July 11, 1933. J. V. GIESLER 1,917,708

METHOD AND APPARATUS FOR DRAWING TUBES

Filed June 25, 1930 3 Sheets-Sheet 1

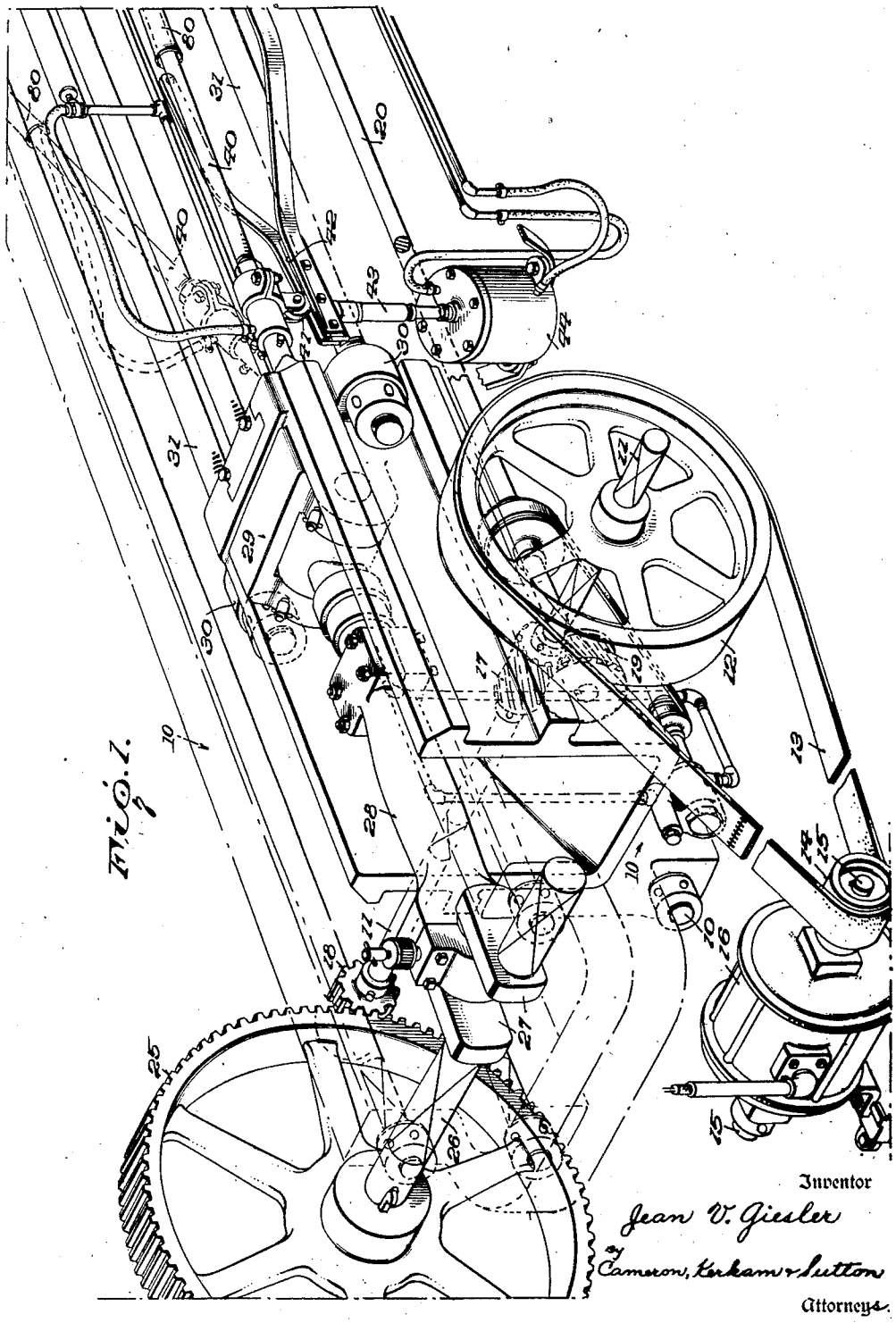


Fig. 1.

Inventor
Jean V. Giesler
by Cameron, Kerkam & Sutton
Attorneys.

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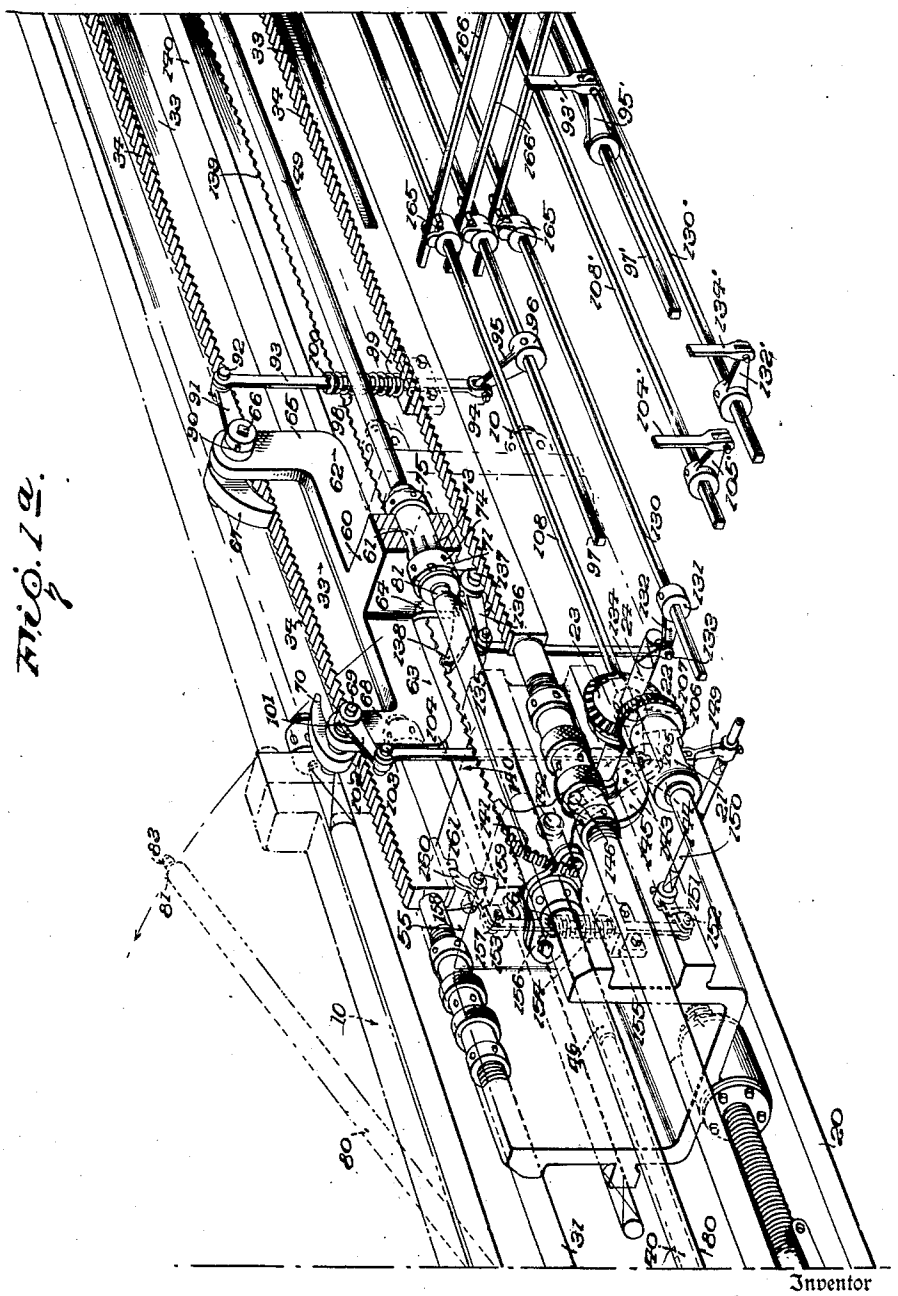


Fig. 1a.

Inventor
Jean V. Giesler.
By
Cameron, Kerkam & Sutton.
Attorneys.

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METHOD AND APPARATUS FOR DRAWING TUBES

Filed June 25, 1930 3 Sheets-Sheet 3

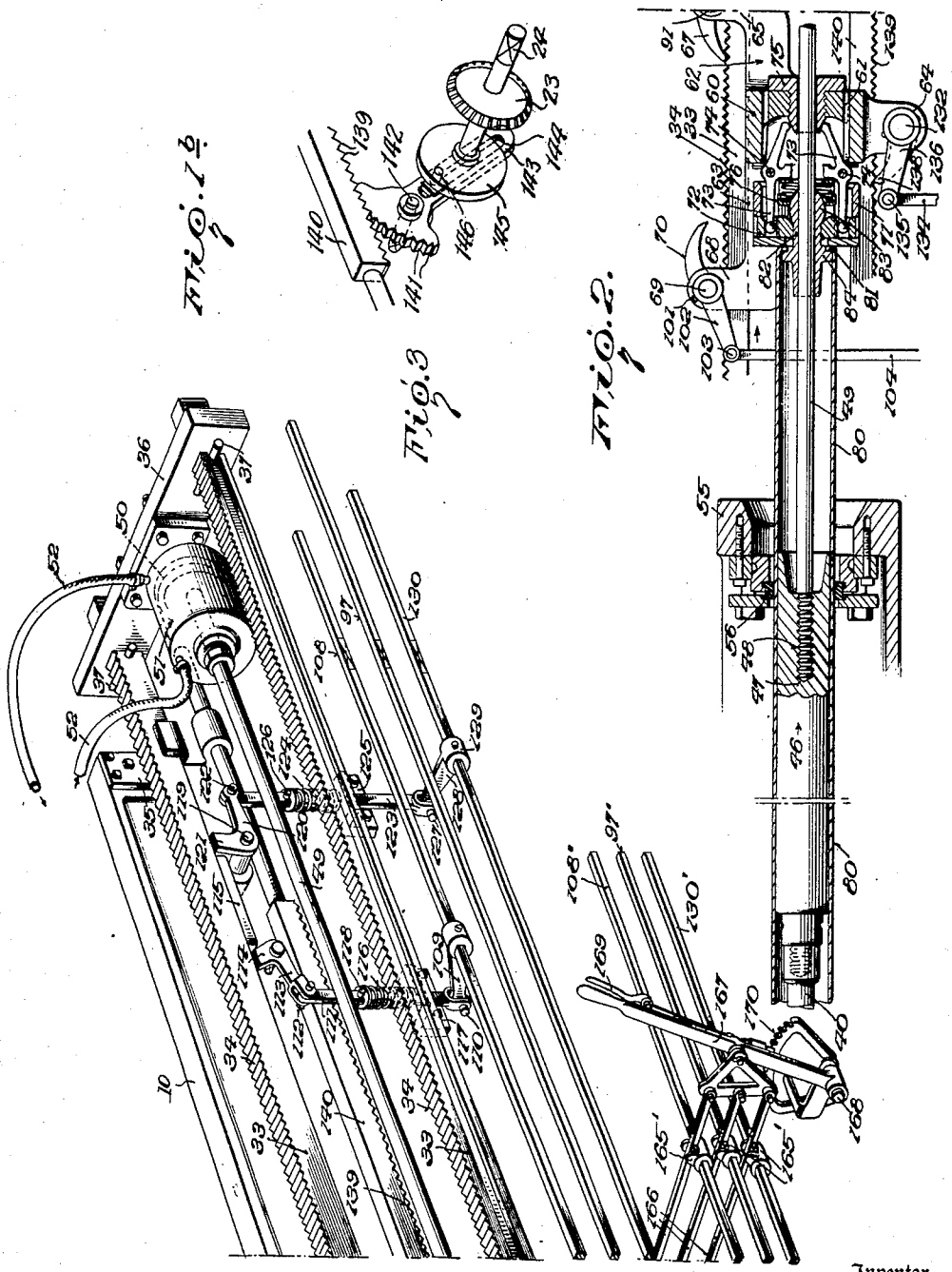


Fig. 1.

Fig. 3.

Fig. 2.

Inventor

Jean V. Geisler.

By Cameron, Kerkam & Sutton

Attorneys

Patented July 11, 1933 1,917,708

UNITED STATES PATENT OFFICE

JEAN V. GIESLER, OF KNOXVILLE, TENNESSEE, ASSIGNOR TO THE FULTON SYLPHON COMPANY, OF KNOXVILLE, TENNESSEE, A CORPORATION OF DELAWARE

METHOD AND APPARATUS FOR DRAWING TUBES

Application filed June 25, 1930. Serial No. 463,784.

This invention relates to a method and apparatus for the drawing of tubes, and particularly for the drawing of relatively-long tubes in accordance with the generic process disclosed and claimed in the patent of Weston M. Fulton, No. 1,654,585, granted January 3, 1928, and entitled Method and apparatus for drawing tubes, and while this invention has utility in drawing tubes of a wide variety of thicknesses, it has special reference to the drawing of relatively long tubes of relatively thin metal.

It is an object of this invention to provide a method and apparatus for drawing relatively-long tubes wherein relatively movable punch and die elements successively effect the drawing of successive sections of a tube and then burnish the same in advance of the drawing of the next section of said tube.

Another object of this invention is to provide a method and apparatus for drawing relatively-long, and particularly relatively-thin walled, tubes wherein the tube is drawn in successive sections by relatively movable punch and die elements and wherein the tube is kept in substantially continuous motion with respect to the die, so that the die also functions as a burnishing element.

Another object of this invention is to provide a method and apparatus for drawing relatively-long, and particularly relatively-thin walled, tubes wherein the tube is drawn in successive sections by the relative movement of punch and die elements and each section after it is drawn is moved with the punch and through the die and then moved relatively to the punch and die before the succeeding drawing operation is initiated, so that the tube receives a burnishing treatment between each two succeeding drawing operations.

In my pending application Serial No. 375,161, filed July 1, 1929, for Tube drawing machines, there is disclosed and claimed a machine for drawing relatively-long and relatively-thin walled tubes in accordance with the process of the aforesaid Fulton patent. Tubes drawn in this machine are found to have, in at least some instances, spaced circumferential markings which correspond with the ends of the successive sections of the tube that are drawn in accordance with the principle of this machine, and while these markings do not appear to indicate any substantial difference in the characteristics of the tube or of the metal in so far as the practical use of the tube is concerned, the lack of uniformity in the appearance of the tube along its length is disadvantageous for some purposes where appearance is material.

Another object of this invention is to provide a method and apparatus for drawing relatively-long tubes which will avoid the surface markings formed on tubes by the use of the machine disclosed in my aforesaid application.

Another object of this invention is to provide a method and apparatus for drawing relatively-long tubes which will avoid the surface markings heretofore obtained in the use of the machine disclosed in my aforesaid application, and which may be practiced and incorporated in a machine of the same general type as that disclosed in said application.

Other objects will appear as the description of the invention proceeds.

Stated broadly, the present invention provides a method and apparatus whereby a tube may be drawn into a relatively-long, and particularly a relatively-thin walled, tube by relatively movable punch and die elements which have relative reciprocation to effect the drawing of the tube in successive sections, the relatively movable punch and die elements moving successively into cooperative relation with successive sections of the tube and drawing the same, and the tube and said drawing elements being moved relatively during the intervals between the drawing operations so that a burnishing action is effected.

The invention is capable of being carried out in a variety of ways, in so far as the method is concerned, and of receiving a variety of mechanical expressions, in so far as the apparatus is concerned, one apparatus being shown on the accompanying drawings, but it is to be expressly understood that the drawings are for purposes of illustration only and are not to be construed as a defini-

tion of the limits of the invention, reference being had to the appended claims for that purpose.

Referring in detail to the drawings, wherein the same reference characters are employed to designate corresponding parts in the several figures:—

Figs. 1, 1*a* and 1*b* together constitute a somewhat diagrammatic perspective longitudinal section of an apparatus suitable for carrying out the method of the present invention and also embodying mechanism in accordance with the present invention;

Fig. 2 is an enlarged axial section through the tube and the punch and die elements, chuck and associated parts; and

Fig. 3 is a fragmentary view of means for driving the intermittently operated rack.

The mechanism shown on the accompanying drawings is designed to be incorporated in a machine of the general character and construction disclosed in my prior application Serial No. 375,161 heretofore referred to, and only so much of said machine is illustrated as is necessary to an understanding of the novel principle of operation employed in operating the relatively movable punch and die elements and their associated parts.

As in the case of the machine disclosed in my prior application, a framework 10 of any suitable size, construction and material, and providing longitudinally extending ways for the rectilinearly movable element carries a driven shaft 11 which may be driven from any suitable source of power. As shown, said shaft 11 carries a pulley 12 driven by a belt 13 from a pulley 14 mounted on the shaft 15 of an electric motor 16 which may be mounted on the frame of the machine or on its base plate or in any other suitable location. Shaft 11 carries a spiral gear 17 and a pinion 18. Spiral gear 17 meshes with a spiral gear 19 mounted on a longitudinally extending shaft 20 which carries the driving element of a clutch 21 of any suitable character and construction, the same being shown as a rolling key clutch of the type illustrated and described in detail in my aforesaid application. Driven from the shaft 20 when the clutch 21 is in operation is a bevel gear 22 which meshes with a bevel gear 23 on a stub shaft 24 that operates the mechanism for periodically moving the tube with respect to the punch and die elements as hereinafter described in detail.

Pinion 18 meshes with a gear 25 on a crank shaft 26 the crank 27 of which, through the connecting rod 28, reciprocates a cross head 29 in suitable ways provided on the frame of the machine. Attached to lateral lugs 30 projecting from the cross head 29 are longitudinally extending rods 31 which, at their forward ends, are connected to rack bars 33 that have steeply inclined teeth 34 and are guided for sliding movement in brackets 35 suitably carried by the frame of the machine. Said rack bars, at their forward ends, are connected by a transverse tie bar 36, transverse pins 37 being shown as passed through apertures in said rack bars and engaging the face of said tie bar 36, so that said tie bar is positively moved with said rack bars.

Pivotally attached to the cross head 29 is a punch rod 40 which carries a roller 41 that runs on a track 42, and which may be raised to the position shown in dotted lines by the elevation of the track 42 by the piston rod 43 of a piston carried within the pneumatic or hydraulic cylinder 44, all as disclosed in my aforesaid application Serial No. 375,161.

Suitably attached to the forward end of the punch rod 40 is a punch 46. Suitably attached to said punch, as by an interiorly threaded recess 47 in the forward end of said punch and a threaded end 48 extending thereinto, is a pull rod 49 which extends lengthwise of the machine and at its forward end is attached to a piston 50 working in a cylinder 51 carried by the tie bar 36. Cylinder 51 has suitable inlet and outlet connections 52 so that the fluid under pressure, whether air or liquid, may be introduced into said cylinder to exert a tension on said pull rod 49. As the punch 46 is attached to the crosshead 29 by the punch rod 40 and the rack bars 33 are also attached to said crosshead, while the tie bar 36 moves with the rack bars 33 and the pull rod 49 is held under tension by its connection to said tie bar 36 as well as being positively connected to the punch 46 by the connection 47, 48, the punch is caused to move both forwardly and rearwardly with the rack bars 33 as they are reciprocated with the cross head 29.

Suitably mounted on the frame of the machine is a normally stationary but optionally movable die block 55 carrying a die 56, said block and die being of any suitable construction and mounted in any suitable way, as disclosed for example in my aforesaid application.

Mounted for rectilinear movement lengthwise of the machine and guided in the frame in any suitable way is a pull block 60 which extends transversely across the machine between the rack bars 33 and which is centrally apertured as shown at 61 to receive a chuck to be described. At each side of the machine said pull block 60 has generally T-shaped elements comprising forwardly and rearwardly extending arms 62 and 63 and a downwardly extending arm 64. Arm 62 has an upwardly extending projection 65, and rotatably mounted therein is a pin 66 which carries a rearwardly extending pawl 67. Arm 63 has an upwardly extending projection 68, and rotatably mounted therein is a pin 69 which carries a forwardly extending pawl 70. These elements are also duplicated

at the opposite side of a machine for cooperation with the rack bar on that side.

Carried by the pull block 60 is a chuck 71 of any suitable construction, that illustrated being of the type illustrated and described in my aforesaid application and comprising jaw pieces 72 pivotally mounted on levers 73 pivotally mounted at 74 and operable by a ring nut 75. A spring pressed tail block ejector is shown at 76. The tube 80 to be drawn is provided at its forward end with a swaged and flanged portion 81 to receive a tail block 82 having a reversely beveled head 83 which cooperates with the clutch jaws 72 to clamp the flanged end of the tube between the shoulder 84 on said tail block and the clutch jaws 72, all as described and illustrated in my aforesaid application.

Pin 66 has suitably attached thereto, as by set screw 90, a crank arm 91 which is pivotally connected at 92 to a link 93 which, at its opposite end, is pivotally connected at 94 to a crank arm 95 that extends from a hub 96 that may slide on and be rotated by a rod 97 suitably supported in the frame of the machine and extending longitudinally thereof. Link 93 passes through a coil spring 98 seated on a bracket 99 suitably attached to an extension of the pull block 60. At its opposite end spring 98 engages a transverse pin 100 carried by the link 93, so that said link is normally urged upwardly, in a direction to depress the pawl 67 into engagement with the teeth 34 of the rack 33.

Pin 69 also has suitably attached thereto, as by a set screw 101, a crank arm 102 which is pivotally connected at 103 to a link 104 that, at its lower end, is pivotally connected at 105 to a crank arm 106 which has a hub 107 that may slide on and be rotated by a rod 108 suitably supported by the frame of the machine and extending lengthwise thereof parallel to the rod 97.

Rod 108 near its forward end has fixedly attached thereto a crank arm 109 to which is pivotally attached at 110 a link 111 which, at its upper end, is pivotally attached at 112 to a bell crank 113 having an upwardly extending nose 114 in the path of a lug 115 carried by the underside of the rack bar 33. Link 111 passes through a coil spring 116 seated on bracket 117 suitably mounted on the frame of the machine, said spring at its opposite end engaging a transverse pin 118 carried by the link 111, so that the nose 114 of the bell crank 113 is normally urged upwardly into the path of lug 115.

Also mounted at 119 on the frame of the machine at the opposite side of the lug 115 from the bell crank 113, is a second bell crank 120 having a nose 121 in the path of said lug 115. Bell crank 120 is pivotally connected at 122 to a link 123 which extends downwardly through a coil spring 124 that is seated on a bracket 125 suitably carried by the frame of the machine and that engages, at its opposite end, a transverse pin 126 carried by the link 123, so that said bell crank 120 is normally urged in a direction to position its nose 121 in the path of the lug 115. The opposite end of link 123 is pivotally connected at 127 to a crank arm 128 projecting from a hub 129 that is fixed on a rod 130 which extends lengthwise of the machine parallel to the rods 97 and 108 heretofore described.

Slidably mounted on and rotated by the rod 130 is the hub 131 of crank arm 132 pivotally connected at 133 to a link 134 which extends upwardly and, at its opposite end, is pivotally connected at 135 to a crank arm 136 carried by a pin 137 which is rotatably mounted in the downwardly extending arm 64 of the pull block 60. Carried by said pin 137 is an upwardly and rearwardly extending pawl 138 which is designed to engage and cooperate with the teeth 139 of a rack bar 140 suitably mounted for rectilinear movement in the frame of the machine.

Rack bar 140 is designed to be given a forward and rearward movement periodically, and any suitable means may be provided to this end. As shown, a toothed segment 141 (Fig. 3) is pivotally mounted on the frame of the machine at 142 and has its teeth in mesh with the teeth of said rack bar. Said segment has attached thereto an arm 143 in which is a longitudinally extending slot 144. Mounted on the stub shaft 24 heretofore described is a disk 145 which carries a pivotally mounted block 146 that may slide in said slot 144 as the disk 145 is rotated, and which by its coaction with said arm 143 oscillates the segment 141 to advance and withdraw the rack bar 140.

To actuate the clutch 21 at the appropriate time and permit the disk 145 to make a single revolution and then come to rest, the clutch 21 has an operating arm 149 carried by a shaft 150 which, at its opposite end, has a crank arm 151 that is pivotally connected at 152 to a link 153 which extends upwardly through a coil spring 154 seated on a bracket 155 carried by the frame of the machine and cooperating with a pin 156 carried by said link 153. Link 153 at its upper end is pivotally connected at 157 to a bell crank 158 pivoted on the frame of the machine at 159 and having an upwardly extending nose 160 in the path of a lug 161 carried by the rack bar 33.

To provide manual means by which all of the rods 97, 108 and 130 may be rotated in order to remove the several pawls from operative relation to their respective racks, each of said rods has suitably attached thereto a hub 165 to which is operatively connected a link 166 that, at its opposite end, is suitably attached to a lever 167 pivoted to the frame of the machine at 168 and having any

suitable locking device 169 cooperating with a segment 170 for retaining the same in adjusted position.

As in my application above identified it is preferred to have the rack bars 33 and their associated parts for applying the drawing force to the tube, i. e. the force by which a drawing operation is effected, symmetrically arranged with respect to the axis of the tube, so that the forces are applied symmetrically with respect to the axis of the tube and there is no tendency to exert a transverse force on the punch and its associated rods. Therefore, as in my application above identified, the mechanism heretofore described is duplicated on the opposite side of the machine from that illustrated in Figs. 1, 1*a* and 1*b*, the parts on the near side of the machine having been omitted for sake of clearness, but rods 97′, 108′ and 130′, together with some of the elements operated therefrom, as 93′, 95′, 104′, 105′, 132′, 134′ and 165′, being indicated. It will also be understood that if desired the rack bars 33 may be provided with teeth on both their upper and lower faces and the pawls and associated parts on each side of the machine may be duplicated for cooperation with the teeth on the upper and lower faces of said rack bars, as in my prior application, but for sake of clearness only one set of pawls cooperating with each rack bar has been illustrated.

In operation the punch and punch rod are moved to dotted line position, and a tail block 82 having first been positioned in the end of the tube, the tube is mounted over the punch, and then the punch with the tube carried thereby is lowered into full line position in which it is axially aligned with the die and die block. The latter are then moved, as in my prior application, over the end of the tube and the several pawls being held in inoperative position with respect to their several rack bars by the lever 167, the pull block 60 may be moved up to engage the chuck 71 with the projecting end of the tail block 82, in which position the flanged end 81 of the tube is fixedly clamped against the tail block and the ring nut 75 may then be rotated in any suitable way to retain the chuck in clamping engagement with said tail block and tube. The pull rod 49 is then attached to the end of the punch and fluid admitted to the cylinder 50 to put said pull rod under tension. Lever 167 is then moved to restore the pawls to operative relation with respect to their several racks, and the machine is ready for the drawing operation.

As the cross head 29 is moved forwardly by the crank 27 the rods 31 and rack bars 33 move forwardly therewith, and the tie bar 36 is also moved forwardly with the rack bars 33, while the punch 46 is both thrust forwardly by the punch rod 40 and pulled forwardly by the pull rod 49. The pawls 67 are now in engagement with the rack teeth 4 and the pull block 60 is likewise moved forwardly therewith. The punch and tube are thus drawn through the relatively stationary die 56, effecting the drawing operation. During this stage of the operation the pawls 67 are held in engagement with rack teeth 34 by springs 98 thrusting upwardly on pins 100 carried by the links 93 and urging the crank arms 91 in a counter clock-wise direction as viewed in the drawings. As the parts are duplicated at opposite sides of the machine, it will be sufficient to describe what takes place at one side only of the machine.

During the forward movement of the rack bar 33 the lug 115 passes off of the nose 114 of bell crank 113 and permits spring 116 to raise link 111 and rotate crank arm 109 in a clockwise direction as viewed in the drawings, to turn the rod 108 and crank arm 105, so that link 104 may move upwardly and rotate crank arm 102 to engage pawl 70 with the teeth of the rack bar 33. As the pull block 60 is moving with the rack bar 33 by reason of the engagement of pawl 67 with the teeth of said rack bar, however, there is no relative movement between said pawl 70 and the rack bar. During the major part of this forward movement of the rack bar 33, and throughout the latter portion of this movement, the lug 115 is engaging nose 121 of bell crank 120, and thereby holding the link 123 depressed. The downward movement of link 123 rotates crank arm 128 in an anti-clockwise direction as viewed in the drawings, and rod 130 is rotated to rotate crank arm 132 in an anti-clockwise direction, so that the link 134 is pulled downwardly and the crank arm 136 rotated in a direction to hold the powl 138 out of engagement with the teeth 139 of the rack bar 140.

When the cross head 29 starts on its rearward movement it pulls the rack bars 33 rearwardly therewith, the pull block 60 is moved rearwardly with the rack bars because the pawls 70 are now in engagement with the rack teeth 34, and therefore the tube moves rearwardly through the die with the punch 46. Pawl 138 is still held out of engagement with the teeth of rack bar 140 by the action of lug 115, and the pawls 67 are still in engagement with rack teeth 34 but there is no relative movement between said pawls 67 and the rack bars 33.

When the tube and punch have moved rearwardly for a suitable major part of the rear stroke, preferably about four fifths of the stroke, lug 115 passes out of engagement with the nose 121 of bell crank 120 and at the same time engages nose 114 of bell crank 113. Bell crank 113 is thus rotated in an anticlockwise direction as viewed in the drawings, to depress the link 111 against the tension of its spring 116 and rotate crank arm 109, rod 108 and crank arm 105 in an anticlockwise direc-

tion, pulling down on link 104 and rotating crank arm 102 to elevate the pawl 70 from the rack bar 33, thereby terminating the rearward motion of the pull block 60 with the rack bars 33 and the punch 46. The rearward movement of the tube through the die is thus terminated. On the other hand, the release of the nose 121 of bell crank 120 permits spring 124 to elevate the link 123 and rotate the crank arm 128 in a clockwise direction as viewed in the drawings, similarly rotating rod 130 and crank arm 132 to raise link 134 and rotate crank arm 136 to engage pawl 138 with the teeth of the rack bar 140. At the same time, the lug 161 on the rack bar 33 engages the nose 160 of bell crank 158, depressing link 153 and rotating crank arm 151 to rotate the shaft 150, so that the clutch 21 is actuated.

The shaft 24 with its disk 145 is given one complete revolution and the sector 141 first moves forwardly and, by reason of its engagement with the teeth of rack bar 140, the latter is also moved forwardly. As pawl 138 is now engaged with the teeth of rack bar 140 the pull block 60 is fed forwardly therewith. This forward motion of the pull block under the action of the rack bar 140 takes place during the remaining portion of the rearward stroke of the punch and rack bars 33 and the first part of the forward stroke of the punch and said rack bars. During this movement of the pull block 60 forwardly under the action of the rack bar 140, the tube is stripped off of the punch and moved forwardly through the die.

When the rack bars 33 on their next forward stroke have attained the speed of the rack bar 140 they assume the forward feed of the pull block 60. At this time the rack bars 33 have moved to the position in which the lug 115 engages the nose 121 of the bell crank 120 to disengage pawl 138 from rack bar 140, and the lug 115 moves out of engagement with the nose 114 of the bell crank 113, permitting pawl 70 to reengage rack teeth 34. If the discontinuance of the rearward stroke of the tube occurred at four fifths of the rearward stroke of the punch, the resuming of the forward stroke of the tube under the action of the rack bars 33 will take place approximately at the end of one fifth of the forward stroke of the rack bars 33. During the interim when the punch is completing its rearward stroke and again "catching up" with the tube as it is moved forwardly under action of the rack bar 140, however, the tube is moved forwardly by an amount equal to that by which the tube was moved rearwardly when the pull block 60 was being fed rearwardly by the coaction of the pawl 70 with the rack bar 33. Hence the speed of movement of the pull block 60 under the action of the rack bar 140 up to the instant when the pawl 138 is disengaged from the rack bar 140 is such that the pull block is moved forwardly by the same amount as that by which said block was moved rearwardly. The forward movement of the pull block 60 under the action of the rack bar 140 should continue until the speed of the rack bar 33 is substantially the same as that of the rack bar 140, so that there is no substantial change in speed when the pull block 60 moves forwardly again under the action of the rack bars 33. Up to this time during forward stroke the rate of forward movement of the racks 33 is less than the rate of forward movement of the pull block 60 under the action of the rack bar 140, so that the pawl 67 may ratchet over the teeth 34 without being disengaged therefrom, while the pawl 70 is held positively disengaged from the teeth 34 during this period by the action of the lug 115 on the bell crank lever 113.

When the pull block 60 is again moving forwardly under the action of the rack bars 33, the pawl 138 is again disengaged from the rack bar 140 by the action of the lug 115 on the bell crank 120, and said rack is returned to initial position by the second half of the cycle of rotation of the disk 145. At the end of the complete cycle of rotation of the disk 145 the rolling key clutch is thrown out of operation automatically in a manner well understood in the art, and the disk 145 remains stationary until the next engagement of the lug 161 with the nose 160 of bell crank 158.

When the tube has been entirely drawn the lever 169 is moved in an anticlockwise direction as shown in the drawings to rotate each of the rods 97, 108 and 130 in an anticlockwise direction and withdraw all of the pawls 67, 70 and 138 out of operative relation to their respective racks, and the pull block 60 may then be moved freely on its ways. The pressure in cylinder 50 having been released, the pull rod 49 may be disconnected and withdrawn from the punch, and the drawn tube may be disconnected from the chuck 70 and withdrawn from the machine.

It is to be understood that the machine so far described is to be provided with suitable means for lubricating the tube being drawn, which means may take the form illustrated and described in my application above identified, and the machine may also be provided with automatic devices of the type disclosed in my prior application for automatically performing the various functions in proper timed sequence, these various automatic mechanisms having been omitted for the sake of clearness and only so much of the machine here illustrated and described as will bring out the novel features of the present machine.

It will, therefore, be perceived that in accordance with the method of this invention as carried out in the apparatus heretofore described, the tube moves forwardly with

the punch, and is subjected to a drawing operation between the relatively movable punch and die elements. The tube is then returned with the punch through the major portion of its stroke, and then before reaching the end of the rearward stroke, at which time the punch has moved out of operative relation with the die, the rearward feed of the tube is discontinued and the tube is fed forwardly while the punch completes its rearward stroke and starts on its forward stroke. Then when the punch has attained a speed equal to the forward speed of the tube the punch comes into operative relation with the die and the drawing mechanism resumes control of the tube and the next section of tube is drawn. This new section of drawn tube then moves rearwardly with the punch during the major portion of its stroke, and then moves forwardly while the punch completes its rearward stroke and starts forwardly on its forward stroke, and then a third section of the tube is drawn. This continues until the entire tube is drawn.

While the proportion of stroke during which the tube moves rearwardly with the punch and then forwardly independently of the punch may be varied, experience has demonstrated that it is desirable that the tube move rearwardly with the punch approximately four fifths of its stroke, and while the punch is moving the remaining fifth of its rearward stroke and the first fifth of its forward stroke, the drawn portion of the tube may be moved forwardly with respect to the die by an amount equal to that by which the tube was moved rearwardly. Thus, if the punch makes a five inch stroke the tube moves rearwardly four inches and then forwardly four inches while the punch is "catching up" with the forwardly moving tube, after which the next section of four inches is drawn, so that the net advance of the tube is four inches for each forward stroke. It is to be expressly understood, however, that these figures are for purposes of illustration only, as the length of the stroke may be varied within considerable limits and the ratio of drawing stroke to the stroke of the punch may also be varied within considerable limits.

During the period that the tube is moving rearwardly with the punch and then forwardly independently of the punch, the tube is receiving a burnishing action, because during both of these movements the tube is being drawn through the die. The last section of the tube to be drawn is thus subjected to two burnishing actions of the die, during one of which the tube is moving with the punch but relatively to the die and during the other of which the tube is moving with respect to both punch and die, before the next section of tube is drawn. Hence the markings that have heretofore arisen from the intermittent action of relatively movable punch and die elements are entirely eliminated and the tube is uniform in appearance throughout.

While the mechanism illustrated is designed to be incorporated in the machine of my earlier application above identified, it is to be expressly understood that such is not essential, as a machine embodying the principles heretofore described may be built for embodiment in machines of a wide variety of constructions. Moreover, it is to be expressly understood that in so far as the method is concerned the mechanism illustrated has been selected for purposes of illustration only, because the method of this invention may be carried out with a wide variety of apparatus, and therefore it is to be expressly understood that in so far as the method of this invention is concerned, it is contemplated that any suitable relatively movable punch and die elements may be employed to draw successive sections of a tube in a step by step motion, while causing the tube to move with and relatively to said relatively movable elements between the successive drawing operations, so as to give the tube a burnishing treatment between the successive drawing operations. Also, while the method has been illustrated by reference to the movement of the punch with respect to a relatively stationary die, it will be apparent to those skilled in the art that the method can be carried out by reciprocating the die with respect to the punch, or by the simultaneous movement of both of said elements. Furthermore, while the invention has particular utility when applied to the drawing of tubes of relatively thin metal, the invention may also be used in the drawing of thicker tubes. Reference is, therefore, to be had to the claims hereto appended for a definition of the limits of the invention.

What is claimed is:

1. The method of drawing tubes which includes intermittently exerting a drawing force on the tube to pull successive portions thereof between punch and die elements, aiding the passage of the tube between said elements during the successive exertions of drawing force by relatively moving said punch and die elements, and moving said tube relatively to said punch and die elements to burnish the tube between successive exertions of drawing force.

2. The method of drawing tubes which includes intermittently exerting a drawing force on the tube to pull the tube in a step by step motion between punch and die elements, reciprocating one of said elements relatively to the other to aid in the drawing of successive portions of the tube, and producing relative movement between the die element and tube to burnish the tube between the exertions of first named drawing force.

3. The method of drawing tubes which includes intermittently advancing successive portions of the tube between relatively reciprocating punch and die elements, permitting said tube to move with the relatively movable element for a portion of its stroke in both directions of reciprocation, and then advancing said tube relatively to said last named element so as to bring said relatively movable elements into cooperative relation with the next succeeding portion of the tube to be drawn.

4. The method of drawing tubes which includes advancing the tube in a step by step motion to bring successive portions of the tube into cooperative relation with relatively movable punch and die elements, and relatively reciprocating said tube with respect to said elements after each advance of the tube to first draw and then burnish the successive portions of the tube.

5. The method of drawing tubes which includes intermittently advancing successive portions of the tube between punch and die elements, reciprocating one of said elements relative to the other through a stroke which is short as compared with the length of the tube, and moving the tube with and then relatively to the relatively movable element to draw and burnish succeeding portions of the tube.

6. The method of drawing tubes which includes intermittently drawing successive portions of the tube by and between relatively moving punch and die elements, and between successive drawing operations moving the tube in opposite directions both with said relatively movable element and relatively to said relatively movable element to burnish the tube.

7. The method of drawing tubes which includes intermittently exerting a pulling force to draw successive portions of the tube while aiding the drawing thereof by the frictional action of relatively moving punch and die elements, and intermittently moving said tube in opposite directions both with and relatively to said relatively movable element to burnish the tube.

8. The method of drawing tubes which includes advancing successive portions of the tube between punch and die elements while relatively reciprocating said elements to draw successive portions of the tube, and then moving said tube in opposite directions and with respect to both of said elements to burnish the same.

9. The method of drawing tubes which includes reciprocating a punch with respect to a die, advancing successive portions of the tube between said punch and die while drawing said successive portions with the aid of the frictional action thereon of said punch, permitting said tube to move with said punch reversely through said die for a portion of the stroke of said punch to burnish the tube, then moving the tube relatively to said punch and die to further burnish the tube.

10. The method of drawing tubes which includes advancing successive portions of the tube between punch and die elements while reciprocating one of said elements relatively to the other through a stroke which is short as compared with the length of the tube to draw successive sections of the tube, and reciprocating said tube in opposite directions with respect to the relatively stationary one of said elements between successive drawing operations to burnish the tube.

11. The method of drawing tubes which includes intermittently exerting a drawing force on the tube to advance successive portions of the tube between punch and die elements by strokes which are short as compared with the length of the tube, reciprocating one of said elements relatively to the other to move the tube in both directions with respect to the other of said elements to aid in the drawing operation and to burnish the tube, and moving the tube with respect to said elements to bring successive portions of the tube into cooperative relation therewith.

12. The method of drawing tubes which includes intermittently exerting a drawing force to advance successive portions of a tube between punch and die elements, moving said punch during the exertion of the drawing force to assist the passage of the tube between said elements, and moving the tube with and with respect to said punch to burnish successive portions of the tube by their relative movement with respect to the die.

13. The method of drawing tubes which includes thinning the wall of a tube by intermittently advancing successive portions of the tube between punch and die elements while reciprocating said tube with and relatively to the punch during the intermittent advances of the tube to both draw and burnish the same.

14. The method of drawing tubes which includes intermittently exerting a drawing force on a tube to draw successive portions thereof through a die during the successive exertions of drawing force, reciprocating the punch relative to said die and in frictional contact with the tube, and between exertions of drawing force moving said tube with said punch relatively to the die and then relatively to the punch and die to bring succeeding portions of the tube into cooperative relation with said punch and die.

15. The method of drawing tubes which includes intermittently exerting a drawing force on the tube to advance short sections of the tube between punch and die elements, relatively reciprocating said elements through corresponding short lengths of movement to aid the passage of said tube therebetween and to burnish the tube, and moving the tube rela-

tively to said elements through corresponding short distances to move successive sections of tube into cooperative relation with said elements.

16. The method of drawing tubes and burnishing the same which includes intermittently advancing successive short lengths of tube through a die by a drawing force while aiding relative movement between the tube and die, and burnishing the tube by the relative movement between said tube and die during the period between the positive advance of succeeding short lengths of tube into cooperative relation with said punch and die elements.

17. The method of drawing relatively long tubes in successive sections which includes reciprocating successive sections of the tube in opposite directions by and with respect to relatively reciprocating punch and die elements to draw and burnish the tube in a step by step motion.

18. The method of drawing tubes which includes reciprocating successive sections of a relatively long tube in opposite directions between and by the relative movement of relatively reciprocating punch and die elements and during a portion of said reciprocation of the tube advancing the tube with respect to said elements, to burnish the tube and bring successive sections thereof into cooperative relation with said elements.

19. The method of drawing tubes which includes relatively reciprocating a punch with respect to a die, advancing successive sections of the tube with the punch through the die to draw the same and then reversely through the die to burnish the same, and during each advancing movement of the tube advancing the tube with respect to said elements to bring successive sections of said tube into cooperative relation with said elements.

20. The method of drawing tubes which includes reciprocating a tube between punch and die elements in a back and forth movement wherein the forward movement is approximately double the rearward movement, and relatively reciprocating said punch and die elements to aid in the drawing of the tube and to burnish the drawn tube.

21. The method of drawing tubes, which includes reciprocating a tube between punch and die elements in a back and forth movement wherein the forward movement is approximately double the rearward movement, exerting a drawing force on said tube during a portion of each of said forward movements, and relatively reciprocating said punch and die elements to aid in the drawing operation and to aid in the burnishing operation.

22. The method of drawing tubes which includes reciprocating a punch with respect to a die, successively applying a feeding force and a drawing force to said tube, and between successive applications of drawing force and feeding force moving the tube rearwardly with respect to the die.

23. The method of drawing tubes which includes reciprocating a punch with respect to a die, successively applying a feeding force and a drawing force to said tube, between successive applications of drawing force and feeding force moving the tube rearwardly with respect to the die, and aiding the passage of the tube through the die in both directions by the reciprocation of the punch.

24. The method of drawing tubes which includes relatively reciprocating punch and die elements to aid in advancing the tube in a step by step motion with respect to said elements, while intermittently applying a pulling force to the tube, and between successive applications of pulling force reversing the direction of movement of the tube.

25. The method of drawing tubes which includes relatively reciprocating punch and die elements, and advancing the tube in a step by step motion with respect to said elements by alternately applying drawing and feeding forces thereto and between successive applications of drawing and feeding force reversing the direction of movement of the tube while aiding the drawing and reverse movements of said tube by the relative reciprocation of said punch and die elements.

26. In a machine for drawing tubes, the combination of a die element, a punch element, means for reciprocating one of said elements with respect to the other through a stroke which is short as compared with the length of the tube, means for intermittently advancing successive portions of the tube into cooperative relation with said relatively movable elements and means whereby said tube is moved in the opposite direction by reason of the relative movements of said elements.

27. In a machine for drawing tubes, the combination of a die element, a punch element, means for reciprocating one of said elements with respect to the other, means for intermittently exerting a drawing force on the tube to draw the same between said punch and die elements, means for intermittently moving the tube in the opposite direction to that in which the drawing force is exerted, and means for intermittently advancing the tube with respect to said elements to bring successive portions thereof into cooperative relation with said elements.

28. In a machine for drawing tubes, the combination of a die element, a punch element, means for producing relative reciprocation between said punch and die elements, means for drawing successive portions of the tube between said punch and die elements, means for moving said tube between said punch and die elements in the opposite direction, and means for moving said tube with

respect to both of said elements to bring a succeeding portion of said tube into cooperative relation with said elements.

29. In a machine for drawing tubes, the combination of a die element, a punch element, means for reciprocating one of said elements with respect to the other, a block separate from said reciprocating element, means carried by said block for clamping a tube, means for compelling said block to move with said reciprocating element during a portion of its stroke, and means for moving said block with respect to said reciprocating element during the remainder of its stroke.

30. In a machine for drawing tubes, the combination of a stationary die, a punch, means for reciprocating said punch with respect to said die, a block provided with means for clamping a tube, means whereby said block advances with said punch as said punch moves in one direction, means whereby said block returns with said punch for a portion of its stroke, and means for advancing said block with respect to said punch in the opposite direction.

31. In a machine for drawing tubes, the combination of relatively movable punch and die elements, means for reciprocating one of said elements with respect to the other of said elements, a block provided with means for clamping a tube, means whereby said block is made to move with said movable element in opposite directions, and means whereby said block is then made to move relatively to said movable element.

32. In a machine for drawing tubes, the combination of a die, a block provided with means for clamping a tube, intermittently acting means for exerting a drawing force on said block, a punch reciprocating relatively to said die in synchronism with the applications of drawing force, means whereby said block moves said tube reversely with said reciprocating punch between the intervals of application of drawing force, and means whereby said block is moved relatively to said punch between said intervals of application of drawing force.

33. In a machine for drawing tubes, a die element, a punch element, means for reciprocating one of said elements with respect to the other, a block provided with means for clamping a tube, means for connecting said block with said relatively movable element for movement in opposite directions, and means for then moving said block relatively to said movable element.

34. In a machine for drawing tubes, a die element, a punch element, means for reciprocating one of said elements with respect to the other, a block provided with means for clamping a tube, means for moving said block with said relatively movable element in one direction, means for returning said block with said last named element through a portion of its stroke, and means for moving said block with respect to both of said elements to advance successive sections of the tube into cooperative relation with said elements.

35. In a machine for drawing tubes, a die element, a punch element, means for reciprocating one of said elements with respect to the other, a block provided with means for clamping a tube, pawl and ratchet mechanism for moving said block with said relatively movable element in one direction, pawl and ratchet mechanism for moving said block with said relatively movable element in the opposite direction, pawl and ratchet mechanism for moving said block relatively to both of said elements, and means for automatically discontinuing the operation of said second named pawl and ratchet mechanism and initiating the operation of said last named pawl and ratchet mechanism for advancing said tube with respect to said elements.

36. In a machine for drawing tubes, the combination of a relatively stationary die, a relatively movable punch, a block provided with means for clamping a tube, means for moving said block with said punch in opposite directions, and means for discontinuing the movement of said block with said punch near one end of the stroke of said punch and for moving said block forwardly relatively to said punch while said punch completes its stroke and starts on its next stroke.

37. In a machine for drawing tubes, the combination of a relatively stationary die, a relatively movable punch, a block provided with means for clamping a tube, means for moving said block forwardly with respect to said punch, means for moving said block with said punch for a portion of each of its strokes, and means for discontinuing the operation of said last named means and effecting the operation of said first named means during the remaining portions of the strokes of said punch.

38. In a machine for drawing tubes, the combination of a punch element, a die element, means for relatively reciprocating said elements, a block provided with means for clamping a tube, means for nominally moving said block with the relatively reciprocating element, means for periodically discontinuing the movement of said block with said element, and means for relatively moving said block forwardly with respect to said element during the intervals when the movement of said block with said reciprocating element has been discontinued.

39. In a machine for drawing tubes, the combination of a punch element, a die element, means for relatively reciprocating said elements, a block provided with means for clamping a tube, means for moving said block

with said reciprocating element in both directions, means for moving said block independently of said element, and means operated by the movement of said block for discontinuing the operation of said first named means and initiating the operation of said last named means.

40. In a machine for drawing tubes, the combination of a reciprocating punch, a relatively stationary die associated therewith, a block provided with means for clamping a tube, means whereby said punch and block move forwardly and rearwardly by equal amounts, and means whereby said block moves forwardly with respect to said punch by a like amount.

41. In a machine for drawing tubes, the combination of a reciprocating punch, a relatively stationary die associated therewith, a block provided with means for clamping a tube, means nominally connecting said block with said punch for relative movement with respect to said die in opposite directions, means for moving said block forwardly with respect to said punch and die, and means operated by the movement of said block for discontinuing the movement thereof with said punch and initiating the movement of said means to move said block independently of said punch.

42. In a machine for drawing tubes, the combination of a reciprocating punch, a block provided with means for clamping a tube, a relatively stationary die, means for operating said block and punch to move a tube with respect to said die to draw the tube in successive portions and move the tube rearwardly through the die for a burnishing operation, and means for periodically moving said block independently of said punch to bring successive portions of the tube into cooperative relation with said die.

43. In a machine for drawing tubes, the combination of relatively movable punch and die elements, a block provided with means for clamping the tube, means for reciprocating said block and one of said first named elements to draw successive portions of the tube and burnish the same, and means to feed the block forwardly with respect to said reciprocating element between the successive burnishing and drawing operations.

44. In a machine for drawing tubes, the combination of a punch, a die, means for relatively reciprocating said punch and die, a block provided with means for clamping a tube, means for moving said block with the reciprocating element, means for feeding said block forwardly to bring successive portions of the tube into cooperative relation with said punch and die, and means for discontinuing the operation of said feeding means while said block reciprocates said tube in both directions to draw and burnish a portion thereof.

45. In a machine for drawing tubes, the combination of a punch element, a die element, means for reciprocating one of said elements relative to the other, a block provided with means for clamping a tube, means for intermittently feeding said block with respect to said punch and die elements to bring successive portions of said tube into cooperative relation therewith, and means for intermittently moving said block with the relatively reciprocating element of said punch and die to draw and burnish a portion of said tube with the aid of the relative movement of said punch and die elements.

46. In a machine for drawing tubes, the combination of a reciprocating punch, a relatively stationary die associated therewith, a block provided with means for exerting a pulling force on the tube, pawl and ratchet mechanism whereby said punch and tube move forwardly and rearwardly together, pawl and ratchet mechanism for moving said block and punch relatively to each other, and means operated by the movement of one of said members for alternately rendering said pawl and ratchet mechanisms operative and inoperative.

47. In a machine for drawing tubes, the combination of a reciprocating punch, a relatively stationary die associated therewith, a block provided with means for exerting a pulling force on the tube, pawl and ratchet mechanism whereby said punch and block may move forwardly and rearwardly together, pawl and ratchet mechanism whereby said block moves forwardly with respect to said punch, and means operated by the movement of said block for alternately moving said pawl into and out of operative relationship with their respective ratchets.

48. In a machine for drawing tubes, the combination of a reciprocating punch, a relatively stationary die associated therewith, a block provided with means for exerting a pulling force on the tube, pawl and ratchet mechanism whereby said punch and block move forwardly together, pawl and ratchet mechanism whereby said punch and block move rearwardly together, pawl and ratchet mechanism whereby said block moves independently of said punch, and means for bringing said pawl and ratchet mechanisms into operation in timed sequence.

In testimony whereof I have signed this specification.

JEAN V. GIESLER.