June 11, 1940. A. SIMONS 2,203,751

METHOD OF AND APPARATUS FOR DRAWING WIRE

Filed Feb. 26, 1938 2 Sheets-Sheet 1

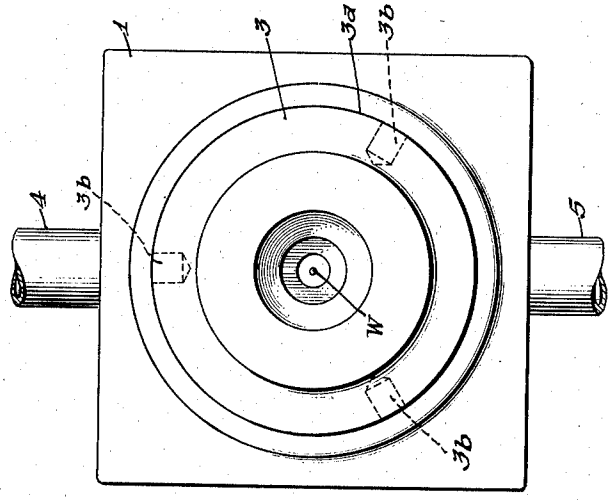


FIG. 2

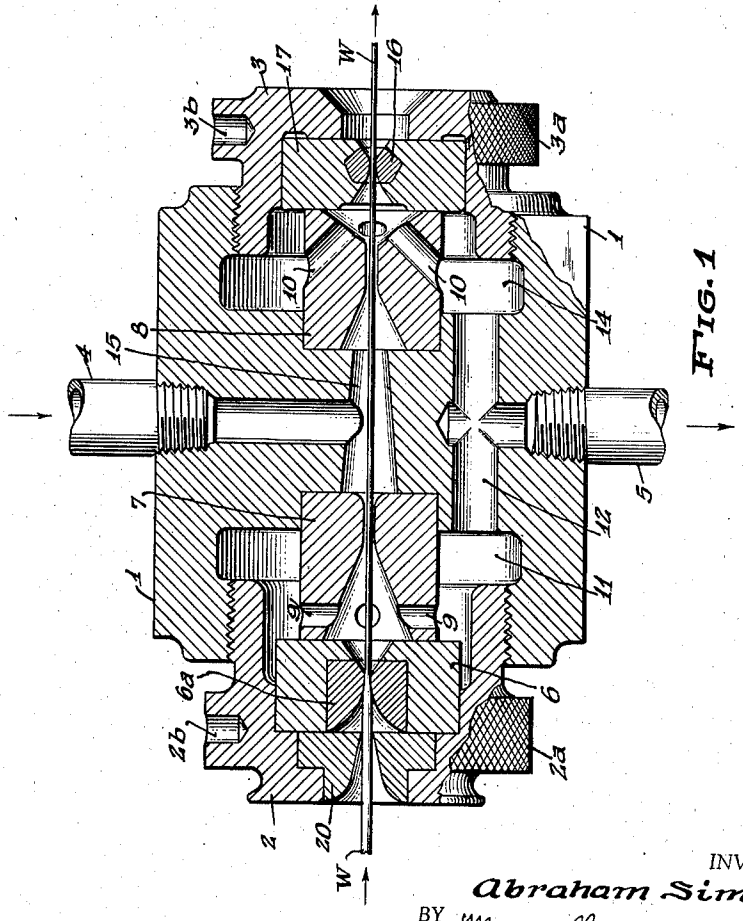


FIG. 1

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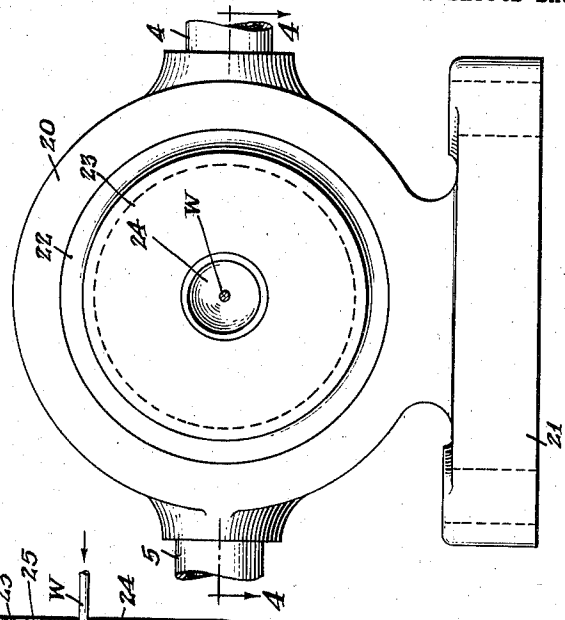


Fig. 3

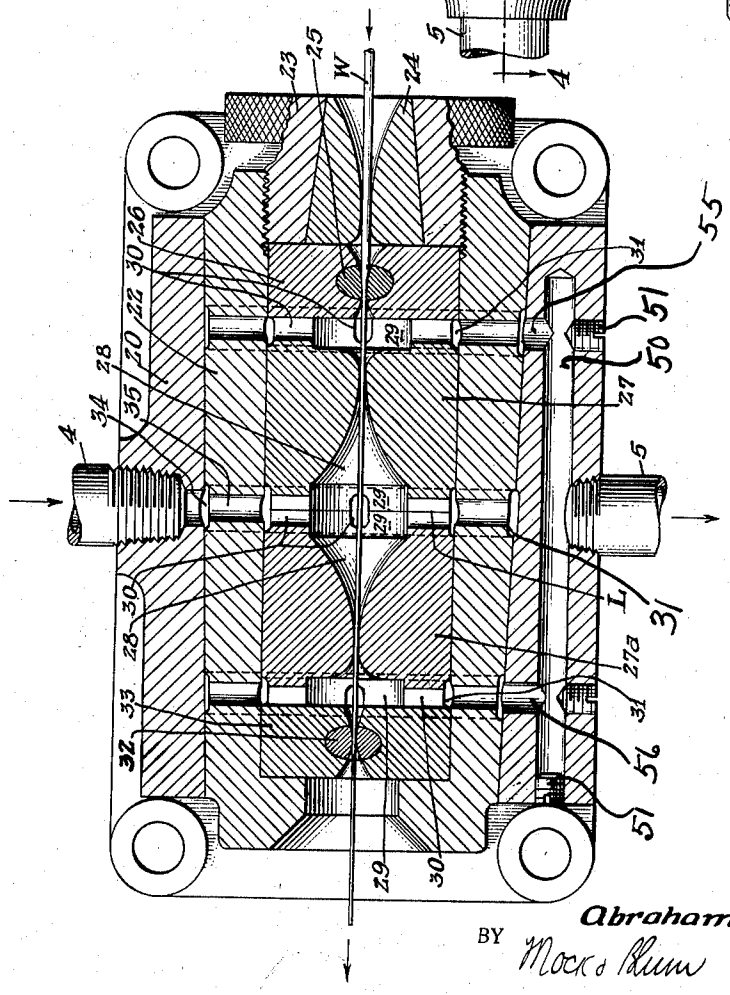


Fig. 4

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Patented June 11, 1940 2,203,751

UNITED STATES PATENT OFFICE

2,203,751

METHOD OF AND APPARATUS FOR DRAWING WIRE

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Application February 26, 1938, Serial No. 192,706

4 Claims. (Cl. 205—25)

My invention relates to a new and improved method of drawing wire and other material and a new and improved apparatus for this purpose.

One of the objects of the invention is to cool and cleanse the surface of the wire or other material effectively, either prior to the first drawing operation, or subsequent to the first drawing operation, or in any intermediate stage.

Another object of the invention is to improve the lubrication of the wire or other material prior to and during the drawing operation, in the first stage or in any subsequent stage.

Another object of the invention is to provide a plurality of drawing dies which are arranged in a gang or series, and to lubricate the wire or other material effectively, by means of lubricant under pressure, intermediate a pair of successive dies.

Another object of the invention is to provide two or more dies whose axes are coincident or non-coincident, so that the force which is required for pulling the wire or the like through an anterior die, produces a resistance to the pulling of the wire through a succeeding die.

Another object is to improve the drawing of a wire, strip, or the like which is made of hard material, so as to diminish the hardening which results from the drawing operation.

Another object of the invention is to provide an apparatus and method whereby the lubricant can escape freely from the apparatus, under little or no pressure, after the lubricant has lubricated and cleansed the surface of the wire.

Other objects of the invention are stated in the following description and drawings which illustrate preferred embodiments thereof, it being understood that the above statement of the objects of my invention is intended generally to explain the same without limiting it in any manner.

Fig. 1 is a central sectional view showing apparatus made according to one embodiment of the invention.

Fig. 2 is an end view taken at the right-hand side of Fig. 1.

Fig. 3 is an end elevation taken at the right-hand side of Fig. 4, which shows a second embodiment of the invention.

Fig. 4 is a sectional view on the line 4—4 of Fig. 3.

The apparatus shown in Figs. 1 and 2 comprises a holder 1, which can be made of steel or other suitable material. Said holder is provided with a tapered bore 15, whose internal diameter decreases towards the outlet end of the device. Fig. 1 shows the wire W and the longitudinal arrows indicate the direction of movement of the wire through the apparatus.

The wire is pulled through the dies which are located in the holder 1, or which are assembled with the holder 1, by means of any suitable pulling device which is located at the right-hand side of the holder 1 and which is exterior to the apparatus shown in Fig. 1. This pulling or draft device may be of a well known type, so that it is not shown in the drawings.

An inlet pipe 4 communicates with said bore 15, and an outlet pipe 5 communicates with a longitudinal outlet channel 12 which is formed in said holder 1. A portion of the wall of channel 12 is provided with a recess. This is because the pipe 5 is threaded in a transverse bore which is formed in the wall of the holder, by means of a drill, and said drill forms said recess. However, said recess plays no part in the operation of the device.

Nozzle members 7 and 8 are located at the opposite ends of the central or axial bore 15. The diameters of the cylindrical portions of the bores of these nozzle members are preferably greater than the thickness of the wire which passes through said nozzle members, so that a slight clearance is provided between the cylindrical portions of the bores of the nozzle members 7 and 8 and the adjacent portion of the wire W.

The nozzle member 7 is provided with a suitable number of transverse channels or bores 9, which communicate with the recess 11. Said recess 11 communicates with the channel 12. A nut or plug 2 is threaded into the inlet end of the holder 1. Said nut 2 clamps in position a die 6, which may have a nib 6a. This nib 6a may be made of any suitable material, such as the well known tungsten carbide material.

The nib 6a may constitute first drawing means, although it need not reduce the wire, as later stated herein. The member 6 abuts the adjacent end of the member 7, so that the nut 2 firmly clamps the members 6 and 7 in position.

An inlet member 20 having a tapered bore, is also clamped in position by the member 2 against the adjacent face of the member 6. The nut 2 is provided with a knurled head 2a and it is also provided with recesses 2b which can be engaged by a suitable tool, in order to insert the nut 2 with suitable force.

The narrow outlet end of the bore 15 is adjacent the bore of the nozzle member 8, which is similar in function to the nozzle member 7. Said member 8 is provided with four or more transverse

bores 10 which are inclined rearwardly and which communicate with the recess 14. Said recess 14 communicates with the outlet channel 12. A die member 17, having a nib 16, is clamped against the adjacent end of the member 8 by means of a second nut 3. The nut 3 is provided with a knurled head 3a and with recesses 3b which are similar in function to the recesses 2b.

A flowable lubricant or a liquid of any kind is supplied under pressure through the pipe 4 to the bore 15. Said liquid may be any suitable liquid lubricant, of the type which is generally used for lubricating wire, during the drawing operation. Said lubricants include various soaps and other ingredients such as tallow and the like. Said lubricants may be liquid at ordinary room temperature.

The lubricant may be supplied through the pipe 4 at any suitable pressure and I place no limitation as to the amount of pressure which may be used. The pressure may be as low as ten pounds per square inch, and it may be as high as thirty pounds per square inch and even higher.

A suitable solid lubricant is preferably supplied to the surface of the wire, anterior the member 6a, but it is not necessary to supply said solid lubricant.

The member 6a may exert the usual reducing action upon the wire in the first pass, or it may exert no drawing action at all, or it may reduce the wire less than is customary in the first pass according to standard practice. This member 6a may serve merely to prevent the escape of the lubricant through the bore of the member 20. It also frictionally retards the feed of the wire through nib 16, so as to exert a back pull on the wire. It is sufficient if the wire W merely has a fairly close fit within the bore of the member 6a, so as to prevent the escape of lubricant backward through the inlet end of the device.

The operation of the device shown in Figs. 1 and 2 is as follows:

When the wire is pulled through the apparatus, it is reduced in thickness or diameter by the nib 16. The member 16 may be a diamond or it may be made of tungsten carbide material or of any material.

I can use an ordinary steel die, if desired.

While the wire is being drawn, lubricant under pressure is supplied to the bore 15 through the pipe 4. The liquid lubricant tends to flow forwardly and rearwardly, relative to the direction of movement of the wire. This lubricant thoroughly washes and cleanses the exterior of the wire from bits of metal, dirt and the like. Likewise, if the wire has been drawn to a certain extent by passing through the member 6a, the liquid lubricant washes off the particles of metal which are formed by the drawing operation.

Sometimes the reducing action of a die forms a fine metallic dust upon the surface of the wire and it sometimes forms little metal slivers on the surface of the wire, and these are thoroughly washed off and removed by the liquid lubricant. The liquid lubricant passes between the wall of the narrow part of the bore of the member 7 and the surface of the wire with great velocity and it exerts great scouring force, because the space thus provided is extremely narrow.

As soon as the lubricant passes into the wider part of the bore of the member 7, its velocity diminishes. The lubricant cannot escape through the bore of the member 6a, or at least the escape of the liquid lubricant can be ignored for practical purposes because of the close fit between the wire and the wall of the bore of the member 6a.

The lubricant passes through the transverse bores 9 into the recess 11 and channel 12 and out through the pipe 5. The bores 9 are preferably perpendicular to the axis of the wire.

The lubricant which passes out of the narrow end of the bore 15 likewise passes with great force and velocity between the narrow part of the bore of the member 8 and the surface of the wire and said lubricant is then rearwardly directed through the bores 10 into the recess 14. Hence the lubricant can flow freely out of the apparatus, directly anterior the nib 16, and also directly behind nib 6a, so that the flowing lubricant merely cleanses the wire at said points, and it also cleanses the approach or the inlet end of member 16. It also cools the axial part of member 16 and of member 6a. The lubricant enters the channel 12 and passes out through the pipe 5. The escape of the lubricant through member 16 is negligible, although some of the lubricant is carried through member 16 by the wire, so that the wire is effectively lubricated.

Hence, the wire is thoroughly cleansed and cooled and lubricated before it is reduced by the member 16, and the dies are also effectively cooled.

The bore of the member 6a can be designed so as to impose a frictional drag upon the wire, which is equivalent to a back pull upon the wire when it is drawn in the member 16. If there is any reduction in thickness in member 6a, it may be less than or equal to or greater than the reduction in thickness in member 16.

As the wire passes out of the apparatus it may be wound upon a suitable reel.

Any suitable draft member can be used for pulling the wire through the apparatus and the reduced wire can be supplied continuously from said draft member to another apparatus which is like the apparatus of Figs. 1 and 2.

The back draft or back pull which is produced by the member 6a can be varied as desired.

The back pull may be equal to about 75% of the elastic limit of the reduced wire which passes out of the member 16.

The invention is particularly useful in making wire from so-called stainless steel, and in drawing hard wires made of hard alloys, such as hard bronze or phosphor bronze, and in drawing nickel-chromium wire which is used for making electrical resistances and the like, and in making music wire. This music wire is generally used in making fine springs.

The drawings are approximately to scale although the dimensions are about 1½ times greater than the actual dimensions.

In drawing stainless steel wire, it is ordinarily necessary to anneal the wire after about six passes or seven passes, in sizes of the kind described, because the stainless steel wire hardens very quickly.

According to the improved method, it is possible to have ten passes or even more before it is necessary to anneal the wire. Likewise, the life of the die 16 is greatly increased, especially if it is a diamond die.

Likewise, a brighter and smoother wire is produced which is particularly useful in the manufacture of the wire belts of "Fourdrinier" paper making machines, and for other purposes.

The invention is particularly useful generally for drawing wires made of alloys which include nickel or chromium or which include both nickel and chromium.

The pipes 4 and 5 may be connected respec-

tively to the outlet side and to the inlet side of a suitable pump, so that the lubricant is pumped continuously through a closed path, with little or no loss. This pump is not illustrated in the drawings as devices of this type are well known per se.

Likewise the lubricant may be passed through filters or the like, in order to remove impurities therefrom.

Since the lubricant contacts directly with the wire, intermediate the members 7 and 8, a substantial cooling effect is secured. The back-pull and the cleaning of wire make it possible to diminish the annealing.

The lubricant which is forced into the apparatus through the pipe 4 may be cooled to any suitable low temperature. A cooling liquid or fluid of any kind may thus be forced through the apparatus, so as to cool the wire and the dies by direct contact anterior the first drawing operation, or between drawing operations.

In utilizing the method, the speed of movement of the wire through the nib 16 may be as high as two hundred and fifty feet per minute, and the flow of lubricant through the apparatus may be about two gallons per minute.

The liquid which is forced through the apparatus need not necessarily be a lubricant, because a valuable feature of the invention is the cooling of the wire and of the die or dies.

The liquid which is located at the anterior end of the die or nib 16 is caused to flow reversely away therefrom, through the rearwardly inclined bores 10, into the recess 14, so as to prevent the wire from carrying the fine particles which pass through the member 8, through said member 16.

While I have given a practical working example in order to explain the invention thoroughly to a skilled person, I do not wish to be restricted to the specific example or to the figures stated herein, as these are given merely by way of illustration.

The diameter of the cylindrical wall portion of the member 7 may be about .056 inch if the wire which passes through said cylindrical wall portion has a diameter of .028 inch. Hence the clearance is .014 inch.

A very vigorous scrubbing action is thus secured by the flowing liquid or fluid, at said cylindrical wall portions. I can force air through pipe 4, or use air to atomize a lubricant which can be sprayed into bore 15. Any inert gas or any gas can be used for this purpose.

In utilizing the apparatus, the longitudinal axis thereof is preferably horizontal although the invention is not restricted to this position of said longitudinal axis.

I do not wish to be limited to a cylindrical contour of any portions of the bores of the members 7 and 8, as it is sufficient if the walls of the bores of said members 7 and 8 are sufficiently close to the wire to secure a scrubbing action, whereby fine particles are substantially removed from the wire, after or prior to a drawing operation.

In the embodiment shown in Fig. 4, the wire W is pulled through the apparatus from right to left. The device of Fig. 4 may be used in the last pass or in any intermediate pass. Said device can be assembled in the die room and inserted into the holder at the drawing bench. Likewise, said device can be turned around the longitudinal axis of holder 20, in order to "cast" the wire, that is, to keep the wire straight in order to coil the wire in a perfect circle on the wind-up reel.

Fig. 3 shows an outer holder 20, made of any suitable metal. This has an integral base 21. The bore of the holder 20 is tapered so that the exit end or left-hand end thereof is of smaller diameter than the right-hand end thereof. The tapered bore of the holder 20 has a circular cross-section. An insert or inner holder 22, which is a metal sleeve, has an outer wall of frusto-conical shape which fits tightly in the bore of the holder 20, so as to prevent the lubricant from escaping between the outer and inner holders. The pull of the wire therefore operates to seat the inner holder 22 firmly in the outer holder 20. However, the inner holder or sleeve 22 is freely turnable around the common longitudinal axis of said sleeve 22 and of said holder 20. Therefore, if the wire does not come out of the apparatus straight, the sleeve 22 can be turned so as to produce straight wire. The inner wall of the inlet end of the sleeve 22 is threaded, so that a plug 23 can be screwed into position. This plug has a knurled outer end. This plug 23 has a guide member 24, made of any suitable metal. Said guide member 24 has a tapered bore, so as to guide the movement of the wire W. The member 24 does not exert any drawing action so that the wire is not reduced in passing through the member 24. The outer wall of member 24 is tapered reversely to the taper of the bore of the outer holder 20. The wire now passes through a first die 25, which may be a diamond die or a die of any suitable type. This die 25 is held in a suitable holder 26 which is made of any suitable metal. The members 25 and 26 may be of any conventional type.

The left-hand end-wall of the member 26 abuts a part of the adjacent wall of a first metal cylinder 27, which fits snugly in the cylindrical bore of the sleeve 22.

The member 27 can be made from a cylindrical blank having planar end-faces, by forming the bore 28, then forming a recess in each end-face so that each recess communicates with the bore, and then milling each end-face so as to provide two diametral slots or grooves which are perpendicular or inclined to each other. Said slots extend to the outer circular edge of each end-face. Hence member 26 has its planar end-face abutting the adjacent planar end-face of member 27, save where the end-face of member 27 is interrupted by the slots.

The metal cylinder 27 abuts an identical metal cylinder 27*a*, along a plane which is defined by reference line L in Fig. 4. Since the members 27 and 27*a* are identical, the same parts are indicated by the same reference numerals. Each member 27 and 27*a* is provided with a tapered axial bore 28. Each end wall of each said member 27 and 27*a* is provided with a recess 29 of circular shape. Each end-face of each said member 27 and 27*a* is also provided with four radial grooves or depressions 30 which communicate with the recessses 29. Said grooves or recesses 30 may be of semi-circular or semi-elliptical cross-section and they are separated by arcs of ninety degrees. Each end-face of each said member 27 and 27*a* is also provided at its circular edge with an annular recess 31, which communicates with said radial grooves 30. The outer wall of sleeve 22 has an annular groove 34, and said sleeve 22 has a bore 35.

In operating the device shown in Fig. 4, lubricant is forced under suitable pressure through the pipe 4. The lubricant enters the continuous annular groove 34, and said lubricant then passes through the bore 35 into the continuous annular passage which is formed by the recesses 31 of the adjacent end-faces of members 27 and 27*a* and

into the radial channels which are formed by the cooperating grooves **30** at the adjacent faces of the members **27** and **27***a*. Said grooves **30** may register in pairs at the adjacent faces of members **27** and **27***a*, but this is not necessary. The lubricant then enters a chamber which is formed by the recesses **29** of the adjacent faces of the members **27** and **27***a*. The lubricant then passes through the oppositely tapered bores **28** in a direction which is parallel to the direction of movement of the wire W, and also in a direction which is opposed to said direction of movement of the wire. As the lubricant passes through the narrow parts of the bores **28** with considerable velocity, it scours the wire after the wire has passed through the first die **25** and before the wire has passed through the second die **32**. At the right-hand side of the member **27**, the lubricant passes through the respective radial grooves **30**.

The inner wall of sleeve **22** has a continuous annular recess which registers with the continuous annular recess **31** at the right-hand end-face of member **27**, so as to form a channel which communicates with the adjacent radial grooves **30**. The sleeve **22** has a bore which communicates with said channel and with a continuous annular recess which is formed in the outer wall of sleeve **22**. The wall of the outlet channel **50** has a bore **55** which communicates with said recess. Hence the lubricant can enter outlet channel **50** even if sleeve **22** and the parts therein are turned around the longitudinal axis of the device.

A bore **56**, similar to bore **55**, permits the lubricant which has passed through the bore of member **27** to enter said outlet channel **50**.

The liquid is under little or no pressure in recesses **29** and grooves **30**. Fig. 4 is also according to scale.

The holder **20** and the sleeve **22** can be formed into the shape shown in Fig. 4, by means of a series of drilling operations. The channel **50** can be readily formed by means of a drill, and its outer end can be closed by means of a plug **51**. A drill can then be used so as to form bores **55** and **56**. The corresponding openings in the wall of channel **50** are closed by additional plugs **51**.

The nib **32** which may be a diamond or which may be made of other suitable material, is mounted in a metal holder **33**, which abuts the adjacent inner end-wall of the inner holder **22**.

Hence the inner holder **22** can be assembled with all the parts located therein, and said inner holder **22** can be inserted into outer holder **20**, at the draw-bench.

In order to give a practical example, the wire which enters nib **25** may have a thickness of diameter of .028 inch. It is reduced to a thickness of .025 inch in passing through nib **25**, and it is further reduced to a thickness of .0225 inch in passing through nib **32**.

While I have shown complete and operative embodiments, I do not wish to be limited to the details thereof and the invention includes numerous valuable sub-combinations which can be incorporated in apparatus which is wholly different from the apparatus disclosed herein.

As one of the features of the invention the wire is subjected to the cleansing action of a moving body of fluid anterior a drawing operation. This fluid is preferably a liquid lubricant. This current of fluid preferably moves into and through a chamber in which the wire is located. In another aspect of the invention said chamber is located intermediate a pair of dies, in which the wire is reduced in a succession of passes.

While I have shown a holder having a single pair of dies, the holder may have either two dies or more. Likewise the invention is not limited necessarily to a holder having a plurality of dies.

In order to specify the invention clearly in the claims, in referring to Fig. 1, it may be assumed that the members **1** and **7** and **8**, together with the members **6** and **17**, are shaped so as to form a chamber which is intermediate the dies **6***a* and **16**. Said chamber communicates with the bores of said dies **6***a* and **16** so that wire can be led through the first die **6***a*, then through said chamber, and then through the die **16**. Said chamber has an inlet **4** and an outlet **5** which is independent of the bores of said dies **6***a* and **16**. Said chambers have portions thereof formed with small bores, so that the fluid which passes through said chamber exerts the desired scouring effect. Said chamber is shaped so that the pressure of the fluid is sufficiently small adjacent the dies **6***a* and **16**, in order to prevent any substantial leakage of the fluid through said dies **6***a* and **16**. The fluid which enters said chambers flows out of the same in two opposed directions, each directions having a component which is parallel to the direction of movement of the wire. In the particular embodiment disclosed, said directions are parallel to said directions of movement. After exerting their scouring effect the components of the fluid enter the outlet. The fluid which flows in the same direction as the movement of the wire flows towards said outlet, in a direction away from the outlet die **16**. The same is true of Fig. 4. Therefore the body of lubricant which enters through the pipe **4** can be considered as being divided into a first part which moves in the direction of movement of the wire, and a second part which moves in a direction which is opposed to said direction. The first part of the body of lubricant is moved away from the die **16** through the members **10**, in a first zone which is anterior said die **16**. The scouring action takes place in a second zone which comprises the narrow part of the bore of the nozzle **8**. Said second zone is anterior the first zone and the velocity of the lubricant in the second zone is greater than the velocity of the lubricant in the first zone. The lubricant may be a liquid of any type or kind, or it may consist of material of any kind which is non-liquid at ordinary temperatures but which can be caused to flow through the device during the operation thereof.

I claim:

1. In the art of drawing wire through a die which has a bore having a longitudinal axis, those steps which consist in contacting the wire, anterior the die, with a moving body of lubricant while moving a first part of said body of lubricant under pressure in the direction of movement of the wire and moving a second part of said body of lubricant under pressure in a direction opposed to the direction of movement of the wire, moving the first part of said body of lubricant away from the die in a first zone which is anterior the die and in a direction which is inclined to said axis, and scouring the wire with said lubricant anterior said first zone in a second zone, the velocity of the lubricant being greater in the second zone than in the first zone.

2. In the art of drawing wire through a die which has a bore having a longitudinal axis, those steps which consist in contacting the wire,

anterior the die, with a moving body of lubricant which is moved towards said die, moving the lubricant away from the die in a first zone which is anterior the die and in a direction which is inclined to said axis, scouring the wire with said lubricant in a second zone which is anterior the first zone, the velocity of the lubricant in the second zone being greater than the velocity thereof in the first zone.

3. Wire drawing apparatus comprising a holder having an inlet and an outlet, a die located in said outlet, a part of said holder forming a chamber which is located anterior said die, so that a wire can be drawn successively through said chamber and then through said die, said chamber having a first zone thereof anterior said die and having a second zone thereof anterior the first zone, the bore of the second zone being smaller than the bore of the first zone, the bore of the second zone being sufficiently small so that when lubricant is forced through the same said lubricant will scour the respective portion of the wire, said chamber having an inlet which is anterior the second zone, the first zone having an outlet so that when lubricant is forced through the inlet, said lubricant is forced successively through the second zone and into the first zone towards the die and said lubricant then flows out of the first zone in a direction away from the die.

4. Wire drawing apparatus comprising a holder having an inlet and an outlet, a first die located at said inlet and a second die located at said outlet, said holder forming a chamber which is located intermediate said dies and which communicates with said dies, so that a wire can be drawn successively through the inlet die and then through said chamber and then through the outlet die, said chamber having a first zone anterior the outlet die and a second zone located anterior the first zone, said chamber also having a third zone immediately succeeding the inlet die and a fourth zone immediately succeeding the third zone, the second and fourth zones being spaced from each other, said chamber having an inlet which is located intermediate the second zone and the fourth zone, the third and first zones respectively having outlets which are directed away from their respective associated dies, the bores of the second zone and of the fourth zone being sufficiently small to cause lubricant which is forced through the same to exert a scouring action on the respective portions of the wire, the bore of the first zone and of its outlet being greater than the bore of the second zone, the bore of the third zone and of its outlet being greater than the bore of the fourth zone, so that when the lubricant flows respectively out of the first zone and out of the third zone, its velocity is less than the velocity of the lubricant respectively in the second zone and in the fourth zone.

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