bar **56** is supported in a vertically adjustable block **40***a* mounted and adjusted as later described. One end of the rod **50** projects through the housing **39** and is coupled with a supplemental rod **50***a*, arranged in the block **40***a*, through a vertically sliding coupling pin, as at **58**, to compensate for the vertical movement of the block **40***a* and the die elements **52** therein. The supplemental rod **50***a* protrudes through the block **40***a* and has a link **59** for coupling the same with the shaft **52***a*, which has a socket at its other end to receive the neck of the die **52**. The neck is thinner than the socket, and the two members are joined together with a loosely fitted pin to permit a small amount of up and down movement of the neck in the socket to retain the die in alined position against its bearing under the pressure of the workpiece. The rod **51** also projects from the housing **39** and is coupled directly through a coupling pin **60** with the shaft **53***a* which is connected with the die **53** in the same manner as the shaft **52***a* and the die **52**. The shafts **52***a*, **53***a* are coupled with the dies **52**, **53** respectively in any desired manner so as to form a unit structure of the coupled parts. It will thus be seen that reciprocating movement of the rods **50**, **51**, in opposite directions to each other, through the medium of the oblique cylinder **46**, will transmit corresponding movement to the dies or die elements **52**, **53**. It will be understood that movement is imparted to the die **52** through the supplemental rod **50***a* and link **59**.

Slidably keyed to the protruding end of the shaft **53***a* is a gear **61** which meshes with the gear **42** so as to rotate the die **53** at the same time that reciprocating movement is transmitted thereto. In like manner, the die **52** is rotated from the gear **43** through a floating or moving gear **62** arranged upon a pivot **63** between two links **64** and **65**. The link **64** is arranged to swing on the shaft **38** whereas the link **65** swings about the protruding end of the shaft **52***a* so as to maintain a constant meshing of the gear **62** with a gear **66** slidably keyed to said protruding end of the shaft **52***a*. This gear arrangement is provided to compensate for the vertical adjustment of the block **40***a* and the die element **52** therein.

The adjustment of the block **40***a* and the die **52** is accomplished through the medium of a rotatable hand wheel **67**, the shaft **68** of which is supported in a head **69**. The head **69** is arranged upon standards **70**, integral with the stationary block **40**, said standards forming a guide for the vertically movable block **40***a*. On the shaft **68** are worms **71** engaging worm wheels **72** arranged upon vertical rods **73** in the head **69**. The rods **73** have collars **73***a* supported within the heads **69** by thrust bearings **74**. The lower portions of the rods **73** are threaded as at **75** into the movable block **40***a*.

Supported in connection with the block **40**, which forms the stationary supporting frame for the lower die **53**, are idler and guide rollers **76**, **77**, by means of which the workpiece is guided at opposite sides of the dies and in passing from one drum **33** to the other drum **34** and vice versa. On the upper surfaces of the block **40** of said frame are supported channeled strips **78** and **79** in each of which a suitable packing **80** is arranged which forms one part of a wiper, the companion of which is shown at **81**. The latter is supported in vertically adjustable channeled plates **82** and **83**, each having rack teeth **84** to be engaged by pinions **85** rotatably supported in the frame and having operating levers **86** by means of which the plates **82** and **83** may be raised and lowered to provide a firm engagement of the pads or wipers **80**, **81** with the workpiece which is represented at **87** and the resulting drawn product **88** as more clearly seen in Fig. 4 of the drawings. In addition to forming wipers, one to remove foreign products or elements from the workpiece **87** before passing between the dies and the other to remove the surplus lubricant from the product **88**, these pads or wipers form seals for a lubricating chamber or bath **89** arranged around the dies **52** and **53** and between the adjacent surfaces of the stationary and movable blocks **40**, **40***a*. The lower end of the block **40***a* is reduced as seen at **90** to provide a passage at the sides of said block opening into the apertures **91** formed in the standards **70** of the block **40***a*. Other apertures **92** are provided in the plates **82** and **83** to register with the apertures **91**. With this construction, any overflow of oil or lubricant in the chamber **89** will pass out through the apertures **92** as will be apparent and extend downwardly through apertures **93** in the flanged base of the block **40** and will return to a receiving supply tank **94** supported in the supplemental frame **21** beneath the top or table portion **21***a* thereof as clearly seen in Figs. 1 and 2 of the drawings. Within the tank is arranged a suitable strainer **95** for straining the returned oil or lubricant.

Extending into the bottom of the tank **94** is a feed pipe **96** which extends to an oil pump **97**, note Fig. 1, driven by any suitable means, for example through a motor **98**, to supply lubricant to

the chamber 89 through a supply pipe 99. It will thus be seen that a constant circulation of the lubricant is provided into and out of the chamber 89 which will serve to maintain most efficient operation of the machine and also keep the lubricant cool and thus prevent overheating of the dies and workpiece.

At each side of the block or frame 40 are arranged upstanding plates 100 forming in conjunction with the frame 40, channels 101 in which are mounted vertically movable top and bottom shutter plates 102 and 103, each carrying a flexible guide shoe 102a and 103a between which the workpiece 87 and the product 88 pass as clearly seen in Fig. 4 of the the drawings. Springs 104 are employed to support the bottom shutters 103, or the shoes 103a thereof in proper position whereas the upper shoes 102a are supported in position by gravity. The vertical movement provided by the shutters is to compensate for positions of the workpiece and product caused by the constantly decreasing and increasing amounts of strip on the let-off and take-up drums respectively.

It will be apparent that the length of the die rods or elements 52 and 53 will be greater than the width of a workpiece to be passed through the machine so that in the reciprocating movement imparted to these die elements, the elements will maintain a constant engagement with opposed surfaces of the workpiece throughout the transverse dimensions of the workpiece at all times. It will also be understood in this connection that in the present illustration, which is given simply to show one adaptation of the invention, the machine is of a relatively limited capacity with respect to the widths of workpieces, but it will be understood that machines may be designed for performing the desired operation upon workpieces of any desired width.

The operation of the machine above described will be readily understood from the foregoing description when taken in conjunction with the accompanying drawings and the following statement. A workpiece as at 87 to be drawn is first threaded through the machine by leading the same from the delivery drum 33, threading the same between the dies 52, 53, by moving the upper die into clearance position and then coupling the end of the workpiece to the receiving and drawing drum 34, after which the vertically adjustable plates 82, 83 will be moved into proper position. The upper die 52 may then be moved into a partially adjusted position upon the workpiece, or if desired, may be forced into full adjusted position upon the workpiece. The lubricant is then introduced into the chamber 89 until the same overflows through the apertures 92. The machine is then put into operation, and if the die 52 had not previously been lowered into full adjusted position, it is now lowered into such predetermined position, and at the same time the dies 52, 53 are reciprocated back and forth at equal speeds in opposite directions transversely across the upper and lower surfaces of the workpiece, and the dies are rotated in opposite directions, at substantially equal speeds, upon their own axes so that their points in contact with the workpiece move in the same direction as the workpiece, but at a surface speed which is less than the speed of the outcoming drawn product 88, while the workpiece is being drawn between the dies 52, 53 by the pull of the take-up drum 34.

The reverse drive or operation of the machine will be understood from the description heretofore submitted. A single initial workpiece may be passed through the machine several times in producing the desired final reduction in thickness of the resulting product instead of the greater number of passes required in machines embodying the conventional or known practices of cold rolling.

In Figs. 10 and 11 of the drawings I have shown a slight modification in the construction which consists simply in substituting relatively large die operating and supporting members 105 and 106 for the dies 52 and 53 and arranging the same in similar manner to the dies 52, 53 so that these members may be operated in the reciprocating manner and in the rotary manner in the same way as disclosed in Fig. 1 and the other figures of the drawings. In these figures, I also provide dies 52b, 53b, housed in blocks 107 and 108, both the dies and blocks being supported between end flanges 105a and 106a on the members 105, 106, which in turn are arranged in bushings 109 and 110 in the stationary and adjustable die supporting blocks of the machine 40 and 40a; the latter being constructed to adapt the same for the modified die structure shown in Figs. 10 and 11.

With this construction instead of directly rotating the die elements 52b, 53b, these elements are frictionally rotated through the members 105 and 106, but the thrust and stress upon the die elements is transmitted to and taken up by the larger diameter supporting members 105 and 106 as will be apparent. With this form of construction the gearing in the rotary drive of the members 105 and 106 will be proportioned so that the surface speed of the elements 52b and 53b shall be less than the speed of the drawn product, the same as in the structure shown in the other figures.

The present application deals primarily with the use of relatively small diameter die elements which are reciprocated back and forth in the manner herein described while at the same time being rotated on their axes. It will be understood that the illustrations in the accompanying drawings, which are described in the foregoing specification, simply represent one or two adaptations of the invention. It will be apparent that many variations and modifications in the form and construction of the several parts of the apparatus as disclosed, as well as in the arrangement thereof, may be made. Different types of drives for the several parts may be employed. It will further be understood that certain of the illustrations in the accompanying drawings are more or less diagrammatic, but nevertheless sufficient to illustrate the fundamental principles of a machine or machines for carrying my improved method into effect.

Having fully described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. The method of reducing the thickness of an elongated workpiece, comprising mechanically drawing a workpiece between a pair of relatively adjustable parallel cylindrical and rod-like die members of the same diameter, supporting the die members throughout substantially the full length thereof, and reciprocating the die members at equal speeds in opposite directions to each other transversely of the direction of travel of the workpiece.

2. The method of reducing the thickness of an elongated workpiece, comprising mechanically drawing a workpiece between a pair of relatively adjustable parallel cylindrical die members of the same diameter, supporting the die members throughout substantially the full length thereof, reciprocating the die members at equal speeds in opposite directions to each other transversely of the direction of travel of the workpiece, and rotating said die members in opposite directions at substantially equal speeds about their own axes, so that their points in contact with the workpiece move in the same direction as the workpiece, but at a surface speed materially less than the speed materially of travel of the drawn product.

3. The method of reducing the thickness of an elongated workpiece, comprising mechanically drawing a workpiece between a pair of relatively adjustable parallel cylindrical die members of the same diameter, supporting the die members by longitudinal friction bearings throughout substantially the full length thereof, decreasing the frictional surface resistance between the workpiece and the die members by reciprocating the die members at equal speeds in opposite directions to each other transversely of the direction of travel of the workpiece, rotating said die members in opposite directions at substantially equal speeds about their own axes, so that their points in contact with the workpiece move in the same direction as the workpiece, but at a surface speed materially less than the speed materially of travel of the drawn product, and controlling the adjustment and spacing of the die members with respect to each other to predetermine the thickness of the drawn product.

4. The method of reducing the thickness of an elongated workpiece, comprising mechanically drawing a workpiece between a pair of relatively adjustable parallel cylindrical die members of the same diameter, supporting the die members throughout substantially the full length thereof, reciprocating the die members at equal speeds in opposite directions to each other transversely of the direction of travel of the workpiece, rotating said die members in opposite directions at substantially equal speeds about their own axes, so that their points in contact with the workpiece move in the same direction as the workpiece, but at a surface speed materially less than the speed materially of travel of the drawn product, controlling the adjustment and spacing of the die members with respect to each other to predetermine the thickness of the drawn product, and operating the die members and adjacent portions of the workpiece in a lubricating bath.

5. The method of reducing the thickness of an elongated workpiece, comprising mechanically drawing a workpiece between a pair of relatively adjustable parallel cylindrical die members of the same diameter, supporting the die members throughout substantially the full length thereof, reciprocating the die members at equal speeds in opposite directions to each other transversely of the direction of travel of the workpiece, rotating said die members in opposite directions at substantially equal speeds about their own axes, so that their points in contact with the workpiece move in the same direction as the workpiece, but at a surface speed less than the speed of travel of the drawn product, controlling the adjustment and spacing of the die members with respect to each other to predetermine the thickness of the drawn product, operating the die members and adjacent portions of the workpiece in a lubricating bath, and sealing the lubricating bath with respect to the moving workpiece.

6. The method of reducing the thickness of an elongated workpiece, comprising mechanically drawing a workpiece between a pair of relatively adjustable parallel cylindrical die members of the same diameter, supporting the die members throughout substantially the full length thereof, reciprocating the die members at equal speeds in opposite directions to each other transversely of the direction of travel of the workpiece, rotating said die members in opposite directions at substantially equal speeds about their own axes, so that their points in contact with the workpiece move in the same direction as the workpiece, but at a surface speed less than the speed of travel of the drawn product, controlling the adjustment and spacing of the die members with respect to each other to predetermine the thickness of the drawn product, operating the die members and adjacent portions of the workpiece in a lubricating bath, sealing the lubricating bath with respect to the moving workpiece, cleaning the workpiece prior to entering the die members, and wiping the drawn product to remove the surplus lubricant.

7. The method of reducing the thickness of an elongated workpiece and substantially maintaining its width, comprising mechanically drawing a workpiece between a pair of relatively adjustable parallel cylindrical and rod-like die members of the same diameter, supporting the die members throughout substantially the full length thereof rotating the die members, and reciprocating the rotating die members at equal speeds in opposite directions to each other transversely of the direction of travel of the workpiece.

8. The method of reducing the trickness of an elongated workpiece, comprising mechanically drawing a workpiece between a pair of relatively adjustable parallel cylindrical die members of the same diameter, supporting the die members throughout substantially the full length thereof by backing rollers of much greater diameter than the die members, supporting the backing rollers in bearings along substantially the entire length thereof, while reciprocating the die members and their respective backing rollers at equal speeds in opposite directions to each other transversely of the direction of travel of the workpiece, and rotating the backing rollers to frictionally rotate the die members in opposite directions at substantially equal speeds about their own axes so that their points in contact with the workpiece move in the same direction as the workpiece but at a surface speed less than the speed of travel of the reduced product.

9. An apparatus for reducing the thickness of an elongated workpiece, comprising a pair of parallel cylindrical rod-like die members, both of the same diameter and each supported by a longitudinal friction bearing along substantially its entire length, means for adjusting the spacing between said die members, means for reciprocating said die members at equal speeds in opposite directions to each other transversely of the direction of travel of the workpiece, and means for drawing the workpiece between said die members.

10. An apparatus for reducing the thickness of an elongated workpiece, comprising a pair of parallel cylindrical die members, both of the

same diameter and each supported by a longitudinal friction bearing along substantilly its entire length, means for adjusting the spacing between said die members, means for reciprocating said die members at equal speeds, in opposite directions to each other transversely of the direction of travel of the workpiece, means for drawing the workpiece between said die members, and means for rotating said die members in opposite directions at substantially equal speeds, about their own axes, so that their points in contact with the workpiece move in the same direction as the workpiece, but at a surface speed materially less than the speed of travel of the drawn product.

11. An apparatus for reducing the thickness of an elongated workpiece, comprising a pair of parallel cylindrical die members, both of the same diameter and each supported by a bearing along substantially its entire length, means for adjusting the spacing between said die members, means for reciprocating said die members at equal speeds, in opposite directions to each other transversely of the direction of travel of the workpiece, means for drawing the workpiece between said die members, means for rotating said die members in opposite directions at substantially equal speeds, about their own axes, so that their points in contact with the workpiece move in the same direction as the workpiece, but at a surface speed less than the speed of travel of the drawn product, and means forming a lubricating chamber around the die members and the workpiece, said means embodying an inlet for the workpiece and an outlet for the drawn product, the inlet and outlet being provided with wipers to serve as seals to prevent loss of lubricant from the chamber and also to clean the workpiece before passing between the die members and to remove excess lubricant from the drawn product.

12. An apparatus for reducing the thickenss of an elongated workpiece, comprising a pair of parallel cylindrical die members, both of the same diameter and each supported by a bearing along substantially its entire length, means for adjusting the spacing between said die members, means for reciprocating said die members at equal speeds, in opposite directions to each other transversely of the direction of travel of the workpiece, means for drawing the workpiece between said die members, means for rotating said die members in opposite directions at substantially equal speeds, about their own axes, so that their points in contact with the workpiece move in the same direction as the workpiece, but at a surface speed less than the speed of travel of the drawn product, means forming a lubricating chamber around the die members and the workpiece, said means embodying an inlet for the workpiece and an outlet for the drawn product, the inlet and outlet being provided with wipers to serve as seals to prevent loss of lubricant from the chamber and also to clean the workpiece before passing between the die members and to remove excess lubricant from the drawn product, and means for circulating lubricant through said chamber.

13. An apparatus for reducing the thickness of an elongated workpiece, comprising a pair of parallel cylindrical die members, both of the same diameter and each supported by a bearing along substantially its entire length, means for adjusting the spacing between said die members, means for reciprocating said die members at equal speeds, in opposite directions to each other transversely of the direction of travel of the workpiece, means for drawing the workpiece between said die members, means for rotating said die members in opposite directions at substantially equal speeds, about their own axes, so that their points in contact with the workpiece move in the same direction as the workpiece, but at a surface speed less than the speed of travel of the drawn product, means forming a lubricating chamber around the die members and the workpiece, said means embodying an inlet for the workpiece and an outlet for the drawn product, the inlet and outlet being provided with wipers to serve as seals to prevent loss of lubricant from the chamber and also to clean the workpiece before passing between the die members and to remove excess lubricant from the drawn product, means for circulating lubricant through said chamber, and means on each side of the die members to guide the workpiece and to aline the workpiece and the drawn product in the plane of the operating surfaces of the die members.

14. An apparatus for reducing the thickness of an elongated workpiece, comprising a pair of parallel cylindrical die members, both of the same diameter, and each supported in contact with a backing roller of much greater diameter than the die members, each of said backing rollers being in turn supported by a bearing along substantially its entire length, means for adjusting the position of one of said die members and its supporting backing roller with relation to the other die member, means for reciprocating the die members and their respective backing rollers at equal speeds, in opposite directions to each other, transversely of the direction of travel of the workpiece, means for rotating the backing rollers to frictionally rotate the die members in opposite directions at substantially equal speeds, about their own axes, so that their points in contact with the workpiece move in the same direction as the workpiece, but at a surface speed less than the speed of travel of the drawn product, and means for drawing the workpiece between said die members.

15. An apparatus for drawing elongated workpieces to reduce the thickness thereof, comprising a pair of spaced parallel cylindrical die members, means for reciprocating said die members in opposite directions to each other transversely of the direction of travel of the workpiece, means for rotating said die members at a surface speed materially less than the speed of travel of the drawn product, and means for drawing the workpiece between said die members.

16. An apparatus for drawing elongated workpieces to reduce the thickness thereof, comprising a pair of spaced parallel die members, friction bearings extending throughout the full length of said die members, means for rotating the die members at a surface speed materially less than the speed of travel of the drawn product, means for drawing the workpiece between said die members, and means for reciprocating the die members in opposite directions to each other transversely of the direction of travel of the workpiece and longitudinally of the axis of said die members.

17. An apparatus for drawing elongated workpieces to reduce the thickness thereof, comprising a pair of spaced parallel cylindrical die members, friction bearings extending throughout the full length of said die members, means for rotat-

ing the die members at a surface speed materially less than the speed of travel of the drawn product, means for drawing the workpiece between said die members, means for reciprocating the die members in opposite directions to each other transversely of the direction of travel of the workpiece and longitudinally of the axis of said die members, and said bearings extending throughout the major portion of the circumference of said die members.

18. An apparatus for drawing elongated workpieces to reduce the thickness thereof, comprising a pair of working rolls, large supporting bearings extending the full length of said rolls and in direct engagement therewith, means for reciprocating said supporting bearings longitudinally of the axis of said rolls, and said bearings being rotatable during reciprocating movement thereof.

19. The method of reducing the thickness of an elongated workpiece, which includes the steps of supporting a pair of dies throughout their operative length, moving the die supports axially of the dies while rotating said supports to reduce frictional relationship in drawing the workpiece between said dies.

20. The method of reducing the thickness of an elongated workpiece, comprising mechanically drawing a workpiece between a pair of parallel cylindrical die members, supporting the die members by longitudinal friction bearings throughout substantially the full length thereof, rotating said die members in opposite directions about their own axes, and reciprocating the die members within their respective bearings to decrease the frictional surface resistance between the die members and their respective bearings so as to permit the die members to rotate within their respective bearings.

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