Nov. 5, 1946. R. W. ANDREWS, JR., ET AL 2,410,594

CARRIAGE FOR METAL DRAWING APPARATUS

Original Filed Aug. 3, 1939 5 Sheets-Sheet 1

Fig. 1.

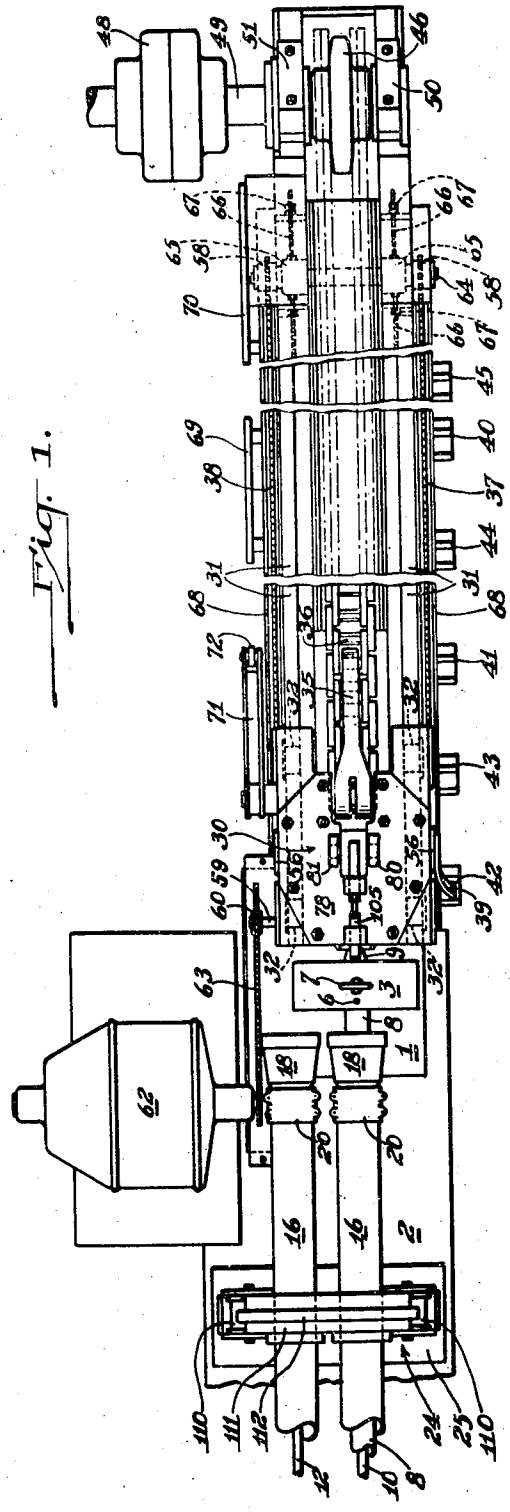
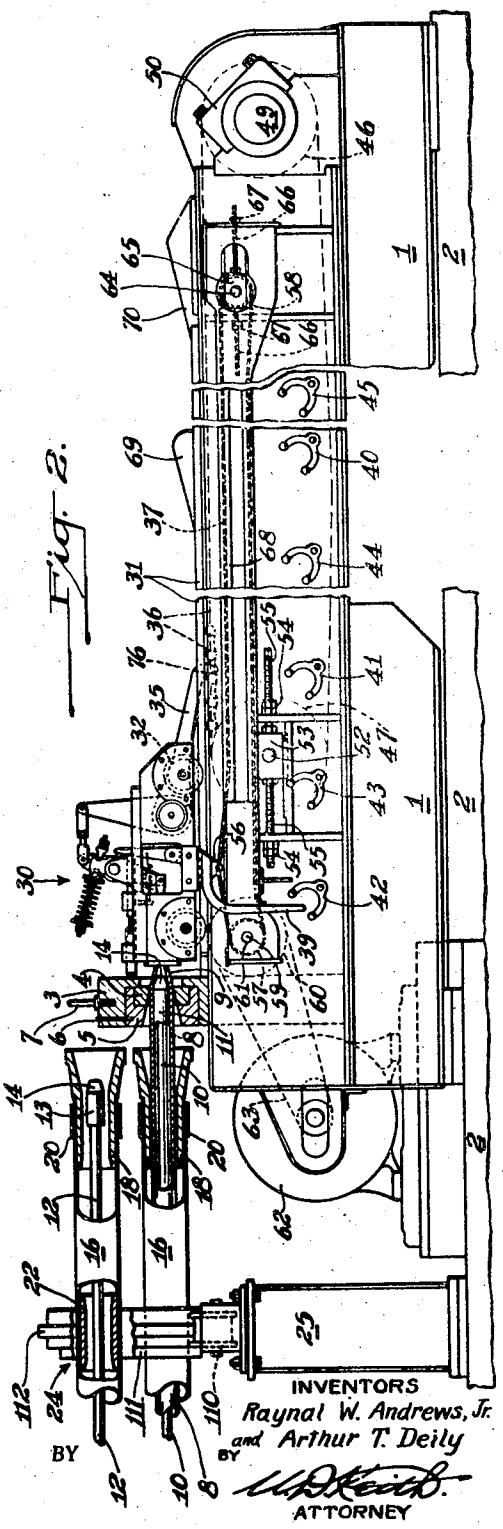


Fig. 2.



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CARRIAGE FOR METAL DRAWING APPARATUS

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Fig. 4.

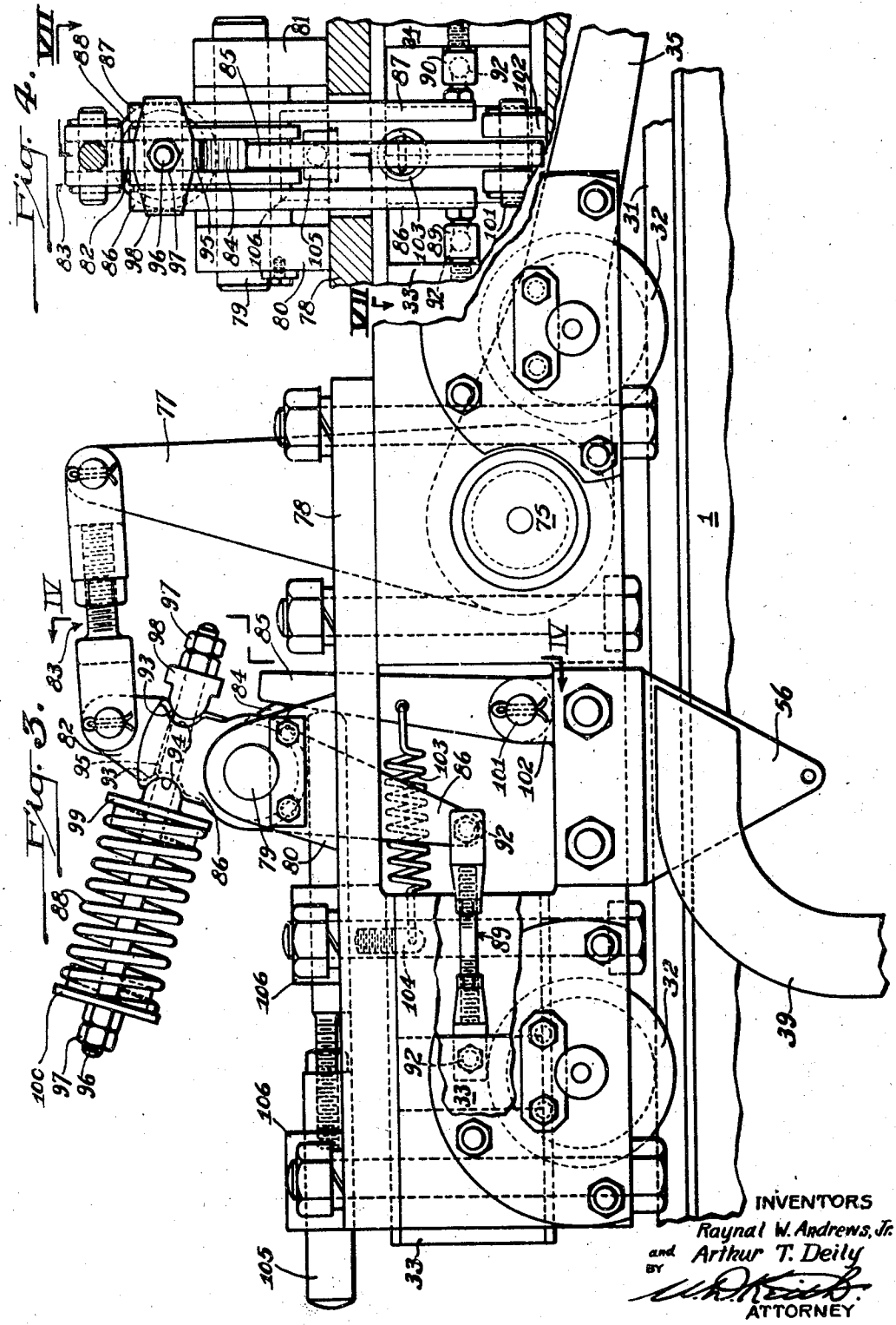


Fig. 3.

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CARRIAGE FOR METAL DRAWING APPARATUS

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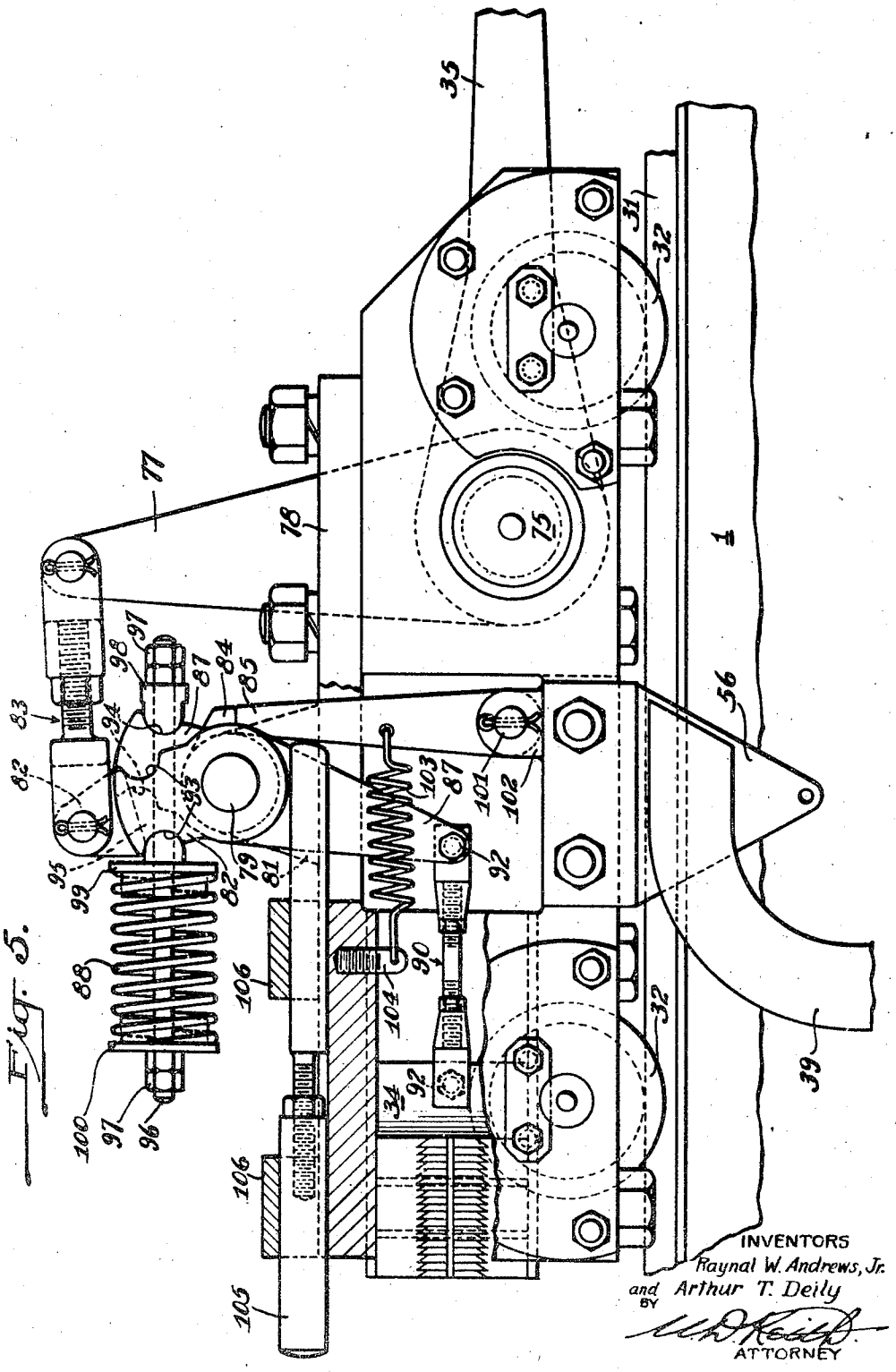


Fig. 5.

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CARRIAGE FOR METAL DRAWING APPARATUS

Original Filed Aug. 3, 1939 5 Sheets-Sheet 4

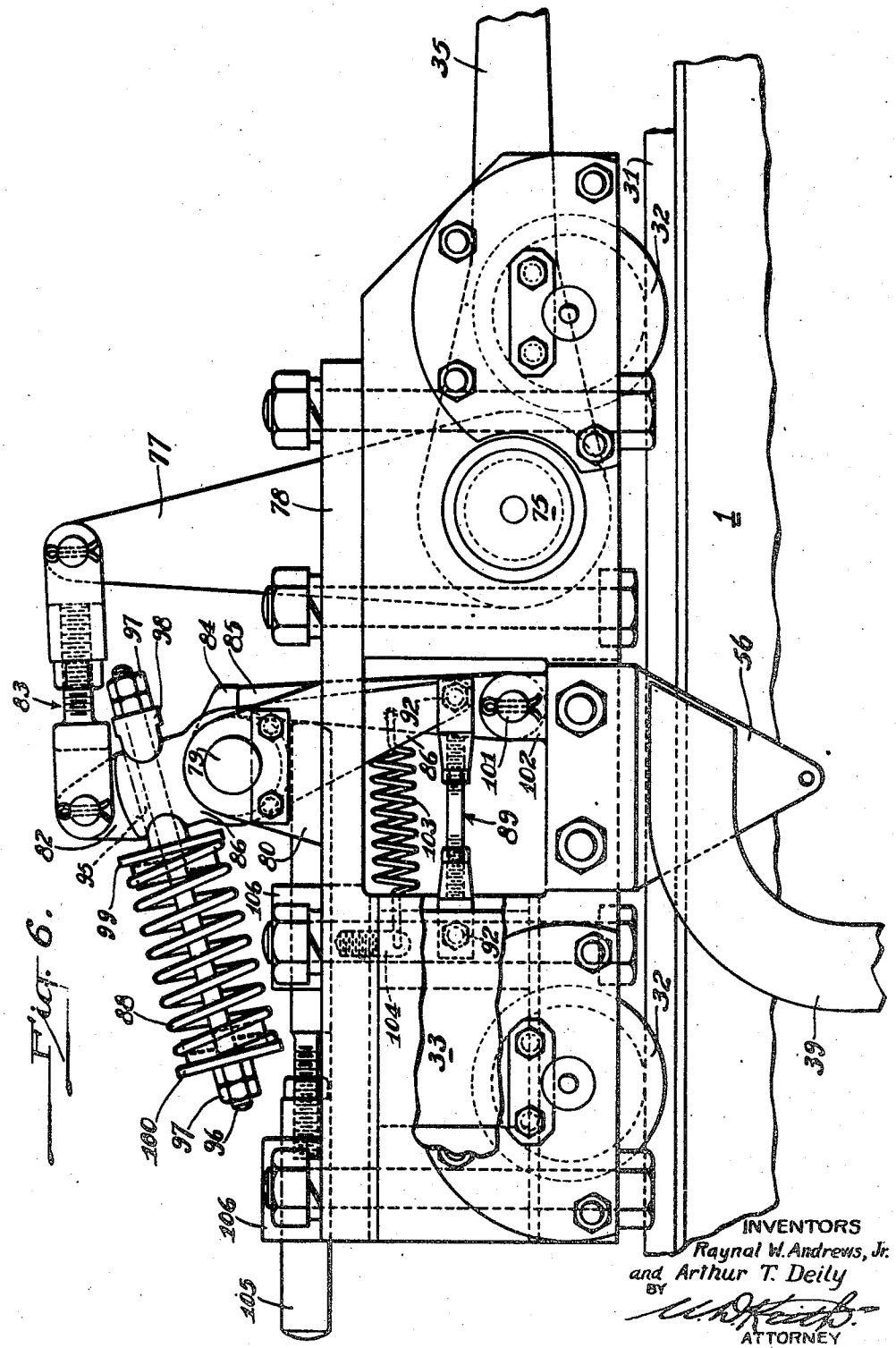


Fig. 6.

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CARRIAGE FOR METAL DRAWING APPARATUS

Original Filed Aug. 3, 1939 5 Sheets-Sheet 5

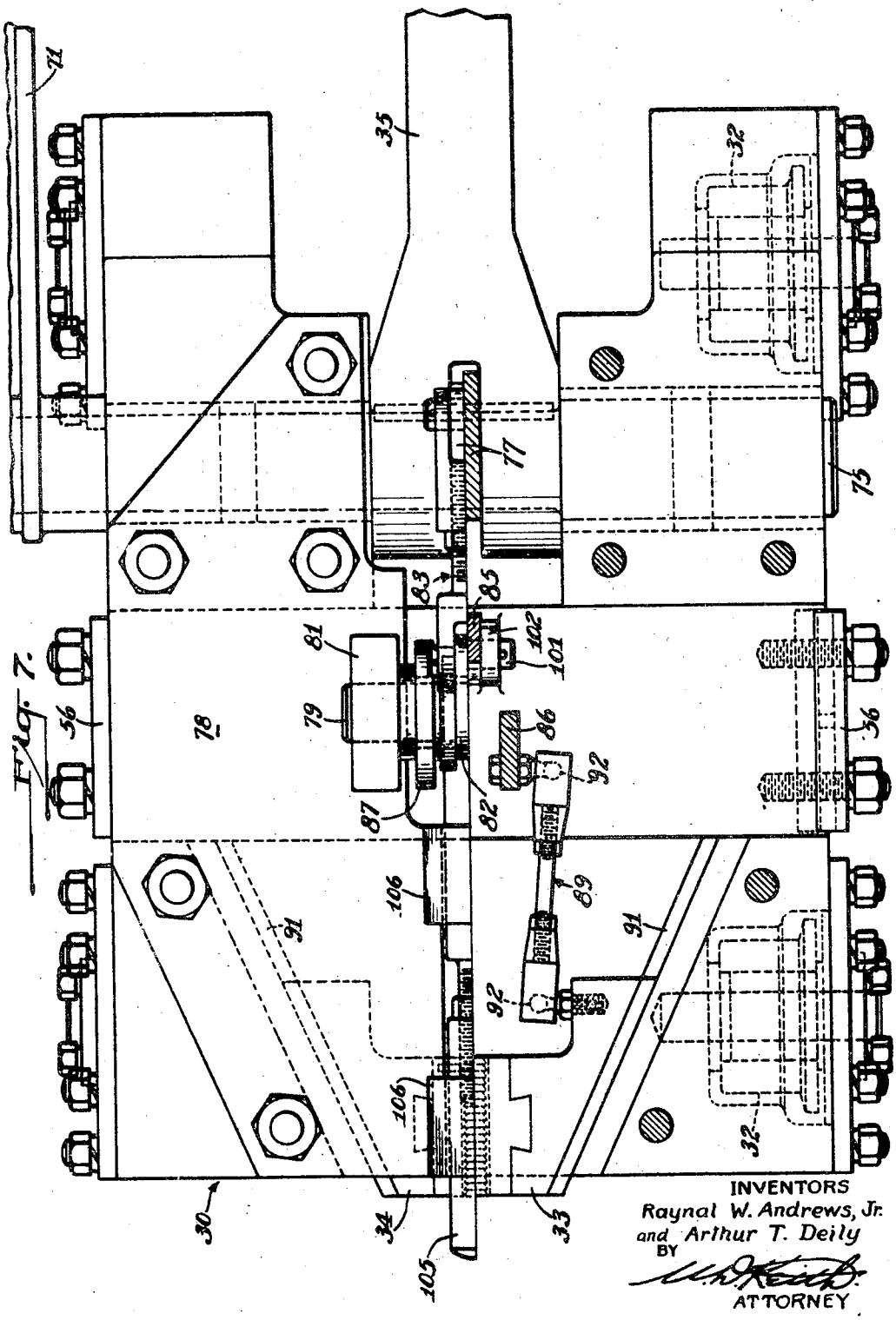


Fig. 7.

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Patented Nov. 5, 1946 2,410,594

UNITED STATES PATENT OFFICE

2,410,594

CARRIAGE FOR METAL DRAWING APPARATUS

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Original application August 3, 1939, Serial No. 288,163, now Patent No. 2,331,953, dated October 19, 1943. Divided and this application June 21, 1940, Serial No. 341,696

8 Claims. (Cl. 205—24)

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This application is a division of our application Serial No. 288,163, filed August 3, 1939, for improvements in Metal working apparatus, now U. S. Patent No. 2,331,953, granted October 19, 1943, and relates particularly to gripping jaw construction and actuating linkages therefor in a carriage for a metal drawing apparatus. Our application, Serial No. 341,697, filed June 21, 1940, for improvements in Metal drawing apparatus is also a division of our above-mentioned application.

This invention relates to apparatus for working metal shapes, and more particularly to draw benches for drawing tubular shapes, rods and the like through a die.

The usual draw bench for tube drawing comprises a supporting frame or frames upon which are mounted a die, a mandrel and bulb, a draw chain or the like, and a carriage having jaws for gripping the work after it has been passed over the mandrel and bulb and inserted through the die. The carriage must be moved to draw the work through the die, and for this motion generally engages with, and receives its drawing force from, a draw chain or similar device.

It has been customary for draw chains to be driven continuously and at constant speeds; and it has further been customary for a carriage to be engaged with the chain while it is in motion at such constant speed, thus accelerating the work almost instantaneously.

The jerking and shock of such rapid acceleration of the work frequently causes breakage in the work and results in waste of material and loss of useful production time. A further cause of breakage, waste, and poor work has been the fact that the gripping jaws of the drawing carriages of prior apparatus have not been designed to engage the work at points other than along the axis of the draw, and work-pieces pointed for engagement by the jaws often have pointed ends which are bent off center or otherwise disposed out of alignment with their normal axes.

The general object of this invention is to improve the drawing devices of the prior art to produce draw benches or similar apparatus in which the drawing operation may be performed with less loss of useful production time and less wastage of material than is now usually obtained. Specifically, this general object is obtained, in whole or in part, by the realization, singly or in combination, of the following more specific objects: The provision in a draw bench of a variable speed draw chain which may be stopped or slowed perceptibly, as the jaws clamp the work,

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for engagement therewith of the hook supported by the drawing carriage. The provision in a drawing carriage of work-engaging jaws adapted to engage such portions of the work-piece as may be located out of the axis of the draw, and of jaw-actuating means adapted to this purpose. The provision of a system or means capable of accelerating and decelerating the drawing carriage during its movement on return to the die head after the completion of a drawing cycle, and the provision of such a system or means capable of actuating said carriage without undue shock.

These and further objects and advantages of this invention, either singly or in combination, are for purposes of convenience illustrated with respect to a specific mechanism which embodies all of the specific features of the invention. It will be understood, however, that these features may be available for single use, or in any suitable combination, to improve the operation of draw benches or similar apparatus which do not include all of said features.

In the drawings:

Fig. 1 is a partial plan view of the preferred form of a mechanism embodying the features of the invention, and showing two mandrel rods the die head, the drawing carriage, the draw chain, two return chains, and the drawing section of a draw bench generally;

Fig. 2 is an elevation of the apparatus shown in Fig. 1 showing in more detail a mandrel-supporting member, the mandrel rods and bulbs, the die head, the drawing carriage, and drawing section of the draw bench generally;

Fig. 3 is a side elevation, to an enlarged scale, of the drawing carriage shown in Fig. 2, in which the work-engaging jaws of the drawing carriage are in a closed position and the draw chain engaging hook is in a lowered position, in its first engagement with the draw chain;

Fig. 4 is a fragmentary view, partly in section, of the jaw-actuating crank, jaw-actuating levers, and associated parts, taken along the line IV—IV of Fig. 3, the crank and levers being rotated into vertical position for simplicity of illustration;

Fig. 5 is a side elevation of the drawing carriage, similar to and to the same scale as Fig. 3, in which the work-engaging jaw shown is in a closed position, but in which the draw chain engaging hook is in a raised position assumed during a drawing action; this figure is partially sectioned to show the latching arrangement on the jaw-actuating crank; one work-engaging jaw and linkage therefor is removed for clarity of il-

lustration, and a serrated jaw insert is shown in the jaw illustrated;

Fig. 6 is a side elevation of the drawing carriage, similar to and to the same scale as Figs. 3 and 5, in which the draw chain engaging hook is in a raised position, but in which the work-engaging jaws are in a retracted or open position as assumed on the return movement of the carriage toward the die head; and

Fig. 7 is a plan view of the drawing carriage shown in Figs. 3, 5, and 6, and to the same enlarged scale, in which one-half is a section taken as indicated by the reference line VII—VII of Fig. 4.

Briefly, the apparatus as shown comprises a draw bench frame, a drawing head or carriage, a drawing die, and two work supporting mandrels. A hollow shape may be passed over one mandrel within a protecting shell or other guiding support by hand or by suitable mechanical loading mechanism (not shown); the mandrels may be rotated to align one work-piece and mandrel with the die; the point of the work-piece may be inserted through the die; and the mandrel and work-piece may be forced into registry with the die conjunctive with the beginning of the drawing action. The drawing carriage and its work gripping jaws may be actuated to clamp the point of the hollow-shaped work-piece, and may be moved along the draw bench by suitable engagement with a draw chain to draw the work-piece through the die. Upon completion of a draw, the work-piece may be released to a convenient rack or removal apparatus (not shown).

Endless return means are provided for automatically traversing the drawing carriage back to the die head after completion of a drawing operation. Such endless return means are preferably operable independently of the drawing chain and preferably are adapted to control the position and rate of speed of the drawing carriage during its return movement.

Die section

The die section of the draw bench will now be described with special reference to Figs. 1 and 2 of the drawings. By the die section is meant that portion of the apparatus immediately adjacent, or associated with, the drawing die. A main frame 1 is secured on foundation 2; and at one end of the main frame (to the left as viewed in Figs. 1 and 2) is mounted a removable die head 3, incorporating drawing die 4, die retaining block 5, and retaining pin 6. The die 4 is removably mounted to facilitate change or replacement of dies to take care of different sizes and shapes of material to be drawn. The die head 3 may be removed from the frame by engagement of a crane hook with an eye-bolt 7. The die head may be suitably shimmed for alignment about the axis of draw in one or more planes, or a tilting die head, adjustable about either vertical or horizontal axes, can be employed if desired.

The work-piece, here a tube 8, is shown with its pointed end 9 inserted through die 4. As shown in the sectioned portion of Fig. 2, the drawing operation has not started, and, therefore, mandrel rod 10 and bulb 11 are not shown in full registry with die 4. A second mandrel rod 12 and bulb 13 are located above and behind mandrel rod 10 and bulb 11. Said second mandrel rod and bulb are shown in a fully retracted position, adapted to receive an undrawn work-piece. Bulbs 11 and 13 are secured to mandrel rods 10 and 12, respectively, by suitable threaded nuts 14, preferably tapered outwardly to facilitate passing of tubular and hollow-shaped stock thereover.

Means not necessarily forming part of this invention may be provided for placing a work-piece on the mandrel when it is in the position of mandrel 12. Means may be provided for rotating the mandrel rods to bring the mandrel rod and work-piece from the position of mandrel rod 12 to the lateral position of mandrel rod 10; and means may be provided for advancing a mandrel rod and its work-piece to the die to occupy the position of mandrel rod 10, bulb 11, and tubular work-piece 8, as shown.

Means are provided for protecting and supporting a work-piece passed over a mandrel rod and bulb. These means preferably take the form of tubular shells 16 supported at convenient intervals along their length by mandrel supports 24 (one of which is shown to best advantage in Fig. 2) comprising bases 25 attached to foundation 2. Adjacent die head 3 suitable bell-mouthed guide bushings 18 are mounted within end portions of shells 16 to facilitate the entry of a hollow shape over a mandrel rod and within the protective and supporting shell. Locking bands 20, adapted to compress tubular shells 16 on bushings 18, may be readily loosened for interchange of bushings of various size depending on the size of tube to be drawn. With respect to the mandrel rod, bulb, and hollow-shaped work-piece, each guide bushing is arranged to partially support the work-piece at a point adjacent the die head when the bulb is forced into registry with the die by means of the mandrel rod. Additional guide bushings 22 are located at suitable intervals within the shells 16 and provide further points of support for the work-piece. Tubular shells 16 are designed to protect the work against scratching and dirt and, with bushings 18 and 22, to support work of considerable length. Where protection of the work from dirt is not a primary problem, the shells 16 may take the form of spaced sections or rings rather than continuous lengths of tubing as shown.

Drawing section

Referring to Figs. 1, 2, 3, 4, and 7, the drawing section of the draw bench is now described. This section of the bench is defined as that portion of the bench, including the associated apparatus, over which the stock is pulled or drawn from the die 4. The drawing section comprises generally frame 1, draw head 30, and tracks or rails 31 along which the carriage may move on carriage wheels 32. Gripping jaws 33 and 34 are located in draw head 30 and are adapted to engage the pointed end 9 of the tubular work-piece 8. Carriage hook 35 is adapted to engage endless draw chain 36. A pair of suitable return chains or other endless driving means 37 and 38 are connected to carriage 30 on either side thereof and adapted to return the carriage to die head 3 upon completion of a drawing operation.

Means are provided upon carriage 30, here in the form of trip arm 39, for actuating a plurality of limit switches 40, 41, 42, 43, 44, and 45, which are located along the main frame 1, as shown. These limit switches are arranged to control acceleration and deceleration of drawing carriage 30 during its forward drawing and return movements, and further to control various other operations to be hereinafter described.

Draw chain 36 is centrally located within frame 1 and is supported over drive sprocket 46

and idler sprocket 47. Drive sprocket 46 is preferably driven by either one or both of two motors (preferably hydraulic, but not shown) connected to a drive coupling 48 at the extreme forward end of the bench (to the right as viewed in Figs. 1 and 2), which drive coupling 48 is connected to the draw chain drive sprocket 46 through a drive shaft 49 held in frame 1 by bearings 50 and 51. The draw chain may be lubricated by continuous immersion in a suitable oil reservoir located in the path of the under portion of the chain, but not here shown. The idler sprocket 47 is located adjacent the die end of frame 1 and is mounted on an idle shaft 52 journalled in adjustable bearings 53. These bearings may be moved longitudinally of the draw bench by means of nuts 54 on screw threaded rods 55, for adjustment of the draw chain tension or for removal of the draw chain.

The draw chain 36 has preferably a short pitch, that is, the links are made as short as possible so that variation in linear velocity of the chain will be kept at a minimum; and the drive motors for the drawing chain preferably have rigid speed control so as to produce as nearly constant drawing velocities as are feasible. By means of this preferred form of apparatus, the drawing speed may be varied from practically a stop up to normal speed, under no load up to heavy drawing load, with rapid and even acceleration, initiated by electrical control operable through limit switch 43.

Return chains 37 and 38 are fixed to carriage 30, through tie plates 56, and are supported and located on either side of frame 1, being engaged by drive sprockets 57 adjacent the die end of said frame and by idle sprockets 58 at the opposite end of said frame. Drive sprockets 57 are mounted on a common drive shaft 59, which carries belt pulley or sprocket 60, and is journalled in suitable bearings 61. The drive shaft and sprockets are driven by electric motor 62 through drive belt or endless chain 63 and belt pulley or sprocket 60. The return chain idle sprockets 58 are located on common idle shaft 64 journalled in adjustable bearings 65. Means for adjusting the tension of return chains and for permitting their ready removal are here provided in the form of threaded rods 66 and adjusting nuts 67 provided thereon. Return chains 37 and 38 are recessed in chain guards 68 for protection of both chains and operator. Suitable means may be provided for lubricating such chains where desirable.

The electric motor 62 operating said return chains is preferably adapted to be used as an electric brake upon the draw carriage 30 as it approaches the die head 3. In this way the movement of the carriage on its return to the die head is positively controlled, thus eliminating the necessity for employing previously used shock absorbers or cushioning devices to stop the carriage at the die head. The two return chains 37, 38 are preferably provided to insure alignment of the drawing carriage with the die head upon its approach thereto, but a single chain or cable may be used with satisfactory results. The acceleration and deceleration of the drawing carriage 30 on its return travel may be accurately controlled through one or more of the aforementioned limit switches, as here shown by switches 40, 41, and 42, which switches are actuated by the drawing carriage trip arm 39.

Other elements of the drawing section of the draw bench which should be noted at this point

in the description are the two chain releasing cams 69 and 70. As aforementioned, the carriage 30 is positively connected to the draw chain 36 by a hook 35 carried by the carriage. Fixed upon the shaft which supports hook 35 is a hook release lever 71 (Figs. 1 and 7), which is mounted in a substantially horizontal position and extends forward of the drawing carriage on one side thereof. On the extremity of release lever 71 is a cam follower in the form of a roller 72, adapted to engage and ride up the contour of cam 69 (Fig. 2) located adjacent the die head of the drawing section of the draw bench, or of stop cam 70 located at the other extremity of the draw bench. At either cam the action of release lever 71 and its roller 72 is to lift hook 35 out of engagement with drawing chain 36, thereby bringing carriage 30 to rest.

Cam 69 is provided for the purpose of releasing the carriage hook from the draw chain when the carriage jaws have failed to engage the work-piece or in case of breakage of the work-piece during forward travel of carriage 30. In either event, there is no drawing tension on the chain. If the carriage 30 has engaged work-piece 8 through the proper clamping engagement of jaws 33 and 34 upon the work, the drawing tension exerted on draw chain 36 will lift the chain and the engaging carriage hook 35 sufficiently high to permit hook release lever 71 and roller 72 to clear the cam 69. Thus the normal drawing operation will continue until the work-piece is free of drawing die 4. At this point, drawing tension is immediately released and the draw chain tends to fall and disengage itself from the hook 35. Cam 70 functions as a safety device and hook adjusting mechanism in the event that hook 35 does not, at the end of the drawing operation and when drawing tension is released, release itself from the chain but falls therewith. In such case, the release lever 71 and its cam follower 72 contact cam 70, with the result that the hook 35 is positively raised and disengaged from the chain 36, and reset in its raised position, thus preventing the continuously traveling chain 36 from dragging the draw head 30 off the end of the bench, or preventing other injury to the assembly.

Draw head

With reference especially to Figs. 3 through 7, the draw head or carriage 30 will now be particularly described. In the carriage are the aforementioned slidable work-engaging jaws 33 and 34 having suitable gripping inserts therein, as seen in Figs. 5 and 7, and which are adapted to grip the work-piece at the die head 3. These jaws are so arranged that one jaw may advance or adjust itself relative to the other, and relative to the work-piece to grip the pointed end 9 thereof and exert an axial drawing force thereon despite any irregular formation or non-axial alignment of said work-piece end. Further it may be noted that the jaws are actuated through a linkage, which will be described hereinafter, by means of the forces exerted by the draw chain 36 on the chain engaging hook 35.

For purposes of clarity in describing the jaw-actuating mechanism and linkage, the carriage 30 and its associated elements have been illustrated in detail to an enlarged scale in Figs. 3, 5, and 6, these views of the carriage having been taken on the same side of the assembled machine as that illustrated in Fig. 2. Figs. 4 and 7 are

supplementary to Figs. 3, 5, and 6 and should be considered therewith.

The carriage or draw head 30 is provided with a transverse shaft 75 journalled in the frame thereof. Centrally on said shaft is keyed the clevised end (see Fig. 7) of carriage hook 35. This hook has a link-engaging portion 76 which is arcuate in form (see Fig. 2) to conform with a link of the draw chain, the said arcuate portion being preferably adapted to engage somewhat more than 90° of arc on any particular link. Also keyed to shaft 75, at one end thereof, and located outside the frame of carriage 30, is the hook release lever 71 and its cam contacting roller 72. The keyed angular relationship of hook 35 and hook release lever 71 on through shaft 75 is such that when lever 71 is in its lower position, its roller 72 would engage cam 69 or stop cam 70, on approach thereto, and rise thereon, thereby raising hook 35.

Also keyed to shaft 75 between forked portions of the clevised end of hook 35 is a crank lever 77 extending in a generally vertical direction above top plate 78 of carriage 30, said hook 35 and crank lever 77 substantially forming a bell crank oscillatable with said shaft 75, in accordance with the forces imparted to the hook by means of the draw chain 36, or to the hook release lever 71 by means of the cams 69 or 70.

Disposed laterally and approximately centrally of carriage 30, above top plate 78, is pin 79 supported and retained in bearing blocks 80, 81. Oscillatable on pin 79 is a centrally disposed crank 82 which extends upwardly therefrom in a generally vertical direction. Adjustable link 83 connects the upper extremities of crank 82 to crank lever 77, whereby crank lever 77, adjustable link 83, and crank arm 82 form, with the frame of the carriage, a quadric-crank linkage.

Preferably integrally formed with the lower portion of crank 82 is a projection forming a latch 84 adapted to be engaged by pawl 85, whereby the quadric-crank linkage actuated by hook 35 or release lever 71 may be latched with the hook in its raised position in a manner which will be more fully described hereinafter.

Also oscillatably mounted on pin 79, on either side of crank 82, are jaw-actuating levers 86 and 87, which levers have portions extending in a generally vertical direction above pin 79 in normally parallel relationship with crank arm 82, and jaw-actuating portions extending below pin 79 to act as lever arms. Jaw-actuating levers 86 and 87 are independently oscillatable on pin 79 and are inter-related in their action by a double-acting spring 88 and associated parts. At the lower extremities of said jaw-actuating levers are adjustable links 89 and 90 connecting to work-engaging jaws 33 and 34, respectively. Said jaws are slidable on converging ways 91 (see Fig. 7). The latterly described portion of the actuating linkage for each jaw may be referred to as a slider-crank linkage, said linkage comprising a jaw-actuating lever, an adjustable link, and a jaw slidable on a converging way.

To provide for convergence of the jaws, and for the angular movement of adjustable links 89, 90 with respect to levers 86, 87 and the jaws 33, 34, suitable ball-and-socket connections 92 have been provided between each of said levers and each of said adjustable links and between each of said links and each of said jaws.

Approximately central of the length of the crank 82 on either side, and in the directions of oscillation thereof, are recessed, concave bearing portions or seats 93, substantially semi-cylindrical in form. On the upper extremities of jaw-actuating levers 86, 87 on either side, and in the directions of oscillation thereof, are similar recessed, concave bearing portions 94, substantially semi-cylindrical in form and adapted to lateral alignment with the corresponding bearing portions 93 on crank 82. Crank 82, at the level of recessed bearing portions 93, has an aperture 95 extending therethrough in a direction substantially tangential to the arc of rotation thereof. Extending through aperture 95, in approximately the same plane as contains the quadric-crank linkage and normally perpendicular to crank 82, is adjustable tie-bolt 96 threaded at either end, to receive adjusting nuts 97. Mounted preferably on the forward end of the tie-bolt 96, in the direction of draw, is bearing member 98 engaging crank 82 and jaw-actuating levers 86, 87 in the aforedescribed bearing portions 93 and 94, respectively. The said bearing member 98, which is axially slidable on tie-bolt 96 and positionable thereon by means of nuts 97, extends laterally across crank 82 and across the jaw-actuating levers 86, 87, and is adapted to engage with either of said jaw-actuating levers or said crank independently, or at times with all of them simultaneously. For engaging the opposite bearing portion of crank 82, or the opposite bearing portions in jaw-actuating levers 86, 87, is a second bearing member 99 similarly mounted on said tie-bolt 96. The two bearing members 98 and 99 are provided with semi-cylindrical or convex bearing surfaces adapted to engage in the aforesaid semi-cylindrical or concave bearing recesses of the crank and the levers.

The bearing member 99, slidable on tie-bolt 96, serves further as a spring seat for double-acting spring 88, which spring is mounted surrounding the said tie-bolt 96 on that portion of the tie-bolt which extends, to the left as viewed in Figs. 3, 5, and 6, toward the jaw portion of the draw head 30. An opposing spring seat 100 is located at the end of tie-bolt 96 and is slidable thereon, being adjustable for position by means of adjusting nuts 97.

Levers 86, 87 and crank 82 are cooperatively related by means of the aforementioned double-acting spring, tie-bolt, spring seats, and bearing members. The two-fold purpose of the spring and associated elements is, briefly, (1) to tend to keep levers and crank in the same axial line so that they may function substantially as one split lever oscillatable on the pin 79, and yet permit the levers to advance or retract relative to each other in response to movement of the crank, and in response to the relative positions assumed by the work-engaging jaws as they positively and separately engage the work; and (2) to store jaw-opening energy by compression in the spring whereby the spring may effectuate movement of the levers to assist in the opening of the jaws, as will hereinafter be specifically explained. Adjustabilities afforded in the various links, and the yieldability of the spring permit ready accommodation of the apparatus to work of varying size and shape.

For engaging the aforementioned latch 84, the pawl 85 is pivotally mounted on pin 101, fitted in suitable bearings 102 located in the base of carriage or draw head 30. A spring 103 connects pawl 85 and an anchoring pin 104, and tends to hold the pawl against either latch 84 (Fig. 3), or the base of crank 82 under the said latch (Figs. 5 and 6). For moving said pawl from its latched

position under latch 84, a longitudinally-extending trip rod 105 is mounted in bearings 106 on top plate 78 of carriage 30. The said trip rod is adjustable for length, as indicated in the drawing, and is so mounted upon the carriage as to contact die head 3 as the carriage approaches said die head. Upon contacting die head 3, trip rod 105 moves against pawl 85, thereby unlatching crank 82 and allowing movement of the said quadric-crank linkage to take place.

The operation of the carriage will now be set forth. Upon movement of carriage 30 to die head 3, trip rod 105 contacts the die head, thus forcing pawl 85 from under latch 84 (Fig. 6) so that hook 35 falls of its own weight in a clockwise direction to move the quadric-crank linkage to the position shown in Fig. 3. Movement of hook 35 to the position of Fig. 3, at which position it engages draw chain 36, closes jaws 33 and 34 upon the work by actuating the above-described slider-crank linkages associated therewith. Because of bearing members 98, 99 and spring 88, levers 86, 87 are caused to follow the movement of crank 82, unless one or the other of the levers meets with other than frictional resistance. Upon the engagement of one or the other of the jaws with the work, further movement of the lever associated therewith is impeded, but the other jaw may move separately a further distance until it likewise engages the work. Thus, when both of the jaws have engaged the work, levers 86, 87 may be slightly displaced with respect to each other, in which case spring 88 and tie-bolt 96 will have assumed a lateral position required by the alignment of the bearing members 98, 99 with respect to levers 86, 87 and crank 82. The action of spring 88 between seat 100 and bearing member seat 99 tends to equalize the work-engaging forces on the jaws 33 and 34. Depending upon the relative adjustment of the lengths of links 83 and 89, 90, greater or less amounts of compression may be built up in spring 88; further the spring 88 will also permit over travel of crank 82 with respect to levers 86 and 87, depending upon the relative length adjustment of said links. Adjusting nuts 97 may be moved to predetermine the maximum length of spring 88, i. e. to load the same as desired.

At the start of a drawing operation the drawing force of chain 36 on hook 35 lifts both chain and hook so that they assume a substantially straight line position from the axis of carriage shaft 75 toward the tangent point on the chain drive sprocket 46. The lifting force on said hook causes it thus to move to a substantially horizontal position, thus causing a movement of the quadric-crank linkage from the position illustrated in Fig. 3 to the position illustrated in Fig. 5. In this latter position, crank 82 has been moved away from the levers 86 and 87, thus placing the spring 88 in compression following the separation of bearing members 98 and 99. The levers 86, 87 are not moved by this action since the jaws 33 and 34 are retained in contact with the work by the drawing tension. As crank 82 assumes the position shown in Fig. 5, spring 103 pulls pawl 85 under latch 84, thereby locking the hook in its upward drawing position.

The position assumed by the carriage elements in Fig. 5 will be maintained throughout the drawing operation until the work is completely drawn. The freeing of the work from die 4 releases the tension between the work and the jaws so that the jaws are no longer maintained in their closed position by the work tension, and are opened partly by the action of spring 88, as it tends to re-align levers 86, 87 with crank 82 by forcing bearings 98, 99 toward each other, and partly by the sudden release of the drawing tension through disengagement of hook 35 from chain 36.

Consequent upon the release of drawing tension by the passage of the work completely through die 4 is the release of tension upon the draw chain 36 which causes the chain to slacken, tend to fall to its idle position, and thus free itself from the link engaging portion 76 of the hook 35. As the hook 35 thus disengages from the chain, carriage 30 comes to a stop. Thereafter, the work being removed, the carriage returns to the die head, its elements being positioned with respect to each other as shown in Fig. 6.

Mandrel section

The preferred means of presenting work-pieces to die 4 will not be enlarged upon since they are fully set forth in our original application, Serial No. 288,163, above-mentioned.

Along the mandrel section of the bench, which is that portion of the bench located on the stock feeding side of the die head 3, are a plurality of mandrel-supporting members 24.

The mandrels are preferably mounted parallel with, and oscillatable or rotatable about, an axis located centrally therebetween so that their peripheries have a locus describing a cylinder. It is obvious, however, that they may be mounted at an angle to each other so that their peripheries will have a locus describing a frustum of a cone. This, or other, alternate construction preferably would be such that when a mandrel is presented to a die, it would assume a position in axial alignment with the axis of draw. Alternate alignment of the respective mandrels with the die has been provided for so that a tubular shape may be drawn while registered with the die by one mandrel rod and bulb, while a new work-piece may be threaded over the second mandrel rod and bulb, in order to speed up the production of the draw bench. The mandrel-supporting members 24 are provided to support the tubular shells 16 and indirectly the mandrels, throughout their length, and for constraining the path of rotation thereof.

Each mandrel-supporting member 24 comprises essentially a frame base structure 25, on which are suitably journalled two supporting rollers 110 adapted to support a disc-like block 111, adapted to be rotated with its track portion 112 bearing on said rollers. Tubular shells 16 are mounted through apertures in block 111.

Operation

Assuming a tube on a mandrel rod in the loading position, the carriage 30 on the tracks 31 at some distance from the die head 3, and the draw chain moving, such as would be the case following completion of a previous drawing operation, a cycle of operations may be instituted by the closing of a control switch (not shown) adapted to initially energize the return chain operating motor 62.

Upon energization of the carriage return motor 62 movement of the carriage 30 toward the die head 3 will begin. The limit switch dog 39 on carriage 30 will first strike the limit switch 45 which, because of the previous closing of limit switch 44, will cause means not shown to index the mandrels to present a tube opposite the die.

At a position along the main frame of the draw bench nearer the die head 3, the limit switch dog 39 on the carriage 30 engages and operates limit switch 40. Upon the movement of limit switch 40, the field control of the return drive motor 62 is, in the operation here described, modified to bring the return speed of the carriage to a substantially constant base value.

At a position along the main frame of the draw bench still nearer the die head, the said limit switch dog 39 engages and operates limit switch 44. Upon the movement of limit switch 44, means not shown are adapted to push the mandrel into the die. At this position the pointed end 9 of the tube extends through die 4 for engagement by the jaws 33 and 34 of the drawing carriage 30.

Upon further approach of the carriage 30 to the die head the limit switch dog 39 strikes and actuates successive limit switches 41, 43, and 42, which in that order respectively decrease the speed of the return drive motor 62 by armature shunt control, decrease the speed of the draw chain 36 to a pre-set initial drawing speed, and stop the motion of the drawing carriage as it approaches the die head by applying dynamic braking through the drive motor 62.

As carriage 30 comes to rest at die head 3, trip rod 105 contacts the die head and releases pawl 85 from under latch 84, whereupon hook 35 falls into and engages its arcuate portion 76 with a link of chain 36. The falling motion of the hook 35 imparts a closing movement to the jaws 33, 34 as described above, whereupon the jaws engage and grip the pointed end 9 of a properly positioned tube 8.

The draw chain 36 may be moving at a slow speed or stopped as controlled by the limit switch 43. If stopped the draw chain would then be started by a manually actuated switch or other device (not shown). Assuming that it is moving at a slow speed as here provided, immediately upon the engagement of the hook 35 with the draw chain, the carriage 30 begins its travel away from the die head and the drawing of the tube begins. Drawing tension through the chain, hook, carriage, jaws, tube, mandrel rod bulb, and mandrel rod raises the hook 35 to its normal position, where crank 82 is latched by pawl 85, clamps the jaws 33 and 34 upon the pointed end 9 of the tube 8, and brings the mandrel rod bulb 11 into final registry with the die 4.

Before continuing with the description of the operation, it may be pointed out that if the jaws should fail to engage the end of the tube there will be no tension on the chain 36 and the hook 35 will not be substantially raised. Rather than permit the carriage 30 to travel out the full length of the frame, means for stopping the carriage and returning it again to the die head are provided. The roller follower 72 of hook release lever 71 will strike the cam 69, which will raise the hook release lever and will release the hook from the chain, whereupon the carriage 30 may have a short return travel back to the die head to reengage tube 8.

Assuming, however, that the jaws have engaged the end of the tube upon the falling of hook 35 into the draw chain, the motion of the carriage outward under drawing tension will continue as first described. The hook will be raised and latched by the tension on the chain, but the jaws will remain closed under the force exerted by the work tending to draw them into tighter engagement therewith despite the fact that compression

of spring 88 aforedescribed will also tend to open the same.

The limit switch dog 39 on the carriage 30 will first actuate and engage limit switch 42, resetting the same and electrically disconnecting from circuit the return drive motor 62 so that the return chains 37 and 38, fixedly connected to the carriage, may cause reverse rotation of the drive motor 62 against no electromagnetic forces.

The limit switch dog 39 will next reset the limit switch 43 and cause acceleration of the drive chain 36 from its initial slow speed to normal drawing speed.

The next limit switch 41 will be merely reset without effect upon the cycle of operations.

Likewise the next limit switch 44 will be reset, to its first position, causing means not shown to become operative for tending to withdraw a mandrel rod, e. g. 10, and bulb, e. g. 11, from registry with die 4. This tendency, however, will remain ineffective while there is drawing tension on a tube 8, but will be adapted to withdraw the mandrel rod and bulb upon completion of the drawing operation.

The next limit switch 40 will be merely reset without effect upon the cycle of operation.

The final limit switch 45 will be reset to an ineffective position without affecting the cycle of operations, whereupon the electric and pneumatic control system will be then in condition for operation as described at the beginning of this drawing cycle.

After passing these limit switches, preferably located within a distance from the die head corresponding to the minimum length of tube to be handled, the carriage 30 will continue to be drawn out along tracks 31 on main frame 1 by draw chain 36 until tube 8 is drawn completely through die 4. When tube 8 makes its exit from die 4, there will be an immediate release of drawing tension throughout the draw bench; and the recoiling effect of the tube 8 in connection with the stored energy in the spring 88 will immediately open the jaws 33 and 34 of carriage 30, whereupon the tube 8 will be released and allowed to fall onto any suitable unloading devices arranged therebeneath (not shown). At the same time the release of tension in the draw chain 36 will permit the chain to fall from engagement with the hook 35 and the carriage will come to rest. Also the pressure of air against the piston in the manipulating mechanism will then be effective to move the mandrel rod and bulb out of registry with die 4 and to retract the same into and within its protective tubular shell 16.

It will also be apparent from the foregoing description that this apparatus is adapted to the drawing of rods and bars not necessitating the use of mandrel rods and bulbs, upon the provision of a push rod in place of each mandrel rod, which push rod would be adapted to advance the work into registry with the die. Also, in a similar modification a fixed mandrel could be employed for drawing substantially hollow shapes.

It should be understood that many of the auxiliary devices with which this draw bench has been described are not essential to its useful operation, and that many other combinations and relations of the parts and associated devices may be employed without departing from the nature and scope of this invention as defined in the appended claims.

What is claimed is:

1. In a draw head for operation in a mecha-

nism of the class described, a mechanism for actuating a work gripping jaw comprising a shaft, a crank freely oscillatable on said shaft, a lever freely oscillatable on said shaft and having an end operatively connected to a movable work gripping jaw, and resilient means associated with said lever and said crank for resisting relative rotation therebetween in either direction and adapted to correlate their oscillation on said shaft, said resilient means including members adapted to engage said lever and said crank, whereby relative angular disposition of the crank and lever is adapted to strain said resilient means.

2. In a work-engaging drawing carriage, a pair of work-engaging jaw members, a mechanism adapted to actuate said jaw members comprising an oscillatable crank adapted to form a crank link of a quadric-crank mechanism, two oscillatable levers normally parallel with said crank located on either side thereof, said levers adapted to operate as cranks for a pair of slider-crank mechanisms in which said work-engaging jaws form slider elements, each of said levers and said crank having portions on either face thereof substantially equally spaced radially from a common axis of rotation configurated to receive seating members, a pair of seating members themselves configurated to conform to said configurated bearing portions, and an adjustable spring unit for correlating said levers and crank comprising the said two seating members abutting either face of said levers and crank, each of said seating members being adapted to seat on at least one of said levers or on said crank at all times, an adjustable tie-rod connecting said seating members, and a spring member interposed between one of said seating members and an end of said tie-rod external to said levers and crank, whereby said levers may be angularly disposed with respect to said crank in either direction while straining said spring and whereby said levers may be slightly angularly disposed with respect to each other to permit relative adjustment of the work-engaging jaws with a work-piece.

3. In a mechanism of the character described, a drawing carriage having two work-engaging jaws, each of said work-engaging jaws having connected thereto a jaw-actuating linkage, each jaw-actuating linkage and connected jaw being adapted to operate as a slider-crank linkage, a single quadric-crank jaw-actuating mechanism adapted to operate each of said slider-crank linkages, a crank of said quadric-crank mechanism and cranks of said slider-crank linkages being oscillatable about a common axis, said cranks being related by means of seating members engaging opposite sides thereof and a tie-bolt carrying an adjustable spring, and means for latching said quadric-crank mechanism in a desired position.

4. In a draw head for operation in a mechanism of the class described, attaching means for positively engaging said head with a drawing member, sliding jaw members adapted to engage the work to be drawn, an operating lever for each of said jaw members, linkage means actuated by said attaching means for operating said levers,

and a single spring means inter-connecting said linkage means and said levers, said linkage means, spring means and levers being adapted, on movement of said attaching means, to simultaneously move all of said jaw members toward the work, and said linkage and spring means being adapted to thereafter independently move any said lever and its jaw member after any other said jaw member has positively engaged the work.

5. In a draw head for operation in a mechanism of the class described, a mechanism for actuating the work gripping jaws comprising a shaft, a crank oscillatable on said shaft, levers oscillatable on said shaft, each having an end connected to a movable work gripping jaw, and resilient means associated with said levers and said crank for resisting relative rotation therebetween in either direction and adapted to correlate their oscillation on said shaft, said resilient means including members adapted to engage said levers and said crank, whereby relative angular disposition of the crank and levers is adapted to strain said resilient means.

6. In a work-engaging drawing carriage, a plurality of work-engaging jaw members, a mechanism adapted to actuate said jaw members comprising an oscillatable crank, a plurality of oscillatable levers normally aligned with said crank and adapted to operate said work-engaging jaws, each of said levers and said crank having portions on opposite faces thereof configurated to receive seating members, a plurality of seating members, an adjustable spring unit comprising the said seating members for pressing opposed seating members toward each other, whereby the levers may be angularly disposed with respect to the crank while straining the spring unit, and whereby the levers may be slightly angularly disposed with respect to each other to permit relative adjustment of the work-engaging jaws.

7. In a mechanism of the character described, a drawing carriage having two work-engaging jaws, each of said work-engaging jaws having connected thereto a jaw-actuating linkage forming with the same a slider-crank linkage, means for attaching said carriage to a drawing member, said attaching means having connected thereto a linkage forming a quadric-crank, jaw-actuating mechanism adapted to operate each of said slider-crank linkages, a crank of said quadric-crank mechanism and cranks of said slider-crank linkages being inter-related by spring means adapted to resist relative angular disposition of one of said cranks from another.

8. In a mechanism of the character described, a drawing carriage having two work-engaging jaws, each of said work-engaging jaws having connected thereto a jaw-actuating linkage forming with the same a slider-crank linkage, and a single quadric-crank mechanism adapted to operate each of said slider-crank linkages, a crank of said quadric-crank mechanism and cranks of said slider-crank linkages being oscillatable about the common axis, said cranks being related by means of seating members engaging opposite sides thereof, and a tie bolt carrying an adjustable spring.

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